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AN ANALYSIS FOR THE IMPROVEMENT IN THE PRODUCTIVE PROCESS AND PHYSICAL ARRANGEMENT OF A DONUTS PRODUCTION ESTABLISHMENT

UMA ANÁLISE PARA A MELHORIA DO PROCESSO PRODUTIVO E ARRANJO FÍSICO DE UM ESTABELECIMENTO DE PRODUÇÃO DE DONUTS

UN ANÁLISIS PARA LA MEJORA EN EL PROCESO PRODUCTIVO Y ARREGLO FÍSICO DE UN ESTABLECIMIENTO PRODUCTOR DE DONAS

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Abstract

Theme: This research proposes a new facility layout for the kitchen of a donut company based on guidelines for Systematic Layout Planning (SLP) and Lean Manufacturing (LM).
Objectives: This paper provides an original small company case study with valuable insights for practitioners interested in layout redesign. The main objective was to analyze the production process of a donut establishment and prepare a layout proposal, identifying points for time optimization and standardization.
Research method: To showcase the application of LM on plant layout design, a donut company's facility is selected. The information was collected through multiple visits and semi-structured interviews with the company's staff, as well as examination of relevant company documentations.
Results: Some of the expected results include production costs reduction, unnecessary movements reduction and less arrangement adjustments. The obtained results encourage assuming its transferability to similar situations than bakery and groceries industries.
Conclusions: This paper provides an original industrial case study with valuable insights for the adaptation of the SLP model to reformulate plant designs.

Keywords: layout, spaghetti chart, chronoanalysis, small company, standardization

Resumo

Tema: Esta pesquisa propõe um novo layout de instalação para a cozinha de uma empresa de donuts com base nas diretrizes do Systematic Layout Planning (SLP) e Lean Manufacturing (LM).
Objetivos: Este artigo fornece um estudo de caso original de uma pequena empresa com informações valiosas para profissionais interessados em redesenho de layout. O objetivo principal foi analisar o processo produtivo de um estabelecimento de donuts e elaborar uma proposta de layout, identificando pontos para otimização de tempo e padronização.
Método de pesquisa: Para mostrar a aplicação do LM no projeto do layout da planta, é selecionada uma instalação de uma empresa de donuts. As informações foram coletadas por meio de múltiplas visitas e entrevistas semiestruturadas com os funcionários da empresa, além de exame de documentação relevante da empresa.
Resultados: Alguns dos resultados esperados incluem redução de custos de produção, redução de movimentos desnecessários e menos ajustes de arranjo. Os resultados obtidos indicam que pode ser adaptável para situações semelhantes às das indústrias de panificação e mercearia.
Conclusões: Este artigo fornece um estudo de caso industrial original com insights valiosos para a adaptação do modelo SLP para reformular projetos de plantas
Palavras-chave: layout, gráfico de espaguete, cronoanálise, pequena empresa, padronização
Resumen
Tema: Esta investigación propone un nuevo diseño de instalaciones para la cocina de una empresa de donas basado en lineamientos de Systematic Layout Planning (SLP) y Lean Manufacturing (LM).
Objetivos: este documento proporciona un estudio de caso original de una pequeña empresa con información valiosa para los profesionales interesados en el rediseño del diseño. El objetivo principal fue analizar el proceso productivo de un establecimiento de donas y elaborar una propuesta de layout, identificando puntos de optimización de tiempo y estandarización.

Método de investigación: para mostrar la aplicación de LM en el diseño de la disposición de la planta, se selecciona la instalación de una empresa de donas. La información se recopiló a través de múltiples visitas y entrevistas semiestructuradas con el personal de la empresa, así como el examen de la documentación relevante de la empresa.
Resultados: Algunos de los resultados esperados incluyen reducción de costos de producción, reducción de movimientos innecesarios y menos ajustes de arreglo. Los resultados obtenidos animan a asumir su transferibilidad a situaciones similares a las industrias de panadería y abarrotes.
Conclusiones: este artículo proporciona un estudio de caso industrial original con información valiosa para la adaptación del modelo SLP para reformular diseños de plantas.

Palabras clave: diagramación, diagrama de espagueti, cronoanálisis, pequeña empresa, estandarización

1. INTRODUCTION

Production engineering, in general, has the objective of optimizing processes in order to make organizations more productive in addition, competitive. Using technological techniques, it is possible to find problems that limit the production of the studied process and propose solutions in order to reduce costs waste and improve processes, seeking greater productivity and profitability.

According to Marques, (2020), the bakery and confectionery sector is quite competitive. Therefore, for a company to stand out, it is necessary to reinvent itself and be always looking for improvements, especially in times of economic and social crisis such as the one caused by the Covid-19 pandemic. Even if the bakery commerce was not affected by several lockdowns in Brazil, the competition is quite strong (Pereira et al., 2020).

