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Management of the bio-waste processing in crisis conditions in the municipal sector

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Abstract: Management of the bio-waste processing is a complex issue, which has not yet been elaborated for the municipal administration. Its importance can be seen in the synergic links of three key areas: the crisis in the energy, the bio-waste and its processing as the most prospective opportunity of crisis solution, and the management in the form of tool for the final solution. The main aim of the scientific paper is based on the theoretical knowledge and study of trends in the field of the renewable energy sources to create a universal exemplary model of decision-making for mayors in the process of the bio-waste management in the municipal sector. The necessary data were obtained using the questionnaire form and the data processing was carried out in the statistical program PSPP method Chi-Square, *T*-test and correlation. The main finding is that the energy crisis is understood as a significant shortage of supply of energy sources to the economy. The results confirm that the utilization rate of the municipal bio-waste for energy purposes is very low. An exemplary model was divided into two main groups, communes and towns. For a more relevant animation, the communes and towns were divided into three sub-categories according to the population. Recommendations are made regarding the collection, processing and use of the bio-waste for each group. Two of the three set out hypotheses were confirmed.

Keywords: biomass, bio-residues, energy crisis, municipality, municipal waste, pyrolysis, renewable energy sources, waste degradation, waste hierarchy, waste management, waste-to-energy

The increasing share of the renewable energy sources for electricity and heat production in order to create adequate additional resources needed to cover the domestic demand is one of the main priorities of the energy policy of the Slovak Republic. The intention of the scientific paper is to transfer these macro-economic attitudes to the municipal sector and to inform the Slovak government about the effects of the energy crisis in the normal life of the commune or town. Due to the development of this relatively new market, there is a massive group of innovations that should be commercialized. We must use the emerging markets to promote the renewable energy sources and technologies. Of course, not only with a sufficient government assistance, but also with the professional competence of the management authorities. The mayors must begin to understand the biological waste as an opportunity to improve the lives of the residents in the commune.

In this scientific paper, we focused on three main areas in the municipal sector, which are the energy crisis, the bio-waste and management. The above areas are closely linked and they pave the way for solutions to many problems that governments are

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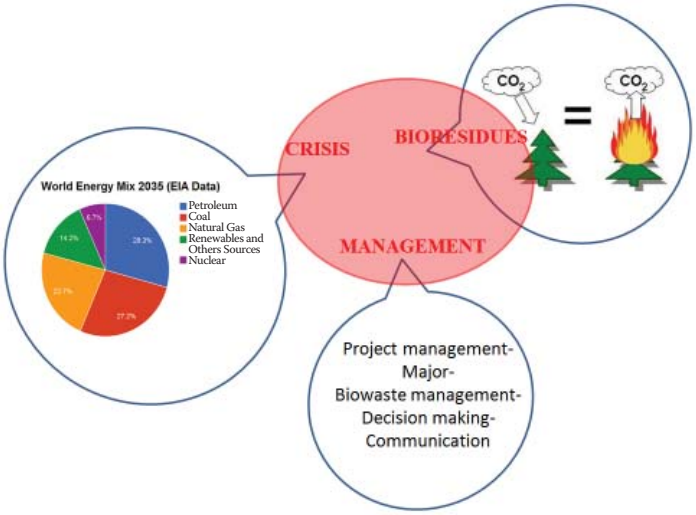

Figure 1. The three key areas

Source: own processing

struggling with. Especially, in dealing with the waste management and the renewable energy sources in accordance with the principles of sustainable development. The Figure 1 The three kea areas indicates the mentioned problems and the necessity of linking.

The first of the above mentioned areas is the crisis in the energy sector, which is also currently found in Slovakia. This state is defined as a crisis because the past years have shown that Slovakia is dependent on one source not only on the gas supply, but it is also dependent on the supplies of oil, coal and nuclear fuel. The gas crisis has given a clear signal that it is a high time to change the attitude towards the renewable energy sources (Pepich 2009). Simultaneously, with the energy crisis, we can also define a second area – the waste management.

The energy crisis is defined in the literature as a social-economic problem caused by the reduced energy supply leading to a lower availability and the increase in prices for consumers (Macinnes 2015). Rinkesh (2015) defines it as follows. He claims that the amount of limited natural resources that drive the industrial society declines, while the global demand for them increases. The energy crisis in a broader sense consists of three main questions: can we run out of energy, how safe our approach to energy is, and how the climate change has impacted the used energy. The answer are provided by Browne (2009), who says that for the first time in the history, we will face an energy crisis not because of the lack of energy, but because it is used incorrectly. Until now, the energy industry has been assessed by two metrics: the contribution to the energy security and the cost of energy supplied to the consumers. At present, we must add another metric: its success in reducing the greenhouse gas emissions, especially the carbon dioxide into the atmosphere. According to Rinkesch (2015), the causes of the energy crisis include the excessive consumption, the population growth, a poor infrastructure (hardware), other unexplored possibilities of the renewable energy sources, the energy waste (energy conservation), natural disasters and accidents, war. The macroeconomic views are clear. The development and use of the renewable energy sources can greatly increase the diversity of the energy supply and contribute to ensuring the sustainable energy supply of state (Herzog 2001). Currently, fossil fuels represent three quarters of the energy mix in the EU.

