

CLEISEANO EMANUEL DA SILVA PANIAGUA
(ORGANIZADOR)

Collection:

**APPLIED ENVIRONMENTAL
AND SANITARY
ENGINEERING
2**

CLEISEANO EMANUEL DA SILVA PANIAGUA
(ORGANIZADOR)

Collection:

**APPLIED ENVIRONMENTAL
AND SANITARY
ENGINEERING
2**

Editora chefe

Profª Drª Antonella Carvalho de Oliveira

Editora executiva

Natalia Oliveira

Assistente editorial

Flávia Roberta Barão

Bibliotecária

Janaina Ramos

Projeto gráfico

Bruno Oliveira

Camila Alves de Cremo

Daphynny Pamplona

Luiza Alves Batista

Natália Sandrini de Azevedo

Imagens da capa

iStock

Edição de arte

Luiza Alves Batista

2022 by Atena Editora

Copyright © Atena Editora

Copyright do texto © 2022 Os autores

Copyright da edição © 2022 Atena Editora

Direitos para esta edição cedidos à Atena Editora pelos autores.

Open access publication by Atena Editora



Todo o conteúdo deste livro está licenciado sob uma Licença de Atribuição *Creative Commons*. Atribuição-Não-Comercial-Não-Derivativos 4.0 Internacional (CC BY-NC-ND 4.0).

O conteúdo dos artigos e seus dados em sua forma, correção e confiabilidade são de responsabilidade exclusiva dos autores, inclusive não representam necessariamente a posição oficial da Atena Editora. Permitido o *download* da obra e o compartilhamento desde que sejam atribuídos créditos aos autores, mas sem a possibilidade de alterá-la de nenhuma forma ou utilizá-la para fins comerciais.

Todos os manuscritos foram previamente submetidos à avaliação cega pelos pares, membros do Conselho Editorial desta Editora, tendo sido aprovados para a publicação com base em critérios de neutralidade e imparcialidade acadêmica.

A Atena Editora é comprometida em garantir a integridade editorial em todas as etapas do processo de publicação, evitando plágio, dados ou resultados fraudulentos e impedindo que interesses financeiros comprometam os padrões éticos da publicação. Situações suspeitas de má conduta científica serão investigadas sob o mais alto padrão de rigor acadêmico e ético.

Conselho Editorial**Ciências Exatas e da Terra e Engenharias**

Prof. Dr. Adélio Alcino Sampaio Castro Machado – Universidade do Porto

Profª Drª Alana Maria Cerqueira de Oliveira – Instituto Federal do Acre

Profª Drª Ana Grasielle Dionísio Corrêa – Universidade Presbiteriana Mackenzie

Profª Drª Ana Paula Florêncio Aires – Universidade de Trás-os-Montes e Alto Douro

Prof. Dr. Carlos Eduardo Sanches de Andrade – Universidade Federal de Goiás

Profª Drª Carmen Lúcia Voigt – Universidade Norte do Paraná



Prof. Dr. Cleiseano Emanuel da Silva Paniagua – Instituto Federal de Educação, Ciência e Tecnologia de Goiás
Prof. Dr. Douglas Gonçalves da Silva – Universidade Estadual do Sudoeste da Bahia
Prof. Dr. Eloi Rufato Junior – Universidade Tecnológica Federal do Paraná
Profª Drª Érica de Melo Azevedo – Instituto Federal do Rio de Janeiro
Prof. Dr. Fabrício Menezes Ramos – Instituto Federal do Pará
Profª Dra. Jéssica Verger Nardeli – Universidade Estadual Paulista Júlio de Mesquita Filho
Prof. Dr. Juliano Bitencourt Campos – Universidade do Extremo Sul Catarinense
Prof. Dr. Juliano Carlo Rufino de Freitas – Universidade Federal de Campina Grande
Profª Drª Luciana do Nascimento Mendes – Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Norte
Prof. Dr. Marcelo Marques – Universidade Estadual de Maringá
Prof. Dr. Marco Aurélio Kistemann Junior – Universidade Federal de Juiz de Fora
Prof. Dr. Miguel Adriano Inácio – Instituto Nacional de Pesquisas Espaciais
Profª Drª Neiva Maria de Almeida – Universidade Federal da Paraíba
Profª Drª Natiéli Piovesan – Instituto Federal do Rio Grande do Norte
Profª Drª Priscila Tessmer Scaglioni – Universidade Federal de Pelotas
Prof. Dr. Sidney Gonçalo de Lima – Universidade Federal do Piauí
Prof. Dr. Takeshy Tachizawa – Faculdade de Campo Limpo Paulista



Collection: applied environmental and sanitary engineering 2

Diagramação: Camila Alves de Cremo
Correção: Mariane Aparecida Freitas
Indexação: Amanda Kelly da Costa Veiga
Revisão: Os autores
Organizador: Cleiseano Emanuel da Silva Paniagua

Dados Internacionais de Catalogação na Publicação (CIP)

C697 Collection: applied environmental and sanitary engineering 2 / Organizador Cleiseano Emanuel da Silva Paniagua. - Ponta Grossa - PR: Atena, 2022.