According to performance indicators of Brazilian bakeries and confectioners in 2020 (ABIP, 2020), published by the Brazilian Association of the Bakery and Confectionery Industry (ABIP), there was a drop of 3.3% in the segment in 2020, not accounting inflation, that is, sales fell from R$ 95.08 billion in 2019 to R$91.94 billion in 2020. In the performance indicators of Brazilian bakeries and confectioners in 2019 (ABIP, 2019), also published by ABIP, bakeries should review productivity, layout, recipes, the quality of its raw material and processes, as it is the time to adapt to new technologies, innovations, high quality, creativity and marketing.

In a market study of the bakery industry carried out by SEBRAE (2017), "product quality" and "price" were highlighted in the rankings of differentiation strategies considered important by businessmen in the sector to stand out from their competitors. According to Passini et al. (2019), to reduce costs and improve product quality in an increasingly competitive market, process standardization is essential. After all, through standardization it is possible to increase quality and reduce expenses and waste, which directly influences the final price of the product.

A donut, a popular sweet in the United States, is a sugary doughnut-shaped fried dough that can have various types of fillings and toppings. Despite having a simple production process, if not well planned and executed, it can result in a lot of waste for the company, whether in terms of resources, labor, time and/or money (Dweiri et al., 2021).

With this in mind, it is important that the company improves and standardizes its processes and has a layout that fully integrates people, machines and materials, and consequently enables a more efficient and economical production.

According to ABIP (2020), the billing of the bakery and confectionery segment fell about R$3.14 billion from 2019 to 2020. The Association assesses that, despite the year 2020 was been marked by the pandemic of the new coronavirus, the sector managed to minimize the major side effects of the crisis. The sector reinvented itself, held back layoffs as much as possible and continued to innovate.

Therefore, despite the crisis, for a company to remain in the market, it is always necessary to seek the increase in productivity and profitability. Thus, it is possible to improve the process, as one of the problems of companies in this segment is usually the lack of planning in the projection of the physical arrangement, which can lead to a drop in production and revenue (Gazoli de Oliveira et al., 2021).

In the case of the studied company, the kitchen project was the responsibility of the cook, who at the time did not have knowledge about physical arrangements and processes, so the machines and equipment were placed in a disorderly manner and there is not enough space for employees to move around. . Thus, without a good kitchen layout, the levels of effectiveness

and efficiency are not the best and the company ends up wasting resources, time, money and labor in activities that do not add value (Passini et al., 2019).

Having an efficient kitchen layout provides better use of the available area, facilitates the supervision and coordination of activities, people and information, and the flow of materials. Furthermore, it reduces the risk of work accidents, increases the efficiency of labor, equipment and the flexibility of the production system for possible variations in production (Passini et al., 2019).

The studied problem was that the company does not have an efficient production process and layout. The hypothesis was that it is possible to increase productivity by implementing an efficient production process and layout.

This research aims to analyze the production process of a donut establishment and prepare a layout proposal, identifying points for time optimization and standardization. The paper is structured as follows: Section 2 reviews the scientific literature and gives a brief overview of factors considered during a facility layout design. Section 3 explains the research methodology and simplifies the criteria of layout alternative selection. Section 4 provides the results and discussions. Finally, Section 5 concludes with the main research findings and provides future research directions.

2. THEORETICAL REFERENCE

2.1 Standardization

According to Gaither & Frazier (2004), product standardization results in a higher volume of each model or part, which can influence a decrease in production costs and investments in inventories, and provide a high in quality and ease of automation. For this to be possible, according to PEINADO & GRAEML (2007), it is necessary to carry out an analysis of the mapping of a process, enabling a better assessment and thus facilitating the identification of problematic points or areas that were not perceived in daily life.

A standardization system creates, uses and controls performance and procedural standards, forming an information system that supports the execution, control and improvement

of operations. The standardization documentation must contain all relevant information for production, be directed to employees, have a simple language and content to facilitate understanding, be possible to be performed, be based on practice and meet all the needs of the work. The process consists of a cycle that begins with the identification of improvement, followed by the development and approval of a new standard, and training with everyone involved in the process to be put into practice (Lucena et al., 2006).

2.2 5S

According to Ribeiro (2017), 5S is a methodology that includes a process of cultural change, it aims to form a culture to combat waste, disorder, dirt, lack of hygiene and lack of discipline for order and cleanliness. The 5S is a physical and behavioral foundation for the success of many management and quality tools.

