

Article

Big Data Manifestation in Municipal Waste Management and Cryptocurrency Sectors: Positive and Negative Implementation Factors

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Abstract: Two mainstream topics have been widely discussed over the past few years: ways to reduce the human impact on nature and the way that the industrial revolution 4.0 changes industries. The aim of this research topic is to analyse the positive and negative factors of big data implementation in the sector of cryptocurrency (as part of the industrial revolution 4.0) and in the sector of municipal waste management. The analysis reveals the differences and similarities between the cryptocurrency and municipal waste management sectors in the context of big data. The findings are significant for the estimation of the technological development of digitalized and non-digitalized sectors.

Keywords: big data; circular economy; cryptocurrency; municipal waste management; industry 4.0

1. Introduction

The authors of this paper were involved in the research of the industrial revolution 4.0 (hereafter, Industry 4.0), disruptive technologies [1,2], Municipal Waste Management (MWM) [3,4] and CryptoCurrencies (CC) [2,5]. Based on the results of this research and work experience, we developed the analysis of the MWM and CC phenomena influenced by the Big Data (BD) phenomenon. Notably, this is an interdisciplinary study that includes the analysis of BD, MWM and CC phenomena and their interactions, classifications of attributes, and is a pilot study. Our opinions on the topics will enable analysis of these phenomena in various directions. For example, how does BD influence the MWM and CC sectors, does this manifestation affect in a positive or negative nature, and what problems can be solved in these sectors? We attempt to answer these questions.

Climate change and the Industry 4.0 are major challenges of today's societal life. Various types of interest groups with their specific operational objectives and philosophical ideologies may be identified. The issue of climate change is disclosed in different ways. For example, the Animal Liberation movement, based on the ideology of the philosopher P. Singer [6], emphasizes the principles of the ethical treatment of animals and encourages the consumption of plant-based food, as the meat industry (farming) degrades nature. Stiebing W. H. [7] states that "anthropogenic environmental problems (those created by human activities) were important causes of decay of the Greco-Roman economy and society: Hughes agrees with Mikhail Rostovtzeff that the persistent inflation, food shortages, and population decline of the late Roman Empire were largely due to an agricultural crisis that occurred because "men failed to support nature"". Ecofeminism emphasizes male dominance over

both women and nature and offers solutions to ecological challenges, establishing equal opportunities for women, becoming scientists, natural resource managers, regulators, advocates and legislators [8]. Morton T. [9] highlights the idea of a “fall out of consumerism altogether” and criticizes consumption in general; young climate activist Greta Thunberg invites the youth and many other groups to protest for climate justice.

Industry 4.0 will have impact on many sectors which will be affected by technological shift. Industry 4.0 is characterized by a massive implementation of cybernetics on the way to an end-to-end value chain with an industrial Internet of Things (hereinafter–IoT) and decentralized intelligence in manufacturing, production, logistics and industry, and in human needs services. Each individual branch of industry, such as real estate, health, transportation, trade, agriculture and others, has been targeted for digital transformation. Digitalization and big data processing capabilities are the main prerequisites for the Industry 4.0 evolution. The big data phenomenon is being implemented in a variety of business sectors: medicine, pharmacy, livestock production systems (pig data), banking sectors and many others. In the era of smart and digital development, companies are interested in solutions that allow their processes, machines, employees and even the products and services themselves, to be integrated into a single integrated network for data collection, data analysis, the evaluation of company development and performance improvement [10].

It is already obvious that Industry 4.0 will affect other industries, in the same way as Uber, an application leveraged by the Internet and mobile technologies, which changed the transport sector, or the way mobile phones and the Internet had a strong impact on the photography sector. Therefore, it is important to discuss the potential impact of big data as an element of the impact of the industrial revolution 4.0 on industries. Would big data have similar interactions with traditional (municipal waste management) technologies and with Industry 4.0 technologies (cryptocurrency)? Will the Industry 4.0 and traditional industries develop at the same speed and to the same extent?

It should be noted that all environmental protection theories are based on a common provision—pollution and environmental policy—and are inseparable from these phenomena, too. The impact of pollution on the environment manifests itself in various forms and affects the entire ecosystem: water, air, soil, biodiversity and natural resources. The main problematic source of pollution is in municipal waste.