Formato: PDF

Requisitos de sistema: Adobe Acrobat Reader

Modo de acesso: World Wide Web

Inclui bibliografia

ISBN 978-65-5983-988-9

DOI: <https://doi.org/10.22533/at.ed.889220305>

1. Environmental and sanitary engineering. I. Paniagua, Cleiseano Emanuel da Silva (Organizador). II. Título.

CDD 628

Elaborado por Bibliotecária Janaina Ramos - CRB-8/9166

Atena Editora
Ponta Grossa - Paraná - Brasil
Telefone: +55 (42) 3323-5493
www.atenaeditora.com.br
contato@atenaeditora.com.br



Atena
Editora
Ano 2022

DECLARAÇÃO DOS AUTORES

Os autores desta obra: 1. Atestam não possuir qualquer interesse comercial que constitua um conflito de interesses em relação ao artigo científico publicado; 2. Declaram que participaram ativamente da construção dos respectivos manuscritos, preferencialmente na: a) Concepção do estudo, e/ou aquisição de dados, e/ou análise e interpretação de dados; b) Elaboração do artigo ou revisão com vistas a tornar o material intelectualmente relevante; c) Aprovação final do manuscrito para submissão.; 3. Certificam que os artigos científicos publicados estão completamente isentos de dados e/ou resultados fraudulentos; 4. Confirmam a citação e a referência correta de todos os dados e de interpretações de dados de outras pesquisas; 5. Reconhecem terem informado todas as fontes de financiamento recebidas para a consecução da pesquisa; 6. Autorizam a edição da obra, que incluem os registros de ficha catalográfica, ISBN, DOI e demais indexadores, projeto visual e criação de capa, diagramação de miolo, assim como lançamento e divulgação da mesma conforme critérios da Atena Editora.



DECLARAÇÃO DA EDITORA

A Atena Editora declara, para os devidos fins de direito, que: 1. A presente publicação constitui apenas transferência temporária dos direitos autorais, direito sobre a publicação, inclusive não constitui responsabilidade solidária na criação dos manuscritos publicados, nos termos previstos na Lei sobre direitos autorais (Lei 9610/98), no art. 184 do Código Penal e no art. 927 do Código Civil; 2. Autoriza e incentiva os autores a assinarem contratos com repositórios institucionais, com fins exclusivos de divulgação da obra, desde que com o devido reconhecimento de autoria e edição e sem qualquer finalidade comercial; 3. Todos os e-book são *open access*, *desta forma* não os comercializa em seu site, sites parceiros, plataformas de *e-commerce*, ou qualquer outro meio virtual ou físico, portanto, está isenta de repasses de direitos autorais aos autores; 4. Todos os membros do conselho editorial são doutores e vinculados a instituições de ensino superior públicas, conforme recomendação da CAPES para obtenção do Qualis livro; 5. Não cede, comercializa ou autoriza a utilização dos nomes e e-mails dos autores, bem como nenhum outro dado dos mesmos, para qualquer finalidade que não o escopo da divulgação desta obra.



PRESENTATION

The e-book: “Collection: Applied Environmental and Sanitary Engineering 2” consists of fifteen chapters that present works that aimed to contribute both to improving the quality and health of the environment and man, as well as to the development of technologies to reduce costs and improve the quality of basic sanitation, remedying and reducing the environmental impacts resulting from human activities.

Waste management in Brazil is “invisible” in the eyes of government plans at the municipal level, which is why precarious sanitation conditions prevail in most municipalities. In view of this, the scientific community has been reiterating through numerous studies, the need to implement systems for the collection and final disposal of waste in an environmentally more correct way.

The basic sanitation system in Brazil has been restructuring itself due to security and information technology that helps to monitor and automate water and sewage treatment systems, the final disposal of waste, the loss of water resources due to failures or ruptures of pipe among others. Added to this, the numerous software that are developed to improve operating systems that can present information in real time and operation in continuous flow, helping operators.

Finally, the study and development of new treatment technologies from agro-industry residues or from new technologies that aim to implement and improve the efficiency of existing conventional processes,

In this perspective, Atena Editora has been working with the aim of stimulating and encouraging researchers from Brazil and other countries to publish their work with a guarantee of quality and excellence in the form of books and book chapters that are available on the Editora’s website and elsewhere. digital platforms with free access.

