

MARKET VALUE OF WATER SUPPLY AND SEWAGE NETWORKS – DETERMINANTS, ATTRIBUTES AND VALUATION METHODS

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Purpose: The uniqueness of water supply and sewage networks as assets, combined with the specific characteristics of their market, generates a number of challenges in their valuation. The purpose of the conducted research is to identify and assess the attributes of water supply and sewage networks that affect their market value.

Design/methodology/approach: The primary research method applied in this study was the case study and comparative analysis. Data were collected through document analysis and conducted interviews with representatives of selected enterprises and local government units from the Pomeranian Voivodeship in Poland.

Findings: As a result of the conducted research, a set of market attributes influencing the market value of water supply and sewage networks was identified, and their percentage impact on value was determined.

Research limitations/implications: Both Polish and international literature lack studies on the valuation of water supply and sewage networks. In particular, there is a noticeable gap in the methodology for calculating their market value.

Practical implications: The identified market attributes affecting the market value of water supply and sewage networks, along with the determined percentage impact of these attributes on value, can be used by property appraisers and valuation experts to determine the value of this specific type of asset.

Social implications: The acquisition of water supply and sewage networks from private investors, particularly households constructing such networks for their own needs, is a complex and socially challenging process. The research findings presented in this article may be applied to determine fair compensation based on the market value of water supply and sewage networks.

Originality/value: The research results address a topic that has been undertaken extremely rarely, and the specific outcomes in the form of market attributes and their calculated weights based on national market data have, to the authors' knowledge, been published in a scientific journal for the first time.

Keywords: water supply networks, sewage networks, valuation, market value, market attributes.

Category of the paper: Research paper; case study.

1. Introduction

A number of tasks in the field of water management in many countries, including Poland, are carried out by local government units. The responsibilities related to the management of water supply and sewage networks as well as water distribution are performed either directly by municipalities or delegated to municipal companies. Different solutions may apply with regard to the division of responsibilities. Most often, a company is entrusted with both the assets (including networks) and the distribution (sale) of water as well as sewage collection. However, in some cases these responsibilities are separated, whereby one company is assigned the assets (the enterprise managing the network), while another entity is responsible for water distribution and sewage collection (for example, the city of Gdańsk between 1992 and 2023) (Czaplak, 2024).

A company performing a public utility function faces a dual nature. On the one hand, it has an unusual owner in the form of a municipality (a local government unit which, by nature, should operate on a non-profit basis), while on the other hand it remains a business entity that must function in the market, with its management required to make economically rational decisions aimed at generating profit.

Regardless of whether water supply and sewage networks are managed directly by a municipality or indirectly through a designated company, decisions concerning assets sometimes involve the acquisition or disposal of networks. This raises the problem of determining the value (and subsequently the price) of such a specific asset as water supply and sewage networks. Information about the value and in particular the market value, of such assets may be required, for example, for the purchase of a water supply or sewage network from a private investor¹, the contribution of assets in kind to a company, or the resolution of court disputes.

Both Polish and international literature lack studies on the valuation of water supply and sewage networks. In particular, there is a methodological gap in the calculation of their market value.

The purpose of the research was to identify and assess the attributes of water supply and sewage networks that influence their market value.

The first part of the article presents the specific characteristics of water supply and sewage networks as valuation objects and discusses the theoretical essence of market value. The following section provides a review of the scientific literature concerning valuation methods for water supply and sewage networks.

¹ Private investors sometimes construct water supply and sewage networks as so-called accompanying investments, necessary for the proper functioning of, for example, a residential housing estate. Such private investors are often households building residential houses to meet their own needs.

The research section of the article presents findings that provide a basis for applying comparative methods² to determine the market value of water supply and sewage networks. The main part of the study was conducted in 2025 and covered selected municipalities in the Pomeranian Voivodeship in Poland. The primary research methods applied in this study were the case study and comparative analysis. Data were collected through document analysis and interviews conducted with representatives of selected enterprises and local government units.

2. The Specific Characteristics of Water Supply and Sewage Networks as Objects of Valuation

The article analyzes the issue of transactions involving assets in the form of water supply and sewage networks. The discussion focuses in particular on networks constructed by private investors, with the understanding that such projects are usually undertaken as an accompanying element of other investment ventures. Developers build these networks to provide water supply and sewage disposal for new residential estates or commercial facilities, while private individuals do so in connection with the construction or modernization of a single-family house. Consequently, the construction of networks forms part of a broader investment project.