It should also be noted that the European Commission adopted a circular economy action plan to provide a boost and create new jobs, for growth and investment, and to develop a carbon-neutral, resource-efficient and competitive economy. It provided a new approach to municipal waste management, a transition from the linear model “take, produce, throw away”, to the circular economy model ‘waste prevention, eco-design, re-use, recycling and creating a circle market cycle’. How will digitalization impact upon municipal waste management? Is it possible to apply big data instantly to increase the efficiency of municipal waste management? Do environmental policies need to be improved and prepared for big data?

Big data has a significant impact on the financial ecosystem, too. The speed of funds, fund availability, risk determining efficiency and even customer behaviour that forecasts financial crises or warns about the inefficiency of spending might have many improvements in the global financial market. Moreover, having global data on financial behaviour might reduce the gap between the developed and third world countries.

Actuality: big data and cryptocurrencies are recognized as part of Industry 4.0, while environmental quality is fundamental to human life on earth. The comparative analysis of big data manifestation on two different sectors presupposes the theoretical and practical application of the results, obtained during the research.

Scientific issue: big data is considered to be a game changer for many industries, however, to date there has been no research analysing the impact of big data on different industries.

The object of the topic: big data manifestations on two sectors: municipal waste management and cryptocurrency.

The aim of the topic: to disclose the interactions and to establish the classifications of peculiarities of big data implementation in two sectors: municipal waste management and cryptocurrency.

The main objectives of the topic are as follows:

1. To reveal the positive and negative aspects of big data interaction with cryptocurrency and municipal waste management;
2. To estimate the differences between big data interaction with digital and non-digital technologies;
3. To identify obstacles and positive factors of big data interaction with cryptocurrency and municipal waste management.

2. Materials and Methods

This study focuses on analysing possible interactions between different phenomena: big data, MWM, cryptocurrency. The development speed of Industry 4.0 influences the dynamics of these interactions and the formation of new cognitive attitudes and positions.

The research is interdisciplinary in nature, which presupposes analysing the interactions of the phenomena in legal, economic, managerial, sociological or even philosophical aspects.

The data for this paper were gathered using document analysis and statistical data methods. Firstly, the authors identified the keywords that revealed the object of the study. Secondly, using the EBSCOhost Research, HeinOnline, Oxford Journals Collection and MRU eBooks Databases, relevant and reliable scientific literature (Monographs, Research Papers, Research Reviews) were selected based on the meaning of the keywords. Thirdly, using official institutional databases such as Publications Office of the EU and European Court of Human Rights, selected official and up-to-date legal documents for investigation such as EU legislation (TFEU, Directives, Communications) and cases from the European Court of Human Rights.

The statistics data were gathering using Eurostat and European Environment Agency (EEA) databases.

The selected scientific literature, legal acts and case-studies were processed using content analysis. Content analysis is a research technique used for making replicable and valid inferences from texts to their context of their use [11]. This method identifies thematic lines that divulge the content of big data, cryptocurrency and MWM. This enables us to study the characteristics of the phenomena, their interrelationships and the features of their interactions, objectively and systematically.

It is noteworthy that this method was used in parallel with the linguistic method. The aim of the linguistic (Latine lingua-language) method is to reveal the meanings of the definitions by analysing the texts of scientific literature and legal documents. This avoids ambiguities and/or interpretative contradictions. For example, in order to disclose the regulatory content of MWM, the authors relied on the presumption that the legislative subject is rational, avoids contradictions in the law and all words contained in the legislation are meaningful and necessary.

The systematic analysis method was applied in the research. Using this method, we developed a complex viewpoint for analysing the interaction between different phenomena (DB, MWM, cryptocurrency) and its peculiarities. We revealed essential differences of big data interaction with cryptocurrency as a digital technology and big data interaction with municipal waste management as non-digital technology. As mentioned, the interaction of digital and non-digital technology generates different speeds of technological development.

The study used a comparative method, whose purpose is to determine the relationship and specificity of two objects (big data and MWM vs. big data and cryptocurrency). The data obtained by this method are significant, revealing the content of the classification of these interactions of the phenomena.

The critical-analytical method was applied in order to assess the validity of knowledge about the objects and to detect weak, less-well-argued statements and to properly evaluate the reports of institutional entities (for example Eurostat, EEA). This method was also used to formulate the interim and final findings.