Cleiseano Emanuel da Silva Paniagua


SUMÁRIO

CAPÍTULO 1..... 1

563 – COMO A GESTÃO DE RESÍDUOS É TRATADA NOS PLANOS DE GOVERNO DOS(AS) CANDIDATOS(AS) À PREFEITOS(AS)

Cristiane Ferreira Pimenta

Henrique Ferreira Ribeiro


 <https://doi.org/10.22533/at.ed.8892203051>

CAPÍTULO 2..... 8

ESTUDO COMPORTAMENTAL DE USINAS DE BENEFICIAMENTO DE RESÍDUOS CLASSE A DA CONSTRUÇÃO E DEMOLIÇÃO

Cristiane Ferreira Pimenta

Henrique F. Ribeiro


 <https://doi.org/10.22533/at.ed.8892203052>

CAPÍTULO 3..... 24

QUANTIFICAÇÃO E COMPOSIÇÃO DOS RESÍDUOS DA CONSTRUÇÃO CIVIL EM ÁREAS DE TRANSBORDO E TRIAGEM

Cristiane Ferreira Pimenta

Henrique F. Ribeiro

 <https://doi.org/10.22533/at.ed.8892203053>


CAPÍTULO 4..... 33

COMPOSTAGEM DE RESÍDUOS ALIMENTARES DO RESTAURANTE UNIVERSITÁRIO DA UNIVERSIDADE FEDERAL DE VIÇOSA

Deysiane Antunes Barroso Damasceno

Marcos Oliveira Dantas

Mônica de Abreu Azevedo


 <https://doi.org/10.22533/at.ed.8892203054>

CAPÍTULO 5..... 44

II-1785 - SETORIZAÇÃO DE UM SISTEMA DE ESGOTAMENTO SANITÁRIO I – DETERMINAÇÃO DAS CARGAS ORGÂNICAS

Moema Felske Leuck

Carlos André Bulhões Mendes

 <https://doi.org/10.22533/at.ed.8892203055>

CAPÍTULO 6..... 65

MANAGEMENT OF FLUORESCENT LAMPS: A CASE STUDY IN THE METROPOLITAN REGION OF RECIFE, PERNAMBUCO, BRAZIL

Eduardo Antonio Maia Lins


Marília Gabriela Jonas de Santana

Andréa Cristina Baltar Barros

Adriane Mendes Vieira Mota

Maria Clara Pestana Calsa

Adriana da Silva Baltar Maia Lins

 <https://doi.org/10.22533/at.ed.8892203056>

CAPÍTULO 7..... 75


ONLINE MONITORING OF THE MUNICIPAL SOLID WASTE COLLECTION SYSTEM

Eduardo Antonio Maia Lins

Roger Ramos Azevedo

Fuad Carlos Zarzar Júnior

Joaquim Teodoro Romão de Oliveira

 <https://doi.org/10.22533/at.ed.8892203057>


CAPÍTULO 8..... 83

IMPLEMENTATION OF IMPROVEMENT ACTIONS IN THE SOLID WASTE MANAGEMENT PROCESS IN SMALL AND MEDIUM CITIES: CASE STUDY OF THE MUNICIPALITY OF PATROCÍNIO LOCATED IN THE STATE OF MINAS GERAIS – BRAZIL

Cleiseano Emanuel da Silva Paniagua

Bruno Elias dos Santos Costa

Valdinei de Oliveira Santos

 <https://doi.org/10.22533/at.ed.8892203058>

CAPÍTULO 9..... 95


A IMPORTÂNCIA DE INVESTIMENTOS EM SEGURANÇA DA INFORMAÇÃO PARA AS OPERADORAS DE SERVIÇO DE SANEAMENTO: UM OLHAR SOB OS INCIDENTES DIVULGADOS

