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Modeling Activities Related to Improving Energy Efficiency in the Public Procurement Process in Poland

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Abstract: The public procurement system in Poland remains highly centralized, although thanks to European Community directives, it is part of European law. Therefore, it has established procedures for sustainable public procurement, including so-called green public procurement. In addition to the Public Procurement Law of 11 September 2019, other provisions introducing specific instruments (e.g., energy labels, environmental labels) should be taken into consideration, as such provisions make it easier for contracting authorities to take environmental aspects into account in tender procedures. Bearing in mind the existing legal regulations, this article features a diagnosis of the degree of use of measures to improve energy efficiency in public procurement procedures and models activities related to improving this situation. For this purpose, surveys were conducted for 120 entities applying the provisions of the Public Procurement Law. Taking into consideration the results obtained in the survey, 15 factors related to the improvement of energy efficiency in tender procedures were selected with the help of 12 purposively selected experts connected with the issues raised in this article. Thanks to their expert knowledge, three key factors determining the wider use of this instrument were modeled by means of the systems theory–based methodology of network thinking. The paper also attempts to indicate the key factors determining the wider use of this instrument, using the network thinking methodology for this purpose. As a result of the conducted research, it was found that these factors include human capital, industry, and the energy crisis. Research on the subject in the Polish literature remains innovative and allows for the formulation of application recommendations for decision makers. The concept of energy efficiency in this paper refers to the ratio of the results obtained to the energy input. Efficient use of energy aims to reduce the amount of energy needed to deliver products and services.

Keywords: energy efficiency; public procurement; sustainable development; community policy

JEL Classification: H57; Q43; Q48; Q58

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1. Introduction

Recent decades have brought significant development of industry, resulting in increased emissions of greenhouse gases into the Earth's atmosphere [1]. In August 2021, a part of the Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) was published [2], in which the years 2011–2020 were recognized as the warmest decade in history [3]. During this period in Poland, there was an average of 13 days per year with a minimum temperature of 30 degrees, while in the 1970s this figure was only 4 days. Currently, the impact of human activity (industry, transport, or agriculture) on the natural environment has visible consequences, thus drawing attention to the need to apply the principles of sustainable development.

It is also worth noting that higher air temperature [4] is not the only global environmental problem. The visible effects of global warming [5] include the following:

- melting of natural ice sheets and glaciers,
- rising sea and ocean levels,

- higher frequency and intensity of extreme weather events (e.g., prolonged heat, heavy rainfall and storms, strong hurricanes),
- disturbances in the circulation of water in nature (droughts and floods, including flash floods),
- extension of the vegetation period of flora,
- steppe-formation of areas previously covered with regular vegetation and an increase in the frequency and range of forest fires, and
- changes in the range of occurrence of flora and fauna species, including pests and vectors of infectious diseases.

Stopping climate change is a key task, the success of which depends mainly on political [6] and economic [7] decisions. The most important challenge is to reduce the emission of greenhouse gases into the atmosphere [8]. Therefore, one of the key elements is the shift in the direction of energy policy—the transition from traditional fossil fuels [9,10] towards zero-emission energy sources [11]. These decisions concern large corporations, companies and factories, as well as individual households. Many Poles have recently decided to install photovoltaic panels [12], producing significant energy with this technology [13]. Individual actions should also include successive replacement of heat sources harmful to the climate and health (e.g., coal-fired stoves) in homes, reduction of electricity consumption through the principles of rational consumption [14], and thermal modernization of buildings [15]. However, apart from actions, it is also important to build knowledge and social awareness about climate change [16] and its consequences.

With countries around the world spending an average of 12 to 20% of their gross domestic product on procurement, the public sector is considered to be at the forefront of reducing environmental impacts and promoting more sustainable products and services. Greater focus on public procurement may therefore limit the negative impact of the greenhouse effect and at the same time accelerate the energy transformation [17]. If legislation passed by governments prioritizes the purchase of energy-efficient products [18], it is likely that more and more producers will manufacture these to meet the requirements [19]. Both in theory and practice, this will expand the market for these products, and thus lower prices for all consumers. It will ultimately increase energy efficiency and steer public procurement towards more sustainable options.