3. Literature Review

3.1. Aspects of Big Data Characteristics

Although a considerable part of the information was described as “unorganized facts” [12], the era of big data should become a game-changing factor. Lagoze C. [13] states that big data “disrupt fundamental notions of integrity and force new ways of thinking and doing to re-establish it”. Big data differs from many other types of data because of their variety, volume and velocity [14]. Big data is a set of constantly collected information that creates vast amounts of data on various social, economic and asset management (for example) interactions, and can be used for optimization and effectiveness. In general, such data can be used for IoT where machines can communicate with machines, without human intervention. “Mining big data offers the potential to create new ways to optimize processes, identify interdependencies and make informed decisions” [15].

Information is no longer created and used for a single purpose [16]. Owners seek to use asset information to achieve the sustainable and safe performance of complex systems through their life-cycles [17].

Although the definition of big data has existed in scientific literature for over 15 years, recently, scientists have been actively involved in big data adaptation for specific sectors. Technological development and further scientific studies deliberate on big data adoption challenges and opportunities in medicine [18], and the financial system [19–21]. Taking into account the importance of global warming and the importance of waste management, there is a pressing need to improve global waste management. It is evident that air pollution, waste management and climate change are intertwined. According to European Environment Agency statistical data, several air pollutants are also climate forcers, which have a potential impact on climate and global warming in the short term. As mentioned, air pollution is a global threat leading to large impacts on health and ecosystems [22]. According to Eurostat, in regards to waste management, households are one of the main sectors that contribute to emissions of air pollutants in Europe. Private households were the biggest contributor to total emissions of ozone precursors in 2016 at 25%; closely followed by the transport industry at 24%. In 2016, the total waste generated in the EU-28 by all economic activities and households amounted to 2538 million tones, and households contributed to 8.5% of total waste [23]. Data gathering and systemization are important aspects related to MWM as phenomenon. Notable it includes household sector, which is part of waste management system.

3.2. Aspects of Big Data Processing

According to Mayor-Schonberger et al. [18], there are a few relevant aspects for data processing: (i) data privacy and accountability; (ii) infrastructure for data gathering and processing and; (iii) social habits of data scoping and sharing.

Privacy: Two major issues in regards to big data is the security and privacy of the individuals [24]. The scientific approach towards privacy during data processing process, i.e., the authorization approach, is used to control change, and there are different hierarchy levels depending on the use of configuration items [25].

Infrastructure for data gathering and processing: Report on the availability and retrievability of data and an audit to verify the consistency of the information [26].

Mayor-Schonberger [18] found that big data is:

- more comprehensive (data quality and quantity)
- analysed using machine learning tools which are more advanced than conventional statistical tools
- processed, generating existing questions and hinting at novel ones, while at the same time generating new hypotheses.

Wolfertab et al. [27], after having analysed the data chain, classified the stages of data into four stages: (i) raw material, (ii) processing, (iii) transport and (iv) marketing; all the stages were analysed through two different aspects (layer of data chain), technical and business.

Social habits of data scoping and sharing: Social habits and sharing are developed through two approaches. Firstly, privacy and security and, secondly, habits of gathering information and sharing. According to Jang et al. [28], the increasing amount of management data generated remotely shows the increasing availability of data, and the developments in social data sharing and collecting—determines behavioural change. The Directive (EC) 95/46 General Data Protection Regulation [29] (hereinafter—GDPR) sets forth the legal norms that form the legal framework governing social and individual aspects of data collection and processing. “The field of data protection has been on the role and content of the primary rules of the system” [30].

Big data outcome: Farboodi et al. [21], who analysed big data and finance, found that the “growing amount of data reduces the uncertainty of investing in a given firm”, therefore, in the long run, the access to big data processing would influence company development and speed up the process of decision-making. According to Begenau et al. [19], due to the development of big data technology, a new class of online investment firms using big data to facilitate capital generation has emerged. According to the authors, there is also an inclination that big data would most likely influence the weight of small and medium enterprises and large companies in the economy.

Big data importance to science: i.e., “big data analyses can accelerate research” [18]. According to Wamba et al. [31], big data may facilitate the understanding of the consumers, optimize supply chains, improve financial analysis and improve the management of human-based decisions. “The complexity and huge values of big data research in the field of environmental management will inevitably facilitate further improvement and innovation of existing evaluation theories and methods” [32].