Carlos Henrique Jorge

Dalton Issao Ito

Mariana Espindola de Souza

André Gambier Campos

 <https://doi.org/10.22533/at.ed.8892203059>

CAPÍTULO 10..... 111

AQUACAD-PLUGIN: SIMULAÇÕES HIDRÁULICAS NO AUTOCAD

Luis Henrique Magalhães Costa

Arthur Brito Gomes

Letícia de Vasconcelos Rodrigues

David Ermerson Farias Eugênio


 <https://doi.org/10.22533/at.ed.88922030510>





CAPÍTULO 11 122

AQUACAD: CONVERSÃO ONLINE ENTRE ARQUIVOS DOS PROGRAMAS DA PLATAFORMA CAD, GIS E DOS SIMULADORES EPANET E SWMM

Luis Henrique Magalhães Costa

Guilherme Marques Farias

 <https://doi.org/10.22533/at.ed.88922030511>

CAPÍTULO 12.....	131
APLICAÇÃO DO TANK MODEL NA MODELAGEM DA BACIA HIDROGRÁFICA DO RIO PIRANHAS EM GOIÁS	
Tales Dias Aguiar Débora Pereira da Silva	
 https://doi.org/10.22533/at.ed.88922030512	
CAPÍTULO 13.....	142
UTILIZAÇÃO DE BAMBU “DENDROCALAMUS LATIFLORUS” COMO CAMADA SUPORTE EM FILTRO ANAERÓBIO PARA REMOÇÃO DE DBO E DQO EM TRATAMENTO DE EFLUENTES SANITÁRIO	
Fagner Moreira de Oliveira Adão Genilson Pereira	
 https://doi.org/10.22533/at.ed.88922030513	
CAPÍTULO 14.....	149
DEGRADAÇÃO DE ANTIDEPRESSIVOS RESIDUAIS E CAFEÍNA EM ÁGUA, ESGOTO DOMÉSTICO E LODO DE ESTAÇÃO DE TRATAMENTO EMPREGANDO FOTÓLISE DIRETA	
Ismael Laurindo Costa Junior Adelmo Lowe Plestch Yohandra Reyes Torres	
 https://doi.org/10.22533/at.ed.88922030514	
CAPÍTULO 15.....	167
AVALIAÇÕES ECOTOXICOLÓGICAS DE CONTAMINAÇÕES CAUSADAS POR BIFENILAS POLICLORADAS: UMA REVISÃO	
Rhayane Andrade Junior Rosana Gonçalves Barros Viníciu Fagundes Barbara	
 https://doi.org/10.22533/at.ed.88922030515	
SOBRE O ORGANIZADOR.....	178
ÍNDICE REMISSIVO.....	179

ONLINE MONITORING OF THE MUNICIPAL SOLID WASTE COLLECTION SYSTEM

Data de aceite: 01/04/2022

Eduardo Antonio Maia Lins

Federal Institute of Pernambuco - IFPE /
Catholic University of Pernambuco

Roger Ramos Azevedo

Fuad Carlos Zarzar Júnior

Joaquim Teodoro Romão de Oliveira

ABSTRACT: The amount of solid waste generated does not increase gradually with the increase in population and excessive consumption. An ineffective waste collection system can harm public health and the environment. In this work, a methodology was developed and used to assist the waste collection system in the City of Recife, facilitating the management of urban solid waste collection. Such methodology, based on software created by the urban cleaning company of the city. It was possible to verify some problems in the tactical and operational management in the collection of solid urban waste in the city of Recife, such as: not optimizing the fleet of existing vehicles, productivity above the preparations as optimal in most sectors, densities below or above average, among others. Thus, there was a need to identify the collection system so that the management would become more effective. Advantages facilities with the implementation of the system generated a reduction of irregularly dumped waste, making an operation 75% cheaper, thus obtaining an income for investment

in equipment, gain of scale and improvements for an operation.

KEYWORDS: Garbage, OnLine Management, Collection, Trucks.

RESUMO: A quantidade de resíduos sólidos gerada no planeta vem aumentando gradativamente com o aumento populacional e consumo excessivo. Um sistema de coleta de resíduos ineficaz pode trazer danos à saúde pública e ao meio ambiente. Neste trabalho foi desenvolvido e aplicado uma metodologia para auxiliar o sistema de coleta de resíduos na Cidade do Recife, facilitando o gerenciamento da coleta de resíduos sólidos urbanos. Tal metodologia, baseada em softwares criados pela empresa de limpeza urbana da cidade. Pôde-se constatar alguns problemas no gerenciamento tático e operacional na coleta de resíduos sólidos urbanos na cidade do Recife, tais como: não otimização da frota de veículos existente, produtividades acima das estabelecidas como ótimas na maioria dos setores, densidades abaixo ou acima da média, entre outros. Com isso, verificou-se a necessidade de reestruturação do sistema de coleta para que o gerenciamento se tornasse mais eficaz. Vantagens obtidas com a implantação do sistema gerou uma redução de resíduo despejado irregularmente barateando a operação em 75%, obtendo assim, uma renda para investimento nos equipamentos, ganho de escala e melhorias para a operação.

PALAVRAS-CHAVE: Lixo, Gestão On-Line, Coleta, Caminhões.

INTRODUCTION

The urbanization process that Brazil has been going through since the 1950s, with the consequent density of urban centers, has caused many Brazilian cities, especially those that grow rapidly, to suffer serious environmental, social and sanitary problems (MARTINS, 2012). The sanitary problems are mainly caused by the inadequate management of Municipal Solid Waste (USC) where they are thrown in a disorderly way in the streets, squares, streams, and wastelands causing risks to humans and the environment (WHO, 2007).

Economic and cultural aspects together with the demographic issue accelerate the deterioration of natural resources, where the amount of solid waste produced by populations is related not only to the level of wealth, but also to the values and habits of life, determinants of the degree of willingness to perform consumption. Americans, for example, generate about two kilograms of municipal solid waste (USC) per inhabitant per day, and the Japanese, also of high purchasing power, exhibit behaviors that result in a significantly lower generation, slightly more than one kilogram (GODECKE *et al.* 2012).

