Improving the delivery performance: a case study applying statistical approaches for brazilian fast food

Melhorando o desempenho de entrega: um estudo de caso aplicando abordagens estatísticas para fast food brasileiro

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Abstract

Purpose - Brazilian demand for a faster way of food feeding is growing and delays in delivery time impair customer satisfaction. Although food delivery apps are popular, the work aims to find the root causes of delays at a popular pizzeria in the Brazilian State of São Paulo, highlighting that the pizza manufacturing processes are the same as in past years.

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Design/methodology/approach - An anonymous survey conducted with the customers showed the key points of improvement for pizzerias in the city where the pizzeria was located. Data was collected from the pizzeria in question, so its non-compliances could be identified and further investigated using statistical analysis. Findings - The results showed a strong correlation between delivery time and the hour of order. Deliveries were faster on Monday compared to the other days of the week, possibly due to a reduced number of orders on this day, but it doesn’t explain the fact that Tuesday, Wednesday, and Thursday, which also had low numbers of orders, had high delivery times. This research work intends also to show that the process of the coming order is standard by apps, but the pizza manufacturing process is not. It means the concept of service quality is not reached during a period. Originality/value - This work has shown that applying quality tools and statistical analysis can bring advantages even for small food service companies. Other establishments that suffer from similar problems could also use the strategies for solving the delays.


**Type Case Study.**

**Resumo**

**Propósito** - A demanda brasileira por uma forma mais rápida de alimentação de alimentos está crescendo e os atrasos no tempo de entrega prejudicam a satisfação do cliente. Embora os aplicativos de entrega de alimentos sejam populares, o trabalho visa encontrar as causas básicas dos atrasos em uma pizzaria popular no Estado de São Paulo, destacando que os processos de fabricação de pizza são os mesmos dos anos anteriores.

**Design/metodologia/abordagem** - Uma pesquisa anônima realizada com os clientes mostrou os principais pontos de melhoria para as pizzarias na cidade onde a pizzaria estava localizada. Foram recolhidos dados da pizzaria em questão, pelo que os seus incumprimentos puderam ser identificados e investigados com base em análises estatísticas. **Constatações** - Os resultados mostraram uma forte correlação entre o prazo de entrega e a hora do pedido. As entregas foram mais rápidas na segunda-feira em comparação com os outros dias da semana, possivelmente devido a um número reduzido de pedidos neste dia, mas isso não explica o fato de que terça-feira, quarta-feira e quinta-feira, que também tinham um número baixo de pedidos, tiveram prazos de entrega altos. Este trabalho de investigação pretende também mostrar que o processo da próxima encomenda é padrão por aplicações, mas o processo de fabricação de pizza não é. Significa que o conceito de qualidade de serviço não é alcançado durante um período. **Originalidade/valor** - Este trabalho mostrou que a aplicação de
Introduction

Food Service, or food made outside the home, can be defined as the set of businesses and services that aim to serve consumers who eat outside their own houses. According to data from the Brazilian Food Industry Association (ABIA), this service represents 2.9% of the Brazilian GDP, moving to R$ 560 billion in 2019, with an increase of 6.3% compared to 2018. This is due to the growing change in the Brazilian lifestyle population, which seeks fast and practical food, considering the fast-paced daily life (Delivery Much Online, 2020). However, in 2020, with the declaration of the global pandemic by the World Health Organization (WHO), the possibility of expansion to delivery systems opened up, as restaurants were unable to open their doors to the On-Premises system, or consumption on-site. With this, in the midst of the pandemic scenario, a new competitive reality emerged for the market, in which companies were forced to adapt and readjust themselves, which allowed delivery systems to grow by 78% in the transition between the realities of 2019 and 2020 (Silva et al., 2018), (Delivery Much Online, 2020). Coronavirus disease 2019 (COVID-19) has changed the overall presentation of daily life; individuals now value non-contact services more for their safety, which has changed consumer behavior in the food service business sector (Lee et al., 2022; Zhao and Bachao, 2020; Bae and Chang, 2021; Shim et al., 2021)

Under these circumstances, food delivery apps have gained popularity because they allow customers to accept delivery at home without risking exposure to the coronavirus in public places (Lee et al., 2022).

Bonfanti et al. (2023), presented that since the outbreak of the Covid-19 pandemic, restaurants, and catering services have improved online food ordering and delivery services (OFODSs), suggesting the three dimensions of customers' expectations: 1) basicness of expectations; 2) accuracy of expectations; 3) attainability of expectations, providing, also, specific activities in which restaurants and catering business could invest.

The Food Supply Chain (FSC) resilience model for critical infrastructure collapse due
to natural disasters can be presented considering managerial actions through the chain: innovating, transforming, adapting, and flexibilising business models and operations (Serra and Jauregui, 2021). Based on this, a new challenge arises for companies, to continuously improve the quality of the delivery system, making it faster and more practical, in addition to delivering content with the best possible.

