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ASSESSMENT PROFILE OF WASTE MANAGEMENT SYSTEM IN UKRAINE BASED ON THE STAGE MODEL OF DEVELOPMENT

This paper presents a theoretical substantiation of the stage model of waste management development. These stages have been derived inductively from analysing different European waste management systems and can be supported by a system of indicators as well as a critical empirical-content-related analysis of waste management data from various European countries. Main aim of this research is to assess the waste management system in Ukraine based on the model under study, create an assessment profile.

Keywords: stage model of waste management development, assessment profile, system of indicators.

Introduction. Waste management has extensive effects on overall sustainability. Separate collection and sorting of waste add to recycling/reuse, decrease the need for new resources, cut down the amount of land needed for landfills and the amount of fossil energy, if we use waste for energy production. The objective of comprehensive sustainable waste management is to deal with society's waste in a way that is environmentally efficient, economically affordable, and socially acceptable. Providing sophisticated disposal in terms of technology and organization adds to social purposes like a livable physical environment, but social sustainability also requires intra-generational responsibility of waste management.

The problem setting. In Ukraine solid waste management plans and concepts were adopted which include impossible task and the main reason for their implementation impossibility is the low environmental awareness of the population. Research showed that the majority of European countries have successfully implemented a strategy of solid waste management, and now in some countries is forbidden to place on the landfills the solid waste that have not been processed. New strategies, that aimed to use alternative energy resources, regard as an alternative as well the municipal solid waste. The development of a country's waste management system illustrates a sequence of comprehensive innovation projects that apply for appropriate requirements. European scientists have proved existence of six stages of waste management development. These stages have been derived inductively from analysing different European waste management systems and can be supported by a system of indicators as well as a critical empirical-content-related analysis of waste management data from various European countries. It is significant to determine the stage of development that can be attributed to the stage of waste management system in Ukraine and define the factors that influence on the system's development. This help to create realistic plans that include tactical and strategic tasks that correspond to the economic, social, legal and environmental level of development of the country.

Analysis of recent studies. Investigation of waste management and involving waste in the economic sector were studied by a lot of Ukrainian scientists, in particular V. Michthenko, H. Vygovska [9; 11; 12]. This research paper is based upon the central hypothesis that modern society's waste management system passes through several stages. These stages have been derived by U. Gelbmann, H. Klampfl-Pernold, G.Schmidt [4; 10] from analysing different

European waste management systems and can be supported by a system of indicators.

Main aim of this research is to assess the waste management system in Ukraine using the model under study as a basis for defining the relevant indicators and for creation of an assessment profile which displays the current economic, social, legal and environmental level of Ukraine's development.

Basic material. With the industrialisation waste emerged in the proper sense. Waste had to become a problem so that waste management could develop. Within industry, commerce as well as households non-renewable resources were used with increasing intensity. Furthermore the economic development of the industrial system took up pace. Products got replaced faster and more frequent and were devaluated to waste. Through the development of new technologies and energies, the large scale use of raw materials that have been rarely used yet as well as the development of new markets a self-reinforcing process came into being [8]. All these factors lead to an increasing economic and social change as well as a so far unknown amount of waste.

Waste management is viewed as part of a generation, collection and disposal system. The move to a more sustainable society requires greater sophistication to manage waste. A traditional approach is unsustainable as it lacks flexibility and long term thinking. The drive to create a more sustainable country has required governments, business and individuals alike to examine the environmental and social impacts of current and proposed activities.

The aim of the classification waste management development into several stages that be derived by U. Gelbmann is to prove that waste management is nothing else but an on-going innovation process that is driven by a changing environmental awareness of the population on the one hand side and technological steps on the other hand side. Therefore the stage model represents the transition of waste management from the pure disposal management over a more or less controlled waste management to a resource efficient material flow management (figure 1).
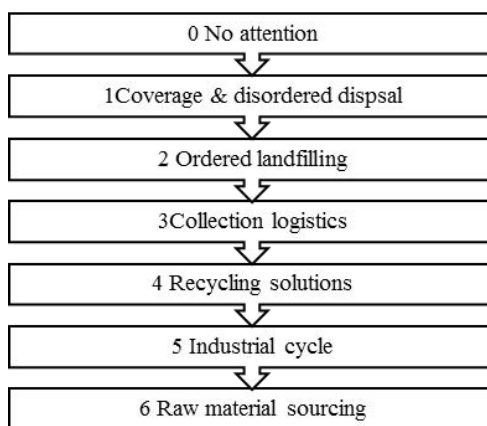