Energy efficiency is one of the features most often utilized in sustainable public procurement programs [20]. One of the reasons is that it deals with both the environmental and economic aspects of sustainable development. An energy efficient product will often have a lower life cycle cost [21] than its inefficient alternative and also lower associated greenhouse gas emissions [22]. Examples of types of products and services for which this is particularly relevant include the following:

- IT equipment—computers, displays, image processing equipment,
- vehicles and transport services,
- lighting (internal and external),
- heating, ventilation, and air conditioning,
- data center services,
- design and construction of buildings, and
- medical and catering equipment.

The presented facts make one think about the extent to which energy efficiency is used in tender procedures carried out in Poland and allows for the modelling of key factors that determine the success of this process [23]. The aforementioned modeling is possible thanks to the use of the methodology of network thinking, which in the next steps allows us to create a change management model, and thus to introduce changes in the entire public procurement system in Poland.

2. Energy Efficiency and Public Procurement

The Act of 20 May 2016 on Energy Efficiency [24] is the national legal act that horizontally defines the technical parameters to be met by products ordered under public

procurement and what technical conditions must be met by buildings purchased, rented or used by the public sector. The Act has transposed into national legislation the provisions of Directive 2012/27/EU of the European Parliament and of the Council on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC [25].

Although Directive 2012/27/EU imposes specific obligations in the field of energy efficiency only on government institutions, national regulations have extended the obligation to purchase products, services and buildings with good energy performance to public authorities [26], which include, among others, government administration bodies, state control and law enforcement bodies, as well as courts and tribunals. Public authorities are obliged to do the following:

- purchase energy efficient products;
- commission services whose performance is related to energy consumption;
- purchase or rent energy-efficient buildings [27] or their parts that meet at least the minimum requirements in terms of energy savings and thermal insulation specified in the regulations issued on the basis of art. 7, sec. 2, point 1 of the Act of 7 July 1994—Construction Law;
- in used buildings belonging to the State Treasury undergoing reconstruction, ensure compliance with the recommendations referred to in Art. 10, point 3 of the Act of 29 August 2014 on the energy performance of buildings (Journal of Laws of 2021, item 497);
- implement other energy efficiency improvement measures in the field of energy performance of buildings.

The obligation of public authorities to take specific actions to improve energy efficiency applies to public contracts for supplies, services or works whose value is equal to or exceeds the EU threshold amounts. The requirements in terms of technical parameters related to energy efficiency are indicated by the contracting authority primarily in the description of the subject of the contract. They may optionally decide to assign products that meet the above criteria of energy efficiency requirements with a sufficiently high weight (score) within the bid evaluation criteria, which will translate into the nature of the contract being awarded.

In the case of energy-related products for which an energy label has been adopted in the form of delegated acts of the European Commission, contracting authorities may request the submission of an appropriate energy label to confirm that these products achieve the highest levels of energy efficiency [28–30].

3. Sustainable Public Procurement in Poland

In 2021, 613 awarding entities awarded 1938 public contracts taking into account environmental aspects, with a total value of PLN 7,529,457,088.11 (excluding VAT). Compared to 2020, this represents an increase in the number of green contracts of 535, with a simultaneous increase in the number of contracting authorities awarding such contracts (from 363 contracting authorities in 2020 to 613 in 2021). On the other hand, the value of green contracts awarded in 2021 decreased. Comparing both reference years, the value of green procurement decreased by PLN 4,530,679,218.6 (excluding VAT). The share of green companies in the total number of public contracts awarded in 2021 amounted to 1%, while their value accounted for 4% of the total value of public contracts awarded.

Pro-environmental instruments were used in the largest number of cases in contracts for services, similar to previous years. In this type of contract, bid evaluation criteria relating to environmental aspects, including the energy efficiency of the subject of the contract, were most often used, and environmental requirements related to the performance of the contract were also defined. In the case of supply contracts, environmental requirements were most often specified in the description of the subject of the contract, and environmental aspects were taken into account in the bid evaluation criteria. On the other hand, in construction works, the most commonly used pro-environmental instruments

included environmental requirements related to the performance of the contract, as well as environmental requirements included in the description of the subject of the contract.

Figure 1 shows the number of public procurements in Poland in 2021 in which relevant environmental aspects were applied.

