Chapter 12
Geolocation for Tracing the Optimal Route for Claims Attention of Dairy Products

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Abstract Given their size, Mass consumption companies constantly resolve a large number of claims. Sometimes, these claims are not attended to with the necessary speed owing to non-optimized prioritization. The following article proposes using georeferencing, routing, and forecasting to improve this process. To achieve the above, the case of a leading company in the dairy industry will be analyzed internally and externally, as well as the application of quality tools.

Keywords Distribution · Optimal route · Forecast · Supply chain · Logistics · Transportation

12.1 Introduction

Managing a supply chain in a competitive environment in which companies must operate is challenging. For this reason, "the supply chain strategy helps managers to improve their business, but also the integration with their suppliers and customers" (Perez-Franco et al. 2016). In the present work, we analyze the context of a dairy company with a personalized customer service strategy that presents the problem of insufficient personnel to deal with claims, added to a process with a bottleneck.

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This study aims to draw an optimal route using MyRouteOnline, a route planning software, to achieve efficient claims attention.

12.2 Case Study: Analysis

Despite being a substitute product, dairy products are part of the primary family basket in Peru (Zavala 2010). This can be explained by its essential nature, which means that milk-based products contain rich quantities of calcium, proteins, and vitamins (Adzic et al. 2020). This characteristic makes the dairy product market less sensitive to globalization than other markets (Monenci et al. 2021). Therefore, during the pandemic, this industry persisted as one of the most critical aspects of production, processing, and distribution (Sharma and Sinha 2020). One particularity faced by the dairy industry in the Peruvian context is the lack of refrigeration in some households. In the first trimester of 2020, only 58.2% of homes had a fridge (INEI 2020). As milk-based foods are traded as conserved and usually preserved in aluminum jars, this has become an issue (García-Jaime 2019; Batista-Branco 2019; Gomez-Gonzalez 2019).

In this way, the relationship between dairy product businesses and their consumers and how it is handled acquires relevance. The relationship above is B2C, and one of its particularities for the supply chain is that agility has a beneficial impact on generating value for customers and, thus, satisfaction (Gligor et al. 2020). In addition, food distribution channels have the most significant potential to generate value (Gazdecki and Goryńska-Goldmann 2020). To capture positive impacts, agility may be within the different processes of the supply chain. One of these is dealing with complaints. It is considered an essential element of customer engagement because it demonstrates a company's commitment, which can be due to claims that may focus on customer needs and interests (McCole 2004). Specifically, this study focuses on complaints in the dairy industry.

12.2.1 General Analysis

To face a competitive industry, dairy companies should develop strategies. It can be based on Michael Porter's generic competitive strategies, which depend on the scope and advantage of cost leadership, differentiation, cost focus, and differentiation focus (Porter 1985). The generic strategy of the analyzed dairy company is cost leadership because of its process efficiency, trajectory, market knowledge, standardized products, and process efficiency. As a result, the company produces large volumes at low costs per unit (Weinberger 2009). Moreover, the company is constantly looking to decrease costs to achieve greater efficiency while maintaining high quality.

The company highlights a reduction in costs and competitive prices compared with the competition. Thus, regarding generating value, Osterwalder and Pigneur proposed a business model canvas where the value proposition might address customer needs through newness, performance, customization, "getting the job done," design, brand, price, cost reduction, risk reduction, accessibility, and convenience (Osterwalder and Pigneur 2009). In this case, the value proposition considers the accessibility of its products and recognition of the brand throughout the national territory.

12.2.2 Supply Chain Analysis

The supply chain involves manufacturers, suppliers, retailers, and customers (Babu et al. 2009). Moreover, food industries are essential for sustaining the community's health and nutrition; thus, operations must guarantee efficiency and be innocuous (Orellana et al. 2022). One of the highlights of the dairy industry in Latin America is that innovation emerges from the interaction between agents, incentives, and institutions (Castillo et al. 2021; Castillo et al. 2019). The above can be seen in the last mile logistics of the company, which works with distribution centers strategically located to deliver products to different customers around Peru. Regarding this characteristic, outbound distribution is estimated to be costly, accounting for up to 20 percent of the manufacturing cost (Chopra and DL 2020).

According to the Council of Logistics Management, supply chain management is the process of planning, implementing, and controlling the flow and storage of raw materials, in-process inventory, finished goods, and information related to the point of consumption efficiently and at the lowest cost to satisfy customer needs (Riveros and Silva 2004). In this company's case, its supply chain begins with milk recollection in the different stables around cities, such as Arequipa, Moquegua, Cajamarca, and the surroundings of Lima. Subsequently, the milk is collected and produced in a factory in Lima's industrial zone. The finished product is then distributed and marketed at different cellars, markets, and supermarkets throughout the country.