The 5S designation is due to the five activities (pronounced in Japanese) that are part of the methodology, starting with the letter "S":

- SEIRI - Use, Selection and Classification
- SEITON – Ordering, Arranging and Organization
- SEISO - Cleaning and Inspection
- SEIKETSU – Standardization and Health and Hygiene
- SHITSUKE - Self-Discipline and Self-Control

2.3 Timeline

According to Slack et al. (2018), to make sure that consumer demand will be met, it is important to determine the sequence in which the work will be developed. This sequence requires a detailed schedule, which consists of showing when each of the activities must be started and completed, just as the simultaneity that they can present. The tasks' simultaneity make them often compete for resources and with different capacities and competences.

2.4 Diagrams

Flowcharts represent the sequence of steps in a job by means of graphic symbols, in order to facilitate its analysis and understand how it works. It is a visual resource used by production managers to analyze production systems, seeking to identify opportunities to improve process efficiency (Peinado & Graeml, 2007).

The spaghetti diagram, according to Ortiz (2010), is a tool used to map the current state when the work environment has a large amount of equipment and circulation area. Your analysis can reveal a significant amount of lost movement and transport and thereby allow you to rearrange your workspace to make it more effective. The process consists of using a sheet of paper and drawing the entire work area, identifying the larger drawings such as machines, shelves, supply areas and warehouses, observing the workers in the studied area, continuously drawing the employees' path and finally perform the analysis. Faveri (2013) complements that it is a useful tool to establish the ideal layout based on the distances traveled by employees. This name is given by the similarity between the product route in a mass production and a spaghetti dish. Using the spaghetti diagram, it is possible to identify the times that add value in production and those that do not add value, thus making it possible to detect and eliminate waste (Rocha, 2017).

According to Peinado & Graeml (2007), the relationship diagram is a qualitative method for analyzing proximity between areas, production sectors or departments, indicating the degree of importance of proximity between departments. Its ranking and criteria consist of "A" being close, "E" especially important to be close, "I" important to be close, "O" desirable to be close, "U" need not be close, and "X" is undesirable to be close next.

2.5 Chronoanalysis

For Peinado & Graeml (2007), chronoanalysis, also known as the study of times, is a way of measuring work through statistical methods. According to Slack et al. (2018), the study of time is a work measurement technique, its objective is to record the times and rhythm of work, in this way it is possible to obtain the time needed to carry out the work with a defined level of performance. Among the benefits of chronoanalysis are: elimination of useless

movements and simplification of useful movements. Martins & Laugeni (2005) define that chronoanalysis is important to establish standards for production planning, provide data for the determination of standard costs, budget determination and balancing study.

To carry out this process, according to Peinado & Graeml (2007), tools such as: stopwatch, camcorder, clipboard and verification sheet are needed. And its development, according to Martins & Laugeni (2005), is done as follows:

1. Divide the operations into elements, taking into account the number of elements and the time of each one of them;
2. Observe and record the time spent by the operator;
3. Determine the number of cycles to be timed using Equation 1:

$$N = \left[\frac{Z \times R}{Er \times d_2 \times X}\right]^2$$

where:

N: number of cycles

Z: normal distribution coefficient A: Sample range

Er: Relative error

d_2: coefficient as a function of previous timings X: average.

To use the expression, a previous timing must be performed, taking its average and amplitude from the times obtained. It is also necessary to define the probability and relative error values.

4. Assess the operator's speed, which is done subjectively by the timekeeper. According to the Westinghouse System, four factors are analyzed:
   - Skill is the competence to follow a method;
   - Effort is associated with a constant pace during an operation;
   - Conditions related to the environment, machines and tools;
   - Consistency of movements, to estimate work efficiency.
5. To determine tolerances, work interruptions should be provided so that personal needs are met and provide rest, with the aim of alleviating the effects of fatigue at work.
6. Determine normal time, process of evaluating the operator's working speed times the average amount of timings. In this step, as exposed in Equation 2:

$TN = TC \times VO$ (2)

where:

TN - Normal time;

TC - Timed time;

VO - Operator Speed.

7. Determine standard time, which is calculated by multiplying normal time by a tolerance factor, as exposed in Equation 3.

TP = TN × FT (3)

where:

TO - Standard time; FT - Tolerance factor.

2.6 Tools

According to Peinado & Graeml (2007) most of the problems found in companies can be studied and solved through the use of quality tools such as the Ishikawa diagram and the 5W2H. The Ishikawa diagram according to the authors Slack et al. (2018) is a method designed to find the roots of problems, through questions such as what, where, how and why, but adding possible answers, being widely used in improvement programs. The 5W2H action plan, according to Lobo (2010), consists of a form for the execution and control of tasks. These tasks start with the survey of data on the problem to be solved. With this data a spreadsheet is developed in which is defined: what will done (what); who will do (who); when will it be done (when); where it will be done (where); why it will be done (why); how it will be done (how) and how much will it cost (how much).