3.3. Big Data and Cryptocurrency: Ways to Leverage the Financial Sector

The importance of cryptocurrency as a technology was stressed by a number of scientists. Cong et al. [33] showed that blockchain technology could have an impact on the development of industrial and commercial industries, as it is totally different from the existing payment systems. Limba et al. [34] define cryptocurrency threats to national security, which, according to authors, are homogenous for all countries and therefore are recommended to be regulated/solved worldwide.

Blockchain technology is based on fast transactions [35] executed by the system itself [36,37]. McKinsey [38] maintains the same position: “A blockchain is an encoded digital ledger that is stored on multiple computers in a public or private network.” Therefore, there is a potential to generate vast quantities of data, whereas transactions and systemized data are available at sight.

The blockchain is working on a decentralized database with independent network-based processing, and the mechanism is constantly updating the database [39–41]. The database is autonomous, which carries a lower risk of data loss.

Important changes in the financial sector would arise if traditional banks adopted the blockchain system to improve transaction efficiency [42,43]. In this case, the global banking sector would become more deeply integrated and would connect more participants in unified data networks. Cong et al. [35] state that ‘generating decentralized consensus entails distributing information that necessarily alters the informational environment’. Moreover, according Cong et al. [35], a blockchain-based system “can mitigate informational asymmetry and improve welfare and consumer surplus through enhanced entry and competition, yet, distributing information during consensus generation may encourage greater collusion”. Moreover, “it can deliver higher social welfare and consumer surplus through enhanced entry and competition, yet it may also lead to greater collusion” [35].

“The anonymity of a paper currency can protect the individual against the risk that the state—whether democratic or dictatorial—could misuse the information that can be collected regarding the use of a payment system” [44]. Moreover, anonymity is important in implementing GDPR or similar legislation.

The issuance of a central bank digital currency is widely discussed by scientists and bankers [45–47]. Despite different scientific approaches and outcomes, any realization of cryptocurrency-based central banking systems would generate vast quantities of additional data, which would be highly important for the technological improvement of cryptocurrency using big data.

The number of daily cryptocurrency transactions exceeds one million, therefore, the volume of data already is sufficient for it to be used for analysis. However, implementing further blockchain-based improvements, such as central bank transactions, may cause extremely big data growth; Swift [48] had thirty-four million transaction messages per day. Therefore, by integrating central banking systems into a blockchain-based central bank, cryptocurrencies might cause an increase in data availability, which, in turn, may lead to improvements in social and economic life.

3.4. Municipal Waste Management: The Main Features of the Phenomenon

The definition of municipal waste management can be obtained from a wider as well as from a narrower perspective. From a wider perspective, it reflects lifestyle and the outcome of technological development as a result of global technologization (as it is stated in the industrial revolution 4.0). In the narrower sense, municipal waste management is defined in the Directive (EU) 2018/851 [49]. According to this law document, municipal waste means: (a) mixed waste and separately collected waste from households, including paper and cardboard, glass, metals, plastics, bio-waste, wood, textiles, packaging, waste electrical and electronic equipment, waste batteries and accumulators and bulky waste, including mattresses and furniture; (b) mixed waste and separately collected waste from other sources, where such waste is similar in nature and composition to waste from households. We base our findings on the definition set forth herein.

Firstly, the Treaty on the Functioning of the European Union (hereafter TFEU) [50] divulges the environment as the principal area of political discourse, and the European Union policy on the environment contributes to the pursuit of the following objectives: preserving, protecting and improving the quality of the environment. Regarding the protection of the environment in particular, The European Court of Human Rights pointed out that (1) "... this is an increasingly important consideration in today's society, having become a cause whose defense arouses the constant and sustained interest of the public, and consequently the public authorities" [51]; (2) "Public authorities assume a responsibility which should in practice result in their intervention at the appropriate time to ensure, that the statutory provisions enacted with the purpose of protecting the environment are not entirely ineffective".

Secondly, municipal waste management is a business sector, consisting of various subsectors. This determines the decentralized information data flow. Directive (EU) 2018/851 [49] sets forth the definitions of municipal waste management. According to article 3 (9) of directive 2018/851 "waste management" means the collection, transport, recovery (including sorting) and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and including actions taken as a dealer or broker".