Therefore, we focus on the relationship between manufacturers and customers. To address these complaints, the company has a call center where customers can make their claims. In this way, once the complaint is made, if the precedence of the product is a refrigerated place, the claim is transferred to the quality area; otherwise, it does not proceed. Subsequently, the traceability of the product is performed to determine the attention priority level. According to the priority level, the pickup date was seated for face-to-face intervention. Therefore, the company seeks prompt and personalized attention to its customers because customers who feel valued in the connection and know that the organization is paying attention to their needs are more likely to become repeat customers (Aulia 2022).

One of the logistics controllers associated with the analyzed case is efficiency, which can be measured as the number of hours or days to attend to a claim in a particular area. Similarly, another driver is the company's responsiveness to dealing with a high number of claims. It also highlights the transport availability controller and the information provided to customers to answer their questions about the product.

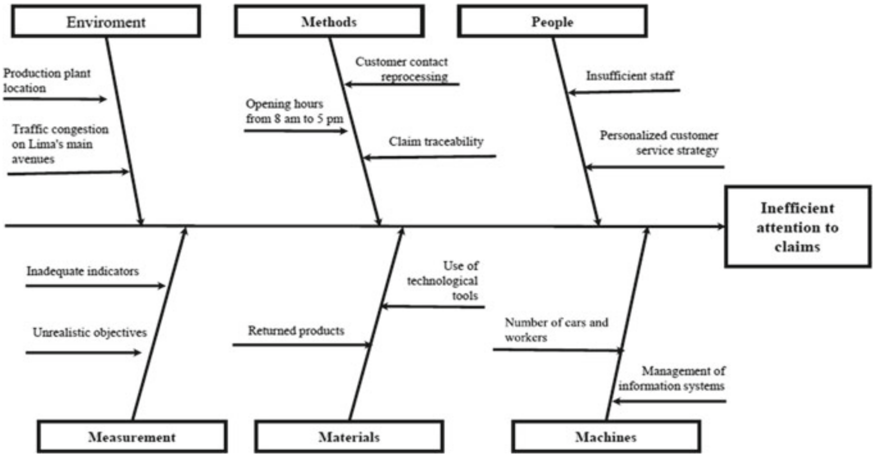

Fig. 12.1 Company's Ishikawa diagram

12.3 Identification of the Problem

The identified problem was inefficient attention paid to claims. Figure 12.1 shows the analyzed problem by applying a fishbone diagram. Thus, this study focuses on personalized customer service strategy, traffic congestion, use of technology, and information systems management to improve efficiency in the attention of defective product complaints.

One of the factors analyzed was the environment, pointing out the factory's location on the outskirts of Lima and, related to that, the traffic congestion on the major avenues. Another point is the methods used in the process, such as the range of attention from 8 a.m. to 5 p.m. and claim traceability. However, it is essential to consider the balance between the attention process and people. For example, the company has insufficient staff to claim attention, but these people offer personalized customer services. Another relevant aspect is the measurement, and at this point, the indicators used to monitor the process are inadequate, combined with unrealistic objectives. This process works with Excel; the machines are the specific number of cars and management information systems.

12.4 Methodology

To analyze and determine the optimal routes for picking defective products, it was necessary to determine a way to organize and prioritize the different districts that were going to be visited. The collected data correspond to the different claims received in 2021, sorted by district and place to visit.

Geolocation is a process in which information is obtained from a person, company, event, or city at a given geographical point (Serna 2017). This point can be determined by the coordinates, which usually come from satellites, to obtain the global position of the point. In this way, the application of geolocation in this work identifies the claim positions' geographical positions so that the possible optimal routes can be identified. This is possible because of the proliferation of GPS-equipped devices and map-based applications, which have enabled people to instantly obtain location data and other spatial information (Forman 2021; Reza et al. 2017).

The dairy company provided the data for use. Specifically, the reclamation history for 2021. This database contains 4141 records. Then, the address, latitude, and longitude columns were generated using the Google extension Geocoding by SmartMonkey. As a result, 88 records were eliminated, and the remaining 4053 records were correctly georeferenced. Subsequently, this database was uploaded to QGIS and converted into a geographic file. Figure 12.2 shows the historic claims according to their geographical origins.

Route optimization efficiently determines the best route from a warehouse or distribution center to its destination. This "effective" route must be executed in the fastest and most profitable manner possible (Verizon Connect, s.f.). Likewise, it should be noted that the best route often does not necessarily involve the shortest route. That is because route search optimization focuses on minimizing the total driving time, considering the number of visits and other variables such as time windows for delivery times, vehicle load, the distance between distributors and delivery points, and even congestion and traffic accidents.