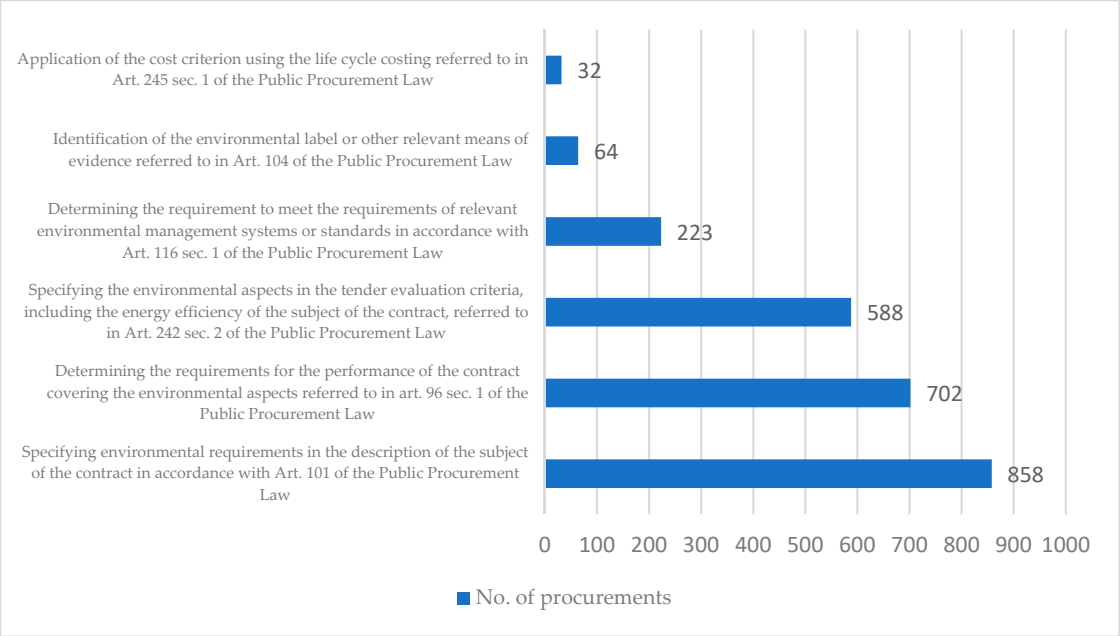

Figure 1. Environmental aspects in public procurement in Poland. Source: [31].

The presented data led to the assumption that, despite the favorable legal provisions related to the award of energy-efficient public contracts, the degree of use of this solution in Poland remains negligible. It is therefore worth examining the reasons for this situation and which factors can contribute to improving the existing state of affairs. Since public procurement is of a systemic nature, adequate research methods have been subordinated to research on energy efficiency in this area.

4. Description of the Research Methods Used

In order to verify the degree of use of sustainable energy efficiency in public procurement in Poland, surveys were conducted on a sample of 120 entities obliged to apply the Public Procurement Law. The purposive selection of the sample of respondents who know the procedures of awarding public contracts and conduct tenders was to ensure the reliability and professionalism of the obtained answers. The replies obtained from the respondents became the basis for the search for key factors influencing the improvement of the existing state of affairs and thus indicating recommendations for decision makers. Therefore, the second stage of the research made use of the systems theory–based methodology of network thinking. Since the essence of the methodology is to address the problem from different angles, factor analysis was carried out in a group of 12 specialists. The specialists included employees of universities, entrepreneurs and environmentalists. Since the group of respondents included people not related to the public procurement market, in accordance with the principles of the methodology, various points of view on the problem were obtained. The selection of experts for the study was also purposive. The criterion for their selection was the area of activity closely related to the issues raised in the article. These were people who are familiar with the issues related to energy efficiency on a daily basis; however, in accordance with the methodology, they represent different fields of activity. In order to correctly identify the key factors, the legislator's point of view was adopted. In order to narrow down the area of analysis for the purposes of this paper, it was assumed

that the number of factors in the network selected in the first stage of the study (surveys) would not exceed 15.

Reliable reasoning (in accordance with the methodology of network thinking) was made possible by two meetings with experts on MS TEAMS, during which the test procedure was arranged and presented, and the dependency network (Figure 3) and the impact strength (Table 1) of factors previously selected in the survey were established. This allowed us to construct a management model and, most importantly, to select key factors necessary to improve energy efficiency in public procurement procedures. In this way, in accordance with the subsequent steps of the methodology of network thinking, objective conclusions and recommendations were obtained with the help of experts.

Table 1. The Influence Matrix.