The share of the renewable energy sources is on the rise, from 6% of the gross domestic energy consumption in 2000 to the current 10% in the EU, and globally around 9% of the total energy carriers (Conti 2015). To compare, according to the US reports for the Energy Information Administration (EIA), the predicted composition of the energy mix in 2035 includes 14.2% RES (Sieminski 2013). This upward trend is evident also in Slovakia. In 2002, the renewable energy sources accounted for about 1.6% of the total consumption of the primary RES (to produce electricity, heat, cooling and transport). Now, it is the above 10%. Slovakia is currently in operation for over 1600 installations using the renewable energy sources only for electricity (Faber et al. 2012).

The energy future is clearly the biomass (Lavray 2009). Biomass is the term much broader than the concept of the organic waste (Law no. 309/2009 on the promotion of renewable energy sources). Agricultural cooperatives, forests, communes are the biggest producers of biomass in Slovakia (Lajdová et al. 2016). Currently, we use about 13 000 GWh (47 PJ) of energy

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from biomass per year in Slovakia, whereby the biomass is accounted in the total use of energy from the RES for about 42% (Ďuďák 2009; Pepich 2010; Tauš et al. 2010; Kopetz 2013). Except economic profit, the use of the biomass also brings other improvements such as the energy independence of the state, the possibility to create new jobs, the capital appreciation of funds and the environmental protection. In addition, it leads to a better balance of trade in the country by reducing the claims on the import of energy carriers. Kuhnová (2011) is also connected to the discussions on biomass and she claimed that it was problematic whether renewable sources can function without subsidies. As in the past, the system will not raise the prices sharply and will not burden the families and the European industry. When the objectives for the share of RES had been set, the EU was convinced that extending technologies will be cheaper. Roughly a third of the municipal waste consists of the organic waste; therefore, a possible solution for reducing the amount of waste is a promising and proven technology of their possible recovery. At the municipal level, we are talking about the municipal biomass. This is about all biological "waste", which is produced in the commune and its surroundings. It is unnecessary the organic mass and waste that must be disposed of or prospectively evaluated. Many authors focus on the bio-waste as a part of the community biomass and its conversion into energy (Liamsanguan 2007; Altmann 2010; Ricci 2010; Jandačka 2014; Veverka 2015). Guštafíková (2015) points out that Slovakia belongs among the worst EU countries in this aspect. Today, we landfill more than 70% of the waste, which is a shame on the European level. The potential of jobs and resources that have to be imported to Slovakia are untapped (Renner 2012). It should be noted that the municipality prefers the waste disposal in a landfill because it is cheaper than its recovery (Odkladal 2016). It leads to the fact that the municipalities are not interested in the development of a separate waste collection and the landfill disposal dominates. Oravcová (2013), Augustine (2014), Odkladal (2016), deal with waste recovery in various ways. They point out the benefits of the energy recovery of waste at the municipal level and the huge reserves in the use of the municipal waste for energy purposes. It is significant that while our general and professional public rejects any suggestion of building facilities for the energy recovery (NIMBY – Not In My Backyard), the public of the Western Europe enjoys the benefits thanks to these solutions. The Slovak professional terminology does not have such a wide range of terms for the seemingly identical devices for "waste incineration" as English. In the English-written literature is carefully distinguished whether it is a classic waste incineration = incineration plant, sometimes called the "mass burn", or if it is about the use of energy from this process, such facilities are referred as the WtE, e.g. Waste to Energy (Gerlach 2014; Kizlink 2014; Okhla 2014; Yuanyuan 2015). In the recent period, especially in America, a new acronym was expanded – EFW = energy from waste, which in turn refers to the gasification of waste as well as pyrolysis, or even called the "Feedstock Recycling", i.e. the chemical and thermal decomposition of waste plastics to the gaseous or liquid fuel. The legislative terminology is not developing as quickly as the technological advances, therefore, it is still not possible to name, describe (or allow) all of the processes. However, only the present mayor can decide about the future of the municipal waste. It may be taken as a source of energy, income or as an unnecessary burden. This call is wide-ranging and brings many risks. To receive a successful outcome, the representative as a manager must be able to handle many areas. In the municipal sector, the bio-waste is taken rather as a burden, not as a benefit. The ignorance of the potential use of such an organic source of energy is unacceptable. A rational management of the indigenous renewable energy sources is in accordance with the principles of sustainable development, thus becoming one of the pillars of the sound economic development of society.

Public administration is characterized in management by many specifics that determine the use of various instruments. The pressure of the modern management trends is high and the organization of the "bureaucratic and rigid" environments are forced to accept these trends coming from the private sector and subsequently to apply them with regard to their own conditions and options. The literature in this context puts many management skills to have a vision, be creative, dynamic, systematic and persistent. The municipal manager should be able to communicate with different types of people. It is very important to have the analytical thinking, as well as intuition, to follow the values ("value-driven"), to be consistent in his/her behaviour, to have a certain charisma (Wald 2007; Majtán et al. 2009).