2.7 Processes

There is a correlation between the definition of the layout and the type of process, taking into account that the definition of the physical arrangement is based on the characterization of the process Rocha & Nonohay (2016). According to Ritzman & Krajewski (2003), processes are fundamental activities that companies use to perform tasks and reach their goals, and these activities are transformed with the objective of adding value, creating one or more products for the customer. The type of process varies, as there are specific production processes for each manufacturing system and according to Slack et al., (2018)production processes can be classified into five types: design processes, jobbing process,

batch processes, mass process and continuous processes. The batch process consists of each time a process is executed, more than one product is produced, in this way, each part of the operation has periods in which it is repeating itself, while the "batch" is being processed.

2.8 Physical Arrangement

According to Slack et al. (2018), a physical arrangement of a production process determines the positioning of a company's facilities, machines, equipment and employees, as if a layout is incorrect it can negatively influence financial costs and production flows, in addition to generating queues service, causing inconvenience to customers.

According to the authors, Martins & Laugeni (2005), to define the physical arrangement, it is necessary to have information about the sequences of operations and assembly, specifications and characteristics of materials and products, space for employee movement, information on shipping, storage of materials raw and finished products and transport.

Corrêa and Corrêa (2007) state that decisions regarding physical arrangement must be based on the competitive strategy of the operation and the definitions of the type of layout chosen. That is because when a layout project is well planned it can bring great performances; otherwise, it can affect the efficiency levels of the process. Likewise, Martins & Laugeni (2005) remark that the main types of arrangements are product, positional, cellular, mixed and process.

According to Peinado & Graeml (2007), the type of layout by process groups all processes and equipment of the same type and functionality. The materials and products move looking for the different processes of each area needed, being able to group similar operations or assemblies in the same area. The method for applying this arrangement consists of:

1. Collect data about the area, machinery and equipment;
2. Evaluate and relate the requirements and spatial needs according to the area of the site, taking into account the proximity factors of equipment and machines according to the process flow, through a flowchart that indicates the sequence of operations that the products will pass through the production process;
3. Collect the necessary area data for each work grouping and circulation area;
4. Identify the relationship between the groups to position them according to the process flow, through a relationship diagram;

5. Design a detailed layout, with the shape and size of the location, arrangement of furniture, equipment, machinery, corridors and other details using a design software.

3. METHODOLOGY

In order to achieve the objective, this work was structured in stages. Fig.1 Exposes the description of each one of them.

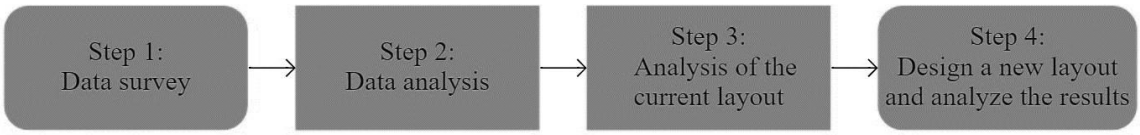

Figure 1. Flowchart of the steps of the used method

Stage 1: The activities were initiated through meetings with managers and employees, together with on-site visits to collect information and identify the company's main problems. The visits consisted of analyzing and timing the production process, from the arrival of the kitchen assistants to the finished product, photos were also taken and measurements were taken of the kitchen area, including the furniture and machines, with the aid of a measuring tape. After collecting this information, it was possible to create a flowchart with the description of the entire process for future analysis.

Step 2: Through meetings and brainstorming together with the application of tools such as Ishikawa diagram, 5W2H, flowcharts, timeline and production chronoanalysis, it was possible to identify the main problems and point out points for improvement.

Step 3: With the help of design software, the current layout was designed with the shape and size of the place, including the arrangement of furniture, equipment, machines and corridors to enable the application of relationship and spaghetti diagrams.

Step 4: Analysis of the results and proposal of improvements through the new layout design and suggestions related to standardization and organization.

4. RESULTS AND DISCUSSION

4.1 Company Presentation

This research was performed in a company that has been operating in the food sector for a year and a half, located in the city of Curitiba/PR, specializing in the real American donut, which is made daily by hand. Its target audience encompasses the middle and upper classes, having a wide menu with more than 25 options of donuts ranging from sweet and savory, with and without filling. The company affirms to be focused on innovation and creativity.