No.	Name of Factor	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	Sum of A
1.	Efficient, cost-effective public procurement	-	1	0	2	1	0	1	2	2	1	0	0	3	0	3	16
2.	State policy	3	-	2	2	0	1	0	1	0	3	1	2	3	3	3	24
3.	Human capital	2	0	-	0	0	2	0	1	0	0	0	2	1	2	2	12
4.	Industry group	1	2	0	-	2	0	2	2	1	0	0	0	1	2	3	16
5.	Offer evaluation criteria	2	0	0	0	-	0	0	0	0	0	0	2	0	0	2	6
6.	Mentality of ordering parties	1	3	0	0	0	-	2	2	0	0	0	2	0	0	0	10
7.	Description of the subject of the contract	2	0	0	0	0	0	-	0	2	0	0	2	0	0	2	8
8.	Trainings	2	0	1	0	2	2	2	-	0	0	0	0	0	0	2	11
9.	Life-cycle costing	1	0	0	0	2	0	1	0	-	0	0	0	0	0	2	6
10.	Taxes	1	0	0	1	0	0	0	0	0	-	0	3	0	0	0	5
11.	International regulations	1	2	0	1	1	0	1	1	0	0	-	0	0	2	2	11
12.	Grey economy	2	2	1	0	0	1	0	0	0	3	0	-	0	1	0	10
13.	Energy crisis	1	3	0	3	0	0	0	0	0	0	2	0	-	3	0	12
14.	National regulations	2	0	0	0	2	0	2	2	0	2	0	2	0	-	2	14
15.	Reduction of CO_2 emissions	1	2	0	2	2	0	2	1	0	0	2	0	2	2	-	16
The sum of P		22	15	4	11	12	6	13	12	5	9	5	15	10	15	23	-

Source: own study.

It should be mentioned that the management-related literature allows model designers to use a wide range of auxiliary methods [32], such as a component-based approaches, cases, conceptual models [33], design patterns, and causal loop diagrams [34]. However, these techniques usually neglect the internal dynamics of changes in the object and the external environment. Therefore, a more integrated approach should be sought after in modeling management processes; one approach is the methodology of network thinking developed by three Swiss professors: Gomez, Probst, and Ulrich [35].

The methodology of network thinking comprises six interconnected and nonsequential phases, thanks to which it is possible to come back to an already finished phase or pass through it a number of times. These phases encompass the following: goal setting and modeling the problem, impact analysis, capturing and understanding the possibilities of

altering the situation, clarifying management possibilities, devising strategies and steps to take, and providing a solution to the problem [36].

5. Results

5.1. Analysis of Survey Results

Research conducted among 120 employees of entities obliged to apply public procurement regulations was aimed at determining the degree of use of sustainable energy efficiency among Polish contracting authorities. The structure of the research sample is presented in Figure 2.

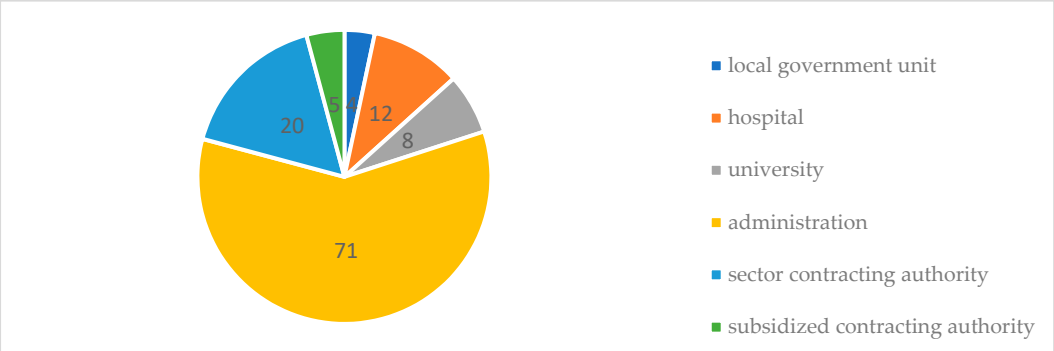

Figure 2. The structure of the research sample. Source: own study.

