

# INTELLIGENT KNOWLEDGE MANAGEMENT IN THE SECTOR OF WASTE DISPOSAL ENTERPRISES

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**Abstract:** Information is perceived as the resource, that constitutes relationships in the network of enterprises and their customers, as well as extra-marketing value, which can be successfully implemented in IT environment, for example in the sector of waste disposal enterprises. That is why, the interactive contact and involvement of the stream supplier in researched sector, the intelligent processes of selection and recycling of communal waste, and commercial and marketing value of waste can be interesting as a source of marketing information for researchers and readers of this article. Therefore, smart methods of knowledge management, including marketing knowledge in the sector of waste management enterprises in the environment of IT solutions raise interest. The goal of the paper is to present three-sphere business model based on intelligent management of knowledge and competences in enterprises of the waste management sector. The main part of the paper will be focused on one of the sub-areas of the model, i.e. the subarea of knowledge commercialisation. This will be implemented through in-depth case study analysis.

**KEY WORDS:** INTELLIGENT MANAGEMENT, GARBOLOGY, SMART MANAGEMENT, WASTE DISPOSAL ENTERPRISES, WASTE MARKETING-VALUE,

## 1. Introduction

The concept of **intelligent knowledge management** occurred as a result of the process of transformation of traditional business relationships into specific type of cooperation of enterprises, based on circulation of knowledge, in most situations in innovative way, in a wide range of activities. It also concerns studied companies of the sector of waste collection and recycling, as well as their partners and customers. Peculiar character of cooperation is associated with the fact of approaching information as resource constituting relationships in the network of enterprises and their customers, which can be successfully implemented in IT environment. **Technological tools** enable smart management of communal waste through effective division into stream fractions, which consequently allows for separation of the material for recycling and reuse, management of the fraction obtained from mechanical-biological waste treatment, and first, minimising the amount of non-productively stored waste. Knowledge about chemical composition of packaging getting into the waste stream, tightens the process of precise selection. **Commercial use** of information automatically registered by separator scanners of specific fractions of communal waste is another operational sub-area of smart knowledge management, i.e. marketing knowledge in this case, which has been neglected before. Information included in the barcode is important for identification and registering a specific type of product. Thereby, it has marketing value, useful in market research in functional approach to management in a company. In the studied case, intellectual value (knowledge, skills and competencies) is created by enterprises, their cooperants and customers for further satisfaction of target market needs, in at least **three-spherical business model**. This model often has multi-concept, or holistic nature while combining relationship marketing, supply marketing, integral, internal, systemic, strategic as well as social marketing. Companies representing the sector of waste management apply intelligent knowledge-based solutions which result in interactive formation of market value.

## 2. Management of knowledge – holistic approach - identification of research category and review of literature

According to one of the first holistic approaches, in Alavi's and Leidner's view, knowledge management is defined as systematic and specific process of acquiring, organising and communicating workers' implicit and explicit knowledge in organisational terms, for the purpose of increasing effectiveness of productivity of other involved entities, while showing the presence of „other entities” of the environment in the process in a quite concise way (Alavi, Leidner, 1999). KM is more broadly

perceived by Bounfour who approached it as a set of procedures, infrastructure, technical and management tools created for forming, sharing and expanding knowledge resources inside and outside organisation (Bounfour, 2003).

A holistic approach to knowledge management is undoubtedly presented by Demerest's model. The structure of this model shows not only a scientific expression of knowledge, but also social aspects of knowledge formation. It is not limited to the stage of knowledge externalisation, but concerns repeated social interactions. Knowledge management ought to be supported by all organisation stakeholders, which, consequently will be reflected in results of all involved parties. This is about a complementary approach to knowledge management as scientific and social category.

Holistic approach to knowledge management is based on three pillars: (1) company strategy, i.e. strategic organisational concept of knowledge and learning, both intra- and inter-organizationally, (2) environment of creation, co-sharing and application of knowledge, dependent on the company and objective determinants in direct and indirect relations, (3) knowledge tools supporting the process of effective knowledge management, i.e. platform of intra-organizational, network and commercial knowledge of the company, supported by IT tools (Choo, 1998; Nonaka Konno, 1998; Von Krogh, Ichijo, Nonaka, 2000; Alvarenga Neto, 2008).