To exemplify the methodology, we used the Miraflores district to identify the address of claims. In this study, we identify multiple points of sale of the company's products, such as markets, convenience stores, supermarkets, and nano stores that are much smaller and have less than 15 square meters of the store, or perhaps no stores at all but a street cart (Blanco and Fransoo 2013), highlighting which are related to a claim. Figure 12.3 illustrates the different sale points within the Miraflores district.

Given that the different claims correspond to addresses distributed all over Lima, it was necessary to establish a method to organize and prioritize the pickup. Therefore, the strategy used is based on the APEIM model (APEIM 2020), which separates the Lima districts into ten different zones. In this study, we work with data corresponding to nine out of ten zones, as listed in Table 12.1.

Figure 12.4 shows the geographic scope of each of these APEIM zones.

The districts for this investigation were selected based on the APEIM zones mentioned above. Therefore, route-optimization software was selected, focusing on minimizing distance, minimizing time, and balancing distance and time (MyRouteOnline 2011). MyRouteOnline, an access-free route optimization software that uses different parameters to determine the best route and obtain multiple stop-driving directions, was run (MyRouteOnline 2011). In the following section, we will show and discuss the results obtained from the software.

Fig. 12.2 Geolocation of historical claims 2021

12.5 Results

We determined the optimal routes for each zone by using the free version of MyRouteOnline. com. Figure 12.5 shows the route optimization for zone 1, which consists of the districts Puente Piedra, Comas, and Carabayllo and represents 12.2% of the total population in the Lima Metropolitan Area (CPI 2022).

Hence, considering six stops and the 49.2 km to commute, the optimized route should take approximately 4 h, as shown in Table 12.2.

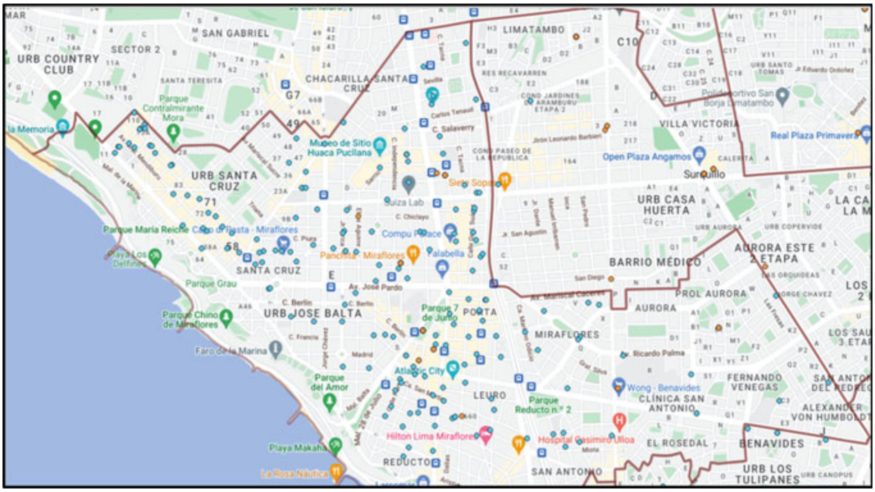

Fig. 12.3 Sale points in the district of Miraflores

Table 12.1 APEIM zones used in the analysis

APEIM Zones	Districts considered in the APEIM zone
Zone 1	Puente Piedra, Comas, Carabayllo
Zone 2	San Martín de Porres, Los Olivos, Independencia
Zone 3	San Juan de Lurigancho
Zone 4	Breña, Cercado de Lima, La Victoria
Zone 5	Ate, Lurigancho, San Luis, El Agustino
Zone 6	Lince, Pueblo Libre, San Miguel, Jesús María, Magdalena del Mar
Zone 7	La Molina, Miraflores, Santiago de Surco, San Isidro, San Borja
Zone 8	Chorrillos, Surquillo, San Juan de Miraflores
Zone 9	Lurín, Villa María del Triunfo

On the other hand, Fig. 12.6 shows the route optimization for zone 2, which is integrated by the following districts: San Martin de Porres, Los Olivos, and Independencia, representing 12.4% of the total population in the Lima Metropolitan Area (CPI 2022).

Thus, considering five stops and the 56.9 km for commuting, the optimized route should take approximately 3 h, as shown in Table 12.3.

Figure 12.7 shows the route optimization for zone 3, which is conformed by the San Juan de Lurigancho district and comprises 10.8% of the total population in the Lima Metropolitan Area (CPI 2022).