The profitability of such ventures is evaluated by investors in the context of the entire construction project, rather than solely from the perspective of the network construction costs. It should be noted that private investors may accept a selling price lower than the expenditures incurred, since they obtain additional benefits from connecting their property to the municipal system, including an increase in its value. In the case of infrastructure developed by municipalities, various fees may be charged to distribute the construction costs of the network among the property owners who benefit from it (in Poland these are referred to as infrastructure improvement fees). However, when a private investor independently finances the construction and transfers the network to a utility company, such fees do not apply.

From the perspective of the entity acquiring the network, the key factor is an analysis of the transaction's profitability. The purchase price should correlate with the revenue-generating potential of the given infrastructure. For example, a 5-kilometer network serving a single residential building will have a lower value than a network of the same length and capacity serving ten buildings. Another factor influencing value is the potential for future connections to the existing network, although this aspect is difficult to estimate both in terms of the number of connections and the timing of their implementation.

Water supply and sewage networks relatively rarely become the subject of market transactions. The literature points to two primary cases (Trojanowski, Kisiel, 2012):

² Comparative methods are applied in real estate valuation.

- the disposal of networks (most often internal ones) together with an organized property complex including land, buildings, and structures, which occurs, for example, in the sale of enterprises. In such transactions, the price of the network itself is rarely extracted, as the total value of the entire complex is usually reported;
- the transfer of ownership of the network to a municipality or a company managing the infrastructure.

In the first case, transactions usually concern internal networks used for distributing utilities within the area of a given property or enterprise. The present discussion, however, refers to so-called municipal networks, which are characterized by different functional and economic attributes. The most significant problem remains the incidental nature of such transactions, which makes it impossible to apply the comparative approach based on market prices.

The second of the described variants occurs when, in a given area, the only purchaser of the network is the utility company operating the infrastructure. In such cases, the financial terms depend on the company's policy and the outcome of negotiations between the parties. The absence of competition among buyers in a given area results in a monopolistic market. Competition, however, may be considered in terms of general policies supporting investment within a municipality and in building a competitive advantage over neighboring, rival municipalities.

3. The Concept of Market Value

One of the most important concepts in economic sciences is the category of "value". Although the term "value" occupies a central place in economic theory, it remains ambiguous, imprecise, and far from definitive resolution. In contemporary economics, it is commonly understood that not all goods possess value, but only those characterized by utility, scarcity, and accessibility (Kucharska-Stasiak, 2016). Moreover, it appears that modern economists are less interested in debating the definition of value itself, and more focused on formalized tools and methods of determining the prices of goods. This implies that the issue at hand is primarily one of valuation and the appraisal of goods rather than a theoretical discussion about the value of a commodity (Trojanowski, 2019).

Valuation is therefore a procedure through which value is determined. The value of a property, as the outcome of a valuation, may differ from the actual price of the property resulting from a concluded transaction. E. Kucharska-Stasiak considers value as a hypothesis of price (Kucharska-Stasiak, 2011). As D. Trojanowski notes, if value is a hypothesis, then the valuation process may be equated with research aimed at formulating such a hypothesis (Trojanowski, 2019).

Publications concerning real estate valuation indicate the existence of subjective and objective categories of value, assigning specific types of value to particular groups (Mączyńska, Prystupa, Rygiel, 2008). Subjective value is understood as the value determined with regard to the individual preferences of a party to a sales transaction. Objective value, on the other hand, is the value verified by the market through comparison with the prices of similar objects achieved on the market. The basis of valuation in this context is not the individual preferences of the buyer or the seller, but rather the opinion of the wider market expressed, for example, through the prices of comparable objects. The distinction between subjective and objective categories of value in fact suggests a particular procedure aimed at determining value. It therefore seems that subjectivity or objectivity should be applied rather to the process of valuation than to value itself (Trojanowski, 2019).

It is therefore essential to consider what is meant by objective valuation or the objectification of real estate valuation. This issue may be approached in two ways. First, the objectification of valuation may be understood as an attempt to detach from one's own judgments and beliefs and to adopt what is indicated by the market (understood as the majority view). Second, the appraiser may strive to confirm (or refute) their own hypotheses through evidence derived from the market, which would be consistent with perceiving value as a hypothesis of price. In both cases, the study should be based on independent and verifiable market evidence.

In valuation practice, value is generally not defined as a separate category, but rather differentiated into many types (Appraisal Institute, 2020). The most frequently applied type of value is market value. However, this concept does not have a uniform definition. Definitions of this category differ across national laws and professional standards despite ongoing attempts to standardize real estate valuation. In Poland, market value is most often defined in the context of real estate valuation. This article, however, concerns water supply and sewage networks, which are linked to real estate. For this reason, an analysis of the concept of market value specifically in relation to real estate appears to be justified.