According to Choo's views, the company functioning as knowledge-based is an enterprise that approaches knowledge in strategic dimension (1), through the prism of its significance in a specific context of creation and decision making. The awareness of the importance of knowledge in a definite dynamic and complex environment of company functioning, the ability to search for and interpret appropriate information that allows for understanding of trends and scenarios of the environment that is made of customers, cooperating entities as well as competitors and other entities, constitutes the strategic goal of the company. Knowledge creation is a process of forming and / or acquiring knowledge, or information organising and processing for generation of new knowledge through dispersion and learning in organisation. Now, generated knowledge, constitutes foundations for assumptions aiming at creation of new knowledge and thereby development of new skills and competences inside the company, and among other participants in the so-called knowledge-community (community of knowledge), in which the different entities can be the participants.

Nonaka and Konno are the authors of the concept of knowledge creation environment (2) (Nonaka, Konno, 1998) and Nonaka, Tsoukas and Snowden are still its promoters. Knowledge environment is a context in which knowledge is created and applied. This environment can have a real nature (that is office area, organisational units in company and entities

in the network), and / or virtual nature (that is the form of e-mail, videoconferencing, online relations), and / or psychological nature (that is expressed in ideas and concepts). Knowledge environment can be created by individuals, task groups, project teams or informal groups of entities. Knowledge environment is made of sub-spheres of creation, interaction and dialogue, as well as systematization and the process using and accessing. This corresponds to each of the elements of SECI Model by Nonaka and Takeuchi. The aforementioned concept of knowledge environment ought to be enhanced by elements inside the organisation that support creativity. They include trust, tolerance and care. According to Alvarenga Neto, „favouring conditions” are necessary on tactical level as an element combining strategic dimension of knowledge management with its operational implementation. In this context, knowledge management should not represent its control, but promoting creation and making it available within knowledge-based organisation, that is the ecosystem of knowledge.

IT tools, as well as practices and processes serving implementation of the concept in actual operations are the third sphere of holistic model of knowledge management (3), that provide its intelligent nature. They differ depending on the level of implementation of knowledge management. This is because strategic level is focused on formation of knowledge community (i.e. community of practice/knowledge), space for organisational learning and tools of strategic concept of knowledge formation. Operational level rather concerns coordination in implementation of tasks resulting from strategic concept of knowledge management, application of competitive competences and market research.

### 3. Regional Municipal Waste Treatment Facilities – legal background for creation of the researched entities and methodology

Regional Municipal Waste Treatment Facilities are described in the Law on waste of 14th December 2012 and the Directive 2002/83/EC that determines the minimum requirements for establishment of such an entity. The documents also describe hierarchical method of waste management through:

- prevention of waste generation,
- preparation of its reuse,
- recycling,
- other processes of recovery,
- disposal.<sup>1</sup>

The law provides the possibility to divide voivodeships, in voivodeship plans of waste management (VPWM) into regions, if they comply with the minimum requirements as determined in clause 35 section 5 of the law. It states that the region of municipal waste management constitutes an area of neighbouring communes that comprise in total at least 150 thousand inhabitants and is operated by facilities referred to in section 6. The area of a commune of 500 thousand inhabitants can also be the region of municipal waste management. New regulations included in the amendment to the law on waste of 22nd January 2015 define a regional facility for municipal waste processing as the waste management plant of the capacity sufficient to collect and process waste from the area inhabited by at least 120 thousand inhabitants. Also, it must comply with the requirements of the best available technology referred to in clause 207 of the law of 27th April 2001 – Environmental protection law, or technology referred to in clause 143 of this law, including those applying new available technologies of waste processing, or providing:

- mechanical and biological treatment of mixed municipal waste and separation from mixed municipal waste the fractions that are suitable for recovery in whole or in part, or,

- processing of separately collected green waste and other bio-waste, and producing from them a product of fertilising qualities, or substances supporting plant cultivation that comply with requirements as determined in separate regulations, or other material after the process of composting or fermentation admitted for recovery in the R10 recovery process that meets the requirements determined in regulations issued on the basis of clause 30 section 4, or,
- landfilling of waste generated in the process of mechanical and biological treatment of mixed municipal waste and remains from segregation of municipal waste of the capacity that allows for reception of waste for the period of at least 15 years, in the amount not smaller than generated in the facility for mechanical and biological treatment of mixed municipal waste<sup>2</sup>.

Furthermore, the region of municipal waste management may comprise neighbouring communes of various voivodeships if it is provided for by voivodeship waste management plans of these voivodeships.<sup>3</sup> Another important provision of the quoted law concerns introduction of the notion of transregional facility which can be an incineration plant for municipal waste with the capacity sufficient for reception and treatment of mixed municipal waste collected from the area inhabited by at least 500 thousand residents, that meets the requirements of the best available technology called “transregional municipal waste incineration plants”.

