REVIEWER'S REVIEW
of D.Sci in Economics, Professor of the Department of Marketing and Logistics
Sumy National Agrarian University
Prof. Olena NIFATOVA
for **Han Yafeng's** dissertation
**«Development of integrated e-waste management system
based on resource-saving in China»**,
applied for the degree of Doctor of Philosophy
from the field of knowledge 07 Management and administration
in the specialty 073 Management

Relevance of the topic of the dissertation. In terms of volume and environmental impact on the planet, waste electrical and electronic equipment has become the fastest growing waste stream in the world. The distribution and environmental impact of e-waste varies across regions of the globe. In developed countries, there is usually infrastructure for e-waste recycling, but in low- and middle-income countries the infrastructure for managing e-waste is still under developing or non-existent, and therefore e-waste is mainly managed by the informal sector. In such cases, e-waste is usually disposed of in poor conditions, posing a serious threat to human health and causing serious environmental pollution in the areas where it is collected and disposed of. All this determined the choice of the topic, purpose, and objectives of the study. In this way, it is necessary to introduce the progressive systems for their separate collection and processing based on resource conservation. Lack of inclusiveness of the issues of determining the theoretical and methodological foundations of integrated electronic waste management in accordance with the basic principles of the circular model of China's economy using digital technologies determines the relevance of the topic.

Connection of work with scientific programs, plans, topics. The dissertation topic corresponds to the provisions 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 project "Towards circular economy thinking & ideation in Ukraine according to the EU action plan" within the Erasmus+ Programme of the European Union.

The scientific novelty of the results consists in the integration of digital technologies into e-waste management system at the urban level in China based on circular economy strategies implementation. The scientific essence could be concluded as follows:

First obtained:

- 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 proposed.

Improved:

- The conceptual framework for a digitally enabled circular economy in the context of the product life cycle has been developed. Unlike the existing ones, it involves the various Industry 4.0 digital technologies covering all stages of the product life cycle to accelerate the circular economy transition.

- The evaluation index system for assessing the level of circular economy development at the city level has been proposed. As opposed to the existing ones, it is based on 17 indicators differentiated by three "economy-resources-environment" dimensions with five relevant evaluation metrics, including (i) economic strength, (ii)

economic efficiency, (iii) resource reduction, (iv) pollution reduction, and (v) reuse and recycling.

- An intelligent logistics and recycling system for e-waste management based on advanced digital technologies in city Xinxiang has been developed and designed, which is based on the setting up a three-tier logistics and recycling system with community collection points, regional collection stations and regional collection centers as its core, and as opposed to available one, it forms a new type of intelligent and comprehensive recycling system with reasonable layout and comprehensive coverage.

Further developed:

- The 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.

- The 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.

4. The scientific and practical significance of the dissertation is that the main provisions of the thesis are brought to the level of methodological developments

and practical recommendations that can be used by public authorities during the development of strategies and programs for the management of circular economy related assets in colleges and universities. The proposal of the waste management program for China in this study has been considered by the decision-makers in improving the waste management and even could be applied to the urban waste management of the city of China after mature development. The results of the study were implemented into the activities of Henan Institute of Science and Technology while developing an electronic waste management system.

The main results obtained personally by the author:

This study explores the construction of an intelligent logistics and recycling system for the recycling of e-waste in Xinxiang city, which consists of four parts: e-waste logistics and recycling network coverage, e-waste logistics and recycling process tracking, e-waste logistics and recycling routes intelligent recommendation, and e-waste inventory management. The e-waste logistics and recycling network will be combined with the intelligent recycling bins based on IoT to build a three-tier logistics and recycling system with "points, stations and centers" as the core. By setting up community collection points (collection booths or mobile collection vehicles), regional collection stations (collection stores) and regional collection centers (processing and utilization centers), a new intelligent integrated recycling system with reasonable layout and comprehensive coverage will be formed.

The tracking of the recycling process of the reverse logistics of used and end-of-life household appliances will utilize the logistics tracking technology, adopting the fusion of multiple tracking technologies to realize the heterogeneous sharing and chain query of waste household appliance reverse logistics recycling data. Through the wireless communication network and technology, comprehensive road traffic information is obtained, global positioning system/GIS control center is used to

obtain the road traffic condition and the state of logistics vehicles on the recycling logistics network, the whole process of vehicles is tracked, the comprehensive control of the recycling logistics state is realized. The visualization management platform is established to visualize the utilization plan of the recycling vehicles, the optimization of the transportation scheme and the dynamic control of the vehicles and goods within the platform. Based on logistics and recycling information data management, it establishes the inventory management of waste household appliances, collects all the data in the work of inventory processing, and realizes the inventory decision-making support.