The amount of waste produced by a population is variable and depends on several variables such as: income, climate, floating population, festive periods, etc. And to perform an efficient collection, it is necessary to understand that the operation encompasses from the departure of the vehicle from your garage, in addition to the efficiency of the collection during the route for removal of local waste to the return to the starting point (CUNHA; CAIXETA FILHO, 2002).

Often, these paths that should be carried out by fleets can be diverted by numerous factors without the prior knowledge of a company. The use of technological systems has been one of the great solutions for companies in order to control possible deviations of paths of fleets of waste collection trucks, in addition to inspection for an adequate packaging of waste. This work aimed to bring solutions to the problems presented and strategies to improve the efficiency of collection trucks in the collection and packaging of municipal solid waste (US) in the city of Recife, Pernambuco, Brazil.

METHODOLOGY

Recife is a municipality in the State of Pernambuco, Brazil. With a territorial area of approximately 218.435 km², being formed by an alluvial plain, islands, peninsulas, and mangroves as its main geographical characteristics. It consists of 94 neighborhoods, with an estimated population of 1,653,461 inhabitants (IBGE, 2020).

The generation of waste in Recife was analyzed according to the weighing data in the CTR - Candeias landfill, provided by DLU (Urban Cleaning Board), in which it belongs to EMLURB (Urban Maintenance and Cleaning Company). The relational data of urban waste weighing in the landfill were analyzed in variation of the total values collected from the first

half of 2016 to the first half of 2018, in order to relate the intrinsic virtues to the aspects mentioned, the study was based on pre-existing parameters in books and articles on the generation of municipal solid waste.

The weighing record began with the arrival of the vehicle and/or equipment at the landfill, where the vehicle was previously registered and linked to the collection/cleaning service it performs. Weighing was carried out at the entrance and exit of the vehicle in the landfill.

RESULTS AND DISCUSSION

Regarding the amount of garbage generated, according to Brown data (1993), garbage production can range from approximately 0.46 to 2.27 kg/inhabitant/day, depending on the city and the reference country. Corroborating the author, the weighing data obtained show that Recife has values like the estimated margin. Table 1 shows the variation of the average garbage production from the first half of 2016 to the first half of 2018 using as a basis the population growth obtained through IBGE (2020).

Semester	kg/et/day
2016.1	1,63
2016.2	1,66
2017.1	1,51
2017.2	1,50
2018.1	1,63

Table 1 - Generation of Solid Waste in Recife.

Source: EMLURB - DLU (2020).

According to Peral (1989), the generation of waste, that is, the amount of waste produced by a population, is quite variable and depends on several factors, including:

- the population's standard of living: the volume generated grows as the population's income increases.
- the time of year.
- way of life of the population: it is influenced by the daily migration between the city center and the periphery.
- movement of the population during the holiday periods, weekends and festive days.
- new methods of packaging goods, such as the use of packaging and packaging without a return.

- **The Collection System**

According to Table 2, it is observed that it is possible to select the types of collection of the highest volume of residue. This analysis demonstrated, in a summarized way, that garbage collection still takes place largely in the Household Collection, that is, a collection method in which the citizen has the residue in front of his residence usually in plastic bags that seek to facilitate the operation. However, only this procedure is not enough for the perfect operation of the operation, ideally, the residue is arranged outside the reach of animals, in a capped dumpster, with sufficient protection to avoid accidents to the worker and still be made available only when the collection time of the region is close. However, it is noticeable that society often does not receive the proper instructions, making it difficult for the operation to be optimized. It is also emphasized that it is a collection service most used in Brazil, being considered one of the most expensive.

Collection Type	2016	2017	2018
HOME	60,12%	64,61%	77,91%
SCRIPTED	8,97%	9,04%	10,56%
SELECTIVE SEVERAL	0,26%	0,27%	0,35%
OTHER	30,66%	26,08%	11,19%
Total Collected(t)	482	448	486

Table 2 - Volume by collection type.

Source: EMLURB (2020).

The data presented in Table 2 show a significant increase in household collection. This growth is through the implemented logistics that sought to serve the hard-to-access residences with tipping strategies. Thus, known due to the “pulls” that occur through a manual collection with workers as pedestrians to access limited access locations, such as alleys and staircases and through a motorized collection by smaller vehicles compared to the traditional collection truck of 15 or 18m³. These other vehicles are smaller trucks and motorcycles that access narrow, steep streets where the truck would not be able to access. After collection, the garbage is taken to the main corridors and left in planned locations, called containment points that are local where the residue remains for a maximum of 1 hour until the traditional collection truck arrives at the site and makes the collection.