4.2 Analysis of the Company's Current Production Process

The donut manufacturing process follows a production pattern, especially in the steps that involve the making of the dough. For a better understanding of its production, a manufacturing flowchart was made, along with the chef, detailing its procedure from the step of picking up the ingredients to taking the donuts to the counter, as can be seen in Fig. 2:

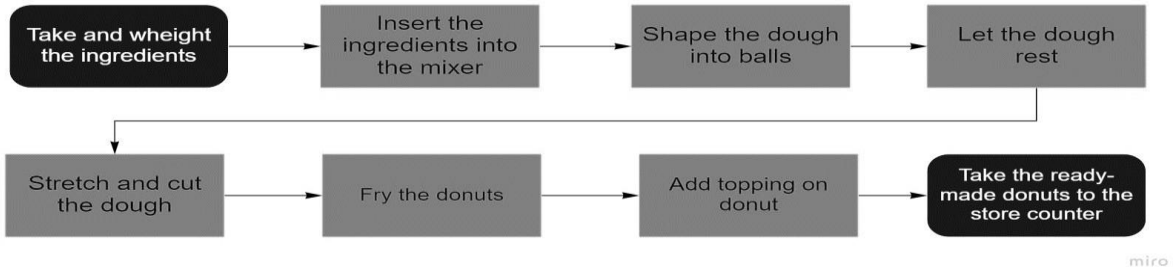

Figure 2. Donuts Manufacturing Process

From the flowchart it was possible to know and study all the necessary steps to carry out the production of donuts, having more information to assist in the application of other analysis tools. In order to identify the points for improvement, the brainstorming tool was used, in order to discuss what would be the main problems of the establishment, such as the need to change and expand the layout, given that the current kitchen was no longer supporting the machines and number of employees needed to meet demand. After the brainstorming, an Ishikawa diagram was structured and the main causes of the problems were identified: lack of standardization of processes and lack of projection of the physical

arrangement of a kitchen in a donut establishment. For a more detailed analysis of the steps of the processes and their respective times, it was necessary to carry out a time-taking study and the creation of a timeline with the distribution of activities per worker.

4.3 Timeline

Taking into account what Lustosa et al. (2008) stated about how production scheduling aims to define when, where and by whom each task will be performed, stipulating when the execution of a product or service must be started and completed. On-site visits were carried out and information was collected on the displacements and schedules of three employees, in order to analyze the performance of each one. The grouping of information was performed using Excel to first assemble the timeline according to the documents made available by the company and then according to the information collected by the team. When comparing both, it was possible to notice differences between what should be done and what is actually done and in how employee 2 is overloaded in relation to the others, for having to take care of the preparation of two pasta, in different regions of the kitchen. , simultaneously, while the other two employees have idle time at certain times, especially the third one as he is undergoing training. Therefore, the use of the timeline makes it possible to adapt the production of the day according to demand, as it allows knowing when production needs to start to be ready at the desired moment, and how to distribute it in a more adequate way to the functions of each operator, aiming at the increase in productivity and better use of the staff.

4.4 Chronoanalysis

In order to study production times, the chronoanalysis method chosen was according to the model presented by Martins and Laugeni (2005), considering the determination of the standard time and analysis of the times according to the objectives proposed in the work. For the model to be applied, the following steps were followed:

1. Division of operations into elements: the operation chosen to carry out this time study was the making of 100 donuts. To carry out this item, the establishment needs an average of three operators, working simultaneously and in an organized manner. The employee works around eight hours a day and six days a week, and his day off is defined by a schedule, given that the place is open every day.

After choosing and studying the operation, the number of elements and their description were

analyzed, in this way, the elements were divided as follows:

1st Element: Take and weigh the ingredients for the dough of the donuts and place in a container.

2nd Element: Place the ingredients already weighed in the mixer and gradually add wheat flour.

3rd Element: Model and knead the dough, dividing it into smaller parts. 4th Element: Resting time for the dough.

5th Element: Stretch, cut and shape the dough in the shape of donuts. 6th Element: Fry the donuts.

7th Element: Finish the donuts by adding the topping.

2. Observation and recording of the time spent by the operator: later, the division of the operation into elements was performed and three timings were recorded, as can be seen in Tab.1.

Table 1
Record of time spent by the operator

Element Nº	Description	1 (min)	Measurement 2 (min)	Measurement 3 (min)	Max. Time (min)	Av. Time (min)	Min. Time (min)
1	Weigh ingredients	5.50	6.00	4.83	6.00	5.44	4.83
2	Mixer	50.25	64.00	46.00	64.00	53.42	46.00
3	Shape dough	5.63	7.58	6.50	7.58	6.57	5.63
4	Rest dough	42.00	60.00	55.00	60.00	52.33	42.00
5	Stretch and cut dough	58.28	69.33	62.40	69.33	63.34	58.28
6	Fry donut	15.00	13.00	16.17	16.17	14.72	13.00
7	Finish donut	87.58	87.00	82.45	87.58	85.68	82.45
	Total	264.25	306.92	273.35	310.67	281.51	252.20

3. Determination of the number of cycles to be timed: the Confidence Degree was stipulated as 80% with a relative error of 20%. Placing these definitions in the cycle determination formula, it is observed that the number of timed cycles reached the previously defined specifications.