Considering six pickup stops and 36.92 km for commuting, the optimized route should take approximately 3 h and 23 min to reach its final destination, as shown in Table 12.4.

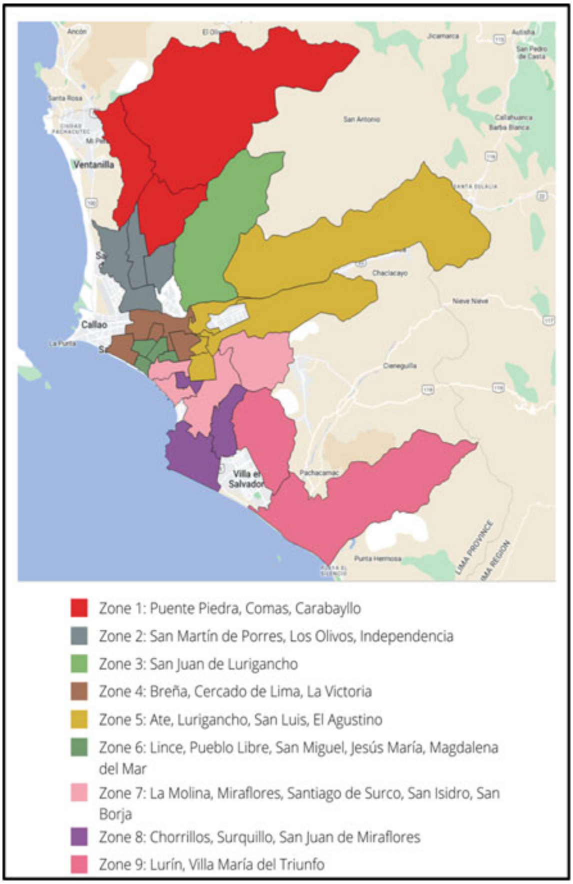

Fig. 12.4 Geolocation of APEIM zones

Figure 12.8 shows the route optimization for zone 4, which includes the districts of Breña, Cercado de Lima, and La Victoria. It is one of the areas with one of the most significant distances to travel in kms. However, it has the avenue of Ramiro Prialé, which facilitates commuting between districts.

This avenue's use means all five expected stops can be met in approximately 3 h and 14 min, as shown in Table 12.5.

Figure 12.9 shows the route optimization for Zone 5, which includes the districts of Ate, San Luis, and El Agustino. This route also uses Avenue Ramiro Prialé, which facilitates the transport of many vehicles between districts.

Therefore, all five expected stops can be met in approximately 3 h and 7 min, as listed in Table 12.6.

Figure 12.10 shows the route optimization for zone 6, which comprises Lince, Pueblo Libre, San Miguel, Jesús María, and Magdalena del Mar districts. The great vehicular congestion stands out in this area, making optimizing routes using main avenues difficult.

Fig. 12.5 Route optimization results for Zone 1

Table 12.2 Summary of route optimization results for Zone 1

	Description
APEIM zone	1 (Puente Piedra, Comas, Carabayllo)
Number of stops	6
Route duration (in h)	04:04
Distance (in kms)	49.2

Therefore, the travel time exceeded 4 h in attending the claim pickup points, as shown in Table 12.7.

Figure 12.11 shows route optimization for zone 7, which contains some of Lima's most residential and urban districts: La Molina, Miraflores, Santiago de Surco, San Isidro, and San Borja.

Therefore, it is possible to use routes independent of the main avenues to reach the six estimated service points. However, vehicular congestion in these districts means that the total time is approximately 4 h, as shown in Table 12.8.

Figure 12.12 shows the route optimization for Zone 8, which consists of Chorrillos, Surquillo, and San Juan de Miraflores.

The best option for this area is the use of main avenues, such as the Panamericana Sur to Chorrillos, with turns towards the target points located in adjacent districts, such as Surquillo, as shown in Table 12.9.