In Poland, the most significant definition of market value is the one provided by the Real Estate Management Act (the statutory definition)³. According to legal regulations, the market value of a property is the estimated amount for which the property should exchange on the date of valuation, in a transaction concluded under market conditions between a buyer and a seller who are each willing to enter into the contract, act knowledgeably, prudently, and without compulsion.

The statutory definition of market value should always be applied unless a specific regulation introduces exceptions. The category of market value is also invoked in tax regulations and applies not only to real estate but also to other assets or services. This raises the

³ The Act of 21 August 1997 on Real Estate Management (Ustawa o gospodarce nieruchomościami, Journal of Laws 1997, No. 115, item 741, as amended).

issue of applying the appropriate definition, or more precisely, adopting the correct guidelines in a given valuation case. According to M. Prystupa, “the definition of market value contained in the Real Estate Management Act may be regarded as a general (universal) standard, while definitions included in other acts and regulations are special (particular) standards” (Prystupa, 2013). Such an approach to the issue appears to be rational.

In addition to statutory definitions, a number of definitions of market value are also included in professional standards such as the International Valuation Standards (IVS) (International Valuation Standards Council, 2024) and the European Valuation Standards (EVS) (TEGoVA, 2020). These definitions reveal both similarities and differences regarding the conditions under which an estimated amount may be considered a market value.

A common feature of the definitions is the indication that value represents the estimated amount that can be obtained for a property on the date of valuation. Market value is therefore determined as of a specific date, ensuring that the estimated value is appropriate for that particular point in time. As emphasized in the IVS, “because of the potential for changes in the market or market conditions, the reported value may be incorrect or inappropriate at another point in time”. Importantly, the IVS also “...assumes the simultaneous conclusion and execution of the contract without consideration of any price changes that could occur in the absence of such simultaneity”. The EVS, on the other hand, stresses that “the hypothetical sale takes place under a private (individually negotiated) contract and is therefore subject to negotiations”. This means that as of the valuation date, the terms of the contract must be negotiated and finalized, and the time necessary for this process must be taken into account in order for the estimated value to be recognized as market value.

As noted earlier, the concept of market value assumes a hypothetical buyer and seller, with market value identified as a hypothesis of the price that objectifies the market by reflecting the most typical behavior of its participants. The literature highlights the need to account for typical (most common) behavior characteristic of a “market investor”. K. Jajuga and P. Cegielski explain the notion of a market (average) investor. According to the authors, “a market investor should be understood as an average (typical) investor actively operating in the market for a given type of real estate, representing a kind of average outcome based on the investment decisions made by participants in that market” (Jajuga, Cegielski, 2003). As they further note, valuation should reflect the behavior of a “hypothetical” market investor who would represent those operating in the studied market. K. Jajuga and P. Cegielski also emphasize that when determining “the market value of a property, in reality we attempt to answer the question: what is the equilibrium price that both parties to the hypothetical transaction - the seller and the buyer - agree upon?” According to the authors, this means that investors include not only buyers but also sellers. The seller, in deciding to conclude a transaction, also considers a range of factors influencing value and usually possesses significantly greater knowledge about them than the buyer (Jajuga, Cegielski, 2003).

Despite the multiplicity of definitions of market value contained in legal regulations and professional standards, the fundamental interpretations and assumptions describing this category, which is so crucial to valuation, remain largely consistent.

4. Valuation Methods of Water Supply and Sewage Networks – A Literature Review

The process of price determination is commonly understood as the procedure through which the value of a given good or service is expressed in monetary units (usually). It is essential that pricing policy remains consistent with the objectives of a company's operations. Regardless of the method adopted, determining a price requires an analysis of data to support this process. Such data include information on:

- demand for a given good or service,
- competition,
- the costs incurred by the company,
- the price levels acceptable to buyers.

In setting prices, particular attention must be paid to the type of asset being transacted and to data on market prices. The literature provides guidance on methods of determining the prices and values of goods and services (Turčínková, 2021). Assets, as a specific category of goods, may be valued using the following approaches:

- pricing methods and techniques based on construction costs,
- pricing methods based on income that will be generated in the future,
- pricing methods based on the prices set by competitors.

