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Selective Collection Routing for the Coreso Company

Enzo Gabriel Valente, Julia Barros de Camargo, Lucas Barbosa, Luis Henrique Marcicano and Olivia Barrao Avelhan
Bachelor's in industrial engineering
Facens University
Sorocaba, São Paulo, Brazil
enzovalentecs@gmail.com, juliacamargox7hqs9@gmail.com, lucasbarbosa0923@gmail.com, marcicanoluis00@gmail.com, olivia.b.avelhan@gmail.com

Abstract

This article portrays the optimization of collections at the Coreso Company, highlighting the importance of routing the most efficient routes in order to reduce operating costs, improve collection times and promote sustainability. The difficulties faced by the company are related to routes established based on little analysis, excessive fuel consumption and the acquisition of available vehicles, which results in the delay of planned collections. This project seeks to promote route optimization by implementing advanced technologies and data analysis, resulting in a more agile and economical operation. This initiative is aligned with the Sustainable Development Goals, which contribute to economic growth and environmental sustainability, thus promoting the implementation of reverse logistics, selective collection, conscious disposal, as well as reducing gas emissions from vehicles. Routing not only improves the profitability of the business, but also strengthens customer confidence in the services provided, promoting the recycling and reuse of materials, preserving the environment and the socio-economic advancement of the region.

Keywords
Routing, Reverse Logistics, Selective Collection, Recycling and Conscious Disposal.

1. Introduction
Product delivery is one of the fundamental pillars of customer satisfaction and a company's operational efficiency. Improving routes not only reduces costs, but also improves collection times and the sustainability of operations. In this context, the group chose the theme “Routing in the Coreso Company” to address the urgent need to improve the routes taken by the company's trucks, which currently face a number of challenges.

Currently, the routes used by Coreso generate excessive expenditure on fuel and vehicle maintenance, compromising the profitability of the business. In addition, inefficient pick-ups often result in deadlines that exceed expectations, generating dissatisfaction and damaging the company's image.

In this way, it is possible to see the project's alignment with the Sustainable Development Goals (SDGs). Improving the routes for the company would help to promote regional economic growth, given that Coreso operates through the cooperative system, which is made up of workers who carry out their work or professional activities with common benefit, autonomy and self-management in order to obtain better qualifications, income, socio-economic situation and general working conditions. Thus, meeting objectives 11 “Sustainable Cities and Communities”, 13 “Action against Global Climate Change” and 17 “Partnerships and Means of Implementation”.

1.1 Objectives

The central objective of the project is to find the best possible route, improving the daily commute efficiently. The idea is to simulate different routes based on variables such as traffic, allowing a precise analysis for each specific day. By identifying the fastest and/or most economical route, the system can help save time, resources and fuel. In addition, the analysis of historical and real-time data will help to predict and avoid unforeseen events on the route. The implementation of optimization algorithms and methodologies can be key to ensuring that the best route is chosen, taking into account all the factors involved. This brings benefits to both individual drivers and logistics companies, where time and costs are crucial.

2. Literature Review

Logistics and supply chain management have been central topics of academic and business discussion, due to their strategic importance in the global competitive scenario. Several recent studies have explored the evolution of these areas, highlighting everything from the role of emerging technologies to sustainability practices. The following is a review of the main themes discussed in relevant studies that address logistics and supply chain management issues in Brazil.

The study by Silva et al. (2005) discusses the impact of reverse logistics as a fundamental tool for sustainability and business competitiveness. The article highlights the concept of reverse logistics, which consists of managing the return of products and materials from the end consumer for reintegration into the production chain or for appropriate disposal. This process contributes significantly to reducing waste and reusing materials, in line with sustainable development practices.

The authors point out that Brazil has both challenges and opportunities when it comes to implementing effective reverse logistics, due to regulatory and structural issues. Companies that adopt reverse logistics practices gain competitive advantages, especially in sectors such as electronics and automobiles. Another relevant point raised by the study is the need for integration between the various players in the supply chain, such as suppliers, distributors and recyclers, to ensure the success of this process.