Figure 1 – **Stages of waste management development,** (composed on the basis of [4])

Analysing the research materials devoted to the experience to solve the problem of waste management in foreign countries, we describe the essence of each stage. Within the stage of "Coverage & disordered disposal" it is the upcoming educational work that needs to create awareness towards the need to protect nature as well as the maintenance of landscape. This

awareness leads to the development and adoption of first laws on waste disposal. First surveys of waste management data are conducted leading to a review of the waste management situation (wild dumping sites, danger to the environment). The central result of this stage is the assignment of authority and responsibility for waste management topics and problem areas. Frequently this is achieved in the form of an extension of remits of existing institutions.

Within the stage of "Ordered landfilling" the closure of wild dumping sites and construction of sanitary landfills is the most urgent task. Several technological innovations are realised in order to keep any associated pollution under control (leachate collection, bottom sealing and gas emission control). The rising waste amount leads to the adoption of regional waste management plans and concepts [3; 4].

On the basis of stage of "Collection logistics" knowledge of waste management data separate collection systems can be introduced. In many cases these systems start with paper and glass but also the introduction of so-called 3-bin-systems can be observed. At the same time waste information centres have to be introduced. The households have to be informed about waste prevention, collection of recyclables as well as the prevention and recycling of hazardous materials. This information is frequently given in the form of telephone advice, media information and advice to schools and environmental organizations. Raising awareness and sensitising of population are of increased importance within the field of public relations: "Successful unmixed collection of recyclables requires the intensive cooperation of the population" [6].

The central issue within the stage of "Recycling solutions" is the obligation to return on side of end consumers as well as the obligation to take back on side of the economy. With the goal of increasing the product responsibility the packaging ordinance calls for the economical use of packaging by industry and consumers. Therefore nationwide collection systems as well as appropriate systems for the reuse and recycling have to be constructed and set up. At the level of material recycling it is the costs for collection, transportation and processing as well as the accumulation of pollutants within secondary raw materials and the existence of a market for the created products that decide on the success [4].

With the preparations for the implementation of the landfill regulation the beginning of stage "Industrial cycle" is marked. The aim is to reduce the reactivity of the disposed waste for the eventual landfill aftercare. Therefore alternatives had to be found and waste is redefined into a resource that can re-enter into the economy's material cycles and thus saving primary resources and energy. The focus however lies on thermal recovery and saving expensive primary energy resources. Collaborations between waste management companies and industry (e.g. cement industry) had to be set up to achieve appropriate solutions in the field of the co-incineration of wastes. Waste management is increasingly understood as a comprehensive task across institutions in the sense of systems for production, treatment, recycling and proper disposal leading to residues that are reused and recycled.

On the stage "Raw material sourcing" the paradigm shift in the sense of the replacement of landfill sites by thermal treatment/recovery plants is completed. Waste management companies are facing new or at least boosted requirements like resource management, closing of material cycles and extension of value added chains. In this sense this sector has the self-perception of being a resource supplier and provider. This development leads to strong interdependencies between waste and raw material markets [4].

For the waste management's stage conception 12 indicators have been selected that can be combined to 4 groups (economy, society, legal, ecology). In this sense there are far-reaching parallels to the environmental analysis. As every other company, countries and regions are embedded into an environment being affected in a direct and indirect way. Within the framework of the classic environmental analysis also technological criteria are subject to

investigation. However the technological development is among the direct control parameters of waste management and not an exogenous determinant and is therefore not included in the analysis [4]. The assigned assessment intervals for the individual indicators were determined by plausibility and analytical methods. At each stage, there are indicators that characterize the condition of a country in 2012. Each of the countries is at the different stages of development, and often there is a transition from one stage to the next. The analysis of 14 countries (Austria, Belarus, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Italy, Poland, Romania, Serbia, Slovakia, Slovenia, and Turkey) confirms the constructed indicator system. In general, there is a correlation between the identified indicators with respect to the underlying development stage [10].