Waste collection is a part of the management of urban waste management unit, where an important role is played by the local conditions. Abroad, the integrated systems of waste management are pro-

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cessed, the so-called ISWM (Integrated Sustainable Waste Management) (Bagchi 2004; Marshall 2013; Menikpura 2013). According to Cermak (2007), the management of the waste management is a sequence of operations arising from the generation of waste from the producer and it ends at the point of processing, or in the place of its disposal. In practice, during the decision-making process, the municipal representative can use many of the decision-making techniques. Randall (2000) offers a very detailed implementation plan for a typical person responsible for deciding about projects related to the waste management. According to Randall, this plan represents a guide which helps the municipal manager during the decision-making process. In our opinion, an excellent tool is the Ishikawa fishbone diagram which we created on the basis of our knowledge (Figure 2).

Slovak municipalities are in very different environments. The geographic location, the age structure, the complexity of infrastructure, the regional economic power or the political inclination is the determinant that may influence the bio-waste management in the region. Every commune or town has own PEST and SWOT analysis. There is a big difference between the structure of the bio-waste (e.g. limiting substances) in the municipality located near a factory or in a mountainous area. Questions related to the "waste management are analysed by many authors (Tittesi 2009; Dupal and Majtán 2013; Seshadri 2015). Szarková (2011) emphasizes the importance of communication and its various forms, e.g., "infotainment". This form informs about the problems in the society and in turn increases the interest of the employees, the public working issues/tasks that the company/firm is trying to solve or to involve to the resolution process. The mayor-manager may use entertainment and informative form of the communication with the citizens. Moreover, he/she can not only spread the message about the problem with the municipal waste, but he/she is also able to offer different solutions and benefits. Other advantage is a combination of the educational and motivational message. The waste management is enhanced all over the world by many expert reports (Ramboll 2006; O'Brien 2008; Kallman 2008; Rosenthal 2008). In this area, we can also use the outsourcing. However, the municipality or town must consider its advantages and disadvantages because it leads to problematic situations. As a result, no one has the control over the entire system and most efforts remain focused on the priorities at a lower level such as the recycling, which are important but not sufficient. The mayor must know how to identify the needs of the community and to sort these needs by priority.

MATERIALS AND METHODS

During the elaboration of the scientific paper, we decided to use various scientific methods. The abstraction, analysis, synthesis, inductive-deductive methods form the basis of the theoretical foundations. In the research process, we used the empirical – exploratory

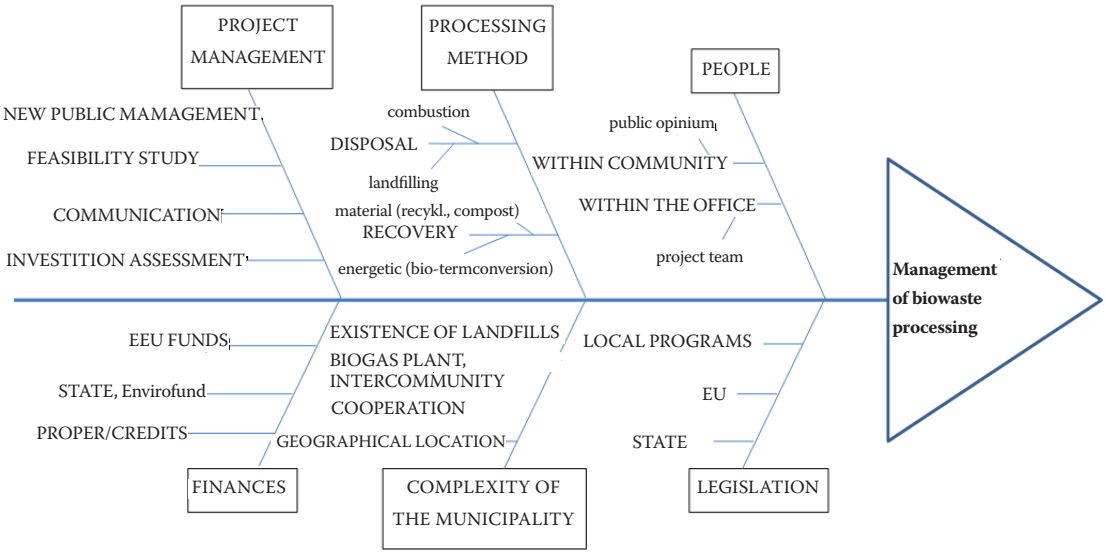

Figure 2. Ishikawa fishbone diagram

Source: own processing

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methods for collecting data through a questionnaire survey. We were looking for the relevant facts that provided a certain empirical picture about the study area – the bio-waste processing. The questionnaire method gives us the opportunity to obtain a large amount of information in a relatively short time, even without a direct contact with the individual respondents. The obtained empirical material went through the classification and relationship analysis. The questionnaire was distributed online to the mayors of randomly selected communes and towns in Slovakia. The questionnaire in the range of 29 questions was sent to 372 municipalities, more precisely to 301 communes and 71 cities (out of 2927 communes and 140 towns in Slovakia). After many reminders, 57 questionnaires were returned that represent the success rate of 15.32%. Then we processed and evaluated these responses by the statistical program PSPP and the graphics editor Microsoft Excel. The analysis of the hypotheses was done in the statistical program PSPP method Chi-Square, *t*-test and correlation. The objective of the questionnaire was to monitor the state of the waste management in Slovak communes and towns. We tried to create a universal model that will be useful in the process of the decision making, implementation and management of the bio-waste processing in the municipal sector. The questionnaire was divided into four thematic groups:

– set of questions leading to the identification of respondents – demographics – questions 1 and 2 (the age structure and the character of building settlements);
– set of questions leading to the financial situation of municipality – finance – financial resources for the waste management – questions 3–6; finance for the waste management from external resources of municipality – questions 7–10;
– set of questions that brought us the answers to the experience of the municipality or city with project management – Project management – Experience with investment project – questions 11–12; functioning of the internal system in municipality with an emphasis on project in the area of the municipal waste processing and its management – questions 13–18;
– set of questions designed to determine the status of the municipal waste management – municipal waste – questions 19–29.