4. Assessment of operator speed and determination of normal time: the Westinghouse System was used for this assessment, taking into account the following factors (with their respective assessments):

- Ability is the competence to follow a method (-0.05);
- Effort is associated with a constant rhythm during an operation (-0.04);
- Conditions related to the environment, machines, tools, etc. (-0.07);
- Consistency of movements, to estimate work efficiency (-0.04).

Therefore, the evaluation factor will be 1 - 0.2 = 0.8. Since the calculated time for operation is 281.50 minutes, the normal time will be 225.20 minutes.

5. Determination of tolerances and standard time: tolerances were taken into account to meet personal needs (5%) and to relieve fatigue (5%), totaling 10% of tolerance.

After finding the normal time and the tolerance factor, it was possible to obtain the standard time, which resulted in 250.22 minutes or 4 hours, 10 minutes and 13 seconds. When analyzing this time and the entire timing process, it is clear that the total production time is high, taking into account production during days when demand is higher. One of the reasons for this value is the new mixer, which takes three times the time of the previous mixer. Another cause is the time spent traveling to search for supplies and utensils.

4.5 Layout

In order to optimize the production process, an analysis was carried out regarding the physical arrangement through the AutoCAD drawing software, use of flowchart and diagrams such as spaghetti and relationship, taking into account the location and organization of furniture, machines and kitchen equipment. After the analysis, it was established that the current layout is of the type by process and its type of process is in batches. It is exposed in Fig. 3.

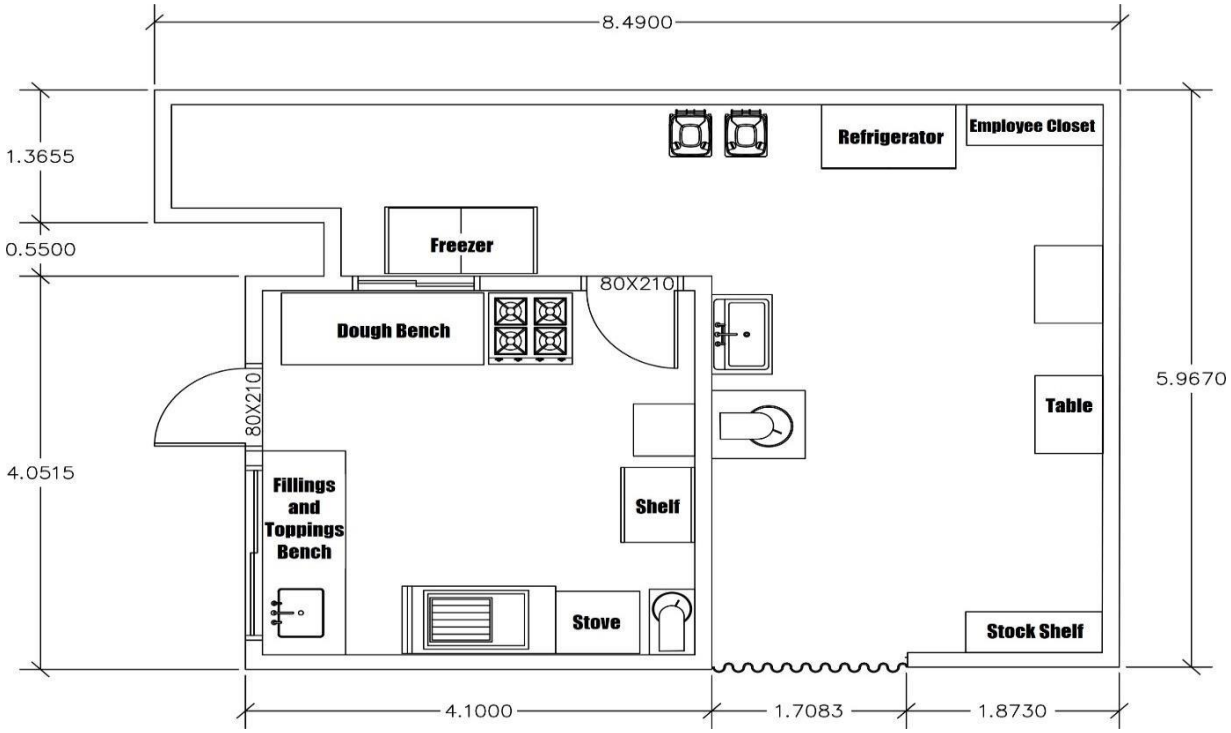

Figure 3 – Previous layout

The spaghetti diagram of the previous layout was based on notes obtained from a production shift with 3 employees. It was observed that employee 2, responsible for the production of the dough, walks a path repeatedly from the dough bench to the mixer, in order to know the point of the dough, generating a distance traveled greater than necessary. It can be seen that employee 1, responsible for preparing and adding the toppings, travels an average distance compared to the other employees. While employee 3, in charge of frying the donuts, traveled less because he had a smaller number of functions, did not have assistance and training to perform the other functions, and the resources were located more effectively. Because it is too small, the sink located on the filling and toppings bench is not used, being covered by a wooden board so that the space is better used.