The paper applies the methods of conceptual research, and qualitative empirical research (case study)<sup>4</sup>. Analysis of the literature of the subject as well as research based on secondary and primary sources was performed.

**Table 1.** Basic information about conducted research

Specification	
research technique	analysis of the literature and sectoral magazines, analysis of webpages, analysis of sponsored interviews, direct interviews
sample selection	targeted selection of typical units
sample size	Leader <sup>5</sup> of waste management sector in Region III, by the criterion of facility machinery and 20 representatives of RIPOK [ <i>Regional Municipal Waste Treatment Facility</i> ] in Poland Over 10 trade webpages related to waste management sector
geographical range	regional range
time range	2014-2018

**Source:** own case study

<sup>2</sup> The Act of 27th April 2001. Environmental Protection Law, clause 35, 143 of the Act on waste

<sup>3</sup> The Act of 15th January 2015 on amendments to the act on waste and other acts.

<sup>4</sup> Application of the method seems justified because:

- research concerns contemporary, dynamic phenomena and knowledge about these phenomena that is created;
- they concern research of actual contexts of these phenomena at rather large ambiguity of borders between their contexts and the very phenomena;
- the subject of research is too complicated to explain the cause and effect relationships by means of the survey method or experiment. (Perry, Ch. 2001; Zabińska, Zabiński, 2007, p. 83),

<sup>5</sup> MASTER Odpady i Energia Sp. Z o.o. enterprise [MASTER Waste and Energy limited liability company], being one of 3 similar facilities constructed in Poland that have the latest plant ensuring mechanical and biological treatment of mixed municipal waste and separation of fractions, from mixed municipal waste, that are recyclable in whole or in part, of the of the capacity of 120 000 Mg/year. The plant, together with the landfill constitutes an integral part of communal waste management system in Region III.

<sup>1</sup> The Act of 14th December 2012, Law on waste, clause 17

For the needs of the research, the entities that have the status of RIPOK [*Regional Municipal Waste Treatment Facility*] by the criterion of indication by a leader and position according to secondary sources of the sector were selected for the analysis of expanded case study<sup>6</sup>.

#### **4. Business model based on intelligent management of knowledge and competences in enterprises of the waste management sector**

The information and knowledge acquired for the competent, multi-faceted and multi-concept activities of waste sector entities establish systemic relationships with stream providers in the process of direct and indirect knowledge diffusion in the subsystem of interactive relations with these entities (Figure 1). Intraorganisational knowledge and competences for implementation of effective technologies foster smart segregation and waste processing operations, which is the aim of waste commercialization and knowledge commercialisation, in relations with recipients of processed waste and raw materials, as well as marketing agencies. This knowledge can offer the extra marketing value for firms and their cooperants (Sztangret, 2016a). In the model, knowledge is a linking element between systemic customer relationships and waste stream suppliers in direct and indirect way, through policy implemented by municipal authorities within the guidelines of the Act on Maintaining Cleanliness and Order in Municipalities, and thanks to interactive educational and promoting actions, most often in IT environment. Knowledge is a determinant of effective logistic processes including the intraorganisational ones when parameters of appropriate waste streams, desired because of applied technological solutions in the plant are determined. Interprocessing of technological knowledge enables meeting customer needs in relationships with recipient of raw materials on secondary market, which is a symptom of integral marketing concept of these entities. Furthermore, it is a method of very aware and committed implementation of social marketing concept following the concept of sustainable development of studied entities. Social dimension of knowledge management in entities of the sector is also important because of creation of broadly understood eco-value and eco-awareness in two further subareas of the model, including such and image in strategic perspective. Moreover, the information acquired on the basis of analysis of collected waste is starting to gain new commercial dimension and offers a broad area for cooperation on functional level of management, i.e. marketing research. Garbology is the area that is still not enough appreciated by entities of both sectors. Marketing knowledge about and from customers, included in the structure of generated waste may constitute the basis for marketing decisions of product suppliers, but also the