Based on analysis of 12 indicators we built assessment profile Ukrainian's waste management system (figure 2). An assessment profile allows representing the waste management situation of our country in a graphical form. The vertical list shows the various above introduced indicators. The stages of waste management are listed in the columns. A point in the specific column and row marks the current development stage in that field. As the development of waste management even within the stages takes time, the point can stand at the beginning, middle or end of each stage.

	Indicators	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Economy	GDP	●					■
Economy	Inflation rate		●				■
Economy	Industrialization		●				■
Society	HDI		●			■	
Society	Unemployment rate			●		■	
Society	"Green" movements	●				■	
Policy	Data collection	●					■
Policy	Separate collection	●					■
Policy	Reporting duties	●					■
Ecology	Landfilling	●				■	
Ecology	Recovery/Recycling	●				■	
Ecology	Contaminates sites	●			■		

Figure 2 – **Assessment profiles** (● Ukraine, ■ Austria)

We describe each indicator, which is considered for a profile, comparing in to the data for each stage, make conclusions about placing of each indicator. We compare Ukrainian assessment profile with the assessment profile of Austria.

The first group of indicators describes the economic situation in Ukraine in 2012. For the profile we take the gross domestic product per capita in Ukraine in 2012 (the amount of money in dollars). In 2012 gross domestic product per capita in Ukraine was $ 3870,4 [5] (table 1).

Table 1 – **Scale of GDP correspondence to particular stage**

Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
… to € 1499	€ 1500 to € 4799	€ 4800 to € 8299	€ 8300 to €12999	€ 13000 to € 21999	€ 22000 to € 25000	€ 25000 to …
	$ 3870, 4					

Inflation is a sustained increase of the general price level (table 2). In the period of rising prices not all prices and wages rise steadily and this affects to distribution of income and leads to uncertainty in the population. An efficient waste management requires the participation of the whole population. Separate collection, which is a prerequisite for the recovery of waste fractions, is only possible if people pay attention and also consider this is useful.

Table 2 – **Inflation index in Ukraine from 2005 to 2012,**
(composed on the basis of [1])

2005	2006	2007	2008	2009	2010	2011	2012
110,3	111,6	116,6	122,3	112,3	109,1	104,6	99,8

The lack of certainty about the future of economic development, that is the result of high inflation, reduces the public attention to the issue of the need to processing the waste. Together with the gross domestic product, inflation is an important indicator of the economic situation in the country (table 3).

Table 3 – **Scale of inflation index correspondence to particular stage**

Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
> 10%		5-10%		0-5%		
This indicator can be considered not only to identify what stage we are. Rather, it supports the validity of the gross domestic product and has been a tendency in the economic development of the country. Despite the fact that the last two years, inflation corresponded to 4, 5 and 6 stages. Previous index were high						
		Ukrainian stage of indicator		← 4,6%		

With regards to the position of industrialization, considering the fact that the municipal solid waste are not used like resources, and the industry has not created a demand for waste, Ukraine's indicator is at the second stage (figure 2).

The second group of indicators is social. Human Development Index (HDI): people are at the center of this concept, which was developed by the United Nations Development Program (UNDP) [7]. Human development is about much more than the rise or fall of national incomes and economic growth.

It is about creating an environment where people can develop their full potential and reach productive, creative life in accord with their needs and interests. People are the real wealth of nations. Development, following this concept, is the expanding of choices. People have to lead lives that they value [10]. Despite of the criticism that the indicator is incomplete, it is significant for the development of waste management. According to the conclusions of the UN's Human Development Report Office Human Development Index in Ukraine was 0, 74 in 2012 year [7] (table 4).

Table 4 – **Scale of HDI correspondence to particular stage**

Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
< 0,5	0,51-0,8		0,81-0,9		> 0,91	
		0,74				

For the stage model unemployment as a social indicator is important because it shows whether a country has potential to create prosperity. Unemployment has a strong impact on the social structure of a country. People whose livelihoods are not backed show little motivation and interest in a functioning waste management community. High unemployment rate is reflected in a slow pace of development of waste management. To assess the comparability of the unemployment rate as a basis, taking the methodology of the International Labour Organization (ILO). In 2011 in Ukraine unemployment was 7,9% [2] (table 5).

Table 5 – **Scale of unemployment rate correspondence to particular stage**

Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
> 15%		7-15%		0-7%		
			7,9%			

"Green" movement indicator measures the development of environmental awareness. The solution to the problems of environmental protection and waste disposal must be the result of awareness of the population about the environmental problems.