Thirdly, municipal waste management is identified as critical infrastructure, interacting with various sectors of the economy [3,52]. Emphasizes interdependencies with energy sector (for example electricity, heating), digital technology implementation (process automation, cyber security), and the engineering (new technology adoption) sector.

Fourthly, the MWM sector is based on a social phenomenon. This means that every person on the planet leaves waste. According to the Eurostat, for 2017, [53] the municipal waste generation totals varied considerably, ranging from 272 kg per capita in Romania to 781 kg per capita in Denmark (the EU-28 average reaches 486 kg per capita) (see Figure 1). The variations reflect differences in consumption patterns and economic wealth, but also depend on how municipal waste is collected and managed.

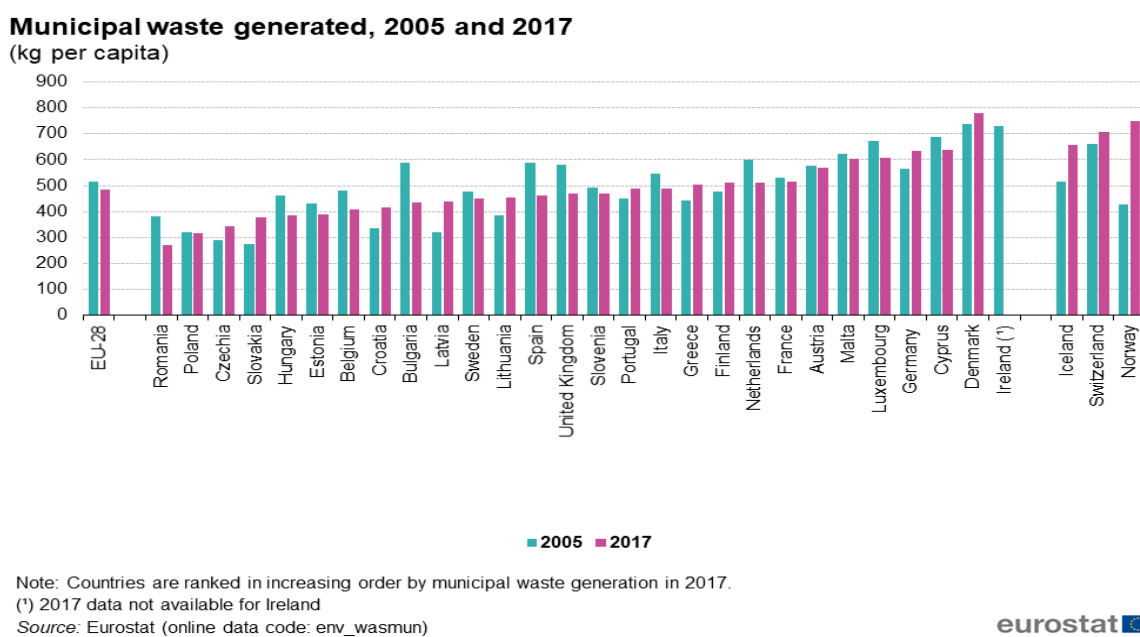


Figure 1. Situation of the municipal waste sector.

Lastly, cultural–economic nature. Waste management in the EU should be improved and transformed into sustainable material management, with the aim of protecting, preserving and improving the quality of the environment, protecting human health, ensuring the prudent, efficient and rational utilization of natural resources, promoting the principles of the circular economy (based on sharing, leasing, reuse, repair, refurbishment and recycling, in an (almost) closed loop, where the products and the materials they contain are highly valued), enhancing the use of renewable energy and providing new economic opportunities and contributing to long-term competitiveness [49].

4. Discussion of Big Data Interactions with Municipal Waste Management and Cryptocurrencies

Potential Interactions of Big Data and Points of Impact on Municipal Waste Management and Cryptocurrency

According to the IBM Institute et al. [54], the definition of big data is perceived throughout four dimensions: volume (terabytes, exabytes), variety (text, image, video, social relation, social behaviour), velocity (barking, streaming) and veracity (authenticity, origin). Yin et al. [55] added an additional value (fresh, old).

According to Yin et al. [55], more efficient risk management systems can be created with big data, which will improve the decision-making for management (more informed decisions) and improve corporate governance.