The surveyed respondents were asked about the tasks that were imposed on them by the Act of 20 May 2016 on energy efficiency. According to the existing regulations, they should apply at least one of the measures to improve energy efficiency during the performance of public contracts, which include the following:

- the implementation and financing of a project aimed at improving energy efficiency;
- the purchase of a device, installation or vehicle characterized by low energy consumption and low operating costs, or their replacement or modernization;
- the implementation of the thermo-modernization project;
- the implementation of the environmental management system confirmed by obtaining an entry in the EMAS register;
- the implementation of low-emission projects referred to in the Act of 21 November 2008 on supporting thermal modernization and renovation and on the central record of emissivity of buildings.

The results obtained during the study are surprising, because only two contracting authorities (1.67%) have implemented projects aimed at improving energy efficiency. The results of the research are therefore largely consistent with the data of the Public Procurement Office.

It should be noted, however, that many contracting authorities emphasized that not using the measures to improve economic efficiency results from the low value of contracts they perform, and thus the lack of any statutory obligation. Moreover, not every order has grounds and possibilities to use these measures due to the specific nature of each order. Many comments also emphasized that the most important factor remains the lowest possible price, which means that more expensive solutions related to energy efficiency are not taken into account at all.

Many contracting authorities (85 people) see the need to protect the climate by introducing solutions and devices with increased energy efficiency, but few are educated in this field. Only 3 positive responses were obtained regarding the question about participation in training on so-called green public procurement. This proves very low social awareness of Polish contracting authorities in terms of promoting energy-saving products and services.

Interestingly, the vast majority of respondents are not familiar with the provisions of the aforementioned Energy Efficiency Act. However, they are aware of the need to improve their knowledge.

Taking into account the issues related to awarding energy-efficient public contracts, the respondents generated 22 factors that determine their use in the system. After a discussion among a group of experts, 15 were selected and became the basis for analyses when using the network thinking methodology.

5.2. Key Factors for the Use of Energy-Efficient Public Procurement in Poland

Due to the issues discussed in this paper, it was decided that energy-efficient public procurement would be at the center of the network. After the discussion of the group of experts, it was assumed that the following elements of the network would be related: state policy, human capital, industry, bid evaluation criteria, description of the subject of the contract, training, life cycle costing, taxes, shadow economy, international regulations, national regulations, reduction of CO_2 emissions, energy crisis, and mentality of contracting authorities. The network of dependencies between these factors is shown in Figure 3.

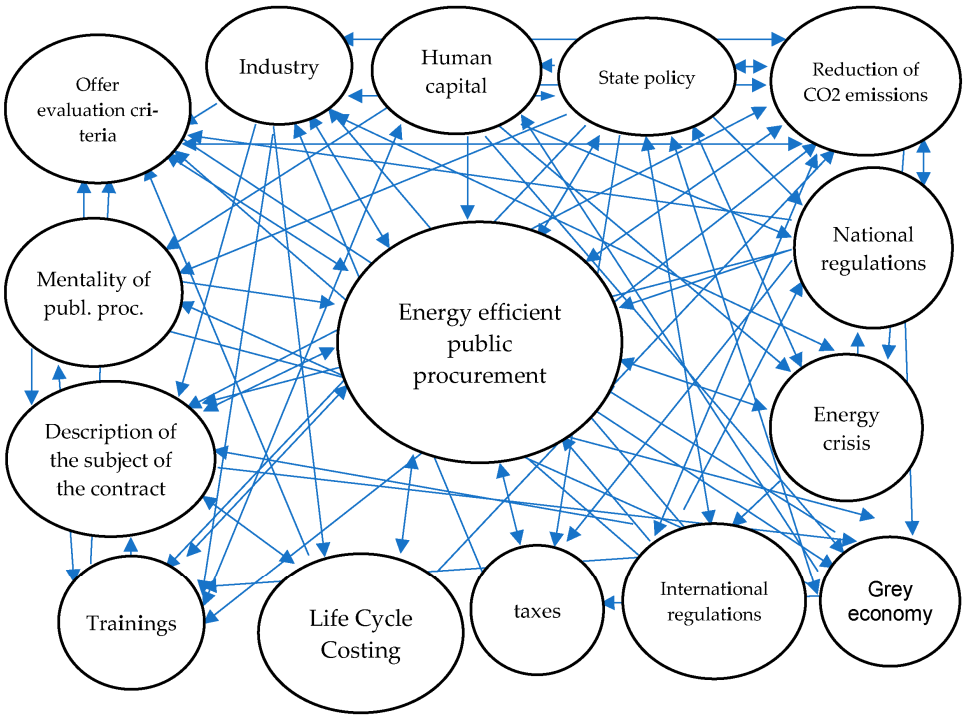

Figure 3. A network of dependencies affecting energy-efficient public procurement. Source: own study.

