COMPARATIVE ANALYSIS OF THE WASTE MANAGEMENT SYSTEM IN UKRAINE AND THE EU

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Introduction. Innovative enterprise solutions are a necessary factor for success and competitiveness in the modern business environment. Rapid technological progress and changes in consumer demand require enterprises to constantly update and improve their products, processes and services. In this context, a scientific study was conducted on the issues of innovative development of the enterprise in the field of a safe waste management system. The purpose of this scientific work was the research and analysis of factors affecting the successful implementation of the innovative potential of enterprises in the field of waste processing, as well as the development of recommendations for the effective implementation and management of the system of safe waste processing. The study was based on the analysis of modern theoretical approaches, as well as on practical examples of successful innovative activities of enterprises. The justification of innovative solutions of enterprises in the field of safe waste processing should be based on the principles of purposefulness, comprehensiveness, planning, orientation to market needs, availability of sufficient information and strategic direction. However, when implementing an innovative path of enterprise development, a number of problems may arise, including insufficient government funding, limited access to information and consulting, limited participation in international programs, problems of financing and transfer of innovations, legal inconsistencies, as well as insufficient training and skills in the field of entrepreneurship. Only this approach will ensure the stability, competitiveness and success of the enterprise in the long term.

It is worth noting that the sector of safe waste collection is gaining more and more importance in the international arena. Growing awareness of environmental issues and the need for effective waste management are driving the development of this sector. One of the key trends in the field of safe waste collection is the expansion of the legislative framework. Many countries are adopting new regulations and policies aimed at improving the efficiency of safe waste collection and treatment. Overall, the global field of safe waste collection continues to grow, with increasing popularity of separate collection and public participation in recycling programs. Efficiency, sustainability and reducing the negative impact on the environment through proper disposal and recycling of safe waste are important

priorities. The expansion of the safe waste collection and processing market indicates its importance in the economy. Companies specializing in these processes demonstrate sustainable growth and receive new opportunities for development. Growing public awareness of the waste problem and active participation in recycling and recycling programs are becoming more common. Companies committed to social responsibility contribute to increasing education about recycling and efficient use of resources.

Let's analyze literary scientific approaches to the topic.One of the most pressing challenges in the face of rapid industrialization is environmental sustainability. Untreated or non-refined waste can emit toxic and hazardous materials to the environment, contributing to the growth of pathogenic microorganisms. Inadequate waste management or segregation can give rise to the generation of hazardous materials that can impose major costs on organizations. One could argue that contamination and massive amounts of unmanaged waste will represent one of the most serious threats facing humanity. It will be extremely important for societies to implement effective waste management. Waste management involves a complex process that, besides disposal activities, involves such mechanisms as collection, transportation, temporary storage, processing, and dumping. This process is concerned with properly managing and disposing waste or recycling and reusing [1]. In most middle-income or third-world countries, factory managers often dump their waste, without any supervision, along roads or in open spaces so that it may be naturally disintegrated or incinerated. They may even leave waste in sea water. Such unjustifiable actions can lead to serious health and safety issues, insanitary conditions, and contaminations. Insanitary conditions and poor management can give rise to various problems such as a growing number of pests, contaminated runoff water and leachate discharge, and social unrest due to disgusting landfill odors. Also, collected wastecan pose major health issues to individuals. Waste disposal through the traditional waste management system, which operates on a daily basis, is extremely impractical and costly. Recycling bins have also proven to be widely ineffective [1]. Such observations underscore the urgent importance of using smart technologies in industrial sectors. Recently, novel ways of waste management through Industry 4.0 (I4.0) smart technologies have come to the fore. Such technologies can serve such processes as reusing, recycling, and repairing industrial waste. Smart technologies can help replace the traditional waste management systems with new systems equipped with smart sensors, and to provide a real-time supervision mechanism and a more advanced management structure. Using smart technologies (either in combination or separately in some cases) in industrial waste management can enhance disposal or recycling operations. However, if such technologies are implemented in organizations without specifically and scientifically formulated plans and without considering types of waste, they will fail to be helpful and can even impose huge costs on organizations. Many studies have explored industrial waste and challenges to waste

management, although they have mostly focused on solid industrial waste. However, industrial waste also includes leachate and wastewater, which are usually poured into water bodies by organizations, and thus damage aquatic ecosystems. To the best of our knowledge, no study has ever explored all industrial wastes simultaneously or investigated their challenges comprehensively. Similarly, no study has handled proper industrial waste management by focusing on indicators and solutions offered by smart technologies. Probing into the challenges of industrial waste management and selecting appropriate smart technologies to respond to such challenges are activities that face a huge degree of uncertainty, which has remained unaddressed in the literature.

