

## **ВІДГУК ОФІЦІЙНОГО ОПОНЕНТА**

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Б.Д.Гаврилишина Західноукраїнського національного університету

Зварич Ірини Ярославівни на дисертаційну роботу

Han Yafeng «Development of integrated e-waste management system based on resource-saving in China», подану на здобуття ступеня доктора філософії з

галузі знань 07 Управління та адміністрування за спеціальністю

073 Менеджмент

### **1. Relevance of the research topic.**

Waste electrical and electronic equipment has become the fastest growing waste stream in the world. This category of waste has a complex composition which contains both hazardous and valuable substances and is known as urban mine. The introduction of systems for separate collection and recycling of waste electrical and electronic equipment driven by digital technologies is an integral component of smart cities. In this regard, the dissertation topic devoted to defining the theoretical and methodological foundations of integrated e-waste management in accordance with the basic principles of the circular model of China's economy using digital technologies is relevant and timely.

### **2. Connection of work with scientific programs, plans, topics.**

The subject of this study is consistent with the basic principles of “The 2030 Agenda for Sustainable Development” (Resolution 70/1 of UN General Assembly), the “European Green Deal”, the “Sustainable Development Strategy of Ukraine until 2030”, and “China's National Plan on the Implementation of the 2030 Agenda for Sustainable Development”. The dissertation was carried out following the topic of the international project "Towards circular economy thinking & ideation in Ukraine according to the EU action plan" (grant number

620966-EPP-1-2020), in which the author investigated the foreign experience of management of circular economy related e-waste management system.

### **3. The scientific novelty of the obtained results.**

The scientific novelty of the results lies in the deepening of the existing theoretical provisions and the developing of scientific-practical and methodical recommendations on the development of integrated e-waste management system based on resource-saving in China. In particular, a conceptual framework for a digitally enabled circular economy in the context of the product life cycle was developed which, unlike the existing ones, involves the various Industry 4.0 digital technologies covering all stages of the product life cycle to accelerate the circular economy transition.

The scientific and methodological approach to form a system for urban e-waste management and to facilitate the implementation of the circular economy model based on the application of digital technologies and an intelligent recycling system towards the formalization of e-waste recycling has been improved. Insights in the form of practical recommendations for urban policymakers and managers have been outlined to implement urban transformation towards smart cities and circular economy by using wide range of technology innovations towards environmental pollution prevention and saving the value of materials and products in the economic system as long as possible. A set of scientifically justified economic incentives eligible for smart e-waste recycling system in line with the legally established requirements in this field in China has been proposed, which encourages consumers engagement to using the smart e-waste recycling platform, has been systematized. Academic researches on smart e-waste recycling in China and cutting-edge smart e-waste recycling solutions from commercial and emerging technology companies have been structured based on the extensive literature review which allowed identifying key challenges and providing countermeasures for future smart e-waste management.

#### **4. The scientific and practical significance of the dissertation.**

The scientific and practical implication of the dissertation consists in improving e-waste management by providing practical recommendations for decision makers to capitalize the potential of digital technologies to support circular economy transition. The results of the study were implemented into the activities of the School of Computer Science and Technology of Henan Institute of Science and Technology while developing an electronic waste management system (certificate dated 06/10/2023), as well as by the School of Information and Engineering of Henan Institute of Science and Technology while organizing the process of managing electronic waste at the territory of campus (certificate dated June 10, 2023).

#### **5. Completeness of presentation of the dissertation material in scientific publications.**

The main materials of the dissertation are published in 9 scientific publications, including one subsection of the monograph, 2 articles in scientific professional journals of Ukraine, 2 articles indexed by the Scopus and Web of Science databases etc. Scientific works reflecting the main scientific results of the dissertation:

1. Han, Y., Shevchenko, T., Yannou, B., Ranjbari, M., Shams Esfandabadi, Z., Saidani, M., Bouillass, G., Bliumska-Danko, K., & Li, G. (2023). Exploring How Digital Technologies Enable a Circular Economy of Products. *Sustainability*, 15(3), 2067. <https://doi.org/10.3390/su15032067> (Scopus, Web of Science).