All this operation is timed and accompanied by real-time tracking, where a monitoring center is performing the aid so that deadlines are met, and all collection sites are met. At all times the plant receives tracking information, traffic, misuse and any other done that may endanger the fulfillment of the operation at the due time.

The collection of waste in daily life becomes a routine, and with this, it became

realized that the vehicles followed the same route from time to time until the collection cycle was closed and thus return the same route of the first day. Emlurb's inspection began to observe the need to reduce the size of the cycle so that the same site was cleaned with a shorter time interval, and so it was done until the cleanness of the site was noticed. In the same way, it happens when you want to reduce costs, where logistics increases the interval of the cycle and thus runs the risk of making the site at the mercy of collection with the material waiting. Regarding the frequency of waste collection, Monteiro (2001) points out that the minimum frequency of permissible collection in a warm climate country such as Brazil is three times a week. For Guerra (2011), one way to evaluate the quality and efficiency of USManagement is the analysis of data on the frequency of household collection and treatment given to waste in the municipality.

The monitoring center, in turn, begins to study these cases, with the help of weighing readings and photographic records performed in the field before and after the collection, and thus define the intervals of the cycle, also called collection frequency. With this, we can create collection routes per day of the week, increasing the frequency in places most in need and reducing in less needy places. With this financial and time savings, some vehicles began to serve more than one location or service with strategic logistics. Canassa (1992) managed to reduce a course from 54,182 meters to 47,131 meters (13%) in Florianópolis (Santa Catarina - Brazil). Eisenstein and Iyer (1997) defined conjuntos of routes different from those being used for collection in Chicago (Illinois - United States), which could reduce the capacity of the trucks used by between 12 and 16%, which means a potential reduction of US\$ 9 million in the costs involved.

The scripted collection had a somewhat lower scale increase when compared to the growth of household collection. This type of collection brings with it a major environmental, economic, and social problem, because the garbage storage sites are usually sidewalks, wastelands, squares and public roads. Your material can be as variable as household waste and can still contain household waste. The materials found deposited irregularly usually have a large volume and difficult access. However, thus, it can be classified as scripted because the site now presents a constant amount of waste to collect.

- **Monitoring strategies**

Faced with such demand and responsibility towards society, the strategy adopted for management was based on routine and cyclical planning on a weekly basis. The technology implemented as the main aid in the monitoramento of the collections was the tracking of vehicles and equipment, as shown in Figure 1.



Figure 1. Rastreamento system for waste collection in Recife.

Source: EMLURB – DLU (2020).

With this tool aligned with monitoring, it was inserted in an online platform for monitoring and extraction of reports, with tracking indexes verified with the previously registered planning, as well as the display of all vehicles and / or equipment in real time, being possible also the classification of equipment, issuance of alerts, quick responses and other functions of great impact for the operation to mitigate its failures, achieving speed gain in solutions and corrections.

The number of vehicles and equipment in operation at the same time, both in business hours and in other times occurs on a large scale, starting to require a team that contains many employees, which may be financially unfeasible for the operation. Thus, filter and sampling methodologies were analyzed to indicate where most of the problems were occurring, in addition to the most severe cases.

The methodology was achieved through automation of verification processes, creation of performance indicators, warnings that would help identify possible risks to the operation, thus causing an improvement in the response time to unforeseen events, enabling decision-making for correction or changes in search of appropriate adjustments to the route.

As well as vehicle monitoring by means of coordinates registered as collection points, other collection points are inserted daily by municipal inspectors, who seek irregular dumping of waste. These locations are registered through a mobile application, where it is launched directly on an online platform requesting the collection and cleaning of the site.

On the other, the selective collection service carried out in Recife is divided into two methods that seek to meet and give the opportunity to all citizens to be able to select their garbage and thus contribute to the environment. It is important to remember that to join this public service the citizen will not have cost and will receive instructions for the dumping of the selected garbage. The citizens receive plastic bags of different colors for the selection of the residue periodically and according to the availability of the resident along the conditions offered by the public power. In general, selective collection methods happen as follows:

- Through the Voluntary Delivery Points (PEV's), which is a stationary collection box located throughout the city, to adapt the demands offered by each region, being available for 24 hours for the dumping of the material. At predetermined frequencies, EMLURB removes THE PEV's with waste, replacing it with a sanitized box, transporting the waste to the sorting centers. Then, the company performs a sanitization of the collector and leaves it prepared for a next replacement.
- The collection at the citizen's door, with date and time marked by trucks suitable for this service, is triggered when there is no PEV, or when there are many employees nearby. It is a faster collection and a higher cost since the whole procedure is repeated to the truck when it reaches its limit or closes the day of activity. To register and participate in such service, the resident must seek EMLURB and inform themselves of the days and times of collection not their address or call the call center dialing 156. With this, the resident will receive the instructions to dispose of the material and the colored bags for the separation of the residue. It is important to say that the city has a limited number of participants due to the small availability of vehicles for such an operation, but in contrast, this number of participants has increased, as well as the volume of weighing of this service. The growth is symbolic, but it does not yet have the speed desired by managers and municipal leaders. According to EMLURB, there was an increase in registration by 0.01% between 2016 and 2017 and 0.08% between 2017 and 2018. These values are still derisory when compared to the most recent value of waste generated in the municipality, onde in 2018, in the best brand, selective collection reached 0.35% of the total volume of waste generated.