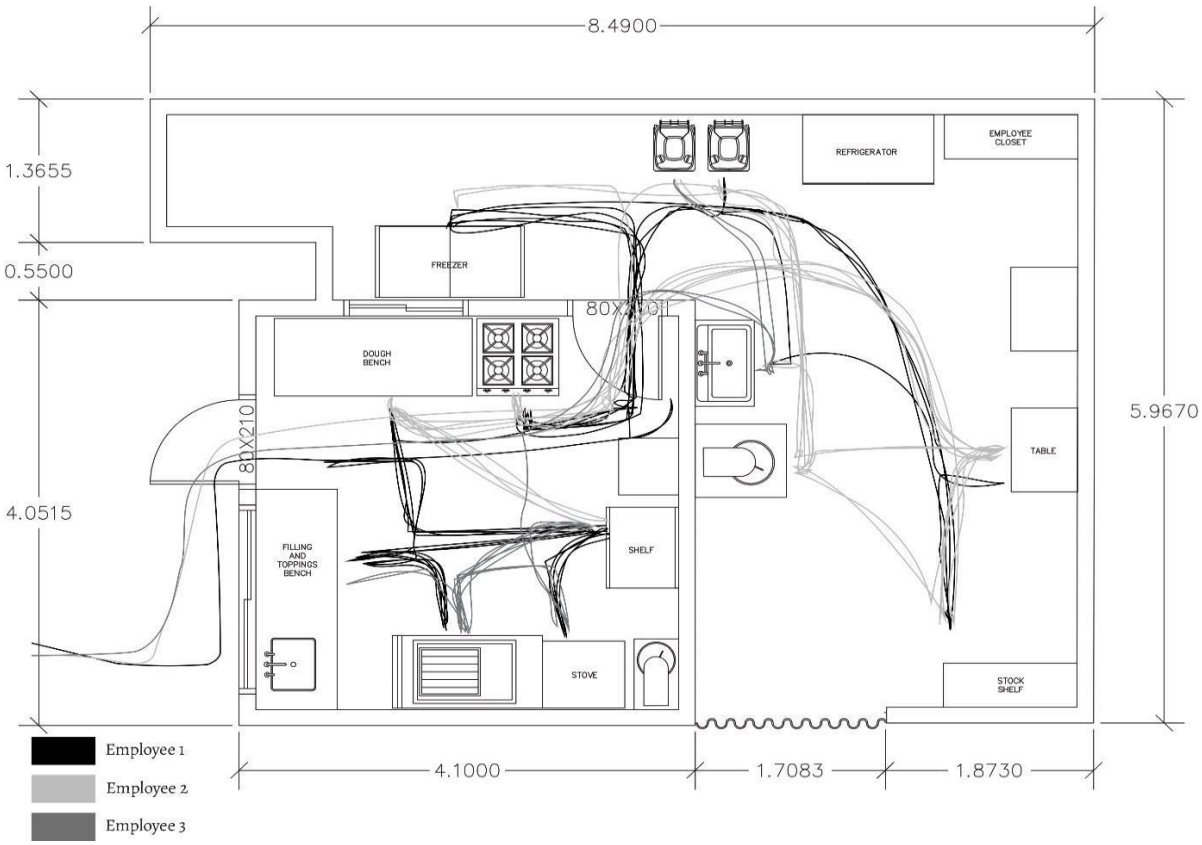

Figure 4 - Spaghetti diagram in current arrangement

Using the spaghetti diagram, it was possible to count the measurements referring to the approximate distances covered by the employees in the current arrangement, which are present in the Table 2:

Table 2
Approximate distance traveled by employee in the current layout

Employee	Travelled distance
Employee 1	87.09 m
Employee 2	161.19 m
Employee 3	32.73 m

It was used the relationship diagram that assigns the degree of importance of proximity between the transforming resources in order to reduce the distance covered by employees. The adopted label was: “A” fundamental to be close, “E” especially important to be close, “I” important

to be close, “O” desirable to be close, “U” does not need to be close and “X” is undesirable to be close.