<sup>6</sup> Sample selection was performed on the basis of leader's indication and on the basis of indications in final report of III stage expert opinion aiming at performance of waste examination in 20 waste mechanical and biological treatment plants financed from resources of the project no POPT.03.01.00-00-375/13-00, „Wsparcie na działania sieci organów środowiskowych i instytucji zarządzających funduszami unijnymi” “Partnerstwo: Środowisko dla Rozwoju” [“*Support for activities of the environmental networks and institutions managing EU funds.*” “*Partnership: environment for development*”] in 2014 from Resources of 2014 Technical Assistance Operational Programme 2007-2013 within Priority III – Support for execution of structural funds operation; Action 3.1. – „Functioning of institutions involved in NSRF”. Executor: Consortium: Uniwersytet Zielonogórski i Zakład Utylizacji Odpadów Spółka z o.o., [University of Zielona Góra and Waste Disposal Facility limited liability company] Zielona Góra 2015, www.ekspertyzambp.com.pl (online: 1.12.2016).

basis for the analysis of overconsumption, deficiencies and wastage. Three subspheres of smart model of knowledge management are linked with knowledge diffusion, expected from operational point of view of each of them, and complementary with applied technological solutions.

#### **5. Information as municipal waste marketing value**

The information contained in, or on waste, that constitutes the stream, and is obtained by an enterprise of studied sector can be used effectively to streamline the selection process, on the level of segregation of raw material to be processed or sold. Furthermore, they can provide information about buying and consumption behaviours of creators/suppliers of waste stream.

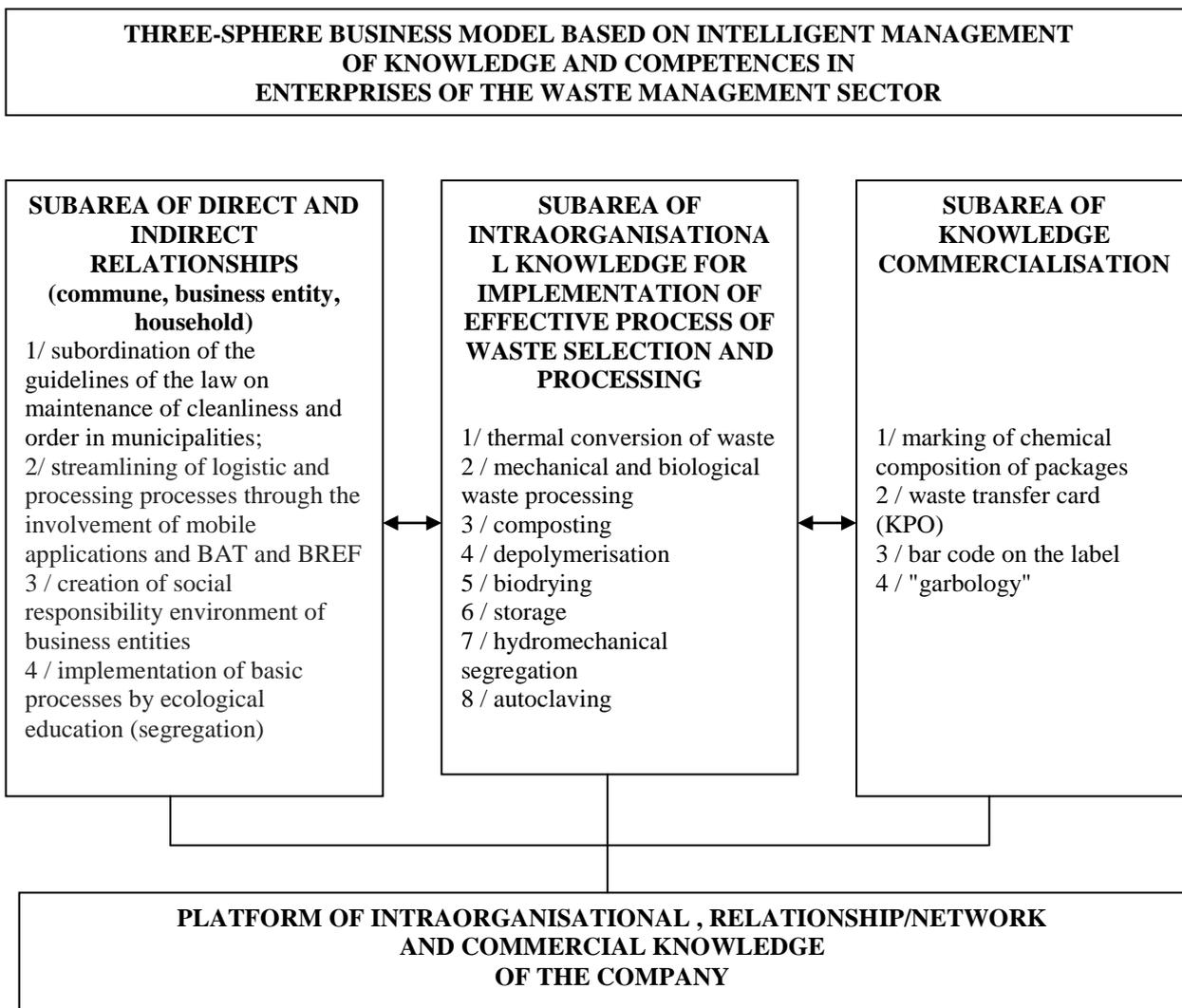
According to the Ordinance of the Minister of the Environment on packaging design patterns of 23 April 2004, **the marking of the packaging of goods** is determined by their chemical composition. The packages which have a significant environmental impact have been distinguished. This allows for identification, with the use of optoelectronic and laser separators, of waste streams for example for pyrolysis, self-depolymerisation or sales on the secondary market. The most important markings are shown in table 2.