2. Han, Y., & Shevchenko, T. (2021). Exploring incentive mechanism in smart E-waste management system in China. *Bulletin of Sumy National Agrarian University*. 4(90), 50-59. <https://doi.org/10.32845/bsnau.2021.4.8>

3. Han, Y., & Shevchenko, T. (2023). Exploring digital technologies and smart systems used in e-waste management in China: seminal research themes. *Bulletin of Sumy National Agrarian University*. 3(95), 3-9. <https://doi.org/10.32782/bsnau.2023.3.1>

4. Han, Y., Shevchenko, T., Qu, D., & Li, G. (2022). Smart E-waste Management in China: A Review. Proceedings of 2nd Congress on Intelligent Systems (CIS2021), Springer Book Series, Singapore, 2, 515-533. [https://doi.org/10.1007/978-981-16-9113-3\\_38](https://doi.org/10.1007/978-981-16-9113-3_38) (Scopus, Web of Science).

Scientific works certifying the approval of the dissertation materials:

5. Han, Y. (2021). Advancing e-waste management system based on intelligent technologies in China. Proceedings of the VII International Scientific and Practical Conference “Modern Management: Trends, Problems and Prospects for Development”, April 14, 2021. Alfred Nobel University, Dnipro (online) P.24-26.

[https://duan.edu.ua/en/index.php?option=com\\_content&view=article&id=467amp&catid=13](https://duan.edu.ua/en/index.php?option=com_content&view=article&id=467amp&catid=13)

6. Han, Y. (2021). Research on incentive mechanism of e-waste recycling in China. Proceedings of Conference “Answers on nowadays economic and environmental challenges in a vision of scientists”, June 29, 2021. Ukraine, P.72-75. <https://odeku.edu.ua/wp-content/uploads/materiali-konf-2021-epsdn.pdf>

7. Han, Y. (2023). Advancing rural waste management program in China: enlightenment from the case study. Proceedings of the scientific and practical conference “Economic development in the context of integration into the European research and innovation area”, June 23-24, 2023. Ukraine, P.27-30. <https://molodyivchenyi.ua/omp/index.php/conference/catalog/book/41>

8. Han, Y., Shevchenko, T., & Zhao F. (2023). Research on the Development of Circular Economy in Modern Agriculture. Proceedings of IV International scientific and theoretical conference “Science of XXI century: development, main theories and achievements”, June 30, 2023. Finland, P.11-14. <https://previous.scientia.report/index.php/archive/issue/view/30.06.2023>

9. Han, Y., Yi D. (2023). Application of smart technology in waste sorting management in rural China. Proceedings of X International scientific and practical conference “Science and technology: problems, prospects and innovations”, July 6-8, 2023. Japan, P.179-183. <https://sci-conf.com.ua/x-mizhnarodna-naukovo->

#### **6. The degree of validity of scientific provisions.**

The scientific provisions, conclusions and recommendations obtained from the research results are sufficiently substantiated and reliable. The dissertation is characterized by a clear adherence to the structural and logical scheme of the research, the correspondence of the scientific results and the provisions issued for the protection of scientific novelty to the set goal and the specific task of the research. The dissertator used a sufficient number of information sources from open databases, regulatory and legal literature, statistical and analytical materials. The results of the research and the author's recommendations have undergone practical testing, which is confirmed by relevant documents. The above is evidence of a sufficient level of validity and reliability of the results of scientific research, conclusions and proposals.

#### **7. The structure and content of the dissertation, its completeness and compliance with the established requirements.**

The dissertation is a comprehensive study devoted to finding a solution to the problem of ensuring the management of the development of an integrated electronic waste management system based on resource conservation in China.

Theoretical foundations were systematized, concepts were deepened and a methodological approach was formed to ensure the management and evaluation of the effectiveness of minimization of the negative impact of electronic waste on the environment and the presence of valuable components determine the need for the introduction of progressive systems for their separate collection and processing on the basis of resource conservation using digital technologies.

It was revealed that the circular economy model is currently the conceptual basis of recycling used products. A review of the literature showed that digital technologies contribute to the acceleration of the transition from a linear model of

the economy to a circular one. Six types of Industry 4.0 digital technologies related to the circular economy model were identified, in particular: cyber-physical systems, Internet of Things, artificial intelligence technologies, big data analytics, additive manufacturing and simulation technologies. It has been proven that digital technologies play an important role in making decisions about environmentally sound economic activities, including in the field of waste management, and the synergy and sustainability of Industry 4.0 will contribute to the further development of a sustainable society.

Based on the results of the research, the author developed a conceptual basis of the circular economy model based on the application of digital technologies implemented at all stages of the product life cycle. We are talking about the application of various Industry 4.0 digital technologies, covering the entire product life cycle to accelerate the transition to a circular model. At the initial stage of the life cycle, that is, at the design stage, digital technologies can facilitate the realization of product design according to circular strategies. Regarding the stage of use, the application of appropriate technologies (namely, cloud technologies, big data analytics and artificial intelligence) contributes to the monitoring of this process in order to extend the life of the product. The final stage of a product's life cycle is closely related to its design at the initial stage. Based on this, it was concluded that increasing investments in the use of digital technologies at the stage of product design is necessary to create the prerequisites for closing the material loop at the final stage.