The communes were divided into three groups according to the population: 0–1800 inhabitants (43% of our respondents), 1801 to 4000 inhabitants (38% of our respondents) and from 4001 to 8000 inhabitants (19% of our respondents). The total number of respondents from the communes included 107 814 inhabitants. The towns were also divided into three groups by the population: from 3000 to 18 000 inhabitants (47% of our respondents), from 18 001 to 38 000 inhabitants (33% of our respondents) and from 38 001 to 418 000 inhabitants (20% of our respondents). The total number of respondents from towns was representing 799 710 inhabitants. To sum up, the total number represented 907 524 respondents. The age structure was divided into the group to 60 years and above 60 years.

Different types of building settlements in our cities and communes were divided into three groups. Family houses, apartment buildings and almost nonexistent hamlets. Nearly half of the population is living in family houses in Slovakia. The second half of the population is living in apartments (Cár 2014). According to our questionnaire, the sample consists of 68% of people living in family houses, 29% in apartments and only 3% in hamlets. The cause of such distortion is the absence of respondents from large cities such as Košice (240 000 inhabitants). Solving of the problem is based on the official reports related to the bio-waste management in Slovak communes as well as on various expert studies, forecasts and expectations of the representatives from the national and foreign institutions. A large part of very important documents involves the use of renewable energy sources at the regional level with the emphasis on the biomass at the level of economy, industry and company. The most important information sources represent the statistical data that are published by the Slovak Statistical Office, the Ministry of Agriculture, and the Ministry of Environment, professional journals and the Research Institute of Agriculture and Food. The data collection consists of the following steps: the clarification of research questions and the selection of certain towns and communes, conducting structured interviews with key persons, document analysis and the development of model for a typical Slovak commune/town in which we animate the current and possible treatment of bio-waste.

RESULTS AND DISCUSSION

In the next chapter, we bring the most important findings by the sub-region to confirm or reject the above hypotheses.

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Demographic characteristics

The sample included communes and towns. Regarding the commune, the age structure of the population to 60 years is about 75%. Most of the population – 76.7% live in family houses. The amount of green bio-waste is bigger near to the family houses than apartments because they mostly have a garden. As the family houses mostly have a garden, the amount of green bio-waste is smaller near to apartments. It is also quite common that people compost own green organic waste in their composting plant at home and so they materially recover this waste. Regarding the town, the age structure of the population to 60 years is 78.3%. The majority of residents – 55.38% – live in apartments. We can assume that the separation will be more organized in the cities, because the community sets up special separation bins in front of the flats.

Finance

The average total municipal budget for waste management is 84 721.82 €. The commune has used 89.18% of the money from its own resources. More than 95% of communes have experience with the EU funds, but only 55% of them were drawn with regard to the municipal waste. There is a significant reserve for Slovak municipalities in the use of funding for the waste management from the EU funds. We have several reasons such as corruption, slowness of the process, the uncertain outcome, dissuasive bureaucracy. Slovak media bring negative news from this area, unfortunately, at frequent intervals. These reasons obviously discourage the mayors from the applications for the financial aid. The mayors often have no idea what are the latest features of the bio-waste processing in the world and what are the possibilities of financing from the EU funds for such technology.

The average total budget of towns for the waste management is 2 737 183.59 €. The commune has used 98.46% of the money from its own resources. All samples have an experience with the EU funds but only 66.6% of them were drawn for the municipal waste.

Recommendations:

– An appeal to the Ministry of Environment to present the latest possibilities of an effective energy or material recovery and to prepare for the municipalities some transparent scheme of funding opportunities for these purposes.
  Actively looking for funding opportunities of the waste management for responsible people.
– Currently, there is a wide portfolio of financial resources at home and abroad that supports the waste treatment.
– A precise selection of an external company that offers services to obtain money from the EU funds. Publicly available references about companies often save time and additional funds.

In the communes, 78.57% of the respondents have experiences with the investment project. The third of these respondents claims that it was a project over one half a million Euros. The communes rely on external companies in the case of the development (55%) and in spending of the EU funds (71.4%). The investment project (for example in the waste management) is a very difficult and complex process. If the commune carefully selects the partner, the main contractor, consultant, the project could be successful and beneficial. Most of the elected mayors (76.19%) consider the municipal budget as a danger. This subjective statement of our respondents convinces us of the fact that the mayors face a difficult financial situation, but they are not able to ensure the solution in the form of an external assistance. Almost 81% of the communes are convinced that their inhabitants are interested in the communal affairs. The following statistics present a paradox. Only 40% of the people are positive about the project on the environment. Only 28.57% of the people make suggestions for improving the operation of the commune and only 26.19% of them participate in the activities. 21.42% of the people are engaged in the innovative projects. The campus (90%), information boards/flyers/posters in different places of the commune (80.9%) are used for information, the promotion of the waste management. The community annually spends only 243.25 € for these activities. It is important to learn about the process of the waste processing already at the younger age. Moreover, some competitions can motivate and extend the knowledge. In the towns, 100% of the respondents have experiences with an investment project. The majority of them (53.3%) claims that it was a project over one half a million Euros. 63% of the towns rely on the external companies. They outsourced many activities such as the development of the social and economic plan, the budget planning, the development of the territorial plan, the audit and the assistance with the preparation of projects for the EU funds. The research confirmed