In Table 1 authors deliver visualized classification of Big Data interaction with MWM and Cryptocurrency sectors. Data, municipal waste management and cryptocurrency have many aspects in common. Therefore, we could raise a hypothesis that in a perfect environment (data availability in all aspects) the results of the implementation/data processing results might have the maximum available impact for both industries.

Table 1. Common aspects of municipal waste management and cryptocurrency interaction with big data.

	Municipal Waste Management	Cryptocurrency
Critical Infrastructure	+	+
Data accountability	+	+
Information can be used for multi purposes	+	+
Variety can be estimated	+	+
Velocity can be estimated	+	+
Volume can be estimated	+	+
Value can be estimated	+	+
Veracity can be estimated	+	+

Source: compiled by authors.

Table 2 shows Big data manifestation in MWM and Crypto Currency from aspect of legal, technical infrastructure and social habits. However, upon analysis of the cryptocurrency and municipal waste management data development stages, significant differences in data infrastructure were identified. As cryptocurrency is a digital product and the data is collected and kept within the network, it already contains all the needed features for big data innovations, whereas municipal waste management needs infrastructure and processing to be implemented. Moreover, municipal waste management development with big data strongly depends on consumers' social habits of data collection and sharing.

Table 2. Big data development stages cryptocurrency/municipal waste management.

	Cryptocurrency	Municipal Waste Management
Data privacy and accountability	Legislature to be implemented	Legislature to be implemented
Infrastructure for data gathering and processing	In place	Need for implementation, development and regulation
Social habits of data scoping and sharing	In place	Need for implementation, development and regulation

Source: compiled by authors on the basis of the Mayor-Schonberger et al. [18] classification.

Table 3 divulge differences of Big Data Manifestation in MWM and Cryptocurrency stages from a technological perspective. The main differences occur due to different ways to collect, process and store. Cryptocurrency, as a digital product, already has ways to store, process and transport data. A clear hierarchical structure ensures the fast implementation of changes. Conversely, in municipal waste management, there are no unified ways or standards for data gathering formats, there is no clear hierarchy of data processing and sharing centres and therefore there is no unified and centralized methodology of collecting, sharing and transporting data, and the processes of improvements will be chaotic and non-centralized.

Table 3. The comparison of big data interactions with cryptocurrency and municipal waste management from a technical data layer aspect.

Stages of A Data Chain	Process	Technology Aspect	
		Municipal Waste Management	Blockchain Based Cryptocurrency Market
Raw Material	Data generation and capture	Very poor existing data available Decentralized data sources locally and globally No systematic approach for data collection No unified data collecting standards	Publicly available transactions of full period Possible unified global classification of collected data
Processing	Data janitorial work Data transformation Data analytics	No unified approach, transformation counterparties, data analysed on local, global hubs, unified standards missing	Possible to apply international accounting and banking standards for data classification
Transport	Data transfer	Unclear data receiving and sending counterparties Data transporting network does not exist	Data can be distributed globally
Marketing	Data transfer Data analytics	Long implementation cycle/data should be concentrated within the decision-making unit, which will enforce decision implementation, which in turn will be delivered by many counterparties	Possible fast financial sector participant decisions on revealed data. Fast implementation of changes

Source: compiled by authors on the basis of the Wolfertab et al. [27] classification.

Table 4 discloses business aspect of big data implementation in MWM and Crypto Currency sectors. GDPR aspects are highly important for the further development of cryptocurrency and big data. Big data reveals three ways of data processing: personal data (related to data subject/natural person), non-personal data and mixed data. In most situations, analysed or processed data are more likely to contain mixed data types.

Table 4. The comparison of big data interaction with cryptocurrency and municipal waste management from the aspect of business data layer.

Stages of Data	Process	Business Aspect	
		Municipal Waste Management	Blockchain Based Cryptocurrency Market
Raw Material	Data discovery Data warehousing	Possible decentralized data warehousing due to missing, data storing standards	Possible to access and store data centralized
Processing	Interpreting data Connecting data to decision (Obtaining business information and insight)	Due to non-centralized and non-studentized data, data interpretations and outcomes are most probably decentralized as well	Centralized first source data, can be delivered for analysing parties. Outcome can be delivered globally/locally
Transport	Information sharing and data integration	Due to the lack of standards, data integration, massive data sharing is difficult and hardly comparable	Immediate sharing of information and data integration

Table 4. Cont.