Rodríguez Melquiades (2015) offers a comprehensive analysis of the transformations in the management of globalized supply chains. The author explores how multinational companies face the complexity of managing geographically dispersed supply chains, addressing issues such as digitalization, transport efficiency and operational flexibility. The study underlines the importance of advanced technologies, such as big data and information systems, which allow for greater visibility and control throughout the supply chain.

One of the main challenges identified is the vulnerability of global chains to interruptions, whether due to logistical issues or political and economic instability. Melquiades points out that companies are increasingly adopting supplier diversification strategies and closer proximity to consumer markets as ways of mitigating risks. In addition, the study emphasizes the role of collaboration between the different links in the chain, promoting greater resilience and agility in responding to crises.

The article by Paiva et al. (2019) investigates the role of technological innovations in optimizing logistics processes. Traditional logistics has evolved substantially with the use of emerging technologies such as automation, the Internet of Things (IoT) and artificial intelligence (AI), which enable significant improvements in efficiency and cost reduction. In the Brazilian context, the article highlights how these innovations are being applied in large operations, especially in the e-commerce sector, which requires agility and precision in customer service.

An important point raised is the use of transportation management systems (TMS) and warehouse management systems (WMS), which facilitate the planning and execution of logistics operations. In addition, the study highlights the importance of investing in training teams to deal with innovative technologies, ensuring that the use of these systems is maximized to obtain better results.

The review of the three studies points to a convergence around some central themes that impact logistics and supply chain management in Brazil and around the world. Sustainability and reverse logistics, discussed by Silva et al, are trends that will continue to gain relevance, both due to regulatory pressures and the environmental awareness of consumers. Melquiades highlights the importance of adapting to an increasingly globalized and uncertain business

environment, which requires flexibility and innovation in supply chain management. Finally, Paiva et al. highlight the role of technological innovations as drivers of operational efficiency. Technologies such as AI, big data and IoT not only improve control and visibility of operations, but also allow for unprecedented personalization and agility in deliveries.

3. Methods

In the context of circular logistics, efficient routing is essential to reduce costs, optimize time and minimize the environmental impact of operations. The method used to plan routes is the Water Drop Method, which is based on a simple and effective concept: dividing the delivery area into smaller regions, starting from a crucial point, such as the warehouse.The way the method works is inspired by the spreading of a drop of water: it starts at the crucial point and gradually expands to cover adjacent areas, following a logic of proximity. In this way, collections are organized in such a way as to serve the closest locations first, before moving on to more distant areas. This approach allows for rational distribution, reducing redundant routes and making the most of available resources such as fuel and time.
In addition, the Water Drop Method is particularly advantageous in areas with a high density of orders, as it makes it easier to segment the region into specific service zones, making the process more manageable. In the case of Coreso, this methodology helps to optimize operations in Sorocaba, ensuring that waste is collected efficiently and sustainably, in line with the principles of circular logistics.

4. Data Collection

The Coreso company provided some information and a list with the sequential order of the street names that it currently follows in its collections (Figure 1), which helped with the study and with the collection of data and calculations used in this project. The truck used by the Coreso cooperative is provided by Sorocaba City Hall. The model provided is a Volkswagen Delivery 9.160, which according to the technical manual has the following characteristics:

- Engine: Cummins ISF 3.8.
- Capacity: 3,800 cm³.
- Maximum power: 160 hp at 2,600 rpm.
- Maximum torque: 61 kgfm from 1,300 to 1,700 rpm.
- Gearbox: 5-speed manual ZF S5 420 HD.
- Front suspension: Parabolic springs.
- Rear suspension: Semi-elliptic and parabolic springs.
- Brakes: Air system with drums on the front and rear wheels, equipped with ABS/EBS.
- Wheels/Tires: 6x17.5 rim with 215/75R17.5 tires.
- Fuel tank: 150 liters.
- Arla 32 tank: 23 liters.
- Curb weight: 3,130 kg to 3,240 kg (varies according to configuration)
- Total Gross Vehicle Weight (GTW): 9,000 kg to 9,300 kg
- Gross Combined Weight (PBTC): 11,000 kg
- Payload capacity: Up to 5,760 kg, depending on configuration