Naturally, there is a difference between price and market value. Nevertheless, in management theory, when referring to pricing methods, in practice the issue at stake is value. The final price is the outcome of a transaction, while determining value represents an attempt to forecast it. Consequently, it is important to consider both the methods of price determination applied by companies and the methods of value determination used by valuation experts in relation to such specific assets as water supply and sewage networks.

The relationship between the prices achieved by goods and their production costs may vary, particularly with respect to complementary goods (water supply and sewage networks are complementary to buildings). In Poland, cost-based methods are applied in special cases to real estate valuation; however, their application results in determining the replacement value (reconstruction cost less depreciation) rather than market value. Furthermore, methods based solely on construction costs do not take into account the relationship between the cost of constructing a network and its income-generating potential (Mika, 2015).

The price or value of an asset based on its income-generating potential can be determined using available investment profitability methods. These methods may be divided into traditional (static) and discounting (dynamic) approaches. In general, traditional measures reduce the analysis to simple indicators that ignore the time factor. Discounting methods, in contrast, provide a clear and coherent framework for assessing the efficiency of investment projects, presenting them in terms of total costs and benefits, and highlighting the relationship or difference between these categories, which allows for an evaluation of the project's effectiveness. Costs and benefits spread over time are adjusted through discounting, which ensures analytical consistency by accounting for both time and risk (Wiśniewski, 2008).

Dynamic investment appraisal methods incorporate irregular cash inflows and outflows incurred by an investor in connection with an investment project. Discounting serves to translate expenditures and outcomes occurring at different points in time into a common point of analysis. The use of discounting methods enables the inclusion of the entire operating horizon of a project in profitability calculations, covering both the implementation and the exploitation phases. Among the discounting measures most commonly used to assess the effectiveness of real investments are net present value (NPV), the profitability index (PI), and the internal rate of return (IRR). Of these, NPV is of greatest importance. The literature describes the application of these methods to the evaluation of typical investment projects (Sierpińska, Jachna, 1998; Damodaran, 2012).

The NPV method is also applied to determining the value of assets, such as real estate. In real estate valuation, professional standards for property appraisers indicate that, depending on the stability of income, the following techniques are distinguished:

- direct capitalization, in which the value of the property is determined as the product of a stable annual income stream obtainable from the valued property and the capitalization rate, or as the ratio of the stable annual income stream to the capitalization rate,
- income stream discounting, in which the value of the property is determined as the sum of discounted income streams obtainable from the valued property in successive years of the adopted forecast period, increased by the discounted residual value of the property.

These techniques are widely described in the literature (Sierpińska, Jachna, 1998; Damodaran, 2012). The research conducted for the purposes of this article shows that local government units or enterprises responsible for managing networks increasingly apply various pricing methods for the acquisition of networks (Table 1). Among the identified methods, NPV and rent capitalization stand out. The application of the NPV method in valuing water supply and sewage networks has been described, for example, in the paper *Price Calculation of Water Supply and Sewage Networks for the Purpose of Purchase by Supply Companies – Net Present Value Method* (Trojanowski, Kisiel, 2012a). The valuation of water supply networks using methods such as NPV, however, encounters a fundamental problem highlighted, among others, by Grafton — namely, that in many countries, water supply charges

cover only a portion of production costs, which results in negative cash flows (Grafton, Manero, Chu, Wyrwoll, 2023).

Rent capitalization, in turn, is presented in *Price Calculation of Water Supply and Sewage Networks to be Purchased by Supply Companies – Rent Capitalisation Method* (Trojanowski, Kisiel, 2012b) and *The Method of Determining the Surrender Value of Water Supply and Sewage Systems* (Mika, 2015).

In both management practice and valuation theory, various comparative methods based on competitor prices are frequently applied. Generally speaking, these methods involve comparing the asset under valuation with other similar assets that have already been sold. Therefore, the application of comparative methods requires access to information on the prices of goods traded on the market and applied by competitors. Using comparative methods, the value of goods is determined on the basis of so-called market attributes, meaning those attributes that significantly affect the value of the asset (Appraisal Institute, 2020). For example, in the case of residential real estate, market attributes include location, neighborhood, house size, technical condition, and standard of the dwelling. In the literature, no studies have been identified concerning the valuation of water supply and sewage networks using comparative methods.