The analysis of interactions between the factors specified in Figure 3 should cover their type and intensity. As far as the type is concerned, the arrow directions indicating one-way and two-way interactions correspond are used to indicated this. The intensity is shown in Table 1, i.e., the so-called intensity matrix. It assumes that 0 intensity corresponds to no effect, while 3 corresponds to a very strong effect. The analysis of the type and intensity of the impact was conducted in a group of 12 experts taking part in the construction of the network during meetings held on MS TEAMS. Having summed up the activity and passivity of the factors, it is necessary to establish how the factors featured in the network are ranked in accordance with the following:

- active factors, i.e., those that very strongly influence other factors but are practically not influenced themselves;
- critical factors, i.e., those that strongly influence other factors while they are also subject to similar influences;

- passive factors, i.e., those that weakly influence other factors but are themselves subject to strong influence;
- lazy factors, i.e., those that both weakly affect other factors and are themselves subject to weak influence.

The influence matrix shown in Table 1 constitutes the departure point for the development of the intensity map. This allows us to allot the factors listed in it to one of the four described groups. At the same time, it makes it possible to ascertain which factors may play an essential role regarding the energy efficiency of public procurement. While creating an intensity map, it is extremely important to draw a boundary between the factors. In this analysis, it is assumed that the dividing lines will extend in places that are formed by dividing the maximum value of A and P by 2. Thus, the obtained values are A = 12 and P = 11.5. The intensity map is shown in Figure 4.

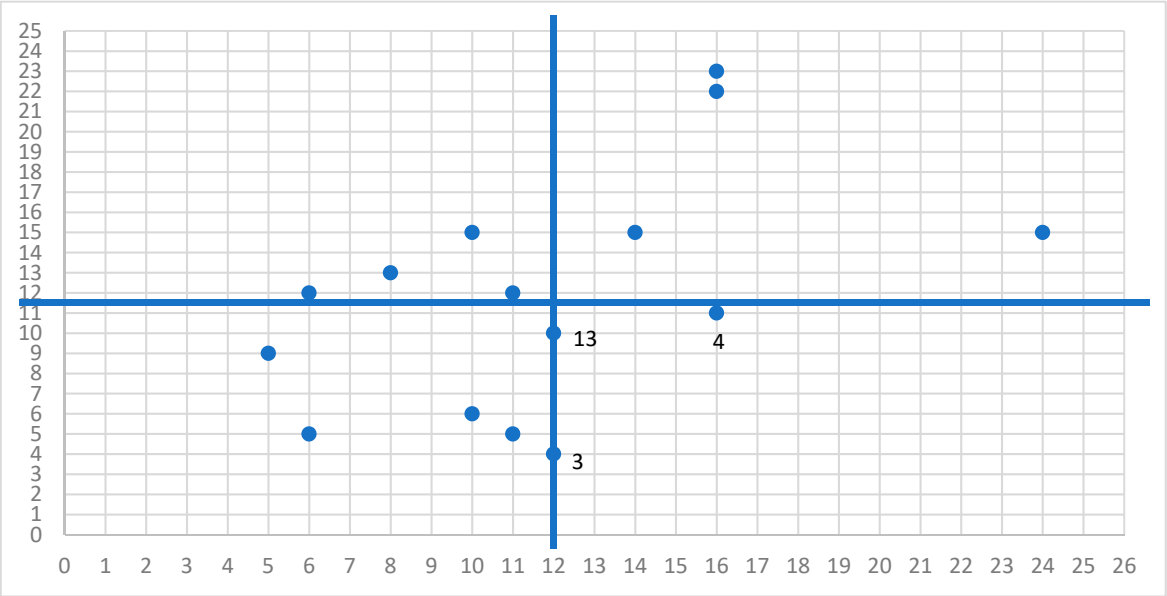

Figure 4. Intensity map. Source: own study.

The intensity map shows that the key factors related to energy-efficient public procurement include the following: human capital (3), industry (4), and the energy crisis (13). At this stage, it is worth determining which of these are managed by decision makers and which remain beyond their capabilities. All the listed factors remain the driving factors.