**Theoretical Referential**

One of the prominent areas in production engineering is production management (Nunes, 2017); one of its subareas is operations and service management, which aims to develop a strategy to increase the added value of commercialized products and to create a competitive advantage for the company against its competitors (Victorino et al., 2018). This type of planning is essential because as the competition increases in number, the customer’s demands also increase, and they become more critical of the products and services offered (Freitas, 2005). The customer is only satisfied if his perception of the product's performance is at least equivalent to his expectations (Kotler and Keller, 2006; Hoffman and Bateson, 2006; Branco et al., 2010). In Table 1, some factors directly related to customers' feelings of satisfaction have been listed, including factors associated with food delivery. The implementation of improvements in the production process interferes with the factors that contribute to satisfaction and, consequently, in the perception of the customer. Thus, an important measure is to identify and minimize the sources of losses in the production process in order to increase productivity (Rios et al., 2020).

<table>
<thead>
<tr>
<th>Factors</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product identification on packaging</td>
<td>Pedanco, 2015</td>
</tr>
<tr>
<td>Product storage</td>
<td></td>
</tr>
<tr>
<td>Service quality</td>
<td>Qin et al., 2010</td>
</tr>
<tr>
<td>Perceived value</td>
<td></td>
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<tr>
<td>Food temperature</td>
<td>Namkung and Jang, 2007</td>
</tr>
<tr>
<td>Food flavor</td>
<td></td>
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<tr>
<td>Food appearance</td>
<td></td>
</tr>
<tr>
<td>Plate or packaging temperature</td>
<td></td>
</tr>
<tr>
<td>Product performance</td>
<td>Kotler and Keller, 2006</td>
</tr>
<tr>
<td>Fulfillment of expectations</td>
<td></td>
</tr>
<tr>
<td>Perceived product performance</td>
<td>Branco et al., 2010</td>
</tr>
<tr>
<td>Information system</td>
<td>Sethu and Saini, 2016</td>
</tr>
<tr>
<td>Food quality</td>
<td></td>
</tr>
<tr>
<td>Attendance service</td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td></td>
</tr>
<tr>
<td>Delivery fee amount</td>
<td></td>
</tr>
<tr>
<td>Hygiene</td>
<td></td>
</tr>
<tr>
<td>Delivery without damage to the product</td>
<td>Kedah et al., 2016</td>
</tr>
</tbody>
</table>
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Table 1. Factors associated with customer satisfaction (adapted from Rios et al., 2020)
Source: Authors, 2023

<p>| | | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Delivery man empathy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivery agility</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delivery time reliability</td>
<td></td>
<td></td>
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<tr>
<td>Website quality</td>
<td></td>
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</tbody>
</table>

In the Lean system, losses are classified into seven types: (a) overproduction - production beyond demand or before the expected date, (b) inventory - excess inventory of inputs or finished product, (c) transportation - occurrence of material movements that do not add value to the product, (d) waiting – the idle time between one step and the next step, (e) movement - unnecessary displacements of workers, (f) defects - generation of products outside the quality standard, and (g) processing - execution of unnecessary or inefficient tasks (Liker, 2005; Fabricio, 2013; Lima and Campos, 2016; Pedroso, 2017).

MASTP (QC story) QC story, in Brazil, known as the method of analysis and problem-solving (MASTP) (Silva et al., 2018), is a procedure for problem-solving (Kume, 1993).

Table 2. MASP phases, their objectives, and comparison with PDCA (Campos, 2004)
Source: Authors, 2023

<table>
<thead>
<tr>
<th>PDCA</th>
<th>MASP phases</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Problem identification</td>
<td>Clearly define the problem and recognize its importance</td>
</tr>
<tr>
<td></td>
<td>Observation</td>
<td>Investigate the specific characteristics of the problem with a broad view and from various points of view</td>
</tr>
<tr>
<td></td>
<td>Analysis</td>
<td>Discover the root causes</td>
</tr>
<tr>
<td></td>
<td>Action plan</td>
<td>Create a plan to block the root causes</td>
</tr>
<tr>
<td>D</td>
<td>Action</td>
<td>Block the root causes</td>
</tr>
<tr>
<td>C</td>
<td>Verification</td>
<td>Check if the blocking was effective</td>
</tr>
<tr>
<td>A</td>
<td>Standardization</td>
<td>Prevent the problem from reoccurring</td>
</tr>
<tr>
<td></td>
<td>Conclusion</td>
<td>Recap the entire problem-solving process for future work</td>
</tr>
</tbody>
</table>

Kume (1993) divides the QC story into 7 steps; however, Campos (2004) presents the tool in 8 steps correlating each one of them to the PDCA cycle (Plan, Do, Check, Act) (Table 2). For the improvement of an organization's results to occur, the solution to its problems must be done in a systematic way and involving everyone. In Brazil, it is very common to give too much importance to the tools used in MASTP, such as the Pareto diagram and the cause-and-effect diagram, without knowing the storyline of the quality control activities. Thus, people end up not knowing what to do with the tools (Kume, 1993; Campos, 2004).