Waste management aims to protect human health and the environment by reducing adverse impacts associated with waste generation and treatment. Nevertheless, waste management system performance is typically not monitored based on environmental impacts but based on indicators such as recycling rates. As part of study [2], Environmental Waste Utilization (EWU) is introduced as an indicator to monitor the capability of waste management systems to reduce the adverse impacts of waste generation and management. EWU quantifies the share of the environmental value of waste which is preserved through waste management. It is operationalized via a spreadsheet-based calculation tool, the EWU Dashboard. Case studies on plastic packaging waste, PAH-contaminated road debris, and food waste are presented to demonstrate the application range of EWU and its advantages against material efficiency indicators. It is shown (Fig. 1) that EWU-based monitoring allows for identifying environmentally preferable waste management strategies and enables sound decision support.

Rapid population growth and urbanisation have accelerated waste generation, and effective waste management has become a major challenge worldwide. With advances in technology and management methods, waste management strategies have begun embracing digitalisation, leveraging the Internet of Things (IoT), big data analytics, cloud/edge computing, machine learning, 5G communication, and blockchain technologies (Fig. 2). Amongst them, the blockchain technology has the structural features of achieving information security and integrity without central guarantees. Blockchain also meets the data record/storage needs of waste management and the design of new mechanisms for effective waste management. These benefits make blockchain an attractive technology in the field of waste management, with researchers and practitioners alike investigating its broad applications to support sustainable waste management.

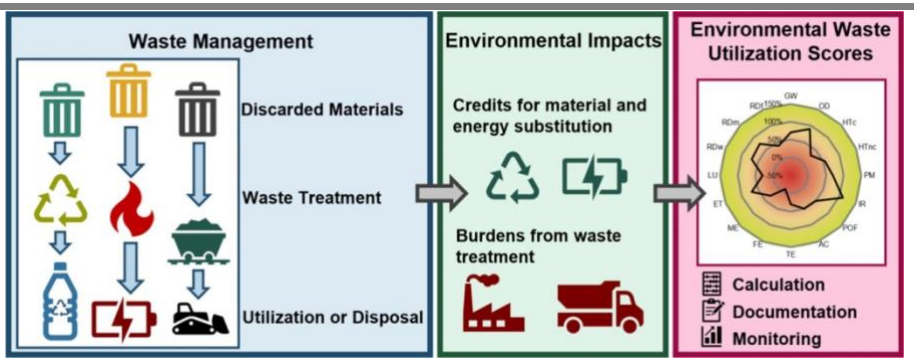

Fig. 1 – Environmental Waste Utilization score to monitor the performance of waste management systems [2]

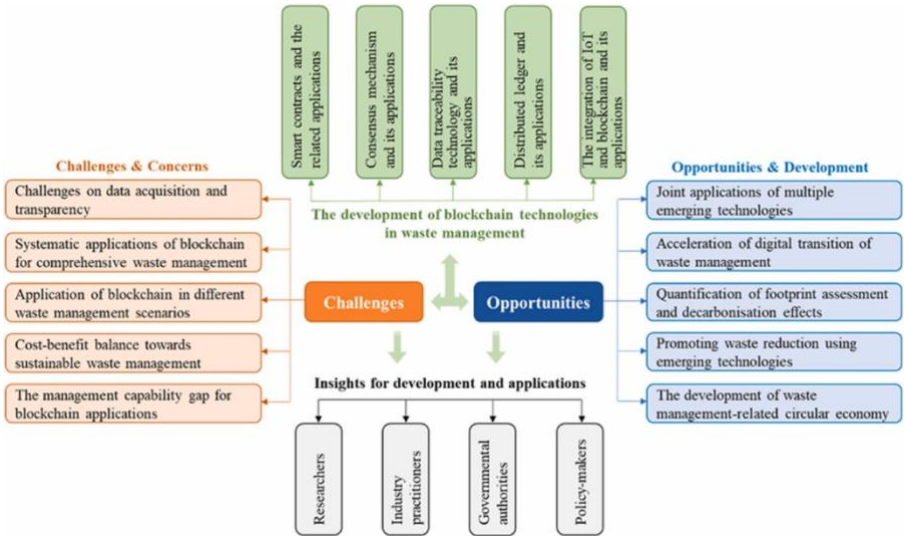

Fig. 2 – Blockchain technology applications in waste management [3]

However, this emerging technology has not yet been widely accepted by potential users. To further champion the application of blockchain technology, this review paper provides a systematic overview of the various pathways in which the technology has been applied in the waste management industry and further discusses its related challenges and opportunities via considering the promising prospect of combining blockchain technology with IoT, artificial intelligence (AI) and life cycle assessment (LCA). The study [3] also provides insights for interpreting some emerging applications of blockchain in the field of waste

management and clarifying the research paths in the context of blockchain, digitalised waste management, and circular economy.

The general practice of waste management is presented in the following literary sources [4-6]. Undoubtedly, the presented topic is relevant and requires detailed research.

Main Body. At the global level, the industry of safe waste collection is gaining more and more importance. Growing awareness of environmental problems and the need for effective waste management is a priority task for the development of many countries.

Sweden, which is one of the world leaders in the use of waste-to-energy technology, burns about 2.5 million tons of waste every year to generate electricity or heat. Dozens of waste processing plants and "garbage" power plants provide energy for about a million families (10% of the population). In Sweden, 99% of waste is used as fuel for power plants or as raw material for production.