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that the current trend is outsourcing. Not only in the commercial sphere, but also in the communal one. When the autonomous body does not have sufficient experts for certain actions, this case is evaluated as ineffective for managing in-house and the actions are outsourced.

The mayors of towns (86.6%) see the size of the city as a benefit. 80% of them see the size of the budget as a threat. Same as in the communes, it is a pity that most of the money on the waste management comes from their own resources, despite the fact that there are many external resources that the city could use. The towns (73%) are convinced that their inhabitants are interested in the town's affaires, but only 26.6% of people around make proposals for improving their operation. This finding confirmed the fact that people are superficially engaged but if they do not see a direct impact on their own "territory", they do not seek the solutions how to improve this issue. Only 60% of the people think that motivational programmes are a good way to promote the proper treatment of waste. The cities annually spend only 389.26 € to raise the public awareness of this issue. Although certain communes and towns say that the education of children includes this issue, the education must continue also to the older age.

Recommendations:

– Training, courses how to receive money on the waste management are a good and not too expensive way to improve this unfavourable situation.
– A very good promotion of the bio-waste processing can improve the proper treatment of waste. People often do not know how much damage they cause, and reversely, how much they could help the environment and thus themselves.
– Obtaining grants, subsidies, the EU funds to promotional activities is one of the easiest ways of getting income into the municipal budget.
– The leaders of towns and communes can motivate the people by submitting proposals for new projects in the field of environment and waste, which could be beneficial for the community.

Municipal waste processing

More than 95% of the communes affirm that they separate the municipal waste, but only 21.5% of them recover it for the energy purposes!

That is almost 80% of the communes, which do not consume the energy hidden in the municipal waste. The organic waste fraction is unutilized, despite the fact that it could be transformed into a source of income for the municipality. In average, there are 706.88 tons of the municipal waste in the communes, and 46.43% of people process the waste at home. Only 9.5% of these municipalities have got a biogas station. In the case of certain communes, they manage an in-house boiler room (54%) and 87% of them use the fuel gas as an input. From these results, it is clear that the municipalities are often turning to external companies because of the municipal waste processing. Such a step could lead to lower overall cost, efficiency or inability of security. The low percentage of the biogas stations may be due to the already mentioned bad experiences with the existing projects. Frequently, a bad initial analysis of inputs and outputs causes problems with the projects. The incompetence of the management or the exaggerated expectations of investors may have the same effect. The dominance of fossil fuels as the input source of boiler rooms presents just a good overall picture of the current situation related to the renewable energy sources in Slovakia.

In the case of towns, 100% of the people separate their municipal waste, but again only a small percentage of them – 33% – uses it for the energetic purpose. Not using the scrap material, in which the energy is hidden, is the most important difficulty. Suitable technical solutions for it are available at present.

In towns, there is in average 26 494.63 tons of municipal waste produced yearly. Only 31.66% of towns process their municipal waste in their own charge. 93.33% of the towns founded a waste collection point for the green waste. 40% of the towns founded a biogas plant and 33% own a boiler. Up to 46.6% of the towns are a part of some micro association of towns in the field of the municipal waste handling.

Outsourcing does not apply only for the administration part, but also for the physical activities, e. g. the waste handling. It is not an exception that boilers are managed by private enterprises. Also biogas plants, sewage treatment plants or composting plants perform public activities but they are commercial entities, even if sometimes the municipalities own a share in their management. Positive is the fact that the towns cooperate in cases concerning the municipal waste issues.

Recommendations:

– For the municipality management, there is at present enormously important, or even inevitable to

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concentrate on the new trends in the bio waste handling. For such purposes, many seminars, conferences and periodicals are at the disposal. From many examples, we can mention the national as well as private ones, e.g. the Slovenská inovačná a energetická agentúra, the Ministry of Environment SR, the Odpady-portál, Energie-portál, the Združenie biomasa, Agrobioenergia, the journal Odpady and other.

– The know-how exchange among the towns and communes in these issues can bring a positive movement in the quality of life of their citizens.
– The transformation of the bio waste by the pyrolysis, gasification, fermentation, burning, composting or fertilizer conversion according to the analysis expediency.

SWOT analysis of a Slovak municipality in the field of the bio waste handling

The city mayor has an SWOT analysis about managing the bio waste at his/her disposal. It is important for the awareness of the current situation and at the same time, for the vision of the future state as it is displayed in Table 1.

In the following text, we bring in accord with the goal of this scientific article typical models of the communities and towns divided according to the size areas.