Quality tools applied to the restaurant and delivery sector Cohen et al. (2022) conducted a study that found reductions in fast-food, and other restaurant dining compared with prior to COVID-19, although overall restaurant consumption remained high with over half of the participants reporting fast-food consumption in the week prior (average

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consumption of twice per week). In this context, Novaski et al. (2020) identified and classified, according to the Lean system, the losses of a bakery in Foz do Iguaçu. The authors built a flowchart representative of the production process and used the GUT matrix and the Pareto diagram to determine which losses had greater importance. It was verified that 77% of the losses were associated with the production sector, therefore, it was proposed to carry out future work for the elaboration of a 5W2H action plan, focusing on the survey of solutions for the improvement of the production stage of pieces of bread and other products (Novaski et al., 2020). Antunes Júnior and Broday (2019) describe the process of manufacturing frozen meals in the food industry in Southern Brazil, analyzing losses of sauce placed in frozen meals during the packaging stage. Thus, this study will demonstrate the adoption of the PDCA Cycle in the aid of sauce loss reduction, as well as proposed measures of control for process continuous improvement. Along the same line, Brito (2016) studied the implementation of quality management tools in a bakery, based on the steps of a PDCA cycle. The author applied a survey-type questionnaire, which was answered by the owner of the establishment, the employees, and the customers, to identify the problems and propose means of solution. The results of the questionnaire showed that, when making a purchase, customers prioritize first and second, respectively, the service and the product reliability. In employees' opinion, the most important criterion for customer purchase is customer service, followed by price; moreover, reliability is the last to be considered (Brito, 2016). In Brito's (2016) study, several tools were used, such as the SWOT analysis, the GUT matrix, the Ishikawa diagram, and the 5W2H. It was found that the most relevant problems in the bakery were associated with the quality of products compared to those of competitors and reliability. It was emphasized that further studies could evaluate the application of a 5S program before the layout changes proposed in the paper were carried out and that the implementation of the action plan measures should be followed by the execution of the last three steps of PDCA (Do, Check and Act) (Brito, 2016). Braga et al. (2018) did a study on the food delivery routing problem. When a customer's order becomes ready for delivery, in general, the delivery person waits for new orders to come out so that he can deliver them together in a single trip. However, the waiting time cannot be so long that the ready orders are delivered late. Based on this, the authors proposed an equation that determines the maximum waiting time for the delivery person, to ensure that orders are delivered within the guaranteed time frame. The authors suggested that future works associated with the topic use the developed equation as a basis for food delivery routing studies (Braga et al., 2018).

Based on the data collected, a study was made with respect to delivery time, seeking
to study how often delays in deliveries occur during weekdays, during the hours of the experienced, and during the 3 months evaluated. For this, the boxplot was used to visualize the mean, median, and interquartile analysis measures, among others. The frequencies of pizza flavors and sizes, and the number of orders on each day of the week and at each working time, were visualized by means of histograms. SWOT analysis, GUT matrix, Ishikawa diagram, and 5W2H were also used in the stages of problem identification, observation, and analysis, as well as in the elaboration of the action plan. Suárez-Barraza et al. (2020) explored, studied, analyzed, and implemented Kaizen–Kata methodology in a service food organization (first-level restaurant), facing challenges in different operational processes that affect and influence the case company performance and customer satisfaction. The service organization implemented the Kaizen–Kata methodology to improve one operational problem process. A case-study approach was used in this research to understand the effects of the Kaizen–Kata methodology in solving problems in their operational service process. Different Kaizen–Kata techniques and tools (histograms, Pareto chart, and Ishikawa diagram) using the Plan, Do, Check, Act improvement cycle framework was used quality. Such factors are crucial to guarantee the company a competitive advantage, in a reality in which many use the same service (Jeronymo et al., 2021).

Thus, this article aims to apply quality tools to a popular pizzeria in Brazil in order to diagnose the possible problems that it may have, understand the root cause of errors, and based on it, propose solutions that make the establishment faster and more efficient in its deliveries, increasing the company's reliability and competitiveness. The introduction should provide a review of recent literature and sufficient background information to allow the results of the paper to be understood and evaluated. It should clearly explain the nature of the problem, previous work, purpose, and contribution of the paper.