The paper presents the results of an empirical study of the relationship between the use of smart technologies and the reduction of environmental pollution and the development of the city's circular economy based on data from 253 cities at the prefecture level in China from 2003 to 2017.

The results of the study show that the creation of a smart city has a significant connection with the reduction of pollutant emissions and the development of the city's closed-loop economy. The implementation of the smart city policy can contribute to the development of the circular economy due to

technological innovations. In the course of the research, it was proven that thanks to the support of technological innovations, smart cities have a lasting impact on the development of the closed-loop economy. The work presents practical recommendations for local authorities and managers regarding the economic development of the city based on smart technologies and the principles of the circular model.

Based on the results of the research, the author proposed a scientific and methodological approach to the formation of an electronic waste management system in accordance with the principles of the circular economy model based on the implementation of digital technologies and smart systems for handling them. This approach will contribute to the sustainable management of e-waste in the city of Xinxiang. By installing an infrared full-container alarm system for smart-containers at each collection point, it was proposed to use "back-office" real-time data for planning and optimizing collection routes. As a result, the cost of waste collection will decrease, encouraging consumers to use official channels for returning used products.

#### **8. Discussion clauses and remarks to the dissertation.**

However, in my opinion, it is appropriate to note that there are certain debatable points in the work.

1. The author considered the standards of waste management in the EU. But the problem of disposal of electronic waste today is gaining archival importance. The world community, within the framework of determining the determinants of sustainable development policy (which, of course, includes three components - the solution of economic, social and environmental issues), allocates significant financial resources of UN agencies (UNDP, WFP, World Bank, FAO, IFAD), and not small ones' European grants. Therefore, attention should be paid to the possibilities for the PRC to resolve the issues raised at this expense.

2. The author claims that "a smart system for the collection and processing of electronic waste, which is based on the creation of a three-level logistics system

that includes public collection points, regional stations and collection centers in accordance with the principles of the circular economy model based on the implementation of digital technologies for handling them is optimal both from the point of view of economic efficiency and environmental safety." It is possible to agree with such a statement not from the positions from which the author considers, but only from the organizational and managerial point of view in a certain territory.

3. The work should highlight the problems related to the formation of the habit of the country's population to the correct disposal of electronic waste, because they are different in origin and, most importantly, differ in methods of disposal with solid household waste.

4. The researcher does not consider electronic waste disposal technologies in his work, because such a goal was not set for him. In our opinion, this would greatly enrich the work. Because even solid household waste disposal technologies have many directions and different effects, and electronic waste constitutes a significant part of them and would significantly ensure resource conservation.

5. The researcher introduces the concept of "system of indicators for evaluating the circular economy of the city", which represents 17 indicators differentiated by three dimensions "economy-resources-environment" with five corresponding evaluation indicators, including: economic capacity, economic efficiency, reduction resources, pollution reduction and reuse and recycling. In our opinion, such a system should take into account cluster distribution, because in real conditions, for the disposal of waste, its producer can use the services of a disposal facility that is territorially close to him, even if it is in a neighboring region. All this will affect the value of the calculation coefficient for a certain region (area) and therefore can be used in a limited way.

But all the remarks I have listed are only of a recommendatory nature and do not affect the overall positive assessment of the dissertation work.



### 9. General conclusion.

The dissertation work of Han Yafeng "Development of integrated e-waste management system based on resource-saving in China", which was submitted for defense to the specialized academic council for obtaining the degree of Doctor of Philosophy in the field of knowledge 07 management and administration with the specialty 073 management according to its relevance, scientific and theoretical level, the main results of validity, the main provisions and results published in professional publications, the novelty of the statement and the practical significance meet the requirements of the order of the Ministry of Education and Culture of Ukraine No. 40 of January 12, 2017 "On approval of requirements for the preparation of a dissertation" and the Resolution of the Cabinet of Ministers of Ukraine of 12 No. 44 of January 2022 "On the approval of the Procedure for awarding the degree of Doctor of Philosophy and the cancellation of the decision of the one-time specialized academic council of the institution of higher education, scientific institution on awarding the degree of Doctor of Philosophy" with changes made in accordance with Resolution of the Cabinet of Ministers No. 341 of 21.03.2022

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