#### **6. Summary**

Knowledge is a linking element in customer relationships, but also a determinant of efficient logistics processes, including intraorganisational ones, in formulating the parameters of appropriate waste streams, desirable because of technological solutions used in the plant. The knowledge acquired in this way provides the material for the concept of integral marketing of these entities, in their relations with the recipient of raw materials, on the secondary market. In addition, obtained information based on the analysis of acquired waste starts to gain a new commercial dimension and opens a broad field of cooperation on functional basis of management, i.e. marketing research. It is not enough appreciated by entities of both sectors yet. The social dimension of knowledge management of the sector actors is also important, given the creation of broadly understood eco-values and eco-consciousness, as well as its image, in the long perspective, in technologically engaged environment of knowledge diffusion. It can be stated that the outlined three-sphere Business model based on intelligent management of knowledge and competences in enterprises of the waste management sector is of innovative and prospective characteristics, which encourages further research analyses in this area.

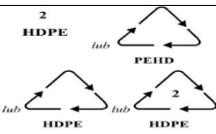
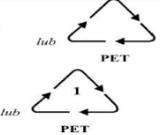
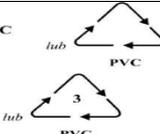
**Waste Transfer Card (KPO)** is another source of information and intraorganisational knowledge, also offering the possibility of its commercial use. This card is the evidence for appropriate disposal of waste by the entity / supplier of the stream, while omitting a natural person, at entitled recipients, according to the waste code as specified in the Code Catalogue<sup>7</sup>. The waste catalogue divides the waste according to the source of its formation into 20 groups as shown in table 3.

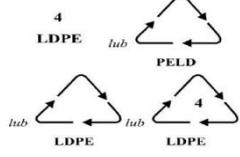
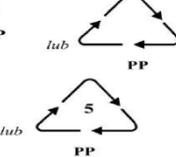
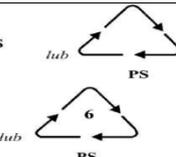
<sup>7</sup> Regulation of the Minister of the Environment of 27 September 2001 on the waste catalogue - Dz.U. [Journal of Law] No. 112/2001, item. 1206



**Fig 1** Business model based on intelligent management of knowledge and competences in enterprises of the waste management sector  
Source: own case study

**Table 2.** Marking of packaging by chemical composition

composition	marking
aluminium, found in for example cans and disposable crockery	<p><b>41</b> <b>ALU</b> <i>lub</i> </p>
polyethylene terephthalate - PET, HDPE, used for example in plastic bottles, dishes, packages, and housings of household appliances	<p><b>2</b> <b>HDPE</b> <i>lub</i> </p>
high density polyethylene - PEHD, HDPE, used for example for production of foils, packaging, garbage bags, sewage pipes, rainwater tanks and garbage containers	<p><b>1</b> <b>PET</b> <i>lub</i> </p>
polyvinyl chloride - PVC, contained for example in syringes, liners and insulation of cables	<p><b>3</b> <b>PVC</b> <i>lub</i> </p>

low density polyethylene - LDPE, PELD, which is contained in plastic bags	<p><b>4</b> <b>LDPE</b> <i>lub</i> </p>
polypropylene - PP, used for example in foam insulation, floor coverings, toys, household appliances	<p><b>5</b> <b>PP</b> <i>lub</i> </p>
Polystyrene - PS, contained for example in Styrofoam, fancy goods and toys	<p><b>6</b> <b>PS</b> <i>lub</i> </p>