**Research Method**

To perform a deeper analysis of the establishment, a study was conducted to understand how the pizzeria has operated until now. The main objective was to comprehend the strengths of the company and the possible flaws in the process, following the steps of QC Story to develop an action plan. This work was developed in 8 steps as shown in the methodological flow in Figure 1. The first step was to establish the theme, identified the gap, and defied the objective of the research, allowing the beginning of the work. Following, step 2 consisted of the intensive research and theoretical development of the related areas,
especially the greater knowledge and comprehensiveness about QC Story, that was chosen for this study. In step 3, with the collaboration of the pizzeria, two visits to the establishment were made to get to know the production process of the pizzas and how the internal organization of the company worked, besides having collected data from orders made in the period from February to March 2022, including flavors and sizes of pizzas, the platform used to make the order, the date and time of the order, and especially the delivery time, which is the focus of this study. For the data referring to values, it has been removed the products under 32 Brazilian reais since they correspond to other products and not the pizzas. Through the knowledge obtained in the last step, it was possible to classify all the main information of the business. The pizzeria, the subject of this work, is in downtown Lorena, a city in the countryside of São Paulo, and its work team is composed of a manager and eight employees. The company works mainly with the sale of pizzas every day of the week, from 6:30 p.m. to 11:30 p.m. The pizzas’ prices are above the average prices for the pizzeria in Lorena, because of the high-quality ingredients used to produce the food. There are three different sizes for the pizza dough and 37 flavors available. Orders can be placed using food delivery apps, the company's website, or by telephone. The customer can choose between withdrawing the order at the pizzeria or receiving the food by delivery. The delivery men from an outsourced company conduct the Delivery service, and, according to the company’s profile on the food apps, the delivery time is up to 90 min.

Currently, the establishment is undergoing renovations and does not allow meals on-site. The place where meals used to occur before the renovations is now being used to store the pizza boxes. For the fourth step, two anonymous, survey-type questionnaires were developed, the first aimed at customers, and the second at employees. The first one asked about subjects such as age, gender, place of residence, presence of a source of income, frequency of orders, and what adds quality to both pizza and the delivery system, aiming at understanding, which is the main problems identified in the customer's view, which were considered weaknesses in the later analyses.

The second questionnaire, on the other hand, asked about several aspects of the pizzeria, encompassing satisfaction regarding delivery time, the physical space for pizza production, customer service and variety, taste, the degree of standardization, and product reliability, to understand if the pizzeria is aligned with the public's perspective and priorities. The questionnaires were based on a Likert scale, ranging from 1 to 5, in which 1 represents "Strongly unsatisfied" and 5, "Strongly satisfied". Based on the collected data, it has been set for step 5. In this step, a study was conducted concerning the delivery time, seeking to
study how often delays in deliveries occur during the week. For this, the boxplot was used to visualize the measures of mean, median, and interquartile analysis, among others. The frequencies of pizza flavors and sizes, and the number of orders on each day of the week and at each time of the day, were visualized through histograms.

After the analyses, the results obtained in the descriptive analyses, which summarize and describe the data obtained through the boxplot and various graphs, were compared with those obtained in the inferential analyses, which are based on the theory of probabilities, concerned with the analysis of the data and their interpretation. In this case, the ANOVA hypothesis test and the Tukey test were used. After collecting all this information, a normality test was performed in order to identify which hypothesis test would be the most appropriate for analyzing the results, then a hypothesis test was performed in order to compare the behavior of the data by performing a stratification of the sample, followed by step 7, in which all the steps of the QC Story in the “Planning Phase” were traced. An action plan was successfully proposed in step 8, suggesting the measures to be taken to apply the improvements to the analyzed problems. Finally, in step 9, the conclusion of the work was drawn up, confirming the achievement of the objective highlighting the main advantages and limitations of the applied methodology, and proposing suggestions for future work.

![Figure 1. The methodological flow of the research](source:Authors. 2023)
Results And Discussions

4.1 Problem Identification

The first stage of the QC story is the identification of problems. In this step, the problems are clearly defined, and their importance is recognized. From the data provided by the establishment, frequency bar charts of the different flavors and sizes of pizza dough were plotted (Figures 2 and 3).

![Bar chart for the frequency of each pizza flavor](image1)

**Figure 2. Bar charts for the frequency of each pizza flavor**
Source: Authors, 2023

![Bar chart for the frequency of each dough size](image2)

**Figure 3. Bar charts for the frequency of each dough size**
Source: Authors, 2023

Figures 2 and 3 reveal that there is a predominance of large pizzas (51.88%) and chicken flavored with catupiry (11.96%). Based on the interview carried out with the owner...
of the establishment, five weaknesses of the pizzeria were identified: (a) higher prices of the products, (b) lack of a WhatsApp number for communication, (c) lack of a place available for meals on-site, (d) occurrence of delays in deliveries and (e) arrival of cold pizzas to the customer. To evaluate which of these points were priorities for the action plan, a survey was conducted with students from Lorena to provide information about the consumers of pizza in the city. In the sample, the mean age was 22 ± 3 years and 55.07% of the individuals were men and 44.93% were women, 66.67% lived downtown and 57.97% had their own source of income. Frequency distribution of the ages is shown in Figure 4.