In Norway, four tons of waste has the same energy value as one ton of fuel oil, which can heat a house for six months. One plant in Norway, working at full capacity, can provide heat and electricity to all schools in Oslo and 56,000 homes.

In Finland, like many countries of the European Union, there is a system of deposit value of packaging, where the buyer pays for the product and for the packaging (usually cans and bottles with drinks). This amount is fixed, and the buyer can return it by returning the used container to the store. The deposit value is always indicated on the package, and machines for returning containers are installed in many places, such as supermarkets, gas stations and small shops. In addition, there are benefits in the country for the payment of housing and communal services for those who sort garbage qualitatively and avoid its excessive generation. This makes it possible not to pay utility bills for 2 months a year.

The main trends observed in the system of safe waste management:

- expansion of the legal framework: many countries adopt new legal norms and policies aimed at increasing the efficiency of safe waste collection and treatment. This includes the creation of special rules for the disposal of hazardous substances, the implementation of safety standards and regulations for the collection and transportation of waste;

- market expansion: the collection and processing of safe waste is becoming an increasingly important sector of the economy. Companies specializing in the collection and disposal of waste demonstrate sustainable growth and receive new opportunities for development. Innovative technologies for processing waste and using it as resources are emerging;

- increasing public awareness: society is increasingly aware of the problem of waste and its impact on the environment. Separate waste collection and public participation in recycling programs are growing in popularity. Corporate social

responsibility campaigns actively promote education about recycling and efficient use of resources;

- technological progress: the development of new technologies in the field of safe waste collection and processing is becoming more and more active. Innovations include the use of biotechnologies, plasma gasification, high-temperature processes and other processing methods that allow reducing the impact on the environment and efficiently using waste.

Globally, the safe waste collection industry continues to grow, and there is a demand for innovation and improved waste management. Priorities include efficiency, sustainability and minimizing negative impact on the environment through proper disposal and recycling of safe waste.

Ukraine is at the stage of development of the field of waste processing, which is considered promising for investment. Today, Ukraine's losses amount to millions of tons of resource-valuable materials contained in household waste due to the lack of a recycling system, including separate collection, which can potentially be used in economic circulation.

According to the Law of Ukraine "On Waste", the main priorities of state policy in the field of waste management are the following directions [7]:

- ensuring full collection, timely neutralization and disposal of waste, as well as compliance with ecological principles during their processing;

– minimization of waste generation and reduction of its danger;

– integrated use of primary material resources;

– support for the maximum possible utilization of waste;

– safe disposal of waste that cannot be processed by developing appropriate environmentally safe technologies and practices for their management.

A more specifically considered issue of the state of the enterprise's industry more accurately reflects the trends in the innovation policy of the industry. Today, the industry of safe waste collection is becoming more and more aware and innovative. The state is trying to promote ideas that will positively affect the development of an innovative enterprise in the field of household waste collection. Based on the priorities of state policy, the main trends and directions of development of the studied industry can be identified:

– expanding the use of technologies: the introduction of new technologies in the collection of safe waste contributes to the improvement of the efficiency and environmental friendliness of the process. For example, the use of automated sorting and recycling systems, the implementation of information systems for waste monitoring and management, the use of drones and satellite surveillance to control waste collection;

– development of innovative recycling methods: the industry of safe waste collection is looking for new and effective recycling methods that allow to reduce the impact on the environment as much as possible and realize resource saving. For example, the development of new technologies for chemical waste processing, the

use of biological methods of cleaning and recycling, the introduction of new materials and processes in waste management;

– creation of environmentally sustainable solutions: in the collection of safe waste, more and more emphasis is placed on the creation of environmentally sustainable solutions. This means the implementation of a waste collection and sorting system with the aim of further processing and use in production, reducing the amount of waste, increasing energy efficiency and reducing emissions of harmful substances;

– promotion of innovation and start-ups: in the field of safe waste collection, there is an increase in support and stimulation of innovative start-ups. State programs and investment funds provide financial support and acceleration to young companies that develop new technologies and solutions in the field of safe waste collection and processing;

– social responsibility: awareness of social responsibility is growing in the field of safe waste collection. Companies set themselves the task of not only ensuring efficient waste processing, but also of contributing to the creation of jobs, supporting local communities and influencing positive changes in society.

These directions and innovations are aimed at improving the efficiency, environmental friendliness and sustainability of the safe waste collection industry, as well as at solving environmental problems and ensuring sustainable development.

The main strategic tasks are to reduce the volume of solid household waste (SWW), which is sent to landfills, by using modern environmentally-oriented technologies for their collection, storage and industrial processing, as well as in environmentally safe disposal.

For a more complete analysis of the industry, it is necessary to conduct a PEST analysis.

PEST analysis (also known as PESTEL analysis or PESTLE analysis) is a strategic analysis tool used to assess the external environment in which an organization or industry operates. The acronym PEST comes from the four factors analyzed: Political, Economic, Socio-cultural and Technological.