Stages of Data	Process	Business Aspect	
		Municipal Waste Management	Blockchain Based Cryptocurrency Market
Marketing	Data-driven services	Decisions can be implemented fragmentedly within decision making units, however not globally	Very fast decision-making is possible with immediate reaction if needed

Source: compiled by authors on the basis of the Wolfertab et al. [26] classification.

Cryptocurrency transactions are public and anonymous, while municipal waste management contains all types of processing data. The data must be collected for specified, explicit and legitimate purposes. Compliance with the mandatory provisions of the above documents must be ensured when implementing big data in both the cryptocurrency and municipal waste management sectors.

Upon the analysis of data regulation, we determined two main directions of mandatory provisions: general and special.

1. General provisions are commonly applicable to most sectors of the economy where data is processed, such as banking, medicine and transporting. For example: big data processing aspects, developing codes of conduct and establishing data protection certification mechanisms.

2. Special provisions are applicable to the municipal waste management or cryptocurrency sectors. The interactions between the BD and MWM sectors create a positive impact on pricing, clearly identifying the amount of waste and its type. It is noteworthy that these specific data can influence the interests of personal data protection; the content of the waste and its nature can reveal an individual's consumption habits, financial status and even data concerning health (personal data related to physical or mental health of a natural person). It is arguable that structural–functional problematic aspects need to be resolved, ensuring the appropriate realization of GDPR and EUdataFF, for example, the functional distribution between waste collection actors (private and public), and personal data pseudonymisation (the processing of personal data in such a manner that the personal data can no longer be attributed to a specific data subject without the use of additional information).

5. Conclusions

The research findings provide the following conclusions:

1. Big data manifestation is possible in both: cryptocurrency and municipal waste management sectors. This means, that big data can influence: (a) elements of Industry 4.0 (CC) that are based on digital development; (b) sectors which are not directly identified as Industry 4.0 elements (MWM). We argue that through big data point of view, this manifestation will reveal the challenges and aspects to reduce the gap between new and old area technology speed of development.
2. The performed data analysis identifies big data adoption obstacles for the cryptocurrency and municipal waste management sectors. These obstacles are not homogenous.
3. The direct elements of the industrial revolution 4.0, digital technologies and their interaction speeds up the process of adoption of phenomenon realisation. Big data and cryptocurrencies are based on digital development, while municipal waste management is a parallel sector which needs additional solutions and calls for digitalization. While digital technology + digital technology = fast evolution, and digital technology + non-digital technology + required additional digitalization infrastructure = long evolution.
4. We classified the BD manifestation in CC and MWM sectors through aspects of the positive and negative elements of interaction:

Big Data Manifestation	Positive Elements	Negative Elements
Crypto Currency	(i) unification of money/transactions availability between different regions worldwide	(i) gathered, stored or transferred data can be stolen or leaked, various threats or risks might arise for countries/region national security
	(ii) stimulates competitiveness and fair pricing	
	(iii) provides ways to solve economic inequality	
	(iv) provides the possibility of fair pricing for end-users.	
Municipal Waste Management	(i) effectiveness which manifests in the socioeconomic context, where beneficiaries are people; and special element—nature and future generations	(i) gathered, stored or transferred data can be stolen or leaked, various threats or risks might arise for countries/region national security
	(ii) global homogeneity presupposes competitiveness and fair pricing	(ii) obstacles for data protection and storage due to its decentralized origin
	(iii) eliminates monopolistic phenomenon	
	(iv) increases the possibility to reduce municipal waste management consequences	
	(v) provides the possibility to identify and replicate good practices	
	(vi) provides the possibility of fair pricing for end-users.	

- Summarizing positive and negative factors: data protection, sufficient GDPR regulation realization including appropriate personal data processing. It should be noted that improperly conducted processes or personal data connection are identified as the biggest obstacles in reaching the set goals.

This study reveals new knowledge of Industry 4.0 and non-Industry 4.0 element interactions. The findings, including classification, are likely to be used in future research, with the possibility of implementing triangular research methods, empirical research methods and practical implementation research. Our findings are important for both the development of science and practical implementations.

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