Figure 4. Histogram of the ages of survey participants
Source: Authors, 2023

The survey conducted with the customers showed that satisfaction with the city’s pizzerias received an average rating of 3.290 ± 1.202. Figures 5 and 6 reveal the influence of age, gender, income situation, and frequency of ordering pizza on the satisfaction parameter.

Figure 5. Influence of age and gender on satisfaction with Lorena’s pizzerias
Source: Authors, 2023
Figure 6. Influence of having an own source of income and the frequency of ordering pizza on the satisfaction with Lorena’s pizzerias
Source: Authors, 2023

The age of the customer did not show a correlation with satisfaction, but it was noticed that women give higher rates than men at any age. Also, rates of satisfaction are higher when the orderings are more frequent and there is a trend of giving lower rates when the customer has their own source of income. The data did not show a statistically significant difference in satisfaction rates based on the district of the customer. The importance given by the customers and the employees of the pizzeria for five aspects related to willingness to buy were compared in Table 3.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Employees of the pizzeria</th>
<th>Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance</td>
<td>1st</td>
<td>4th</td>
</tr>
<tr>
<td>Variety</td>
<td>2nd</td>
<td>5th</td>
</tr>
<tr>
<td>Standardization</td>
<td>3rd</td>
<td>3rd</td>
</tr>
<tr>
<td>Price</td>
<td>4th</td>
<td>2nd</td>
</tr>
<tr>
<td>Reliability</td>
<td>5th</td>
<td>1st</td>
</tr>
</tbody>
</table>

Table 3. Importance ranking of five aspects related to willingness to buy according to the customers and the employees of the pizzeria.
Source: Authors, 2023

The results show a big difference in the ranking order of the two groups. While the customers rated the reliability and the price of the product as the most important factors when choosing a place to buy pizza, the employees placed these aspects at the bottom of the rank and considered attendance and variety as the most important ones. So, it seems that the company’s mindset does not prioritize the customers’ most essential demands.
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Weakness | The action plan possible to focus | Importance rate
---|---|---
Higher prices of the products | Lowering prices | 4.304 ± 0.944
Lack of a whatsapp number for communication | Whatsapp service | 4.319 ± 1.091
Lack of a place available for meals on site | Non-delivery service | 3.116 ± 1.356
Occurrence of delays in deliveries | On-time delivery | 4.797 ± 0.440
The arrival of cold pizzas to the customer | Keeping food warm | 4.826 ± 0.484

Table 4. Shows the mean importance rate given by the customers to each of the weaknesses identified in the pizzeria.
Source: Authors, 2023

The survey suggests that keeping food warm and ensuring an on-time delivery should be the main focus of the action plan to improve the pizzeria’s performance, while a non-delivery service must not be prioritized. To confirm if there is a statistically significant difference between the importance rates given by the customers, 95% confidence intervals were determined for the aspects related to willingness to buy and the weaknesses of the pizzeria. The results are shown in Figure 7.

![Figure 7. 95% Confidence intervals for the aspects related to willingness to buy and the weaknesses of the pizzeria.](image)
Source: Authors, 2023

Based on the confidence intervals, it is possible to conclude that ensuring on-time delivery and keeping the food warm until it reaches the customer are the factors with the higher rates among all the parameters considered in the survey. Also due to the intersection
between the confidence intervals of these two factors, it also means that they are both equally important. The confidence intervals for lowering prices and offering a WhatsApp service also show that these parameters are equally important and higher rated than a non-delivery service. The results suggest that the action plan must provide solutions for the occurrence of delays in deliveries and the arrival of cold pizzas to the customer. However, considering that on-time delivered pizzas cool down for less time, creating an action plan focused on solving the problem of delays will also contribute to minimizing the food temperature issue. Thus, the occurrence of delays was the factor chosen to be further analyzed in the observation step of the QC story.

4.2 Observation of the Delivery Time Problem

The survey with the consumers highlights the importance of the delivery time for client satisfaction. The average delivery time of the restaurant (2.4 ± 1.0 h) was higher than the maximum waiting time promised by the pizzeria (1.5 h), characterizing non-compliance behavior with their product. In the identification step of the QC story method, it is necessary to characterize the problem (non-compliance) on, at least, four aspects: time, space, type, and effects (Kume, 1989). Based on the data provided by the pizzeria, it was possible to do this characterization in the time aspect., analyzing how the delivery time changes according to the month, the days of weeks, and the ordered hour. This analysis was made not only by descriptive statistics but also by hypothesis tests to confirm if there were significant differences between those aspects. The normality test of the delivery time data indicates that it is not normal (p-value < 0.005). However, the sample was large enough (N = 2781) so normality could be assumed.