Decision makers should pay special attention to these factors in the process of shaping energy-efficient public procurement. To paraphrase the words of L. Edvinsson [37], human capital refers to knowledge, skills, innovation, and the ability of company employees to perform tasks efficiently. It also embraces organizational culture and organizational philosophy. The author claims that human capital is inherently integrated with people (employees). An employee's departure from the organization means the loss of certain skills, experiences, and informal connections that this person had. Human capital is not owned by the organization.

Meanwhile, Polish entities awarding public contracts are characterized by a very intensive staff turnover, resulting from low salaries and the need to possess disproportionate knowledge and responsibility. In addition, Polish secondary schools and universities still do not provide substantive preparation for the profession of a contracting authority. These facts mean that the human capital circulating in public procurement units unfortunately remains of poor quality.

As for the industry, it undoubtedly has a very large impact in the form of low-energy public procurement. It is not possible to use energy-efficient solutions and products with a

positive impact on the natural environment in every case. Certainly, industries related to the management of electricity, heat, cold, and compressed air are central to the discussion.

The energy crisis caused by the Ukrainian–Russian war has turned out to be the symptomatic factor influencing the improvement of the energy efficiency of public procurement in Poland. It forces nations dependent on imports of raw materials from Russia (including, to a large extent, Poland) to rationalize activities related to their consumption and thus to look for alternative forms of energy production.

Analyzing Figure 4 carefully, it is worth emphasizing that the most active factor in the network is the policy of the state. However, this is quite a dangerous factor, because while active, it remains very reactive, which can have serious political and economic consequences. However, it is hard to imagine a rational use of the three aforementioned factors without thoughtful and wise actions of the state.

6. Discussion and Conclusions

The third phase of the methodology of network thinking assumes the need for the interpretation of the possibility of changing the situation with reference to key factors obtained in earlier stages. To this end, it is worth applying the scenario method based on the belief that future events cannot be predicted with 100% accuracy. Therefore, a variety of scenarios for the development of the current situation should be anticipated and devised [38]. Table 2 presents, after consultation with a team of 12 experts, optimistic, pessimistic and probable scenarios.

Table 2. Scenarios for developing key factors that determine the use of energy-efficient public procurement in Poland.

Factors	Scenario		
	Optimistic	**Pessimistic**	**Likely**
Human capital	People with extensive knowledge and skills will be employed in public procurement units to apply their potential in the field of energy-efficient solutions	Public procurement units will employ people who are not fully qualified to perform their tasks, thus not utilizing the potential of energy-efficient solutions	Incidentally, public procurement units will employ people who take into account the advantages of using energy-efficient tender solutions
Industry group	Energy-efficient public procurement will be implemented with the use of industries supporting this process	Decision makers will not use the potential of industries who can provide energy-efficient solutions	Energy efficient procurement will continue to be used only occasionally
Energy crisis	The energy crisis will lead to a revolution in the thinking of contracting authorities, consisting of the daily use of energy-efficient solutions	The energy crisis will not change the perception of tender procedures by contracting authorities	The energy crisis will lead to selective use of energy-efficient products and solutions in tender procedures

Source: own study.

The next phase of the methodology of network thinking should explain the ability to drive change. In order to do so, it is worth using a model described by G. Klimarczyk, M. Masadyński, and M. Wyrwicka [39], which takes heed of factors that are controllable and non-controllable by decision makers, feedback and feedforward, as well as indicators (or early warning indicators). The point of reference in this model is the decision maker who influences the use of energy-efficient public procurement. The change management model is shown in Figure 5. Indicators play a unique role in the management model, since they make it easier for decision makers to adopt proper action strategies in the case of untoward changes. The indicators presented in Figure 5 were assessed and verified by a group of 12 experts.

