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Editorial for Volume 10 Number 2: Surveying the Transportation of the E-Waste

Ocotlán Díaz-Parra [1], Alejandro Fuentes-Penna [2], Evangelina Lezama León [3], Myrna Lezama León [3], Miguel A. Ruiz-Jaimes [4], Ricardo A. Barrera-Cámara [5], Jorge A. Ruiz-Vanoye [1]

[1] Universidad Politécnica de Pachuca, México.
[2] Centro Interdisciplinario de Investigación y Docencia en Educación Técnica, México.
[3] Universidad Popular Autónoma del Estado de Puebla, México.
[4] Universidad Politécnica del Estado de Morelos, México.
[5] Universidad Autónoma del Carmen, México.

Abstract. High levels of consumption of electrical and electronic equipment, together with the decline of their useful time of life (obsolescence), has led to a progressive growth in the generation of Waste Electrical and Electronic Equipment (WEEE), also known as e-waste. The problems involving inadequate management of these are reflected mainly in the negative impact on the environment, but it also entails a waste of opportunities for reuse of components that can still generate value. This article presents a review of the literature on the studies that address the appropriate process of recovery of WEEE, i.e., the process of Reverse Logistics, and identifies the trends of study on the subject and proposed new lines of research in the management of the WEEE.
Keywords: Transportation problem, E-waste, Reverse logistics.

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I. Introduction

Environmental impact that involves management of WEEE has been widely addressed by different authors, in addition to giving them initiatives that have been generated by public and private institutions for its control and management. The ideal is good management and proper use of the WEEE in accordance with the pyramid of good use (raee.org), it is recommended to prevent environmental degradation through the following processes ranging from action favourable or more ideal to the less favourable: prevention, minimization, reuse, reconditioning, recycling, energy recovery and finally the disposal [1]. However, the importance which involves defining strategies for the proper recovery of this type of waste not only lies in the concern for the environment, this also can be reflected as a business opportunity that is missing, Since a very significant amount of the components in such waste can be reused and continue generating value. Therefore, it is necessary to use a suitable collection process that manages to get as much product at a low cost.

The process of collection of products, from the point of consumption until their final disposition is known as reverse logistics (RL) [2]. The factors that drive reverse logistics are: legal or environmental, social responsibility, and finally, the cost benefits that can be generated with the recovery of reusable materials [3,4].

The purpose of this document is to present the studies that have been developed to address the problem of e-waste, its solution methods reverse logistics transport and result obtained to define future research lines concentrate.

This articles published from 2013 to date, survey presents comprised of generally such studies related to the management of WEEE, and which include RL, analysis studies that address problems of VRP (Vehicle Routing Problem) and finally the research that has been made to the problem in specific vehicle routing for the inverse of e-waste logistics. Presents a table with these studies concentrate by the author, year, including the methodology used and the results obtained. Finally identifies the trends of the studies and future lines of research are proposed to

solve the problem.

II. Related works

Permanyer [5] performs an analysis of the current cycle of WEEE management and proposes a descriptive method, through a cycle different from management of WEEE where greater emphasis is given on the reuse of products obsolete, as well as the dots and eco-design.

Souza [6] performs a critical review through an exploratory investigation, of models formulated for the management of Closed-loop Supply Chains (CLSC,), and concludes that models are required classical research and optimization of operations as support for decision-making, as well as suggests the need for further empirical research, in particular, econometric models, which use real data.

Wang [7] established a methodology to evaluate the performance of systems of return and treatment of e-waste, through a multivariate model that quantifies the generation of e-waste and thus be able to map your workflow to make a follow-up of the collection efficiency finally. Also applies a multidisciplinary approach to assess the technical performance of the infrastructures of treatment of electronic waste and its environmental, economic and social impact.