The main purpose of the PEST analysis is to identify external factors that can affect the success of the organization or industry. This analysis helps to understand a wide range of influences such as political changes, economic trends, cultural characteristics and technological advances. It allows you to identify opportunities and threats arising in the external environment, which helps in formulating strategies and making management decisions.

The main advantages of PEST analysis are as follows:

1) Broad overview: By analyzing the political, economic, socio-cultural and technological context, a PEST analysis provides a more complete overview of the external environment.

2) Identification of opportunities and threats: Analysis helps identify new opportunities for development and identify potential threats, providing an evidence-based basis for strategic planning.

3) Forecasting changes: PEST analysis helps predict possible changes in the external environment, which allows an organization or industry to prepare for them and adapt.

4) Support of strategic decisions: The results of the analysis can be used to develop strategic plans and make managerial decisions oriented towards the external environment.

In summary, PEST analysis is a useful tool for evaluating external factors that affect an organization or industry. It helps to understand the broader context and make informed strategic decisions to adapt to changes in the environment (Table 1).

Table 1 – PEST analysis of the safe waste collection industry

Aspect	Description
Political	– existing legislation and regulations; – public pressure;
Ecological	– market potential; - economic stability;
Sociocultural	– public awareness; – cultural news;
Technological	– innovative technologies; – infrastructure.

1) Legislation: Ukraine has a regulatory framework that defines the requirements for the collection, processing and disposal of safe waste. There are laws and regulations regulating the responsibility of businesses and citizens in the field of waste management;

2) Public pressure: public expectations for environmentally friendly waste management are growing. Public organizations and activists influence policy-making and encourage businesses to take a more responsible approach to waste collection and disposal;

3) Market: Increasing awareness of waste and environmental management is driving demand for safe waste collection and recycling services. The market has potential for development and investment attraction;

4) Economic stability: stable economic development contributes to an increase in financial resources that can be allocated to the development of infrastructure for waste collection and disposal;

5) Public awareness: public awareness of environmental issues and the need for effective waste management is growing. Support for separate collection and public participation in recycling programs is growing;

6) Cultural influences: Cultural beliefs and customs can affect the efficiency of waste collection and disposal. For example, in some regions there may be traditions that promote environmentally unfriendly waste management;

7) Innovative technologies: the introduction of new technologies, such as the use of biogas plants or automated waste collection systems, can improve the efficiency and environmental sustainability of the waste management process;

8) Infrastructure: the development of infrastructure for waste collection, processing and disposal in Ukraine may affect the availability and efficiency of these services.

Considering the mentioned aspects of the PEST analysis, it can be concluded that the industry of safe waste collection in Ukraine has the potential for development and improvement. There is support from political bodies, the public and the economic environment. The introduction of innovative technologies and the modernization of infrastructure can contribute to improving the efficiency and sustainability of waste management.

The main measures that contribute to solving the problem of solid household waste include [7]:

– creation of infrastructure for the system of separate collection of waste components and formation of separate streams;

– development of the waste processing system, including sorting, briquetting, composting and application of thermal technologies, such as incineration, thermal and biothermal decomposition, as well as gasification;

– the use of anaerobic and other biotechnologies is also an important aspect;

– development of industrial infrastructure aimed at the use of secondary raw materials obtained from waste;

– ensuring ecologically safe disposal of waste or residual products of waste processing at landfills.

These measures are aimed at reducing the amount of waste, improving its management and ensuring the use of secondary raw materials to reduce the negative impact on the environment and create a more sustainable and environmentally safe waste recycling sector [7].

Ukraine is actively working to solve problems in the field of safe waste collection, but there may still be a lot of work to achieve high standards of environmental sustainability. To do this, it is important to continue to strengthen legislation, promote innovation and involve the public in active participation in waste collection and recycling programs.

There are several potential benefits to a municipally owned safe waste collection business. The following can be distinguished among them:

– control over waste: a company owned by the municipality may have a greater ability to control the collection and treatment of safe waste in its territorial community and allows for effective organization and implementation of standards of safe waste treatment;

– impact on environmental sustainability: the utility company has the opportunity to influence the development of environmentally sustainable waste management. By implementing modern technologies and innovative approaches to the treatment and processing of safe waste, the enterprise can help reduce the negative impact on the environment and improve the state of the ecosystem;

– market expansion: a utility may have an advantage when entering the safe waste collection market. Such enterprises often have priority when concluding agreements with local self-government, state institutions and enterprises located on their territory. This can ensure a stable flow of orders and long-term cooperation;

– attraction of investments: the utility company can attract investments from local authorities or other sources of financing to expand its activities or modernize the existing infrastructure and can contribute to the improvement of technical equipment, work efficiency and increase of the company's capacities;

– social responsibility: a community-owned enterprise usually has a social responsibility towards its employees and the local population. It can provide stable employment, decent working conditions and contribute to the development of social programs and projects for local communities.