In summary, management theory provides insights into various methods of price determination applied by companies, while valuation theory focuses on methods of determining the value of assets, including market value. Among these methods, NPV and direct capitalization are of particular importance. Cost-based methods, as a rule, are not applied to determining market value. Comparative methods, on the other hand, require knowledge of the prices of comparable assets and the identification of market attributes (those attributes that affect asset value). Given the aim of the present research, this section indicates the ways in which market attributes can be identified, and in particular how their weights can be determined. Weight should be understood as the percentage impact of a given attribute on the asset's value. It appears that the greatest number of both practical and scientific publications in this field concerns the market attributes of real estate and their weights used in valuation. Publications emphasize that the identification of real estate market attributes should be based on market analysis. In practice, this involves analyzing real estate transaction prices as well as property sale listings, in which sellers highlight the attributes that are significant for value. In terms of determining the weights of market attributes, experts consider the condition of the analyzed market and most often rely on (Polish Federation of Property Appraisers' Associations, 2008):

- results of analyses of data on prices and market attributes of comparable properties traded on the real estate market defined for valuation purposes,
- analogy to similar local markets in terms of type and area,
- surveys and/or observations of potential buyers' preferences.

In the analysis of price data, various statistical methods are applied, as well as the paired-sales analysis method. The paired-sales analysis method, described by M. Prystupa (Prystupa, 2023), involves identifying pairs of properties in a dataset of transaction prices that differ only

in one market attribute. The principle of *ceteris paribus* (all other factors held constant) is applied in this method. The price difference between such identified properties is then related to the so-called price delta, i.e. the difference between the maximum and minimum prices observed on the market. The entire analysis must be conducted within the market of goods of the same type, taking into account the impact of time on price changes.

In this article, the paired-sales analysis method was applied to calculate the weights of market attributes influencing the value of water supply and sewage networks.

5. Market Attributes Influencing the Value of Water Supply and Sewage Networks – Case Studies

This section of the article presents the results of research on the identification of market attributes influencing the value of water supply and sewage networks. The study covered selected local government units (LGUs) and enterprises providing water supply and sewage services in the Pomeranian Voivodeship in Poland. The research area was chosen due to access to data. The main part of the research was carried out in 2025, while documentation and data from interviews were collected between 2015 and 2025.

According to M. Komorowski, in the Pomeranian Voivodeship there are seven organizational forms under which water supply and sewage management is carried out (Komorowski, 2024). More than half of the entities responsible for these tasks operate as companies. Twenty-six municipalities perform these tasks through their departments or municipal offices. In total, 23 cases involve municipal utilities and budgetary units. Eight municipalities have delegated these responsibilities to inter-municipal associations, while in two cases public–private partnerships have been applied. The organizational forms vary depending on the size of the municipality and its population. Regardless of the legal form, entities managing water supply and sewage networks face challenges in acquiring so-called private networks. The research conducted by the authors of this article indicates that in at least seven local government units in the Pomeranian Voivodeship, similar models are used to determine the purchase price of such networks. These models are based on the rent capitalization method described above. First, the rental rate is determined, which for the studied entities analyzed ranged from 4 to 6 percent of the replacement cost (estimated construction cost) of the network. This rent is then adjusted using a set of market attributes and the ratings assigned to them. The adjusted rent is capitalized with the discount rate applied by the enterprise or LGU, and the percentage of network acquisition—relative to its replacement cost—is determined. The studied entities applied different sets of attributes and weights, depending on their specific circumstances and preferences.

To draw general conclusions, the authors analyzed the selected cases to identify market attributes and attempted to determine the weights of these attributes using the paired-sales analysis method. In order to obtain consistent data, each case evaluated a water supply network of the same length (excluding additional elements such as hydrants) as of 24 September 2025. The studied entities applied different principles and indicators for estimating replacement cost (preparing construction cost estimates) of the network. Therefore, it was decided to determine the impact of individual attributes on the percentage of network acquisition (the ratio of acquisition price to replacement cost of the network).

The research identified five key market attributes influencing the value of water supply networks: location, average flow in the network (network diameter), service life of the network, depreciation, and type of network (related to the potential for future connections). Each entity assigned different sets of ratings to these attributes when determining the acquisition price of a network.

Table 1 presents the market attributes influencing the value of water supply networks identified in seven case studies. Analogous attributes appeared in the valuation model for sewage networks, although the number of ratings assigned to individual attributes sometimes differed.

Table 1.