According to the Volkswagen Trucks and Bus emissions table, the VW/9.160/DRC 4X2 model, equipped with a 160 hp ISF 3.8 engine, has approximately 1,950 CO_2 (g/km) emissions, which meets the Proconve P7 (Program for the Control of Air Pollution from Motor Vehicles) emissions standards.

Situação atual empresa Coreso	Terça-Feira		Quinta-Feira		Sexta-Feira	Total
	Manhã	Tarde	Manhã	Tarde	Manhã	
Distância (Km)	38,5	31,5	47,5	29,3	27,6	174,4
Tempo (Min)	51	63	103	67	54	338
Emissão de CO2 (g/Km)	75.075	61.425	92.625	57.135	53.820	340.080

Figure 1. Data on Coreso's current situation.

5. Results and Discussion

5.1 Numerical Results

In numerical terms, the proposal resulted in a reduction in the distances covered on Tuesdays and Thursdays in both the morning and afternoon. On Tuesday, the distance was reduced by 5.5 km in the morning and 0.3 km in the afternoon. On Thursday, there was a reduction of 8.5 km in the morning and 0.3 km in the afternoon (Figure 2).
In terms of time, overall, there was a reduction of 71 minutes, with Thursday morning standing out with a 37-minute reduction. CO2 emissions also fell, with the company currently emitting 340,080 g/km, while the proposal shows a total of 257,790 g/km.

Proposta do projeto	Terça-Feira		Quinta-Feira		Total
	Manhã	Tarde	Manhã	Tarde	
Distância (Km)	33	31,2	39	29	132,2
Tempo (Min)	58	73	66	70	267
Emissão de CO2 (g/Km)	64.350	60.840	76.050	56.550	257.790

Figure 2. Data from the project proposal.

5.2 Graphical Results

5.2.1 Proposed Improvements

In order to improve the routes taken by the Coreso company, changes were proposed in the organization of the routes to promote greater logistical efficiency and sustainability. The new routing was organized to reduce distances traveled, save time, and minimize CO_2 emissions, while respecting the methodology and tools used.

On Tuesday mornings, the proposed route includes the following collection points: CORESO, R. José Bordino Câmara, R. Luiza Pedroso Câmara, R. Oséias José Pinto, R. Suzana de Fátima Piantore, R. Antenor Fraga da Motta, R. Darcy Fruet, R. Nelson Antônio Henrique, R. Maria Marques de Faria, R. Zeferino Xavier de Faria, R. José Gomes dos Santos, R. Florival Cândido, R. José Barbosa dos Santos, R. Eulalina Rosa de Jesus, R. Romilda Peragallo Acquaviva, CORESO (Figure 3 and 4).

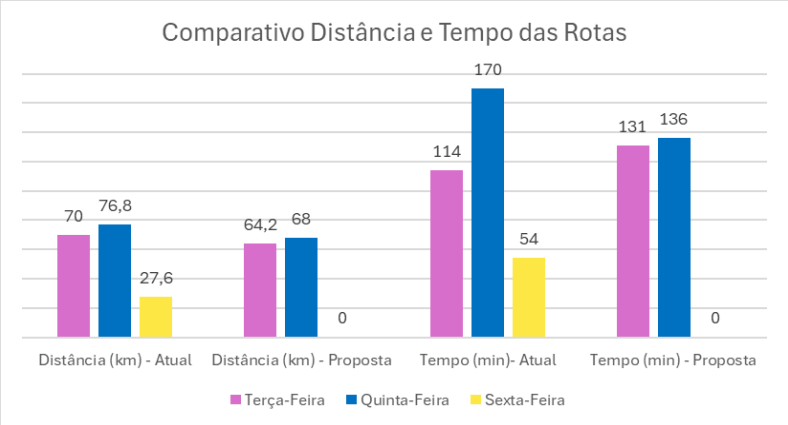

Figure 3. Comparison of distance and time between routes.