Community model sized O1 according to the number of citizens

A typical Slovak community sized O1 according to the number of citizens has up to 1800 citizens. There are in average 426 tons of the municipal waste from which, in average, 275 tons were separated. The community separates up to 100% of its waste, but only 16.6% of the communities use it for the energetic purpose, which creates not even 1 ton per year. Only 44% of them has founded a waste collection point. They do not run composting plants, sewage treatment plants or biogas plants, either. 55% of such communities own a boiler and 80% of them use natural gas as an entrance fuel. The budget for the municipal waste processing is in average around 15 000 EUR and the whole budget for the waste management stands for around 28 000 EUR per year. The money for this purpose flows from their own resources, even when 88.88% of the respondents claim that they have an experience with the EU funding. More than 61% of such communities have an experience with a capital project mostly (54.54%) up to 500 000 EUR. Such a community spends in average 30 EUR per year on raising the public awareness about the proper municipal waste processing and it is done in 94.44% cases by announcements on their web sites. The community is favourably entered in the cooperation with the local agriculture co-operative, restaurants, forests or another community.

Community model sized O2 according to the number of citizens

A Slovak community sized O2 according to the number of citizens has from 1801 to 4000 citizens. Up to 74% of the people live in family houses. There are produced in average 659 tons of the municipal waste from which, in average, 644 tons were separated. The community separates up to 100% of its waste, but only

Table 1. SWOT analysis

	Strengths	**Weaknesses**
Internal factors	Internal background knowledge Personal bonding in the villages Interest of people in the latest happening Size of the population – economies of scale More flexible management of the village Possibility of disposal fees determination	Limited budget Low commitment of people in the innovation projects Weak propagation of the proper bio waste handling
	Opportunities	**Threats**
External factors	Possibilities of drawing money from external sources New technologies of the energy bio waste handling Creation of micro associations aimed at sharing the know-how in the waste issues External education facilities in the waste issues	Missed possibilities of drawing money Environmental disasters Incorrect external cooperation

Source: own processing

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18% of them uses it for the energetic purpose, which creates about 2 tons per year. The whole budget of O2 community for the waste management stands for around 100 527 EUR per year. Nearly 89 000 EUR flow from their own resources and only 6600 EUR per year can be obtained from other than internal sources. The paradox is that 100% of the respondents claim that they have an experience with the EU funding and 50% claim to have an experience with using money for the municipal waste processing. More than 81% of the citizens are interested in the latest happening in their community. Nearly 82% of the communities educate children about the correct waste processing already at the nursery school, or later at the primary school. However, for such an activity, they spend only 246.25 EUR per year. 56% of such communities own a boiler and 100% of them use natural gas as an entrance fuel. Nearly 44% of the O2 communities use an external enterprise for the public greenery, market places and the cemetery maintenance.

Community model sized O3 according to the number of citizens

The communities according to the classification O3 have from 4001 to 8000 citizens. 81% of the citizens are people up to 60 years. 79% of the inhabitants live in family houses. The whole budget of an O3 community for the waste management stands for around 172 645 EUR per year. Nearly 95% of this money comes from their own resources. 100% of the respondents claim to have an experience with the EU funding and capital projects. As many as 75% claim to have an experience with using money for the municipal waste processing. 100% of the communities in the O3 category educate children about the correct waste handling already at the nursery school or later at the primary school. However, for such an activity, they spend only 287.5 EUR per year. There are produced in average 1614 tons of the municipal waste, from which in average 1042 tons were separated. Only 37% of them uses it for the energetic purpose, which creates about 23 tons per year. There is no bio gas plant in the O3 community. 50% of such communities own a boiler and 75% of them use natural gas as an entrance fuel.

Recommendations for the waste handling for communities sized O1–O3

Communities sized O1 to O3 should adopt the **domestic and communal composting policy together with 100% recycling** as a priority in handling the bio waste. If possible, they should make an effort to enforce using the local bio waste as an **entrance raw material** in boilers in the process of **burning**. The transformation of the bio waste to the energy carrier in the form of **pellets or briquettes** and afterwards its selling is an alternative how a community can increase its budget. **Biogas plants** together with suitably set parameters solve many bio waste problems. However, such an investment is really costly. In the community or near the community, there is supposed to be a waste collection point.

Town model sized M1 according to the number of citizens

In our classification of towns according to the size, the M1 towns have from 3000 to 18 000 inhabitants. Only 54.76% of the people live in family houses. The whole budget of a M1 town for the waste management is in average 242.617 EUR per year. Nearly 89% of the money comes from their own resources. 100% of the respondents claim to have an experience with the EU funding and capital projects. As many as 71.42% claim to have an experience with using money for the municipal waste processing. The same percentage, 71.42% of such towns, use an external agency for claiming money from the EU funds. For informing their citizens in the field of the waste management, 100% of the towns use informational leaflets, notice boards, posters. For such a public awareness activity, the town spends 510 EUR per year. There are produced in average 3586 tons of the municipal waste from which, in average, 93% tons were separated. Only 94 tons per year were used for the energetic purpose. Up to 68% of the towns use an external agency for the waste processing and transport. 100% of towns have founded a waste collection point for the green waste. 57% of such towns own their own boiler and 75% of them use natural gas as an entrance fuel. Up to 96% of the towns are favourably entered in the cooperation with another commercial entity or town in the field of waste management.