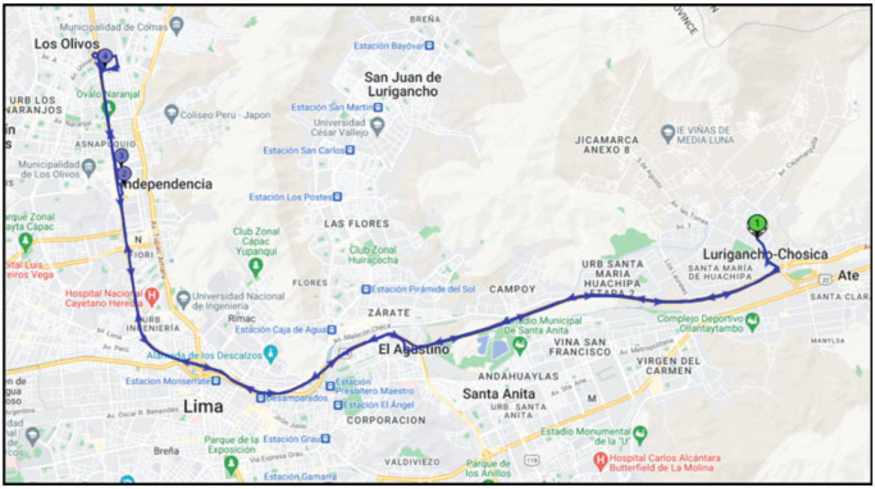

Fig. 12.6 Route optimization results for Zone 2

Table 12.3 Summary of route optimization results for Zone 2

	Description
APEIM zone	2 (San Martín de Porres, Los Olivos, Independencia)
Number of stops	5
Route duration (in h)	03:01
Distance (in kms)	56.9

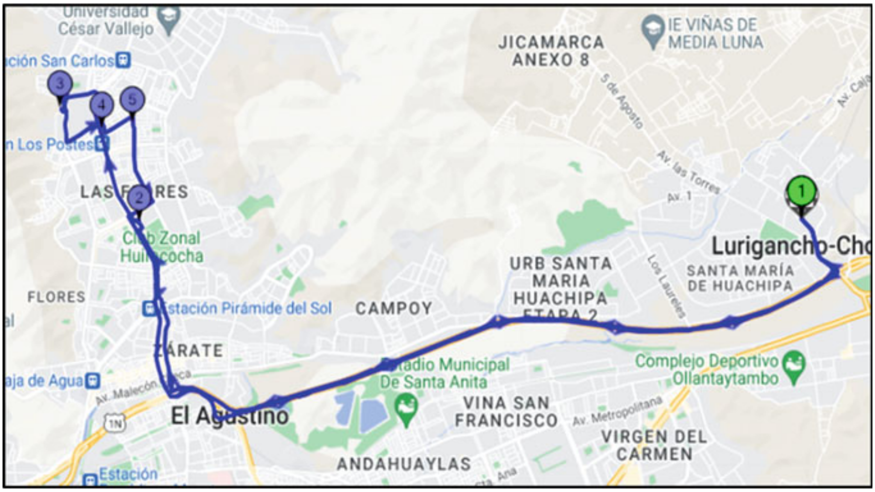

Fig. 12.7 Route optimization results for Zone 3

Table 12.4 Summary of route optimization results for Zone 3

	Description
APEIM zone	3 (San Juan de Lurigancho)
Number of stops	6
Route duration (in h)	03:23
Distance (in kms)	36.92

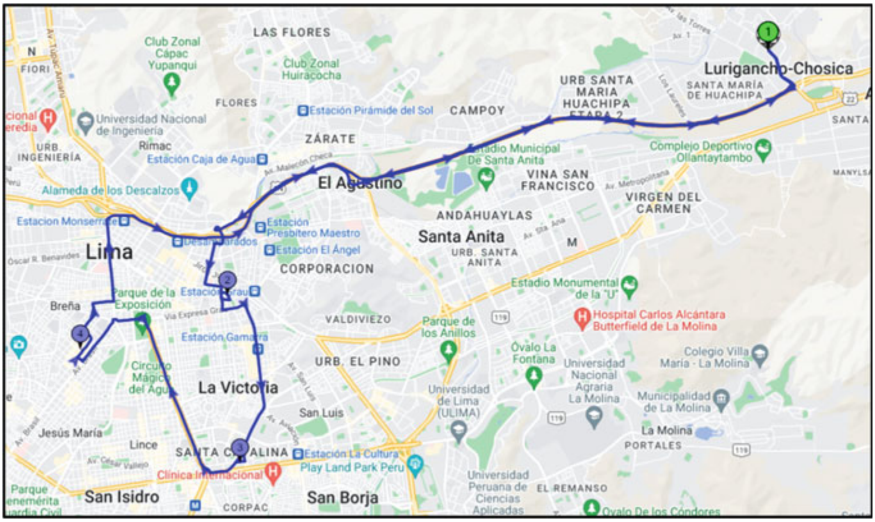

Fig. 12.8 Route optimization results for Zone 4

Table 12.5 Summary of route optimization results for Zone 4

	Description
APEIM zone	4 (Breña, Cercado de Lima, La Victoria)
Number of stops	5
Route duration (in h)	03:14
Distance (in kms)	50.55

Figure 12.13 shows the route optimization for zone 9, which includes the Lurin and Villa Maria del Triunfo districts. It is the area with the most kilometers to commute, but it has the Panamericana Sur avenue, which facilitates the transport of many vehicles between these two districts.