FINAL CONSIDERATIONS

- According to the analyses for 2016, 2017 and 2018, the figures are a proportional order of magnitude among some main services. Most of the time, the residues are placed in the "common garbage" and are not quantifiable, which demonstrates how the issue is treated in a secondary way, a situation that deserves to be changed, because observed individually at the points of generation the volumes may not be significant to enable a system, which does not occur when observing the picture.
- These individual initiatives end up bringing a non-uniform treatment to disposal, the same waste that in some points are discarded, are recycled in others. This fact shows not only the waste of resources but also that, just as it seeks to give correct destination in some points, in others the issue is over considered.
- In the economic aspect, the online collection service has an operational cost of approximately 1/4 of the cost at which the Household Collection would have to collect a similar volume in equal operating time. And consequently, selective collection was evaluated according to the same criteria and obtained a ratio of 1/3 for door-to-door collection and 1/6 for the collection performed in ENP. These

values state that the advantages in reducing irregularly dumped waste cheape-
rate the operation by 75% simply because it leaves the garbage in the correct
place and at the correct time, and even though this value can still be reduced
to 12.5% if the waste is selectively separated and taken to a voluntary delivery
point, thus obtaining a possible income for investment in equipment, gain of
scale and improvements to the operation.

- In general, the software technology allowed to record information pertinent to
waste management, identifying those involved and optimizing processes such
as the request for collection, preparation of routes, issuance of documents, pre-
paration of reports, etc.

REFERENCES

1. BROWN, D. T. **The legacy of the landfill: perspectives on the solid waste crisis**. St. Catharines: Brock University. Institute of Urban and Environmental Studies, 1993. <http://www.brocku.ca/epi/legacy.txt> (Aug 8, 2020)
2. CANASSA, E.M. . **Planning of routes of urban solid waste collectorvehicles**. Master's thesis , Federal University of Santa Catarina, Florianópolis, 1992, 134p.
3. CUNHA, V.; CAIXETA FILHO, J. V. Management of municipal solid waste collection: Structuring and application of nonlinear programming model by goals. **Management & Production**, v. 9, n. 2, 2002. p. 143-161.
4. EISENSTEIN, D.D.; IYER, A. V. Garbage collection in Chicago: a dynarnic scheduling model. **Management Science**, v.43, n.7, p.922-933, July 1997.
5. GODECKE et al. (2012), Consumerism and the generation of municipal solid waste in Brazil, **Rev. Elet. in Management, Education and Environmental Technology**, v. 8, no. 8, p. 1700-1712, e-ISSN: 2236-1170.
6. GUERRA, A.E. (2011) Quality and Efficiency of Sanitation Services. In: **BRAZILIAN INSTITUTE OF GEOGRAPHY AND STATISTICS**. Sanitation Atlas 2011. Brasília: MCidades. p. 28-46. Available in: <http://www.ibge.gov.br/home/estatistica/populacao/atlas_saneamento/default_zip.shtm>. Accessed: 12 Nov. 2020.
7. IBGE - BRAZILIAN INSTITUTE OF GEOGRAPHY AND STATISTICS, 2020. **Result of preliminary census data - 2020**. Available: <https://ibge.gov.br/>. Accessed: 12 Nov. 2020.
8. MARTINS, K. **Disorderly Urban Expansion and the increase in environmental risks to human health: the Brazilian case**. Monograph, University of Brasília, Planaltina, DF, 2012, 65 f.
9. MONTEIRO, J.H.P. (Org.). (2001) **Manual of Integrated Solid Waste Management**. Rio de Janeiro: IBAM. 204p.
10. World Health Organization (WHO). **Population health and waste management: scientific data and policy options**. Report of a WHO workshop Rome, Italy, 29-30 March 2007. Copenhagen: WHO Regional Office for Europe; 2007.