The delivery time increased (7.8%) from February/2022 (2.31 ± 0.98 h) to March/2022 (2.49 ± 1.09 h). Looking at the boxplot of delivery time by these months (Figure 8), this difference between the averages does not appear so high. However, the Analysis of Variance (Figure 9) shows a significant difference between these data (p-value = 0.000 < 0.05). It would be necessary to consider a longer timeline than only two months so a tendency could be confirmed, but this statistically significant increase suggests that the problem is becoming worse as the months go by.
The day with the higher delivery time was Sunday (2.55 ± 0.98 h) and the day with the lower one was Monday (2.04 ± 0.93 h). Both the boxplot and the confidence intervals (Figure 10 and Figure 11) suggest that the delivery time is lower on Monday. This was confirmed using Tuckey’s test and no significant difference was observed between the other days (Table 5).
Figure 10. Delivery time by day of the week: boxplot
Source: Authors, 2023

Figure 11. Confidence interval for average
Source: Authors, 2023

<table>
<thead>
<tr>
<th>Day of the week</th>
<th>N</th>
<th>Average delivery time</th>
<th>Grouping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunday</td>
<td>543</td>
<td>2.5524</td>
<td>A</td>
</tr>
<tr>
<td>Monday</td>
<td>203</td>
<td>2.0427</td>
<td>B</td>
</tr>
<tr>
<td>Tuesday</td>
<td>384</td>
<td>2.4386</td>
<td>A</td>
</tr>
<tr>
<td>Wednesday</td>
<td>261</td>
<td>2.4589</td>
<td>A</td>
</tr>
<tr>
<td>Thursday</td>
<td>281</td>
<td>2.3582</td>
<td>A</td>
</tr>
<tr>
<td>Friday</td>
<td>482</td>
<td>2.3994</td>
<td>A</td>
</tr>
<tr>
<td>Saturday</td>
<td>627</td>
<td>2.3847</td>
<td>A</td>
</tr>
</tbody>
</table>

Table 5. Delivery time by day of the week (Tuckey’s test)
Source: Authors, 2023
In fact, Monday is the day with the lowest number of orders by day (Figure 12), which may explain the reduction in the delivery time. Hence, it would be expected that the delivery time increases with the number of orders by the day. However, plotting these variables (Figure 13), it is not possible to see a clear tendency in the data because Tuesday, Wednesday, and Thursday are days with lower numbers of orders by day and still have a comparatively elevated delivery time. This suggests that the daily number of orders is not the main variable that explains the greater delivery time.

Figure 12. The average number of orders for each day of the week
Source: Authors, 2023

Figure 13. The delivery time as a function of the average number of orders for each day of the week
Source: Authors, 2023

The total delivery period can be segregated into two categories: the time of pizza production, and the delivery time per se (Figure 14). In other words, there are, at least, two sectors directly related to the delivery time: the production sector, and the delivery sector.
The pizza production process can be divided into two steps: the production of previous orders (i.e., a queue in the production) and the production of a specific order. Before the delivery man can deliver the pizza, a minimum number of pizzas must be ready to be delivered, so the delivery fee offsets the costs of the travel. Finally, the delivery time per se varies, for example, depending on the traffic, the destiny, and the route adopted.

![Figure 14. Segregation of the delivery time into two categories](Source: Authors, 2023)

It was also analyzed how the delivery time was correlated with the hour that the order was made. It is possible to see that the first orders of the day have a higher delivery time (Figure 15) and 74.3% of the delivery time variation can be explained by the ordered hour, as suggested by the R-squared value. There are two main reasons that can explain this fact: (a) at the beginning of the expedient, there is a lag time in the production of the pizzas, for example, because of the oven heating time or the initial organization of the employees; (b) at the beginning of the expedient, there are not enough pizzas being ordered, so it takes more time to achieve the minimum number of pizzas to be delivered together. The second hypothesis is supported by the fact that, at the beginning of the expedient, there are fewer orders for pizzas (Figure 16). This pattern was observed for all the days of the week (Figure 17).

![Figure 15. Delivery time by the order hour](Source: Authors, 2023)
4.3 Analysis of the Problem’s Root Causes

The next step of the MASP consisted of analyzing the phenomenon of occurrences of delays in deliveries and their causes, through the creation of a cause-and-effect diagram (Ishikawa diagram), to facilitate the identification of the causes of the problem being analyzed. Such results can be seen in Figure 18. The cause-and-effect diagram showed that the problem of delays can go far beyond just problems with the delivery men, extending to factors associated with process, equipment, materials, place, and management. In this sense, factors such as the presence of only one oven, a poorly optimized layout, both in relation to
the stock of packaging and the place where the pizza is collected by the moto boy, and the lack of prior preparation of the inputs (ingredients and dough), are examples of causes that lead to delays in deliveries. The presence of a poorly optimized layout generates movement losses, according to the Lean system, increasing processing time.

Figure 18. Cause and effect diagram
Source: Authors, 2023

4.4 Plan of Action

From the causes raised in the cause-and-effect diagram, it was possible to proceed to the elaboration of measures to compose the action plan (Table 6).