All four expected claims can be met in approximately three hours due to this avenue's use, as shown in Table 12.10.

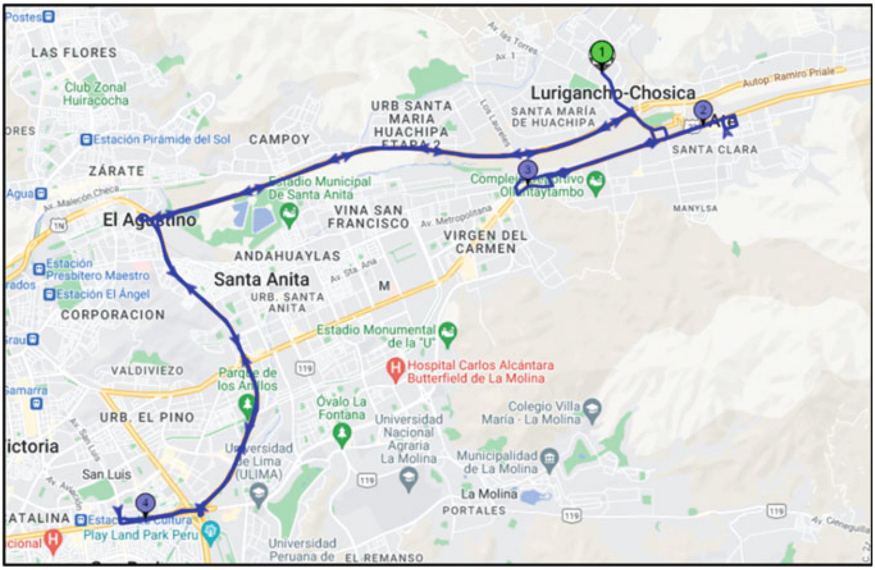

Fig. 12.9 Route optimization results for Zone 5

Table 12.6 Summary of route optimization results for Zone 5

	Description
APEIM zone	5 (Ate, Lurigancho, San Luis, El Agustino)
Number of stops	5
Route duration (in h)	03:07
Distance (in kms)	52.27

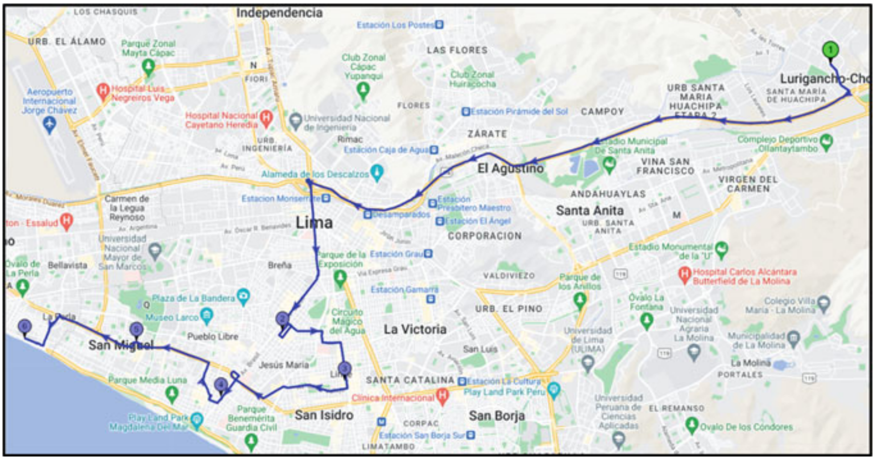

Fig. 12.10 Route optimization results for Zone 6

Table 12.7 Summary of route optimization results for Zone 6

	Description
APEIM zone	6 (Lince, Pueblo Libre, San Miguel, Jesús María, Magdalena del Mar)
Number of stops	6
Route duration (in h)	04:06
Distance (in kms)	39.42