Hoyos and Cardona [8] proposed the collection of WEEE as an opportunity for job creation and inclusion of sectors of society with a low level of education, through social entrepreneurship. In addition to generating employment, this initiative seeks to control in an orderly manner increasing the levels of WEEE, which is a global problem, which is stimulated by factors such as the strategies established by the productive sector (example: obsolescence) scheduled), where he encourages demand for goods so that they can maintain production levels and economic activity does not decrease, causing finally high costs to the environment due to the lack of corporate social responsibility and responsible consumption).

Gonzalez and Cueto [9] proposed areas of study that can increase the efficiency of waste management, through an exploratory study that covers the European regulations for the management of batteries and accumulators. In the proposed areas are the location of the points collection, size of containers, the definition of paths recovery, amount and location of temporary storage and selection of treatment centers, whereas in all these points not only the reduction of total costs of recovery but also the environmental impact of this process.

Banguera, Sepulveda, Fuertes, Carrasco and Vargas [10] conducted a review of the literature of LI models for the management of solid waste, suggesting the future lines of research: how to handle uncertainty about the quantity and quality of? Products and materials recovered by companies? Pricing models according to the demand and the amount of waste generated, models to understand the behaviour of the consumer concerning the will of recycling and finally to propose making models for understanding the economics of solid waste management.

Fagundes, Amorim and Lima [11] implemented an active investigation of the RL process for tires at the end of its useful life in Brazilia, and proposed three main actions to increase the volume of recovery of those articles: first the creation of a municipal laws, then; create and maintain regular communication mechanisms with respect to the importance of RL and the project developed for the tires at the end of its useful life, finally have an active collection deemed routes covering all the required points, achieving an increase in the percentage of collection of 50%, therefore, recommended to apply active research for the collection of solid waste.

Beliënet al. [12] conducted a review of the literature of VRP problems applied to municipal

garbage collection from 1971 until 2010, classifying information.

ShokohyaryMansour [13] developed a simulation applied in the case of management of WEEE in Iran, with an optimization model to determine the best locations of collection centers as well as recycling, through a model of RL than plants It involves the maximization of profits and the social impact, in addition to minimising environmental impact, using OptQuest software and the Metaheuristic Tabu search, neural networks and search scattered algorithm.

Zhao and Zhu [14] developed a model of VRP multi deposits, applied in the transport of waste explosives. For his solution of the model, using the method of lexicographical weighted Tchebycheff modified, applied in the case of the Nanchuan city in China, generated savings of 33% compared to the results thrown by current models.

Sackmann, Hinze, Michael, Kriegery Halifeoglu [15] presented a solution to Waste Collection Vehicle Routing Problems with Time Windows (WCVRPTW), which differs from the traditional, because representation to which the vehicles of waste must be emptied its load at disposal sites, apply two algorithms for their solution: algorithm trained cluster and k-means algorithm.

Habibi, Battaïa, Cung, and Dolgui [16] optimises the coordinated decisions for collection and removal of the WEEE, whereas inventory is balancing restrictions for the disassembly, demand compliance, capacity of the vehicle and the visit to each node's collection at least once. The total cost of this model is compared with the solution of the problem without coordinating the objectives, i.e. evaluating independently gathering and lots of removals, getting lower with the coordinated model total cost. Models are ILOG CPLEX resolved with the use of the instances proposed in the study.

Below, is a summary of the related studies:

Table 1 Summary studies conducted on WEEE, RL and VRP.

Year	Author	Problem	Methodology
2013	Fabera y Stambolidis	TPS y VRP	GA with a special ERX
2013	Fang et al.	VRP	Neighbour Voronoi algorithm with ring k.
2013	Kassem and Chen	RL of VRPSPD-TW	The technique of construction of sequential routes and simulated annealing.
2013	Permanyer	WEEE management	Descriptive method
2013	Rieck and Zimmermann	VRPSDP	MILP
2013	Shokohyar and Mansour	Optimization RL	Tabu search, neural networks and dispersed search algorithm.
2013	Souza	CLSC	Exploratory research.
2013	Stenger et al.	MDVRPPC	Variable neighbourhood search algorithm.
2014	Boschetti and Maniezzo	MTVRP-PDTW	Model SCC and heuristic hallmarked randomized.
2014	Giraldo et al.	WEEE management	Deductive method, survey and interview.
2014	Liu et al.	MDOVRP	HGA
2014	Vaira y Kurasova	VRP	GA with a heuristic random inclusion exploratory and applied research