A questionnaire survey was conducted among the citizens of Xinxiang city, and statistical analysis methods were used to determine the relationship between the variables. It was found that residents' willingness to recycle e-waste will directly affect residents' e-waste recycling behavior. Residents' willingness to recycle e-waste is influenced by the internal environment, thereby adjusting residents' e-waste recycling behavior. Residents' willingness to recycle e-waste is affected by the external environment, thereby regulating residents' e-waste recycling behavior. The incentives for residents to recycle e-waste will adjust residents' willingness to promote the sustainable development of e-waste recycling. Addressing barriers to e-waste recycling will adjust residents' willingness to recycle e-waste, intervene in residents' behavior, and promote the sustainable development of e-waste recycling. Adopting relevant incentives to solve the problems caused by e-waste recycling barriers will increase residents' willingness to recycle e-waste, thereby intervening in residents' behavior and promoting the sustainable development of e-waste recycling.

Was combined the incentive system with the smart e-waste collection system to construct a set of incentives suitable for China's smart e-waste recycling system, which is conducive to improving the e-waste recycling rate and has applicability. Existing smart e-waste collection systems use a single economic incentive method. It

faces fierce competition from unauthorized informal recyclers, resulting in a small number of users and inability to fully utilize its advantages. In the reverse logistics of e-waste recycling, consumers are the starting point of product recycling. By analyzing the characteristics and determinants of Chinese users' recycling behavior, this study selects appropriate incentives for a smart e-waste collection system to meet Chinese consumers' perceptions of waste electrical and electronic equipment. The incentive system is based on economic incentives, including currency, reward points, and tax incentives, and combines negative incentives, mainly fines. Rewards and punishments are employed simultaneously to achieve long-term and sustainable incentive effects. The incentive system is based on the convenient infrastructure of the smart e-waste collection system, and its financial model must be shared by multiple stakeholders from the government, smart e-waste systems, and manufacturers.

Based on the plagiarism check report, the reviewers came to the conclusion that Han Yafeng's dissertation "Development of integrated e-waste management system based on resource-saving in China" is the result of the applicant's independent research and does not contain elements of plagiarism and borrowing in accordance with the resolution of the CMU dated 12.01.2022 No. 44 p. 9. Used ideas, results and texts of other authors have a link to the corresponding source.

Publication of obtained results:

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 (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

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-praktichna-konferentsiya-science-and-technology-problems-prospects-and-innovations-6-8-07-2023-osaka-yaponiya-arhiv/

Remarks and wishes for the content.

Characterizing Han Yafeng`s dissertation as a whole, it should be noted that it certainly has relevance, scientific and practical significance. During the review of the work, some issues of a debatable nature, comments and suggestions arose:

1.   The author's choice of the definition "proposed" for the formulation of the subsection of scientific novelty at the level of "for the first time" is quite controversial. The used form "proposed for the first time" is quite debatable in relation to the results of the scientific work presented in this paragraph. As a rule, dissertation students do not propose "for the first time", but "prove", "justify", "develop", "determine", "establish", etc. In order to "propose for the first time" it is necessary to first "prove", "substantiate", "develop" ... The imperfection of the form used by the author to present the content of the point of scientific novelty "for the first time" is not a significant remark in terms of its content and most likely arose in as a result of translation.

2. Chapter 1 does not define the theoretical and methodological conceptual component of the research.

3. In point 3.2, it was desirable to note the environmental benefits of using the proposed resource conservation management scheme.

4. In point 1.2, during the analysis of the open waste management system, the ways of the negative impact of polluting electronic substances on the natural environment are not sufficiently substantiated.

5. A significant number of abbreviations makes it difficult to understand the content of the dissertation.

6. The conclusions of the work are too broad.

The noted shortcomings and remarks do not reduce the scientific value of the work, which was performed at a high level, and the results have practical application.

Correspondence of the dissertation to the specialty and profile of the board:

However, the expressed comments and wishes do not reduce the overall high evaluation of the conducted research. The analysis of the dissertation and scientific works gives reason to conclude that Han Yafeng's dissertation "Development of integrated e-waste management system based on resource-saving in China" is a completed, independently performed scientific work, which has significant theoretical and applied significance. The dissertation solves a specific scientific task regarding the development of theoretical and methodological principles and the formulation of scientific and practical recommendations for the formation of management system of university's educational and scientific assets in the context of transition to the model of circular economy in China.

The dissertation meets the requirements of the Order of the Ministry of Education and Culture of Ukraine No. 40 dated January 12, 2017 "On approval of requirements for the preparation of a dissertation", the requirements of the educational and scientific program successfully completed by the applicant, the

requirements 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 (approved by Resolution of the Cabinet of Ministers of Ukraine dated January 12, 2022 No. 44), and its author – Han Yafeng – can be recommended for awarding the degree of Doctor of Philosophy in specialty 073 "Management" by a one-time specialized academic council.

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