<table>
<thead>
<tr>
<th>Root cause</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>The presence of just one available oven</td>
<td>Purchase of two more electric ovens</td>
</tr>
<tr>
<td>Weighing ingredients increases production time</td>
<td>Leave ingredients of the most requested flavors previously cut and separated into standardized portions for each flavor</td>
</tr>
<tr>
<td>Less-ordered pizza flavors’ ingredients are not easily accessible</td>
<td>Leave pre-made pizza doughs to ensure there are no delays with fermentation</td>
</tr>
<tr>
<td>Lack of a WhatsApp number to avoid delivery mistakes</td>
<td>Create a commercial WhatsApp to facilitate the company's contact with customers</td>
</tr>
<tr>
<td>Pizza boxes are stored out of the kitchen</td>
<td>Store pizza boxes inside the kitchen</td>
</tr>
</tbody>
</table>
Improving the delivery performance: a case study applying statistical approaches for Brazilian fast food

Delivery men do not choose the shortest route | Develop a Python program to determine the maximum waiting time for the delivery man and, based on it, develop an application for the pizzeria

<table>
<thead>
<tr>
<th>Table 6. Action plan measures designed for some of the root causes.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source: Authors, 2023</td>
</tr>
</tbody>
</table>

The action plan focused on proposing improvements to the production line, the organization and structuring of the kitchen, and the routing of the delivery service. Actions on these issues, such as the purchase of new equipment, can be more effective in solving the problem compared to trying to change the habits of employees, for example. In this way, improvements such as the purchase of more electric ovens, the creation of an application to determine the maximum waiting period for the delivery man, and the storage of packages inside the kitchen stand out as being simpler actions to be carried out by the company and with great return potential. Another possible measure not directly linked to the problem of delivery delays would be to install heating lights to keep the pizzas warm while they wait to be delivered. This is an important issue because, in the survey, keeping the pizzas warm was a factor that the customers attached very high importance to. Currently in the establishment, after the pizzas are packed, they remain on a counter at the exit of the kitchen, away from any heat source that could keep them warm until the delivery man arrives. This can cause the customer to receive the product already relatively cold, which can compromise their perception of satisfaction. In addition, the cooling of pizzas can be further aggravated in the event of frequent delays in deliveries. In the action plan, the purchase of more ovens was suggested. Because of having just one oven available, production flow ends up stopping when the maximum capacity of the oven is achieved, and it is necessary to wait for the baking process to end to restore the production flow. A greater number of ovens will allow for greater production and shorter waiting times. Storing the pizza boxes inside the kitchen also helps to maintain production flow. The fact that employees need to travel constantly to get the pizza boxes generates losses due to movement. It was suggested to leave the dough previously ready, which can be stored frozen for up to 9 days without losing quality and flavor, as suggested in the work of Silva et al. (2018). It would be favorable to prepare the dough of each size (small, large, or family) according to the average proportion in which they are ordered (Figure 3). Another important point is the acquisition of a WhatsApp number for customer service since most customers (83.23%) prefer the delivery modality. Eventually, it may happen that a customer selects the wrong location for delivery and finds
it difficult to report the mistake because most delivery apps do not have the option to contact the establishment by message. Thus, a commercial WhatsApp would facilitate communication with customers. Considering that it is desirable for the delivery man to deliver the largest number of orders in a single journey, it’s important to know the maximum time the delivery man can wait for new pizza orders to be finished, with no order reaching the customer in a period longer than 90 minutes since the order was placed. To help manage the delivery time, two programs were created in Python language, which, together, provide the maximum waiting time. The algorithm developed to find this result is represented in Figure 19.

![Figure 19. An algorithm was developed to determine the maximum waiting time. Source: Authors, 2023](image)

In the algorithm, the variable \( t \) stands for the time elapsed from the departure of the delivery man to the arrival at each order address, considering the shortest route. Other parameters required to determine the maximum waiting time are \( p \): time spent on the pizza production process from the order was read until the packing is finished. In the program, \( p \) was considered a constant value for all the pizzas. \( w \): a period in which each pizza order is waiting to be delivered after it has been finished. \( m \): maximum time the consumer must wait
for the order, according to the pizzeria’s profile in delivery apps. The algorithm checks, for each order, if the sum of the times \( p, t, \) and \( w \) is less than \( m \). If it is true, the algorithm calculates, for each order, the maximum waiting time, symbolized by the variable \( x \), using Equation 1. The program will print the lowest value found for \( x \) as the true result for the maximum waiting time. \( x = m - p - t - w \) (1) The first program aims to determine the best sequence of delivery of ready orders, taking into account the shortest route which, in theory, could be covered in the shortest time interval, allowing the delivery man to return to the pizzeria as quickly as possible, becoming again available for further deliveries. To do so, it is necessary to enter the number of orders that are awaiting delivery, followed by the delivery address for each one. In this first version of the program, only the location of the neighborhood was considered as the address of the request, as it is only a prototype of the final version designed for the application. The result of executing the program can be seen in Figure 20. The program prints the best delivery sequence for the four districts of the city of Lorena entered, also providing the prediction on the time to complete the route.