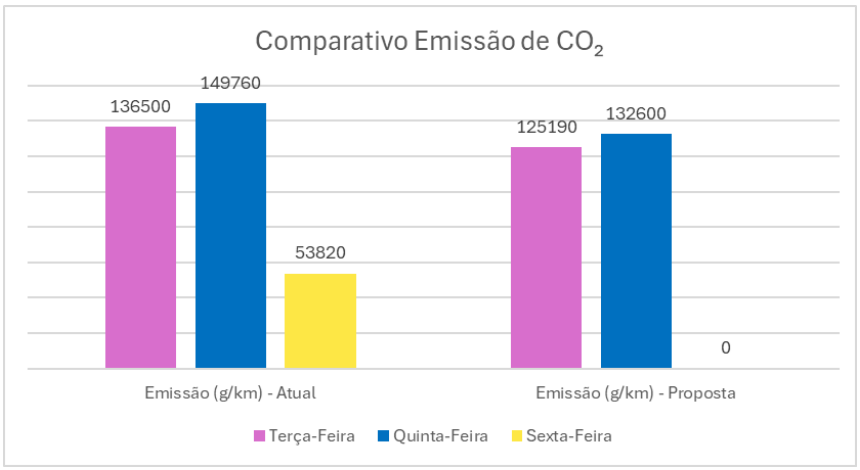

Figure 4. Comparison of CO_2 emissions.

On Tuesday afternoon, the new route covers the following locations: CORESO, R. Ramzia El Hadi, R. Maria de Lourdes Ramos, R. Júlio Cirino Silva, R. João Roque de Oliveira, R. Nelson Ribeiro Pinto, R. José Bueno de Matos, R. Miguel Hidalgo, R. José Claudino, R. Aldrovando Moreira da Silva, R. Caio Zacharias, R. Helena Amaro da Cunha, R. José Girão Sanches, R. Edésio Gomes, R. Maria da Conceição Rocha Grosso, R. Profa. Helenice Carrogi, R. João Lourenço Santos, R. Valdomiro Ferraresi, R. José Abel Buckart, R. Ovídio Antônio Ribeiro, R. Nelson Jacks Rosenberg, R. Timotheo Gomes Proença, R. Benedicto Monteiro, R. Pedro Sanches Pontes, CORESO.

On Thursday mornings, the route covers the following points: CORESO, R. Raimundo Mendes Batista, R. Zilda Monteiro Batista, R. Anitta Metidieri, R. Joaquim Gonsales, R. Antônio da Silva Paula, R. Maria Alves Silva de Paula, R. Dr. José de Paula Netto, R. Armando do Carmo Manfredi, R. Walter Lacava, R. Jackson Gonçalves de Carvalho Gil, R. Silvio Cesar Borges Gorrea, R. Geraldo C. de Oliveira, R. João Nogueira, R. Dácio Panise, R. Maria de Fátima de Moraes Galli, R. Celso Mazzucatto, R. Hermínia Amaral Pignatta, R. Nilton Ernesto, R. Roque Moacir Momm, R. Luiz Migliorini, CORESO.

On Thursday afternoons, the proposal includes the following stops: CORESO, R. Luiz Gabriotti, R. Alberto Grosso, R. Sgt. Alfredo Marcheto, R. Darci de Almeida Silvestrine, R. Benjamim Antônio Bisam, R. Manoel Soares da Silva, R. João Felisbino, R. Sylvio Sommerhauser Rosa, R. Iolanda Gambacorta Rosa, R. Vicente Lázaro Filho, R. João Roman Lopes, R. Ademir Alegre, R. Guineia Bossani Ortega, R. Carlos Gomes, R. Gildo Scareli, R. Elisa Moraes dos Santos, CORESO.