Town model sized M2 according to the number of citizens

The M2 towns have from 18 000–38 000 inhabitants. Nearly 81% of the people are up to 60 years and more than 60% of the people live in a block of flats. The whole budget of the M2 town for the waste

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management is in average 791 516 EUR per year. More than 90% of money comes from the town budget. In average, 26 394 EUR is used from other than own resources. All these towns have an experience with a capital project. 100% of the M2 towns claim that every citizen is actively interested in the latest happening. There are produced in average 23 923 tons of the municipal waste. It is surprising that from the mentioned municipal waste, not even 1 ton was used for the energetic purpose. 100% of the towns funded a sewage treatment plant. An M2 town does not have its own boiler plant. All these towns are able to cooperate in the field of the waste management.

Town model sized M3 according to the number of citizens

The M3 towns have from 38 001–418 000 inhabitants. 71% of the people live in a block of flats. The whole budget of a M3 town for the waste management is in average more than 10 million EUR per year. Up to 99% of money comes from the town budget. All these towns have an experience with a capital project, they are using state or other grants. The town uses around 630 EUR for the promotional policy in the field of the waste management. There are produced in average 84 233 tons of the municipal waste. Positive is the fact that more than 46 thousand tons are used for the energetic purposes. For the completeness sake, it is necessary to add that Bratislava is included in the M3 category with its own garbage disposal plant. The management of the municipal waste in all of these towns is done by an external entity. These towns run composting plants, sewage treatment plants and more than 66% of them the have a biogas plant. 100% of towns are favourably tempered towards the cooperation with another commercial entity or town in the field of the waste management.

Recommendations for the bio waste handling for towns sized M1–M3

While more money is available for the waste management there and the towns have a better access to external financial sources, the basic bio waste policies such as the **communal composting, waste collection points or recycling**, are supposed to exist. **Sewage treatment plant or biogas plant should not be an exception. A boiler** for bio waste is a good solution to the Waste-to-Energy issue. Modern **technologies of the thermochemical, biochemical or physical-chemical transformation** as e.g. the pyrolysis, fermentations or esterification are a big appeal. Advantageous are the output products, which can be subsequently sold. The disadvantage lays in a little experience and investment difficulties.

Evaluation of the hypothesis validity

The hypothesis analysis was done in the statistical programme PSPP by a chi-square statistic method, *T*-tests and correlation.

Hypothesis n. 1: The political allegiance of the mayor has an influence on the biogas station existence

We gained the political allegiance of mayors to a particular political party using the internet portal of the Statistical Office of the Slovak Republic (ŠÚSR 2016). The political influence was defined as a political allegiance of the mayor. Two groups of communities were created. In the first group (n = 11), there were the mayors of the political party SMER SD, or SMER SD in the coalition with other political parties. In the second group (n = 45), there were other political parties or independent candidates. Afterwards the relationship between the political allegiances of the mayor and the particular town or community owning its own biogas station were compared using the Chi-square method. We gained the following facts. *The difference between the communities or towns directed by the mayors with the political allegiance to the political party SMER SD and the others, concerning the existence of a biogas station, was not statistically significant:* $\chi^2 = 0.717$; $p = 0.397$. *Hypothesis H1 cannot be proven.*

It could be assumed that the leading representatives of municipalities with the political allegiance to the leading political party SMER SD will have during the two election terms significantly better built the environmental infrastructure. Our analysis confirmed the incorrectness of our hypothesis (Sigma = 0.397, which confirms the statistical insignificance). It means that the mayors have not, according to their political allegiance, automatically guaranteed a better access to resources as such and neither will it automatically help them with the bio waste processing in the form of a biogas plant. The existence of such device depends mostly upon other factors, for example upon the abilities of the mayor or upon the convenient geographic location. The discovered fact can partly indicate that in increasing the value of the bio waste issues, the existence of corruption methods or bureaucracy has

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Table 2. Hypothesis n. 1

Political party * Gas station Crosstabulation

			Gas station		Total
			yes	no	
Political party	Other parties	Count	9	36	45
		Expected Count	8.00	37.00	45.00
	Smer or other coalition party	Count	1	10	11
		Expected Count	2.00	9.00	11.00
Total		Count	10	46	56
		Expected Count	10.00	46.00	56.00

Chi-square tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	0.717a	1	0.397		
Continuity Correction	0.166	1	0.683		
Likelihood Ratio	0.814	1	0.367		
Fisher's Exact Test				0.667	0.363
Linear-by-Linear Association	0.704	1	0.401		
N of Valid Cases	56				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 1.96; b. Computed only for a 2 × 2 table

Source: own processing

not such a crucial influence as to be statistically significant. The results by PSPP program show Table 2.

Hypothesis n. 2: Citizens that are favourably tempered to projects related to the environment separate more kilograms of waste than the citizens who are not favourably tempered.