The second program is intended to use the equation proposed by Braga et al. (2018) to determine the maximum waiting time for the delivery man. For this, the user must enter the delivery address of each order, in the same sequence proposed by the first program. In this case, it is also necessary to mention for how long (in minutes) each order has been waiting for delivery since the end of its processing and packaging. The result of executing the program is illustrated in Figure 21.

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Figure 20. Result of executing the program to determine the best delivery sequence.  
Source: Authors, 2023

Figure 21. The result of executing the program is to determine the maximum waiting time.  
Source: Authors, 2023
Figure 22 presents the statistics for the variable delivery time in general. As can be observed, the data distribution does not present the behavior of a normal distribution (the normality test presents a P-value < 0.05), and there are values that may be masking the behavior of the mean since the confidence interval for the median presents a different range from the confidence interval for the mean.

The data were stratified to identify if there was an interference in the way the orders were placed. Figure 23 is the statistical analysis of the orders made by telephone. The behavior is similar to the behavior of the sample without stratification and that there is the presence of data that can mask the average.
Figure 23. Statistical analysis of the orders made by telephone.
Source: Authors, 2023

Figure 24. is the statistical analysis of the requests made by the application. You can see that in this case the data also cannot be considered as coming from a normal distribution. However, the confidence intervals for mean and median are not disparate, indicating that the data present a smaller variance.

A stratification was also performed for the delivery system, the data referring to over-the-counter deliveries are summarized in Figure 25.
The data also present a non-normal behavior, however, the confidence intervals for mean and median present a small similarity, which indicates that there is no interference from outliers. Figure 26 presents the data for delivery type. Again there is no statistical evidence of the normality of the data, and there is outlier interference, since there is a significant difference between the confidence intervals for mean and median.

To test the hypothesis of the delivery time difference between the modes offered by the pizzeria, Mood's test for medians was performed. The results are shown below.
As can be seen, the medians cannot be considered equal, and there is a small difference that indicates that phone orders take less time.

As can be seen, the medians can be considered equal, so there is no statistically significant difference between them. It is noted that the programs developed provide approximate results and could be sophisticated by integrating a Google Maps API, for example. This would allow travel time from one point to another on the delivery path to be more accurately estimated. In addition, the programs could be linked to the pizzeria's system, which stores information about the orders, so that the insertion of addresses and waiting times that have already elapsed, during the execution of the program, could be done automatically. Finally, the next stage of the QC story method consists of applying the measures proposed in the action plan and verifying their efficiency in solving the problem. This is done by
evaluating the results, with the positives having to be standardized and the negatives corrected. However, the current work is not intended to apply these solutions, but rather to identify the main problems and propose solutions, complying with the first four stages of the QC story.

In this study, it was possible to effectively develop the stages of the QC story tool corresponding to the “plan” phase of the PDCA in order to develop an action plan with the objective of improving customer satisfaction with the products of a pizzeria in Lorena, SP, for the benefit of quality, bringing a differential to the company compared to competitors. Through the results achieved, it was possible to conclude that the occurrence of delays in deliveries is one of the biggest problems in the pizzeria and that it needs to be solved, since this directly affects the customer experience, in terms of the reliability that the order will arrive within the promised time and the food temperature. In view of the problem presented, the action plan focused on reducing possible losses due to movement in the production stage, in addition to proposing an application to have greater control over the delivery time. In addition, the action plan provides a measure to keep the pizzas warm from the moment the pizza is finished to the time the delivery man collects it for delivery.

**Conclusion**

The main objective of this work was to analyze the possibility of applying quality tools in a popular pizzeria in Brazil, to present improvements in its processes. According to the presented results, possible solutions were suggested to solve the problems, mainly the issue of the high delivery time, which was observed in the research. It was also observed that the method used to place the order does not directly influence its delivery time, it is also important to note that the order methods via the internet or via a cell phone application are not used by most customers, which prevents a conclusion stronger in this case. It showed the possibility of applying quality tools, as well as statistical analysis, for a food service company since this work has an innovative approach to this field. This can also be applied to new research in different segments once you have representative data for analysis. Future work can be conducted in food delivery services to identify the optimal delivery route, with a focus on reducing logistical costs. One possibility would be to evaluate the integration of the program with a Google Maps API so that the elapsed time from the pizzeria to the destination is calculated with greater precision.
References


Hoffman, M.D. and Bateson, J.E.G. (2006), Princípios de marketing de serviços: conceitos, estratégias e casos, Pioneira Thomson Learning, São Paulo, SP.


Kume, H. (1993), Métodos Estatísticos para Melhoria da Qualidade, Gente, Caieiras, SP.

Liker, J. (2005), O Modelo Toyota, Bookman, Porto Alegre, RS


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