**Source:** Ordinance of the Minister of the Environment on packaging design patterns of 23 April 2004; <http://wlawozoszczedzanie.pl/znaki-ekologiczne/oznaczenia-produktow-ekologicznych/oznaczenie-opakowan-ze-wzgledu-na-sklad-chemiczny/> (online: 15.03.2017)

**Table 3.** Catalogue of waste by groups

Waste type	marking
waste arising from the search, extraction, physical and chemical processing of ores and other minerals	01
agricultural, horticultural, hydroponic, fishery, forestry, hunting and food processing waste	02
waste from wood processing and from the manufacture of boards and furniture, cellulose pulp, paper and cardboard	03
waste from the leather, fur and textile industries	04
waste from crude oil processing, natural gas purification and pyrolytic coal processing	05
waste from the manufacture, preparation, marketing and use of nonorganic chemical products	06
waste from the production, preparation, marketing and use of products of the organic chemistry industry	07
waste from the manufacture, preparation, marketing and use of protective coatings (paints, varnish, ceramic enamels), putty, adhesives, sealants and printing inks	08
waste from the photographic industry and services	09
waste from thermal processes	10
waste from chemical treatment and coating of metals and other materials, and from non-ferrous metal hydrometallurgical processes	11
waste from shaping and physical and mechanical processing of metals and plastics	12
waste oils and liquid fuel waste (excluding edible oils and groups 05, 12 and 19)	13
wastes from organic solvents, coolants and propellants (excluding groups 07 and 08)	14
packaging waste; sorbents, wiping cloths, filter materials and protective clothing not included in other groups	15
waste not included in other groups	16
waste from the construction, repair and dismantling of buildings and road infrastructure (including soil and soil from contaminated sites)	17
medical and veterinary waste	18
waste from installations and equipment for the management of waste, sewage treatment plants and the treatment of drinking water and water for industrial purposes	19
municipal waste including selectively collected fractions	20

**Source:** Regulation of the Minister of the Environment of 27 September 2001 on the waste catalogue (Dz.U. [Journal of Law] 2001.112.1206).

The waste code defining the type of waste consists of six digits. Hazardous waste is indicated in the catalogue by the top index in the form of a "\*" star.

The results of the analysis of the information contained in the barcode label of municipal waste and so-called analysis of the contents of the trash can have a marketing value and can be the basis for the marketing decisions of the suppliers of a specific type of product on the market. Therefore, they may be the subject of knowledge commercialization in relationships between enterprises operating in waste management sector as well as companies or research agencies.

**The barcode** is a graphical representation of information through a combination of dark and light elements, determined by the code symbols of the code structure. Graphics correspond to a sequence of numbers, each of which is the carrier of specific information. Two or three initial digits are the country of origin (the country code is 590), the next five digits are the manufacturer's code assigned by the Universal Copyright Convention (UCC). The next digit is the product code assigned

by the manufacturers, and the control digit confirming the correctness of the scan. The digital representation of what the code contained is intended to allow to manually enter the code, if the reader is unable to read the information. The code has the informational value when it is automatically read by the electronic reader (laser, diode or camera), which allows for the product to be identified.

On the other hand, the information from the analysis of "trash can content" (the so-called **garbology**<sup>8</sup> analysis<sup>8</sup>) refers to household shopping and consumption habits, which can be the subject of comparative analysis in the category of the subject (residential and non-residential areas, including industrial areas), geographic location (international, regional, local), territorial unit (city, village), type of residential unit (single or multi-family buildings), or time, with the distinction of "special periods" (e.g. holidays, holidays period etc.). Analysis of the content of trash can may concern:

- the structure of purchased and consumed goods in the household, by residents of a building, estate, district, companies of their groups, in a specific area;
- eco-habits, manifested in purchasing behaviour and tendency to segregate waste;
- quantity of consumed / consumed good of a specific category, in a given unit of time and the amount of single purchase expressed for example by the size of the package;
- intensity of consumption, expressed as the time of filling the trash and the frequency of emptying;
- social level of the household;
- information about consumer habits concerning consumption of highly processed products or products / raw materials;
- information about preferences regarding local, national or foreign product preferences;
- the degree of waste of purchased products: food, household and TV appliances and electronics.

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<sup>8</sup> Garbology is the study of modern refuse and trash as well as the use of trash cans, compactors and various types of trash can liners. As an academic discipline it was pioneered at the University of Arizona and long directed by William Rathje. The project started in 1973, originating from an idea of two students for a class project. It is a major source of information on the nature and changing patterns in modern refuse, and thereby, human society. (Rybczynski, 1992)

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