Given that a safe waste collection company is municipally owned, there may be some disadvantages to contend with:

1) Bureaucracy and slow decision-making: communal structures can have a complex management apparatus that slows down decision-making processes and the implementation of new initiatives. This can affect the speed of response to changes in the field of safe waste collection and innovative approaches.

2) Lack of competition and innovation: There may be less competition in the utility sector compared to private companies. This can lead to less incentive to innovate and improve waste collection and disposal processes. It is important to stimulate utility enterprises to constantly improve and introduce new technologies.

3) Financial constraints: Utilities often face financial constraints and insufficient funding. This can make it difficult to introduce new technologies, upgrade infrastructure and train staff. It is important to ensure adequate financing and attracting investments to support utility enterprises.

4) Absence of a competitive market: in communal property there may be no or limited competition with private enterprises. This can lead to insufficient efficiency and quality of safe waste collection services. It is important to create conditions for the development of competition and to stimulate utility companies to improve quality and efficiency.

Therefore, a community-owned safe waste collection facility can have many benefits, including waste control, impact on environmental sustainability, market

expansion, investment attraction, and social responsibility. It is important to ensure effective management of utility enterprises, to attract qualified personnel and support their development. It is also necessary to create favorable conditions for partnerships between utilities and private entities to improve the quality and efficiency of safe waste management.

The implementation of innovative solutions in the field of safe waste collection will lead not only to achieving certain economic effects, but also social ones. The use of the latest technologies and processes can reduce the costs of waste collection, processing and disposal. This can lead to reduced costs for waste disposal companies and the creation of new markets and opportunities for innovative companies in this field. In addition, reducing environmental pollution and improving air and water quality can reduce the costs of treating pollution-related diseases, which benefits society as a whole.

However, the social effects of innovation in this field are just as important. Reducing emissions of harmful substances and environmental pollution can have a positive effect on people's health, especially those who live near waste collection and treatment sites. This can improve the quality of life of residents and reduce the risk of various diseases. In addition, innovative approaches to waste collection can help create new jobs and support economic development in the industry.

It is important to note that the implementation of innovative solutions in the field of safe waste collection can contribute to increasing the environmental awareness of society. The widespread use of the latest technologies and practices can inspire people to change their behavior and contribute to the introduction of a more sustainable lifestyle. This can have a positive impact on conserving natural resources and reducing waste, contributing to a more sustainable and environmentally friendly society.

The implementation of innovative solutions in the field of safe waste collection will not only help to achieve certain economic advantages, but will also positively affect social progress. It will promote change for the better, ensuring the sustainability of the economy, improving the quality of life and preserving the environment for future generations.

To assess the situation at the enterprise, a SWOT analysis should be conducted. This tool allows you to analyze the strengths and weaknesses, opportunities and threats associated with the implementation of innovations. SWOT analysis helps to identify the company's strengths (experienced personnel, strong brand, financial resources, unique technologies), identify weaknesses (budget constraints, instability of operational processes, insufficient resources), recognize opportunities (new markets, growing demand, changes in legislation , technological breakthroughs) and identify threats (competition, changes in consumer preferences, political instability, changes in legislation). SWOT analysis provides the company with a basis for developing strategies aimed at successfully implementing innovations and achieving competitive advantages.

The obtained results of the strengths and weaknesses of the SWOT analysis of Poltava Communal Motor Vehicle Enterprise 1628, which implements the safe waste management program, are shown in Table 2.

Table 2 – Determination of strengths and weaknesses of Poltava Communal Motor Vehicle Enterprise 1628

Strong sides	Weak sides
– high level of digitization; – availability of own production facilities; – availability of own unused space; – highly qualified engineering and technical staff; – being in communal ownership; – availability of young, creative and energetic employees of financial services; – many years of experience in the market; – positive dynamics of employee labor productivity, capital return and material return; – growing interest of investors; – availability of stakeholders and an effective organizational structure; – clear division of duties between employees and existence of a social task; – reliable suppliers of raw materials and materials; – absence of an analogue enterprise.	– lack of own financial resources; – the development strategy is not fully defined; – rising prices for materials and wages; – outdated car fleet; – an outdated system of calculating the cost of customer service; – the complexity of making risky decisions; – lack of permanent investors.

The company has strengths that can contribute to its success and competitiveness. A high level of digitalization, the presence of own production facilities, unused space, qualified personnel and many years of experience in the market are significant assets that allow us to effectively use digital technologies, improve productivity, attract investors and satisfy customer needs. Having young, creative and energetic employees in financial services can promote innovation and strategic development.

It is also important to use the availability of stakeholders and an effective organizational structure to ensure cooperation and interaction between all stakeholders. A clear division of responsibilities between employees will help ensure efficient work and avoid unnecessary duplication of functions.

The existence of a social task indicates the responsibility of the enterprise to society and the desire to make positive changes in the surrounding environment. This can contribute to increasing the company's reputation and attracting favorable perception from customers and the public.

Reliable suppliers of raw materials are an important resource that can guarantee a stable and continuous supply of the necessary components for production. This allows you to avoid problems with interruptions in production and ensure product quality.