Market attributes affecting the value of water supply networks

Assessed Entity	Municipality ~17k inhabitants	City ~47k inhabitants	Municipality ~30k inhabitants	Municipality ~16k inhabitants	Municipality ~31k inhabitants	City over 200k inhabitants	Municipality ~7.5k inhabitants
Object number	1	2	3	4	5	6	7
Attribute	Ratings assigned to individual attributes						
Location	area I–IV, best-rated are zones within the spatial development plan and in urbanized areas	area I–III, best-rated are cadastral districts preferred in terms of future development, including land value	areas I–IV, additional criterion: location of the network in a municipal road/plot, private road, or private plot	area I–II, development preferences of the municipality	area I–II, development preferences of the municipality	division into districts, best location depends on population density	location assessed multi-criterially depending on land use, number of landowners, number of active connections
Average flow in the network	PVC Ø90–160PE Ø40–160	cast iron Ø80–300PE Ø63–315	PVC Ø90–300PE Ø90–300PE RC Ø90–300	cast iron Ø80–300PE Ø63–315	cast iron Ø80–250PE Ø75–250	cast iron Ø80–600PE Ø63–315	PVC Ø40–160PE Ø40–160
Service life of the network	does not differentiated	cast iron, PE	does not differentiated	cast iron, PE	cast iron, PE	cast iron, PE	does not differentiated
Depreciation	0–100%	0–100%	0–100%	0–100%	0–100%	0–100%	0–100%
Type of network	ring network, terminal network	ring network, terminal network	development network, terminal network	ring network, terminal network	transit network, terminal network	ring network, terminal network	development network, terminal network

Note. Due to the protection of sensitive data and confidentiality obligations, the article does not disclose the names of the enterprises and municipalities included in the analysis; the identifying data remain in the source materials available to the authors.

Source: Authors' own elaboration based on document analysis and conducted interviews.

As shown by the comparative analysis presented in Table 1, the attributes recur across all studied cases, with the exception of the attribute “service life of the network”, which was not distinguished in cases 1, 3, and 7, due to the lack of differentiation of this network in terms of this attribute. The attribute of location, although present in all cases, was assessed differently depending on the specific characteristics of each municipality. In most cases, location ratings were linked to zones (e.g. cadastral districts), ranging from two to four zones. The division into zones often reflected municipal authorities’ preferences regarding development directions. Higher prices were associated with zones where local government supported residential construction, and lower prices were applied in zones where agricultural land use was preferred. In one case, the division was based on city districts, where the district with the highest population density (and therefore highest water consumption) was considered the most valuable. There were also cases where location was evaluated using multi-criteria analysis, taking into account, among others, land function (with roads preferred), land ownership type (municipality or State Treasury preferred), and the number of landowners of the plot crossed by the evaluated network.

The attribute average flow in the network is closely related to the pipe diameter and the volume of so-called trade water. As a rule, the larger the pipe diameter, the higher the network’s value. Service life appeared as a market attribute in municipalities where cast iron networks had been constructed. This type of network is also considered the most valuable. Depreciation depends on the year of construction: newer networks received the highest ratings. In each studied case, the type of network—reflecting its potential for future connections—was also considered. One type was the terminal network, which has a limited number of connections and cannot be extended. By contrast, networks with higher potential (and higher value) were described, depending on the municipality, as ring, developmental, or transit networks.

The above findings indicate that municipalities applied similar criteria when assessing the value of networks, though terminology as well as the type and number of ratings assigned to individual attributes varied. It can therefore be stated that in the Pomeranian Voivodeship a market has formed in which sellers consider similar attributes when determining the acquisition price of networks.

Taking the attributes listed in Table 1 as the market attributes of water supply and sewage networks, an attempt was made to calculate the percentage weights reflecting the impact of each attribute on network value using the paired-sales analysis method. The weights were analyzed separately for each attribute by determining the difference between the maximum price established for a water supply network with all the most favorable ratings and the price of a network reflecting the least favorable rating of the examined attribute (e.g., location). The remaining attributes were assigned the most favorable ratings in order to account for the *ceteris paribus* principle.

Table 2 presents the results of the conducted research for each case study and the calculated average values.

Table 2.
Weights of Market Attributes of Water Supply Networks

Assessed entity	Municipality ~17k inhabitants	City ~47k inhabitants	Municipality ~30k inhabitants	Municipality ~16k inhabitants	Municipality ~31k inhabitants	City over 200k inhabitants	Municipality ~7.5k inhabitants	Min	Max	Average
Attribute	Attribute Weights									
Location	57.92%	39.52%	40.32%	39.52%	29.17%	42.49%	60.91%	29.17%	60.91%	44.27%
Average flow in the network	14.28%	39.52%	40.32%	39.52%	34.66%	41.78%	14.12%	14.12%	41.78%	32.03%
Service life of the network	-	1.97%	-	1.97%	2.91%	3.65%	-	1.97%	3.65%	2.63%
Depreciation	10.44%	7.11%	7.26%	7.11%	15.75%	4.54%	6.70%	4.54%	15.75%	8.42%
Type of network	17.40%	11.86%	12.11%	11.86%	17.51%	7.55%	18.27%	7.55%	18.27%	13.79%
Total:	100%	100%	100%	100%	100%	100%	100%	-	-	101%

Source: Authors' own elaboration based on conducted research.