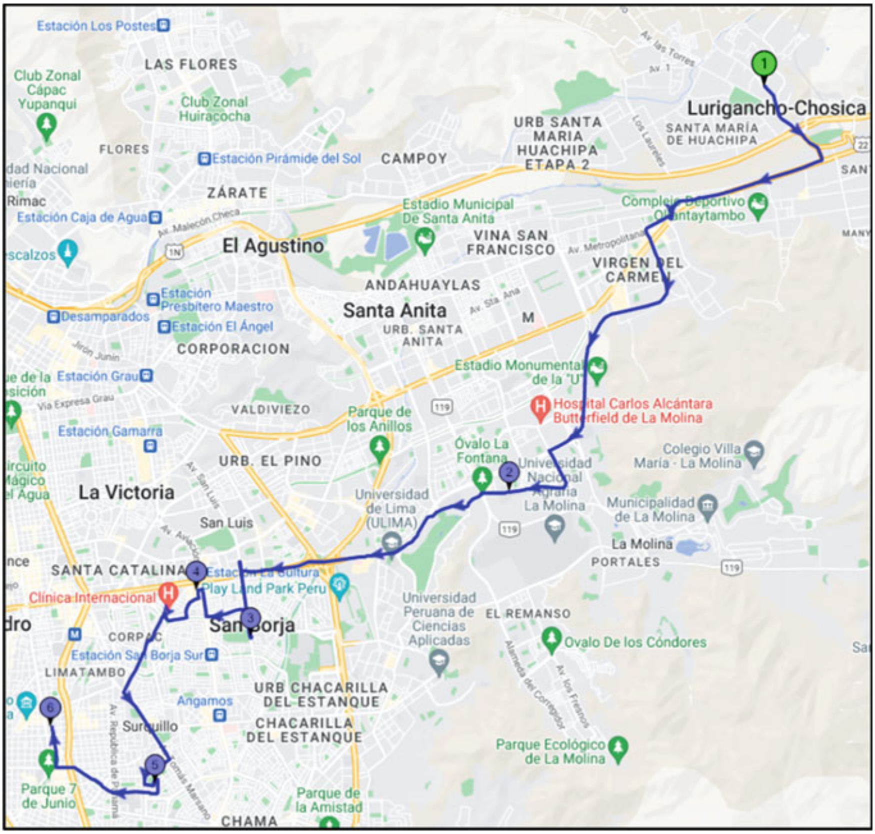

Fig. 12.11 Route optimization results for Zone 7

Table 12.8 Summary of route optimization results for Zone 7

	Description
APEIM zone	7 (La Molina, Miraflores, Santiago de Surco, San Isidro, San Borja)
Number of stops	6
Route duration (in h)	03:59
Distance (in kms)	30.2

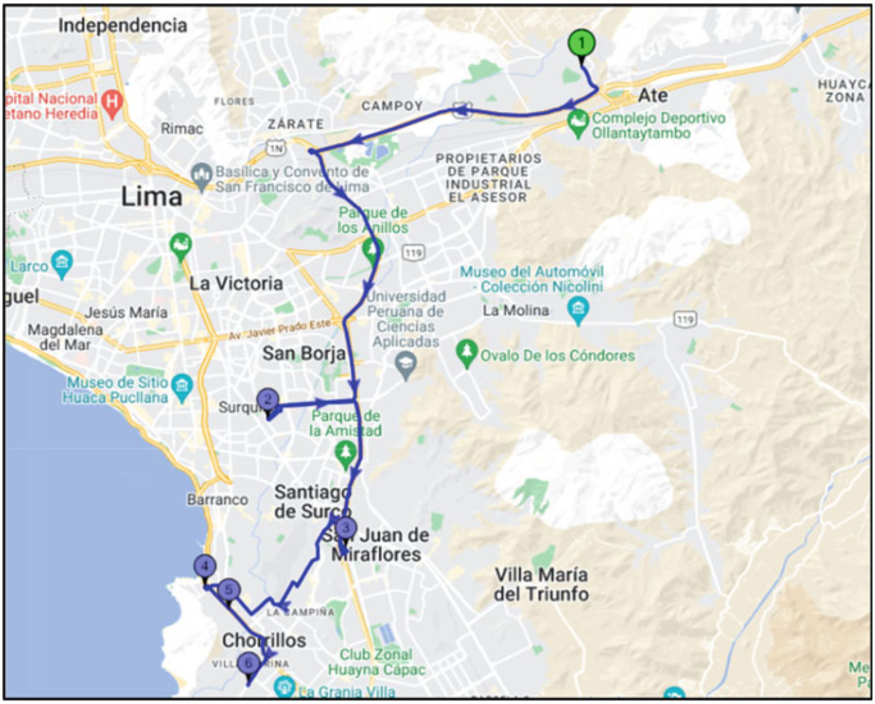

Fig. 12.12 Route optimization results for Zone 8

Table 12.9 Summary of route optimization results for Zone 8

	Description
APEIM zone	8 (Chorrillos, Surquillo, San Juan de Miraflores)
Number of stops	6
Route duration (in h)	04:07
Distance (in kms)	48.13

12.6 Results and Discussion

A summary of the results is presented in Table 12.11. From the summary of the results, the average travel duration to resolve the claims for each APEIM Zone is 3.48 h. It is important to consider that all claims must be addressed during the day for the convenience of retailers. Therefore, it is critical to fine-tuning the routes with new variables that can be determined by testing them.