The absence of an analogue enterprise may indicate the uniqueness and unrepeatability of the enterprise's offer on the market. This creates opportunities for development and taking a leadership position in your field.

However, there are also weaknesses that can potentially affect the company's operations. Lack of own financial resources, not fully defined development strategy, and other problems, such as rising prices for materials and wages, an outdated vehicle fleet, and a system for calculating the cost of customer service, can complicate the operation and development of the enterprise.

To achieve success and ensure sustainable growth, the company should actively work on solving weaknesses, attract additional financial resources, develop a clear development strategy, modernize the fleet and make improvements to the customer service system. It is also important to attract new investors and maintain positive dynamics of productivity and work efficiency.

Despite the existing challenges, the presence of strengths and opportunities allows the company to work on the market, ensuring stability and development in the digitalized economy.

The general conclusion from the indicated strengths and weaknesses is as follows: the enterprise faces some problems, in particular technological lag, unsuccessful investment policy, economic crises and political instability. Such factors can complicate the successful development of the enterprise and affect its competitiveness (Table 3).

However, at the same time, the company has a number of strengths that create the potential for successful development. In particular, this is the expansion of the area of activity, conducting scientific research, creating a social mission and expanding the types of activities. Also important factors are the attraction of investors, the growth of labor productivity and material security of employees, the modernization of technological equipment and the creation of an organizational culture.

So, even though the company faces challenges in its operations, having the potential for change and development can contribute to overcoming problems and achieving success in the future. Emphasis should be placed on addressing weaknesses, such as technological backwardness and the instability of the legal framework, as well as on maximizing the use of strengths to stimulate growth and improve enterprise performance.

Innovative policy for an enterprise whose main activity according to Classification of types of economic activity is the collection of safe waste must be intertwined with modern trends in the field of waste management and take into account key nuances regarding transportation, storage, processing or disposal. In this case, it is important to focus on the following areas for innovative activities at a municipal trucking company that deals with household waste management.

Table 3 – Definition of market threats and opportunities for innovative activity of Poltava Communal Motor Vehicle Enterprise 1628

Market threats	Market opportunities
– technological lag behind enterprises of European countries; – unsuccessful investment and innovation policy; – crisis phenomena in the country's economy; – high rates of inflation; – instability of the legislative framework; – political instability; – low level of introduction of innovations; constant pollution of the environment;	– expanding the area of activity; – conducting scientific research in the field of processing; – creation of a social mission; – expansion of new activities and services; – savings due to recycling and sorting; – attraction of investors; – increase in labor productivity and material well-being of employees; – increasing the profitability of the activity; – modernization of technological equipment; – creation of organizational culture at the enterprise; – appearance on the market of a zero-waste or low-waste enterprise.

– implementation of effective waste collection and sorting systems: development and implementation of innovative methods of collection and sorting of household waste can help reduce the amount of waste, increase the percentage of recycling and contribute to environmentally sustainable development. It is necessary to consider the option of using automated sorting lines, implementing a separate waste collection program and organizing collection points in important points of the city;

– use of energy technologies for waste processing: review the possibilities of using innovative technologies, such as biogas plants or pyrolysis, for processing organic waste into renewable energy. This will reduce the negative impact on the environment and efficiently use resources;

– implementation of information technologies to optimize processes: the use of digital technologies and information systems can contribute to effective route planning, monitoring of container occupancy and resource planning. The use of mobile applications, sensors and a waste management system can improve efficiency and increase the quality of services provided.

Pyrolysis is a process of thermochemical decomposition of organic materials at high temperatures in conditions of limited air access. As a result of this process, waste is decomposed into solid, liquid and gaseous fractions. Various fractions, such as biofuels, syngas or chemicals, can be used as energy sources or raw materials for other processes. Pyrolysis can be particularly effective for processing organic waste such as straw, wood or agricultural waste.

Since Ukraine is closely connected with the countries of the European Union and is gradually integrating into it both economically and legislatively, innovative measures should be taken into account precisely in this context. In Europe, there is considerable attention to environmentally sustainable development and effective waste management. According to the conducted research, the following main ways were identified, taking into account the European experience of safe waste management:

– use of European standards and best practices: study of European standards and best practices for household waste management can help the enterprise to improve its activities. Research of best practices in European countries, use of European regulatory documents and participation in international conferences and exchanges can bring new ideas and approaches;

– involvement in European programs and initiatives: European programs and initiatives aimed at supporting environmentally sustainable development and waste management can provide financial and technical support. The enterprise can join such programs, receive financing for the implementation of innovative projects, as well as cooperate with other European partners to exchange experience and knowledge;

– development of the recycling and sorting system according to European standards: it is important to implement modern waste sorting and processing methods that meet European standards and requirements. This may include the development and implementation of new sorting technologies, modernization of equipment and infrastructure for waste processing in order to achieve high rates of recycling and reuse;

– public encouragement and education: involving the public in the process of waste sorting and environmentally conscious consumption can be an important aspect. The organization of information campaigns, trainings and educational events aimed at raising awareness and involving the public can contribute to improving the quality of waste sorting and processing.