This reorganization of the routes aims to eliminate redundant journeys, ensure collection at an acceptable time and significantly reduce operating costs. In addition, the environmental impact was also taken into account, with evident results in the reduction of carbon emissions, in line with the Sustainable Development Goals (SDGs) and promoting greater efficiency in the service.

5.2.2 Validation

The project was validated through the practical application of the Water Drop Method and the use of digital mapping tools such as Google Maps. These tools made it possible to simulate different routes, considering factors such as distances traveled, estimated times and associated carbon emissions.

To assess the effectiveness of the method, data provided by Coreso and that achieved through the proposal were compared. The numerical results showed a significant reduction in distances traveled and CO_2 emissions. Specifically, mileage was reduced by 5.8 km on Tuesday routes and 8.8 km on Thursdays. Regarding emissions, there was a decrease of 82,290 g/km, from 340,080 g/km to 257,790 g/km. This reduction represents an improvement of approximately 24.2% in CO_2 emissions.

The analysis of journey times also validated the proposal, with a total saving of 71 minutes, the highlight being Thursday morning, which saw a reduction of 37 minutes. This data was corroborated by real-time monitoring of the routes, ensuring that the results were not just theoretical, but also reproducible in practice.

These indicators confirm the viability and efficiency of the proposal, in line with the objectives of sustainability and operational efficiency. In addition, the economic and environmental gains reinforce the applicability of the project in optimizing the logistics processes of the Coreso company (Figure 5 and 6).

Figure 5. Current routes divided into shifts at Coreso.

Figure 6. Proposed routes divided into shifts.

6. Conclusion

With the proposal to improve Coreso's routing, it was possible to eliminate the Friday route and distribute it over new routes on Tuesday and Thursday mornings and afternoons, which significantly reduced the mileage traveled by the truck. This restructuring not only optimized logistics, but also contributed directly to reducing CO_2 gas emissions, aligning the project with sustainability and operational efficiency objectives. In addition, the change brought significant economic benefits, such as a reduction in fuel and vehicle maintenance costs, reinforcing the commitment to responsible resource management. It can therefore be concluded that the analysis and study of data, together with

the implementation of an appropriate methodology, are fundamental to achieving plausible results that can be used in real life, benefiting the company and achieving its objectives by continuously improving its services.

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Biographies

Enzo Gabriel Valente is an undergraduate in Industrial Engineering at Facens University, with experience in purchasing and operations. His interests lie in process engineering, optimization, and continuous improvement analysis. Throughout his career, he has developed effective communication, data management and innovation skills, contributing to the efficiency and improvement of operational processes.

Julia Barros de Camargo is an undergraduate in Industrial Engineering at Facens University, with experience in supplier management, dealing with non-conformities and quality tools. She is interested in the application of methodologies for problem analysis and resolution, lean manufacturing, and Industry 4.0.

Lucas Barbosa is an undergraduate in Industrial Engineering at Facens University, he has a technical degree in Environmental Management and experience in Quality Management System and Product Engineering. He is interested in logistics, production planning, Industry 4.0, and product development, aiming to contribute to innovative and efficient solutions in these areas.

Luis Henrique Marcicano Luís Henrique Marcicano is an undergraduate in Industrial Engineering at Facens University. He works in the Logistics sector at ZF, specifically on Production Planning since 2023. His interests are Production Planning and Production Management.

Olivia Barrao Avelhan is an undergraduate in Industrial Engineering at Facens University. She has experience in Continuous Improvement in a multinational manufacturing company. Interest in environmental causes and factors, Lean Manufacturing, leadership, and organization.