Analyzing the recent protests was organized by people who oppose to the placing of landfills near their villages; we can conclude that the problem of household waste is already defined by population. Ukrainian indicator "Green" movement is a beginning of the second stage (table 6).

Table 6 – **Scale of indicator "Green" movement" correspondence to particular stage**

Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
There are still no institutions that are dedicated to environmental protection	There is probability of occurrence the institutions that are dedicated to environmental issues	There is "Green movement" as an initiative of the population. As a result there is a desire to take more and more responsibility for environmental problems	At this stage a strong legislative influence is important, which is supported by environmental awareness. Again there is a movement of "green"	At this stage important to win political parties who will lobby the environmental public interest	For the first time the Green Party become as a partner in a coalition government	Environmental issues are included in many pieces of legislation. Wastes are considered as alternative energy sources

The legislation has a significant impact on the management of waste in the country or region and may promote innovation. Collection of data about concerning amount of waste, the level of processing, using waste as a secondary resource, is an important component of the strategic plan of the municipalities and country. The appropriate waste management depends on the collection of data and this should be done at the legislative level by specially created service. Table 7 contains a level of attention to this issue at different stages of waste management.

Table 7 – **Scale of indicator "Data collection" correspondence to particular stage**

Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
There is no data collection and no knowledge about the waste flows	First estimates the amount of waste and the number of disordered landfills. However, no exact knowledge about the waste flows	Establish-ment of databases	Due to regular preparation of waste management plans and the legal requirements there are reliable data about the quantities of waste and flows	The waste data are continuously keep up to date. Databases accessible on the Internet	Collecting data on waste, are an important basis for making strategic decisions in waste management	

Separate collection of different waste fractions is possible with the support of the laws. In order to successfully establish in a country or region, it is necessary to work closely with the public (table 8).

Table 8 – **Scale of indicator "Separate collection" correspondence to particular stage**

Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Household waste is generally not separated. Mostly are found in industry approaches for separate collection	Household waste still are not sorted. There are first industrial systems for recycling	There are private companies that collect waste separately. The population voluntarily bring the sorted waste	At this stage, separate collection of different waste fractions	Enshrined in law segregation of wastes	The high level of processing	Waste treats as resources. The maximum level of processing

Indicator "Reporting duties" analyzes requirements for reporting of economic entities in the system of waste management. These requirements develop national authorities in order to get complete information which will be the basis for adoption of strategic decisions. Conclusion about position of Ukrainian indicator are doing based on the fact that in Ukraine there is no widely and generally accessible information about waste management, waste flows, the level of processing, private entities do not provide this information, so the position of the indicator is at the first stage. Group of ecology indicators includes "Landfilling", "Recovery/Recycling" and "Contaminates sites". The landfill as a waste treatment method has been unsuccessful at the various stages of the waste management development with serious challenges. Even at the advanced stages of the waste management development landfilling, despite the goals "avoid, reduce and recycle" and despite intensive innovations in the field of exploitation, has remained an important part of waste management.

Modern landfills are engineered like specialized facilities that controlled by organized storage (depositing) of household waste in compliance with the technical and sanitary standards reducing the negative impact of waste on the air, soil, water. However, more than 80% of the landfills, currently operating in Ukraine does not satisfy to sanitary standards, and, in fact, are dumps (table 9).

Table 9 – **Scale of indicator "Landfilling" correspondence to particular stage**

Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Decentral disordered landfill	Central disordered landfill	Central ordered landfill; accordance sanitary standards	Improvement of sanitary and technical standards in order to ensure minimum impact on the environment	The number of sanitary and technical standards continues to rise. Increased attention to monitoring environmental impact	To disposal on landfill only processing wastes and hazardous waste	Laws forbid disposal of waste that are not recycled

With the principles of modern waste management the recovery of waste is at first place. So, for example, following the Austrian Waste Management Act of 2002 [3]: "Waste should be recovered, if this is ecologically appropriate and technically possible and the resulting of additional costs compared to other methods of waste treatment are not excessive and a market for the recycled materials or energy already available or can be created". Waste management system in Ukraine corresponds to first stage: "For household waste, the recycling of waste fractions is still not organized. In the industrial sector, on the other hand, there are efforts to increase the recycling of production waste" (table 10).