These approaches will help the enterprise to ensure effective waste management, taking into account European experience and principles of sustainable development.

The main strategic directions for Poltava Communal Motor Vehicle Enterprise 1628 may include:

– improvement of the sorting system;
– expansion of processing infrastructure;
– conducting information campaigns and training;
– development of innovative technologies;
– partnership and cooperation.

Taking into account the restraining factors, strengths and weaknesses, threats to the possibility of introducing innovations, the following strategic directions were created for Poltava Communal Motor Vehicle Enterprise 1628 (Table 4).

The strategy for increasing the volume of waste sorting and processing involves the expansion and modernization of sorting lines and processing facilities, the introduction of innovative technologies and the attraction of additional resources and investments. The implementation of these measures will lead to an increase in the volume of waste processing, an improvement in the quality of sorting and recycling, and a decrease in the amount of waste entering the landfill.

The strategy for improving the waste management system includes the development and implementation of effective methods of waste collection, transportation and storage, the establishment of a monitoring system to control the quality and quantity of sorted waste, as well as the implementation of a system of responsibility and regulation of waste management. These measures will help improve the waste management system, ensure an efficient collection and recycling process, and improve control over the quality and quantity of sorted waste.

The strategy for promoting environmental awareness and involving the public includes the organization of educational campaigns and training events on waste management, conducting information campaigns about the benefits of sorting and recycling waste, as well as involving public organizations and activists in joint work with waste. The implementation of these measures will contribute to increasing the environmental awareness of the public, changing the practices of the population regarding the responsible attitude to waste and ensuring a positive impact on the environment.

The strategy for the development of innovative technologies and products for waste disposal involves investing in research and development of new waste processing technologies, cooperation with scientific institutions and innovative enterprises to create new products using waste, as well as the introduction of innovative technologies in the process of sorting and recycling. These measures will increase the efficiency of waste disposal, create new products and materials using waste, and reduce the negative impact on the environment.

Table 4 – Strategic measures for the formation of the innovative policy of Poltava Communal Motor Vehicle Enterprise 1628

Strategy	Measures for implementation	Result
Increasing volumes of waste sorting and processing	– expansion and modernization of sorting lines and processing plants; – introduction of innovative technologies to improve the sorting and recycling process; – attraction of additional resources and investments;	–increase in the volume of waste to be processed; –improving the quality of sorting and processing; –reduction of the amount of waste entering the landfill;
Improvement of the waste management system	– development of effective methods (collection, transportation, storage of waste); – establishing a monitoring system to control the quality and quantity of sorted waste; – implementation of the system of responsibility and regulation of waste management;	–implementation of effective methods (collection, transportation, storage of waste); –establishing a monitoring system to control the quality and quantity of sorted waste; –implementation of the waste management system;
Promotion of environmental awareness and public involvement	– organization of educational campaigns and training events on waste management; – conducting information campaigns about the benefits of waste sorting and recycling; – involvement of public organizations and activists in joint work with waste;	–raising public awareness of environmental issues and the importance of waste management; –changing the attitudes and practices of the population regarding a responsible attitude to waste;
Development of innovative technologies and products for waste disposal	– investment in research and development of new waste processing technologies; – cooperation with scientific institutions and innovative enterprises to create new products using waste; – introduction of innovative sorting and processing technologies.	–increasing the efficiency of waste disposal; –creation of new products and materials using waste; –reduction of negative impact on the environment.

It is worth noting that the company is gradually introducing modern, trendy and at the same time innovative measures that greatly facilitate and simplify its work. For example, there is a route schedule on the company's website, which shows the time, place and number of cars that will arrive for the removal of household waste (Figure 3, a).

One of the innovative decisions made can be considered the introduction of the ecobus (Figure 3, b). Ecobus is an innovative vehicle designed to collect used batteries and electronic waste. This project was created to improve the management and recycling of waste, particularly used batteries, which contain hazardous chemicals.

Ecobus is a special vehicle equipped with special containers for collecting used batteries. This bus can run around the city and collect waste directly from residents. It has special compartments where people can drop off their used batteries and other electronic waste.

After collecting the used batteries, the ecobus delivers them to specialized facilities for recycling. There, batteries are broken down into components such as metals, plastics and other materials that can be reused or recovered. This recycling process helps avoid the release of hazardous substances into the environment and ensures the reuse of materials from collected batteries.

Ecobuses can be used as an additional waste collection tool that complements existing waste sorting and recycling systems. They help raise awareness of environmental issues and expand opportunities for recycling used batteries and electronics.

Ecobuses are just one of many examples of how innovative technologies can be used to solve environmental problems and create a more sustainable future. By collecting and recycling used batteries, ecobuses help reduce the negative impact of this waste on the environment and contribute to the conservation of natural resources.