As shown above, the most important market attribute of water supply networks is location, with an average weight of 44.27%, indicating its impact on value. In contrast, the attribute with the smallest influence among those identified is "service life of the network" (2.63%).

6. Discussion

The research results concern the valuation of water supply and sewage networks, a topic that is rarely addressed, while the specific outcomes in the form of market attributes and their weights, calculated on the basis of domestic market data, have, to the authors' knowledge, been published in a scientific journal for the first time. A certain set of attributes was identified by P. Mika, who, based on his analysis, distinguished three key attributes: the possibility of further network expansion, the age of the network, and its diameter (cross-section) (Mika, 2015). It should be noted that the set of attributes identified by the authors of this article includes analogous attributes.

Both in Polish and international literature, there is a lack of studies on the valuation of water supply and sewage networks. In particular, there is a noticeable gap in the methodology for calculating market value. The authors hope that this article will provide a foundation for the application of comparative methods in the practice of valuing water supply and sewage networks.

At this point, certain limitations of the conducted research should be acknowledged. First and foremost, the study was based on seven cases, which cannot serve as a basis for broad generalizations. The research concerned enterprises from the Pomeranian Voivodeship in Poland, which, on the one hand, is advantageous since it can be assumed that the same economic factors related to the local market apply. On the other hand, in other regions of the country, different attributes may be considered relevant to the prices and values of water supply and sewage networks. It should also be emphasized that the study reflected the preferences of the buyer (the investor), who holds a certain monopoly in the local market. Sellers of water supply and sewage networks cannot choose buyers, as these are always municipalities or municipal enterprises. Nevertheless, the conditions offered by a given municipality regarding water supply and sewage infrastructure, including network buyouts, influence its attractiveness to potential land buyers and homebuilders. Thus, it can be argued that competition arises between municipalities, which compete to attract developers and new residents.

7. Summary

The unusual nature of water supply and sewage networks as goods, combined with the specificity of their market, generates numerous challenges in their valuation. The objective of this study was to identify and assess the attributes of water supply and sewage networks that affect their market value. The primary research method applied for the purposes of this article was the case study and comparative analysis. Data were collected through document analysis and interviews conducted with representatives of selected enterprises and local government units in the Pomeranian Voivodeship of Poland. Seven cases were examined, in which the studied entities applied similar models for determining the buyout prices of private networks. The theoretical part of the study included a review of the relevant literature.

The research identified five key market attributes influencing the value of water supply networks: location, average flow in the network (pipe diameter), service life of the network, depreciation, and type of network (related to the potential for future connections). Using the paired-sales analysis method, weights were calculated for these attributes, indicating the percentage impact of each attribute on the value of a water supply network. The most important market attribute of water supply networks is location, with an average weight of 44.27%. In contrast, the attribute with the smallest impact among those identified is “service life of the network” (2.63%). To maintain consistency, the study was conducted with reference to water supply networks; however, in the authors’ view, the results concerning the set of market attributes and their weights would be similar in the case of sewage networks. Nevertheless, detailed research directly addressing sewage networks should certainly be continued.

The process of acquiring water supply and sewage networks from private investors, particularly households constructing such networks for their own needs, is complex and socially challenging. Household expectations often conflict with the principles of managing public funds. The findings presented in this article can be used to establish fair compensation based on the market value of water supply and sewage networks. The results also provide a basis for applying comparative methods—commonly used in real estate valuation—to the valuation of water supply and sewage networks.