The first group (n = 25) was created by the municipalities, whose citizens were favourably tempered to environmental projects and this group showed an average score 329.68 kg of the separated waste per capita with the SD (standard deviation = 410.02 kg). The second group (n =31) was created by the municipalities, which were not favourably tempered to

Table 3. Hypothesis n. 2

Group statistics

	Positive mood concerning environment	N	Mean	Std. Deviation
Separated kilograms per inhabitant	yes	25	329.6880	410.02557
	no	31	194.3000	105.57459

Ranks

	Positive mood concerning environment	N	Mean Rank	Sum of Ranks
Separated kilograms per inhabitant	yes	25	30.96	774.00
	no	31	26.52	822.00
	Total	56		

Test statistics*

	Separated Kilograms per inhabitant
Mann-Whitney U	326.000
Wilcoxon W	822.000
Z	–1.014
Asymp.Sig.(2-tailed)	0.311

*Grouping variable: Positive mood concerning environment

Source: own processing

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environmental projects with an average score 194.3 kg and the SD = 105.57 kg. The separated waste was calculated as the relationship between the amount of waste and the number of citizens ×1000. Due to the fact of an unequal distribution of data in the file, the nonparametric test Mann-Whitney was used to compare these two groups. This test is equivalent to the *T*-test for the nonparametric spread data. On the basis of the results, we can state that the difference between the favourably tempered citizens and the others, concerning kilograms of the separated waste, is not statistically significant $U = 326$; $p = 0.311$. However, there is a big difference between the individual municipalities. Some separate a minimum (15 kg – community Kolbasov), and some significantly more (town Prešov – 35.88 tons).

Hypothesis H2 cannot be proven.

We assumed that the people who are favourably tempered to the environment will separate more. Our analysis demonstrating that this hypothesis was wrong and the theoretical attitude to the environment has no connection with the final action of the people. The results by the PSPP program is shown in Table 3.

Hypothesis n. 3: The amount of the municipal waste for energetic purposes is statistically significant depending upon the total budget for the waste management of a municipality

We suppose that when there is a larger amount of money in the budget, it will be automatically reflected into the programmes for increasing the value of the municipal waste, in our research into the energetic evaluation. As we have presented, the projects connected with the energetic refinement of the bio waste are very costly. A mutual correlation between the amount of money in the budget and the transformation possibility of waste into energy should exist.

The scale of the whole budget for the waste management correlates r = 0.997 with the scale of the amount of waste used for energetic purposes on significance level p < 0.05. A very significant interdependence between these two variables exists and it is also statistically significant. The hypothesis No. 3 is proven.

The results by the PSPP program are shown in Table 4.

Table 4. Hypothesis n. 3

Correlations

		How many tons used for waste-to-energy
Total budget for waste management	Pearson Correlation	0.997**
	Sig.(2-tailed)	0.000
	N	57

Source: own processing

The above mentioned hypotheses enriched our research with interesting aspects of decision making concerning the bio waste handling, it pointed to the fact that the whole process is not as easy and it depends upon many factors. Even when the public administration has its own specifics and they are presented within the view of the used managing tools, the abilities and skills of the municipal manager create the basic requirement for the successful waste solutions.

CONCLUSION

The energy crisis is a fact that is dangerous for a modern Slovakia at present. From our point of view, it is no longer about the shortage of the energy resources, but rather about the crisis caused by the turbulent political environment. Possible solutions in the field of the municipal sphere were identified. Crucial in the whole issue is the executor, manager, the mayor with a sufficient experience, who will be willing to apply the managing tools for solving the given crisis situation. The general view of the mayors on the up to now unutilized energy sources should be changed. He/she should start to perceive it as an opportunity for the improvement of the life of citizens. He/she should take advantage of his/her managing skills, to make this transformation. The European Union offers the support on both the informational (guided to the regional level) or financial level. It depends on the representative, how he/she will use that opportunity, how he/she is able to manage the mixture of tools.

In connection with energy crisis, we have asked three questions at the beginning of this work. Will we run out of energy? One of possible answers and solutions is to stop the increasing consumption of energy by its more effective usage and storage. How safe is our access to energy, it depends on our attitude to it. The research and development of energy, its diversification between the domestic and foreign supplies is one of the solutions of this problem. In the case of climatic changes it is necessary to always keep in mind the international agreements, in which Slovakia takes part. The change of the bio waste processing from the current dumping to the energetic usage is an unavoidable way, which we have to follow.

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Our western neighbours are the witness. Germany stopped dumping of the solid waste in 2005. A distinctive restriction of dumping in the EU should start in 2030 at the latest. According to the European package for circular economy, by 2030 every member state must lower dumping to the maximum 10% (Odkladal 2016). The biggest problem is, however, the logistics of the municipal waste collection. The EU imports approximately 6 million tons of phosphates per year, but up to 30% should be replaced by the extraction from the waste treatment sediment, the biologically decomposable waste, meat and bone meal or dung (Hutňaň 2015). Public education and advertising of new technological possibilities of the bio waste processing is necessary. It is "our" Slovak phenomenon. We are not for, or rather we are fundamentally against anything new, which could improve our environment. Even if people do not understand this issue, they are against it. The paradox is that they solve the bio waste issues by the worst possible way. That is why it is up to the community and town representatives, the government institutions, the environmental communities and the media to responsibly spread the public awareness of the advantageousness of installing the tools, which could help to solve the problem of the convenient bio waste processing.

We hope that this scientific article provided a comprehensive and overall insight to this issue not only from the technological and technical point of view, but also from the economic and managerial one. More and more the managerial expertise of the elected representatives, which could solve the most important issues also in this case rationally and systematically, not intuitively via the partial measures, comes to the fore.

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