Year	Author	Problem	Methodology
2014	Wang	WEEE management	GA with a heuristic random inclusion exploratory and applied research
2014	Yousefikhoshbakht et al. (a)	VRPSPD	Combined modified tabu search and ants system elite (MTSEAS)
2014	Yousefikhoshbakht et al. (b)	HFFOVRP	tabu search
2014	Yusuf et al.	VRP	GA
2014	Zheng-yang et al.	2E-VRP	GRASP + VND
2015	Cácerez-Cruz et al.	RVRP	exploratory research
2015	Cardona and Hoyos	WEEE management	exploratory research, applied and perceived.
2015	Grau and Gonzalez-Feliu	2E-VRP	GA
2015	Hoyos and Cardona	WEEE management	The qualitative and quantitative approach, surveys and interviews to household consumers and entrepreneurs.
2015	Hyunchul et al.	TOPTW	An exact algorithm based on the branch- and -price approach
2015	Jabali et al.	VRP-SITW	Tabu search and linear programming.
2015	Wang et al.	VRP	Fuzzy dynamic programming.
2016	Beliën et al.	VRP	Exploratory research
2016	Coelho et al.	GSCM	Four districts (FN-VNS) variable neighbourhood search algorithm
2016	Dikas et al.	VRP	Labelling and sharing heuristics algorithms
2016	González and Cueto	RL	exploratory and applied research
2016	Kirci	VRPTW	Search taboo and Hopfield neural networks
2016	Orrego et al.	CVRP	Heuristics scanning of two phases and modified genetic algorithm of Chu-Beasley (AGCB)
2016	Quintero-Ortega	RL, WEEE management	Descriptive research
2016	Shi et al.	VRP-PDTW	Parthenogenetic algorithm (HPGA)
2016	Yousefikhoshbakht et al.	VRP	Effective ranges (ERAS)-based Ant system algorithm.
2016	Yuchi et al.	LIRP-FRL	A new algorithm of tabu search (NTS).
2016	Zhao and Zhu	MDVPR	Lexicographical Tchebycheff method weighted modified.
2017	Ashouri and Yousefikhoshbakht	VRP, OVRP, VRPSPD	Effective combined (CEACO) ant colonies optimization algorithm.
2017	Banguera et al.	RL	exploratory research
2017	Blazsik y Fajfrik	VRPIT	Stochastic general heuristics. Scaling algorithm and simulated annealing.
2017	Chen et al.	DVRPTW	Search for harmony (HS) and variable algorithm algorithm neighborhood descent (VND).
2017	Fagundes et al.	RL	Active research
2017	Habibi et al.	VRP, RL, WEEW	MPL
2017	Sackmann et al.	WCVRPTW	The algorithm of cluster trained and k-means algorithm
2017	Shifeng et al.	DVRP	Algorithm of optimization of monarch butterfly (MBO)
2018	Ali et al.	RL	Interpretive structural modelling (ISM) and MICMAC
2018	Xu et al.	DVRP	(E-ACO) improved Ant Colony Optimization

III. Conclusions

As you could see, there is a wide variety of studies that address the problem of vehicular routes (VRP), however, the problem of garbage collection has long to explore field and within this area of garbage collection, speaking specifically of WEEE still be wide more exploration area, since the WEEE treatment contains characteristics that should be studied in a timely manner.
The line of research on a solution to the problem of routes of vehicle waste collection with windows of time (WCVRPTW), was proposed for future work using various metaheuristics for your solution, as well as other algorithms.

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