Accordingly, the creation of a route system is a positive decision and makes life much easier for the population, but I would like to suggest its improvement. It is necessary to develop a mobile application for consumers. The use of mobile programs for garbage collection is an innovative proposition that helps businesses improve the efficiency and organization of the garbage collection process. Such applications provide a convenient and fast way to order and coordinate garbage collection through mobile devices such as smartphones or tablets.

a)

b)

Fig. 3. a – Examples of waste sorting and took it away;
b – image of the ecobus in action

We can distinguish the following advantages of using mobile applications for garbage removal at the enterprise:

– convenience and accessibility: users can order garbage collection at any time and from any place using a mobile device with Internet access. This allows

you to effectively manage the removal of garbage without the need for personal contact or phone calls;

– an automated process: mobile apps for garbage removal can be integrated with the waste removal management system at the enterprise. It allows you to automatically receive orders, generate delivery schedules and remind customers of the required actions;

– tracking and reporting: Mobile apps can provide detailed information about order status, including pickup time, trash type, address, and payment status. This allows businesses to accurately track waste removal and ensure quality of service;

– promoting environmental awareness: mobile applications can also include information on recovery and recycling processes, advice on waste sorting and environmental news. This helps to increase the environmental awareness of customers and encourages them to a more sustainable way of managing waste;

– reduction of administrative costs: the use of mobile applications allows you to automate many administrative processes related to the removal of garbage. This can lead to reduced personnel costs and improved business efficiency.

In general, the use of mobile applications for garbage collection is an important innovative step for enterprises in the field of waste management. They promote convenience, automation and environmental awareness, which helps to improve the waste collection process and reduce the negative impact on the environment.

To achieve greater effects, attention should be paid to the modernization of the enterprise with new equipment such as biogas plants. The use of energy technologies for waste processing is an important component of the waste management strategy. Innovative technologies, such as biogas plants or pyrolysis, provide new opportunities for converting organic waste into renewable energy.

Biogas plants use the process of biological decomposition of organic materials, such as food waste, sewage or plant biomass, to produce biogas. Biogas, which consists mainly of methane, can be used as an energy source for heating, electricity generation or fuel for transport. The use of biogas plants allows for the simultaneous processing of waste and the production of sustainable and renewable energy, thereby reducing dependence on traditional energy sources and reducing greenhouse gas emissions.

Regarding innovative policies, it is important to take into account modern trends in the field of waste management and focus on the implementation of efficient waste collection and sorting systems, the use of energy technologies for waste processing, and the implementation of information technologies for optimization.

In general, the developed innovative solutions will contribute to the improvement of waste management, the increase of sorting and recycling volumes,

the reduction of the impact on the environment and the creation of a more sustainable future.

Conclusion. Innovative solutions in the field of safe waste collection and processing are an important trend today. Ukraine is at the stage of development of the waste processing sector, which is considered promising for investment. Losses of resource-valuable materials are quite significant due to the lack of an effective recycling system, including separate collection. The European experience of safe waste management was analyzed in the study. On the basis of the obtained results, key factors affecting the choice of innovative solutions in this field were identified. Recommendations were developed for the formation of the innovative strategy of the enterprise, the attraction of innovative capital, the creation of a favorable innovative atmosphere, and the improvement of the management processes of innovative projects in the field of safe waste management. The need for constant updating and improvement of the innovative potential of the enterprise, active cooperation with scientific and business partners, as well as understanding the importance of effective management of innovative projects was determined. It was noted that achieving success in the field of innovative development is a key factor for ensuring sustainable competitive advantage and strengthening the company's position on the market. A detailed analysis of the current situation was carried out, a plan for the implementation of innovative solutions in the waste management system was developed, and a control mechanism for their implementation was developed.

For a more complete analysis of the industry, a PEST analysis was applied based on an assessment of the political, economic, socio-cultural and technological environment. The main measures that contribute to solving the problem of solid household waste have been formed. The advantages and disadvantages of enterprises engaged in waste collection are determined. In order to assess the situation at the enterprise, a SWOT analysis was conducted, which made it possible to analyze the strengths and weaknesses, opportunities and threats associated with the introduction of innovations. Based on the calculations, a program was developed to ensure effective waste management, taking into account European experience and principles of sustainable development. The expediency of integrating the route system, which greatly facilitates the life of the population, the introduction of the ecobus, the development of a mobile application for consumers, which allows you to order and coordinate the removal of garbage through mobile devices, is considered. Modernization of the enterprise with the help of new equipment is defined as the direction of effective waste management. Innovative technologies, such as biogas plants or pyrolysis, provide new opportunities for converting organic waste into renewable energy. The modern trends in the field of waste management allowed us to focus on the following innovative areas related to the use of efficient waste collection and sorting systems, the use of energy

technologies for waste processing, and the introduction of information technologies for optimization. The developed innovative solutions will help to improve waste management, increase sorting and recycling volumes, reduce environmental impact and create a more sustainable future.

The financial projections presented in this article relate to investment and operational financing needs during the reform of the waste management system. The investment plan is designed to ensure that all calculated costs can be covered from various sources of financing. In addition to international organizations, the state budget of Ukraine, the local budget of the Poltava region, the budgets of territorial communities and the population in particular will be the donors of this project.

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