Table 10 – **Scale of indicator "Recovery" correspondence to particular stage**

Stage 0	Recycling is not carried out for household waste. In the industrial sector, there are few approaches for the recovery of waste that are already involved in the production process
Stage 1	For household waste, the recycling of waste fractions is still irrelevant. On the other hand, in the industrial sector, there are efforts to increase recycling of production waste
Stage 2	For the first time private companies sell the collected waste, however due to lack of recycling facilities in their own country the collected waste sell to foreign countries for recycling. In the industrial sector, by contrast, there are already functioning systems
Stage 3	Separate collection system of household waste can be expanded. However, the rate of resource recovery from waste that is the result of large volumes of waste separation is still very low. In addition, most of the separately collected waste fractions throw away on a landfill
Stage 4	Recycling rate increase and companies create capacities for recycling of the waste
Stage 5	The separate collection and recycling of separate waste fractions to reach a high level. The degree
Stage 6	of recovery that possible and economically viable, it will be shown, however, only in the future

For the first time the term "legacy" used in the Environmental Report of the Advisory Council on the Environment in 1978 in connection with polluting old sediments. Noted, that every abandoned landfill automatically constitutes a legacy. This can lead to "improper anthropogenic pollutants of ground, one of which is already latent or acute environmental hazard to us" through open landfills or disposal sites, contaminated former operating sites or contaminated soils [10]. Contaminated sites within a region or country are considered as an important indicator of long-term effects of waste and how much negative impact on the environment now and in the future (table 11).

For Ukraine that is still at the early stages of waste management, the phenomenon occurred that the ecological field is less well developed than the other areas. This observation suggests that it is difficult for a country or a region to achieve an ecological progress in the short term, whereas in the other areas already within a few years, improvements are noticeable. Country's analysis shows that focus along the various development stages is different.

Table 11 – **Scale of indicator "Contaminate sites" correspondence to particular stage**

Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Contaminated sites are still unknown	Many smaller landfills are closed. To produce first legacy	Landfills that do not conform to the standard may create more contaminated sites	Contaminated site is identified as a problem and the first laws that related this issue to be adopted and be prepared the first plans for their removal	Identification of contaminated sites and the establishment of further monitoring	Prevention of the future contamination	

Whereas at the first stages law & policy and ecological issues lead to a certain pressure to the waste management's development and then the economic and technological issues will arise.

Conclusions. The stage model of waste management acts on the assumption of a hypothesis that the waste management of a modern society goes through various stages. The model has been constructed according to the development of various waste management systems. A first validation took place in the form of consecutive case studies analyzing the waste management system of different countries. As the model turned out to describe the current situation of waste management in any European country, was prospective to carry out this assessment for Ukraine. Defining these stages it is possible to give valuable directions towards the formulation of strategies in Ukraine.

Based on the research authors concluded that waste management in each country depends on the overall economic, social, legal development. Indicators that do not have statistics, but to describe how law and society contributes to solving the problem of waste management. These indicators are defined by the authors themselves based on research conducted in this area.

Prospects for further research based on the analysis of impact indicators for the development of waste management is to create optimization model for integrated municipal solid waste management in Ukraine.

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Оціночний профіль системи управління відходами в Україні на основі фазової моделі розвитку

У роботі представлено теоретичне обґрунтування фазової моделі розвитку управління відходами. Досліджувана модель виведена на основі аналізу європейських систем управління відходами за допомогою 12 індикаторів, які характеризують економічний, соціальний, правовий та екологічний стан країни на кожній фазі розвитку системи. Мета статті полягає в проведенні оцінки системи управління відходами України на основі досліджуваної моделі, побудові оціночного профіля системи.

Ключові слова: фазова модель розвитку управління відходами, оціночний профіль, система індикаторів.

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Оценочный профиль системы управления отходами в Украине на основе фазовой модели развития

В работе представлено теоретическое обоснование фазовой модели развития управления отдохами. Исследуемая модель выведена на основе анализа европейских систем управления отходами с помощью 12 индикаторов, которые характеризуют экономическое, социальное, правовое и экологическое состояние страны на каждой фазе развития. Целью статьи является проведение оценки системы управления отходами Украины на основе исследуемой модели, построение оценочного профиля системы.

Ключевые слова: фазовая модель развития управления отходами, оценочный профиль, система индикаторов.