ÍNDICE REMISSIVO

A

Ação antrópica 147

Água 2, 36, 37, 41, 44, 46, 47, 48, 49, 50, 52, 53, 54, 59, 60, 61, 62, 63, 64, 96, 98, 99, 100, 101, 102, 103, 104, 105, 107, 111, 112, 113, 121, 122, 123, 127, 128, 129, 130, 132, 133, 136, 137, 149, 152, 153, 157, 158, 159, 160, 161, 162, 168, 170, 171, 174

Águas superficiais 46, 54, 55, 56, 57, 58, 59, 60, 61, 62, 64, 149, 150, 151, 161, 163, 170, 172

Antidepressivos 149, 151, 152, 154, 155, 159, 163

Áreas de Transbordo e Triagem (ATT) 24, 25, 26, 27, 31, 32

B

Bacias hidrográficas 47, 63, 123, 131, 140, 141

Back-end 124

Bambu 142, 143, 144, 145, 147

Bifenilas policloradas (PCBs) 167, 176, 177

Bioensaios 167, 174

Biofilme 142, 144, 145, 147

Biota 86, 149, 150, 176

C

Collection 24, 44, 45, 67, 68, 71, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94

Compostagem 3, 19, 20, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43

Conselho Estadual de Política Ambiental e Recursos Hídricos (COPAM/CERH) 147

Construção civil 4, 10, 11, 12, 14, 15, 17, 20, 22, 23, 24, 25, 27, 28, 31, 32

D

Demanda Química de Oxigênio (DQO) 143, 147

E

Ecotoxicologia 167, 169, 175, 176

Estação de Tratamento de Esgoto (ETE) 142, 143, 147

F

Fármacos 149, 150, 151, 152, 155, 156, 158, 160

Filtro anaeróbio 142, 143

Fluorescent lamps 65, 66, 67, 68, 69, 70, 71, 72, 73

Fotólise 149, 151, 153, 154, 156, 157, 158, 160, 161, 162, 163

Fototransformação 149

Front-end 124

G

Garbage 75, 77, 78, 79, 80, 81, 82, 83, 84, 86, 88, 89, 91, 92

Gestão de resíduos 1, 2, 3, 4, 7

Gradiente reduzido generalizado 131, 133, 136

H

Hazardous 65, 66, 72, 73

I

Impactos ambientais 8, 17, 34, 107, 142, 150, 174

Impactos sistêmicos 167

L

Landfills 83, 84, 86, 92, 94

Linguagem de estilo - CSS 124

Linguagem de marcação - HTML 124

M

Meio ambiente 8, 23, 27, 28, 32, 34, 41, 61, 75, 95, 96, 141, 142, 149, 154, 168, 176

Microcontaminantes 149, 151, 157, 163

Modelos hidrológicos 131, 132

Model-View-Controller (MVC) 124

Municipal Solid Waste (USC) 75, 76, 77, 82

O

OnLine Management 75

Organismo-teste 167

P

Patógenos 33

Plano de governo 1, 2, 4

Política Nacional de Resíduos Sólidos (PNRS) 34, 41

Poluentes emergentes 149, 150

Poluentes Orgânicos Persistentes (POPs) 167, 168, 176

Problemáticas ambientais 1, 2

Produtos farmacêuticos 149

R

Radiação solar 135, 149, 151, 153, 162, 163

Reciclagem 3, 8, 9, 10, 11, 12, 14, 15, 16, 17, 20, 23, 24, 25, 26, 27, 29, 31, 34, 172

Recursos hídricos 41, 44, 61, 122, 130, 131, 132, 137, 141, 142, 147

Recursos naturais 9, 61

Resíduos alimentares 33, 35, 40

Resíduos da construção e demolição 1, 8, 9, 10, 11, 17, 18, 23, 24, 25, 26, 27

Resíduos orgânicos 33, 34, 35, 42, 43

S

Saneamento básico 2, 7, 60, 63, 64

Segurança cibernética 95, 97, 98, 99, 100, 101, 104, 105, 106, 107

Selective collect 83

Simulador hidráulico 111

Sistema de abastecimento de água 104, 111, 112, 127

Sistema de Esgotamento Sanitário (SES) 44, 46, 59

Softwares 48, 75, 103, 112, 122, 123

T

Tank model 131, 132, 133, 135, 136, 137, 138, 139, 140, 141

Tecnologia da informação 95, 97, 98, 99

Tecnologia operacional 95

Teste de germinação 33, 35, 36

Trucks 75, 76, 78, 79, 81

U


United States Environmental Protection Agency (USEPA) 106, 109


V


Variáveis ambientais 131


W

Water resources 83, 92, 131

 www.atenaeditora.com.br


 contato@atenaeditora.com.br


 [@atenaeditora](https://www.instagram.com/atenaeditora)

 www.facebook.com/atenaeditora.com.br

Collection:

**APPLIED ENVIRONMENTAL
AND SANITARY
ENGINEERING
2**

 www.atenaeditora.com.br

 contato@atenaeditora.com.br

 [@atenaeditora](https://www.instagram.com/atenaeditora)

 www.facebook.com/atenaeditora.com.br

Collection:

**APPLIED ENVIRONMENTAL
AND SANITARY
ENGINEERING
2**