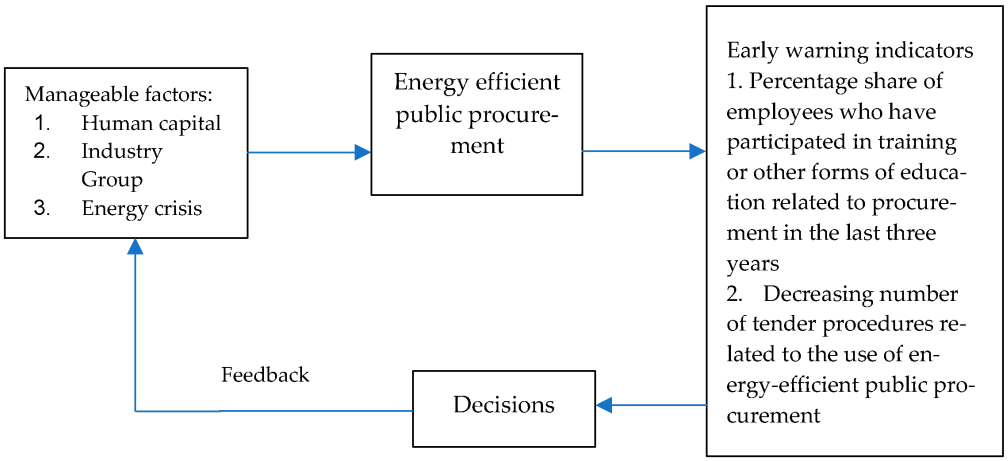

Figure 5. Management model for the use of energy efficient public procurement. Source: own study.

From the point of view of using energy-efficient solutions in public procurement, a proposal for action should be devised in keeping with the methodology of network thinking.

Undoubtedly, one of the main factors related to the use of energy-efficient public procurement is investing in human capital. The lack of knowledge, skills and experience usually results in poorly prepared tender specifications and the choice of standard, and thus most often the cheapest solutions. With regard to human capital, it is worth considering raising the level of knowledge and skills of people involved in public procurement, both on the part of contracting authorities and contractors themselves. This can be aided by a wide training program aimed at promoting pro-environmental criteria, as well as a well-thought-out recruitment process that imposes high substantive and formal requirements on candidates for work in the public procurement system. It is worth mentioning that the profession of a public procurement specialist has existed for several years, and its introduction was requested starting in the 1990s by The World Bank.

From the perspective of energy efficiency in public procurement, the industry sector covered by the tender is very important. It is not possible to use environmentally friendly solutions in every case. Optimization of industrial processes, modernization of lighting systems, and projects related to thermal modernization have led to significant progress in terms of improving energy use in Poland. However, if we compare the energy efficiency of the Polish economy to the energy efficiency of the most developed European countries, it remains three times lower. However, this presents a huge potential for action and the possibility of achieving great improvement. Currently, the highest energy consumption can be observed in the construction, transport, and industry sectors. It is in these sectors that the greatest potential for reducing energy consumption remains. The decrease in energy consumption in the industry sector and the increase in transport and services both characterize countries with a high rate of economic growth.

As research results have shown, an important factor contributing to the improvement of energy efficiency has been the crisis caused by the Russian–Ukrainian war. According to one study, if winter temperatures were typical for this time of year, 147,000 more people would die in conjunction with rising energy prices in Europe. If the predictions of scientists from Copernicus Climate Change [40] are correct, there will be 79,000 additional deaths because of this. The largest number of victims of the energy crisis will be from Italy, where energy prices have increased by almost 200% since 2020 and the population is aging. According to The Economist, if temperatures fall below average, the number of deaths could increase even more. As part of maintaining energy supplies and prices at a stable level, the European Union member states already agreed in September that they would voluntarily reduce electricity consumption by 10 percent by March 2023. In addition, they will reduce consumption by 5 percent during peak hours. As we can see, the energy crisis in Poland is a factor that should force actions related to the implementation of energy solutions

that are more effective than before. There is no turning back from energy transformation and decarbonization. To meet the challenges of the energy transformation that await us, Poland needs large-scale nuclear energy and renewable energy sources—in particular the offshore ones located in the Baltic Sea.

As shown by the results of the conducted research and by network analysis, the key factors in the use of energy-efficient public procurement are human capital, industry, and the energy crisis.

Energy efficiency is one of the features most often utilized in sustainable public procurement programs. One of the reasons is that it encompasses both the environmental and economic aspects of sustainable development. An energy efficient product will often have a lower life-cycle cost than its inefficient alternative and also lower associated greenhouse gas emissions.

The task of the state in the coming years, in accordance with the results obtained using the methodology of network thinking, will therefore be to conduct successive and consistent activities in strategically important sectors of the national economy as well as educate conscious and responsible officials awarding public contracts, while offsetting, at the same time, the effects of the energy crisis by preferring energy-saving and low-emission solutions. Public procurement in Poland faces a very serious challenge, which will affect whether energy transformation will be accompanied by technological transformation or whether the economy will remain dependent on fossil fuels for many years to come.

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