References

1. Appraisal Institute (2020). *The Appraisal of Real Estate. 15th ed.* Chicago: Appraisal Institute, pp. 22-32.
2. Czaplak, J. (2024). The Main Premises of the Re-municipalisation of Water Supply and Sewage Management on the Example of Gdańsk (Główne przesłanki rekomunalizacji gospodarki wodociągowo-kanalizacyjnej na przykładzie Gdańska). *Optimum. Economic Studies, No. 2(116)*, pp. 179-193, doi: 10.15290/oes.2024.02.116.09
3. Damodaran, A. (2012). *Investment Valuation: Tools and Techniques for Determining the Value of Any Asset.* 3rd ed. Hoboken, NJ: John Wiley & Sons.
4. Grafton, R.Q., Manero, A., Chu, L., Wyrwoll, P. (2023). *The price and value of water: An economic review. Cambridge Prisms: Water, 1, e3, 1-17* <https://doi.org/10.1017/wat.2023.2>.
5. International Valuation Standards Council (2024). *International Valuation Standards 2024.* London: IVSC.
6. Jajuga, K., Cegielski, P. (2003). Discount Rate in Real Estate Valuation – Methodological Foundations (Stopa dyskontowa w wycenie nieruchomości – stopa dyskontowa – podstawy metodologiczne). *Nieruchomości, No. 10*, C.H. Beck, p. 40.
7. Komorowski, M. (2024). *Structuring the Financing of Municipal Infrastructure Projects (Strukturyzacja finansowania projektów infrastrukturalnych gmin).* Doctoral dissertation. Gdańsk: Wydział Zarządzania, Uniwersytet Gdański.
8. Kucharska-Stasiak, E. (2011). Measurement of Value in Economics – Repercussions for Property Valuation (Pomiar wartości na gruncie ekonomii – reperkusje dla wyceny nieruchomości). *Studia i Materiały Towarzystwa Naukowego Nieruchomości, Vol. 19, No. 1*, p. 11.
9. Kucharska-Stasiak, E. (2016). *The Economic Dimension of Real Estate (Ekonomiczny wymiar nieruchomości).* Warsaw: PWN, pp. 1-459.
10. Mączyńska, E., Prystupa, M., Rygiel, K. (2008). *How Much is Real Estate Worth (Ile jest warta nieruchomość).* Warsaw: Poltext, pp. 1-232.

11. Mika, P. (2015). *The Method of Determining the Surrender Value of Water Supply and Sewage Systems*. *Świat Nieruchomości - World of Real Estate Journal*, 94, pp. 17-22.
12. Polish Federation of Property Appraisers' Associations (2008). *Interpretative Note: The Application of the Income Approach in Real Estate Valuation (Nota interpretacyjna: Zastosowanie podejścia dochodowego w wycenie nieruchomości)*. Resolution of the National Council of 9 December 2008. PFSRM.
13. Prystupa, M. (2013). Hierarchy of Legal and Methodological Conditions in the Real Estate Valuation Process (Hierarchia uwarunkowań prawnych i metodologicznych w procesie wyceny nieruchomości). *Rzeczoznawca Majątkowy*, No. 1(77), p. 9.
14. Prystupa, M. (2023). *Real Estate Valuation Using the Comparative Approach. A Discussion of the Standard with Examples (Wycena nieruchomości przy zastosowaniu podejścia porównawczego. Omówienie standardu wraz z przykładami zadań)*. Warsaw: PFSRM, pp. 34-35.
15. Sierpińska, M., Jachna, T. (1998). *Enterprise Evaluation According to Global Standards (Ocena przedsiębiorstwa według standardów światowych)*. Warsaw: PWN.
16. TEGoVA (2020). *European Valuation Standards 2020. 9th ed.* Brussels: TEGoVA.
17. Trojanowski, D. (2019). *The Dilemmas of Commercial Real Estate Valuation in Poland (Dylematy wyceny nieruchomości komercyjnych w Polsce)*. Gdańsk: Wydawnictwo Uniwersytetu Gdańskiego, pp. 1-371.
18. Trojanowski, D., Kisiel, P. (2012a). Price Calculation of Water Supply and Sewage Networks for the Purpose of Purchase by Supply Companies – Net Present Value Method. *Świat Nieruchomości - World of Real Estate Journal*, No. 1(79), pp. 34-39.
19. Trojanowski, D., Kisiel, P. (2012b). Price Calculation of Water Supply and Sewage Networks to be Purchased by Supply Companies – Rent Capitalisation Method. *Świat Nieruchomości - World of Real Estate Journal*, Vol. 2(80), pp. 24-32.
20. Turčínková, J. (2021). The Value-Based Pricing Determination Matrix for Pricing Method Selection. *Journal of Business Economics*, No. 92(3), pp. 1-15.
21. Wiśniewski, T. (2008). *Evaluation of the Effectiveness of Real Investments with Particular Consideration of Risk (Ocena efektywności inwestycji rzeczowych ze szczególnym uwzględnieniem ryzyka)*. Szczecin: Wyd. Naukowe Uniwersytetu Szczecińskiego, p. 58.