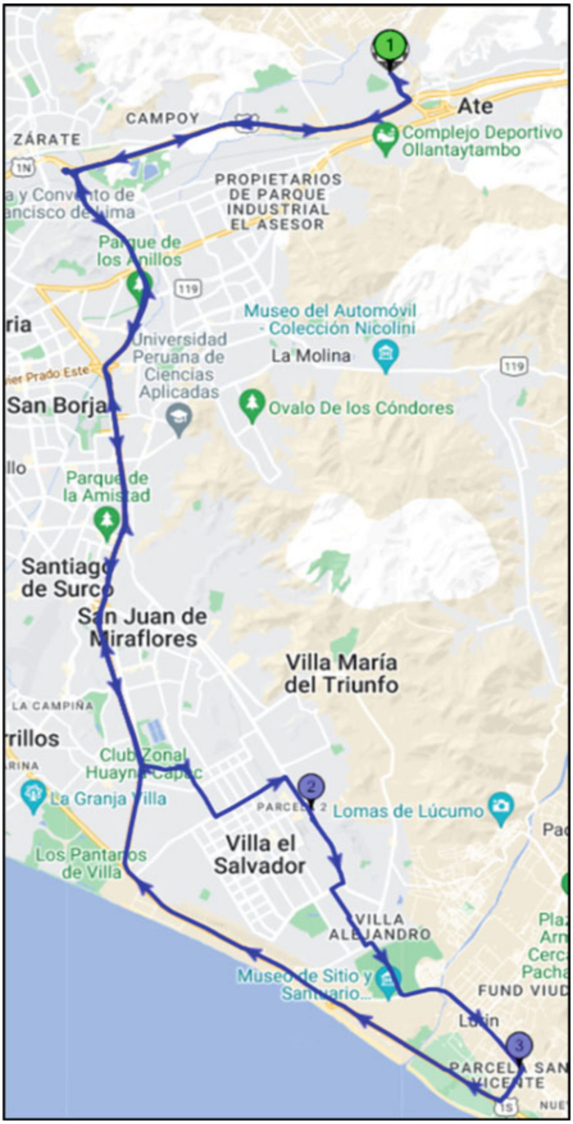

Fig. 12.13 Route optimization results for Zone 9

Table 12.10 Summary of route optimization results for Zone 9

	Description
APEIM zone	9 (Lurín, Villa María del Triunfo)
Number of stops	4
Route duration (in h)	03:13
Distance (in kms)	96.16

Table 12.11 Results Summary

APEIM Zone	Number of Stops	Route duration (in h)	Distance (in kms)
Zone 1	6	4.04	49.2
Zone 2	5	3.01	56.9
Zone 3	6	3.23	36.92
Zone 4	5	3.14	50.55
Zone 5	5	3.07	52.27
Zone 6	5	4.06	39.42
Zone 7	6	3.59	30.2
Zone 8	6	4.07	48.13
Zone 9	4	3.13	96.16

12.7 Conclusions and Recommendations

In a growing country like Peru, mass consumption companies receive more and more complaints from customers dissatisfied with their products (Greg et al. 2020). Prompt attention to complaints influences the reputation of the company and the demand for its products. Thus, Peruvian brands need to provide specialized customer services.

In that sense, when the company needs to deal with complaints for defective products and immediate pickup is required, research has shown that, on average, the number of stops needed to retrieve defective products is five for each APEIM zone in the Lima metropolitan area. Likewise, consider a 30-min stop. Each route takes approximately 3.5 h, or about 51.1 km, to address the complaint and provide a solution.

There were limitations throughout the investigation. Currently, the company does not extract the latitude and longitude values for each prompt, so the exact location of each complaint needs to be extracted and introduced on the QGIS platform. Although the provided data were sufficient to generate routes, the process might have been automatized by already providing the coordinates. In addition, the data provided were only about last year; having it for more years could have been helpful to elaborate on the significant points mentioned in the next paragraph.

For the actual research, the information used was for 2021; thus, we propose using more recent and historical data for subsequent investigations. The other significant points are based on the conclusions: First, prioritization criteria are established to attend to the claims. This can be achieved by considering different factors that characterize the zones given by the APEIM model to develop more precise criteria and deliver the service faster. Second, considering historical data, we determined how route optimization improves the current claim resolution time. Finally, a forecasting tool such as Holt-Winters can be developed based on a seasonal method.

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