Table 3
Relationship diagram

	A	E	I	O	U	X
Fillings and toppings bench	3	4, 5, 6	11	5, 7, 8, 13	2, 10, 12	-
Dough bench	5, 10, 11, 12	4	7	3, 13	1, 6, 8	-
Fryer	1, 5	4	5	2	6, 7, 8, 10, 11, 12, 13	-
Stove	5	1, 2, 3, 6, 12	-	-	7, 8,10, 11 13	-
Shelf	2, 3, 4	1	3	1	6, 7, 8, 10, 11, 13	-
Oven	-	1, 4, 8, 11	7, 8	13	2, 3, 5, 10, 12	-
Large sink	-	-	2, 6	1, 8, 10, 12	3, 4, 5, 11, 13	-
Freezer	-	6	12, 6	1, 7, 10, 13	2, 3, 4, 5, 10, 11	9
Employee closet	-	-	-	-	-	8
Bigger mixer	2, 11	11, 12	-	7, 8, 13	1, 3, 4, 5, 6, 8	-
Stock shelf	2, 10, 12	6, 10	1	-	3, 4, 5, 7, 8	13
Dough table	2, 10, 11	4, 10	8, 13	7	1, 3, 6	-
Trash cans	-	-	12	1, 2, 6, 8, 10	3, 4, 5, 7	11

The proposal to improve the physical arrangement was based on the timeline and on the results of the diagrams mentioned above. The improvement points applied consisted of removing the wall that divided the environment to improve the circulation area and performing a grouping of equipment and furniture. In this way, one area was destined only for dough production and another for frying and adding topping, thus improving efficiency and reducing employee fatigue compared to the previous arrangement, as both the person in charge of the dough production and the responsible for adding the toppings and frying the donuts would have the necessary resources nearby. Equipment and furniture that were not useful for the process were also removed, such as the sink on the cover and filling bench, and a stainless steel dish rack was added next to the other sink. Finally, a separate area was created for employees who previously did not have their own place to eat and rest. The result is exposed in Fig. 5.

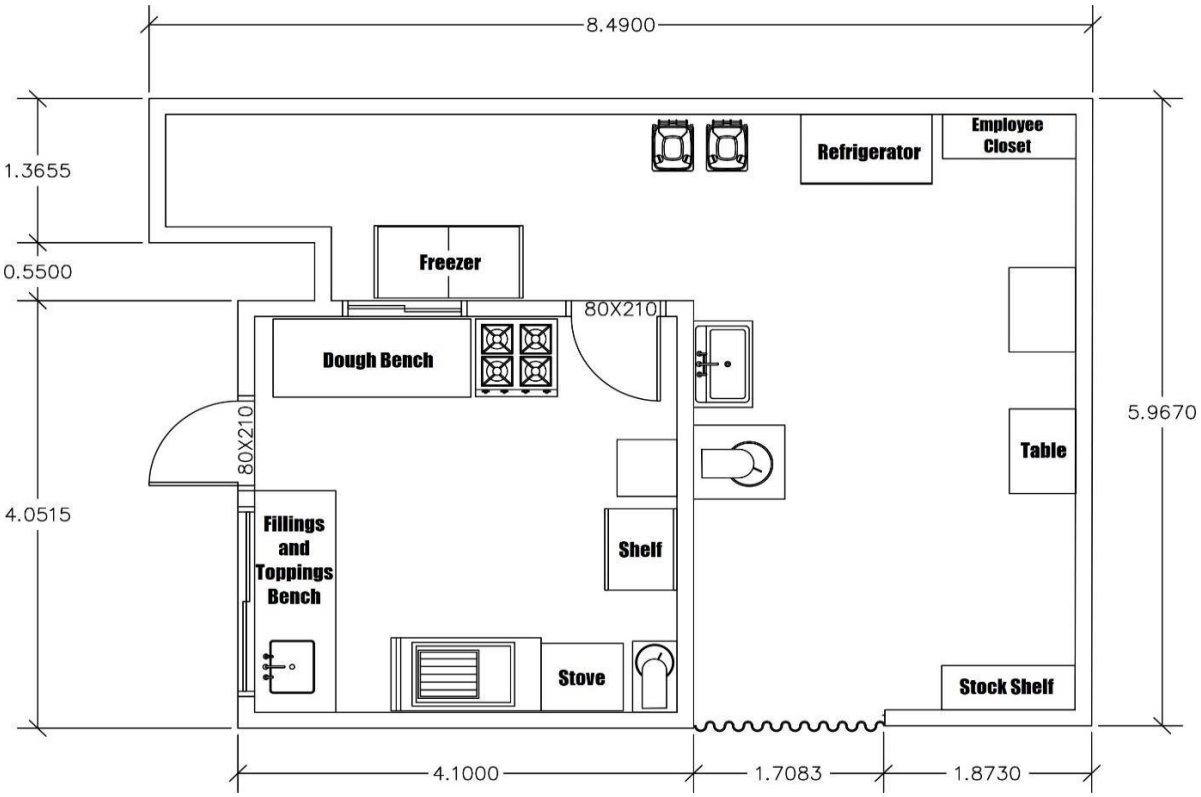

Figure 5 – Proposed layout

A simulation of the spaghetti diagram was performed in the projection of the suggestion of the new layout also through AutoCAD based on the same actions that were previously noted to

demonstrate the improvement in the process, and the following data are presented in Fig. 6 and Table 4:

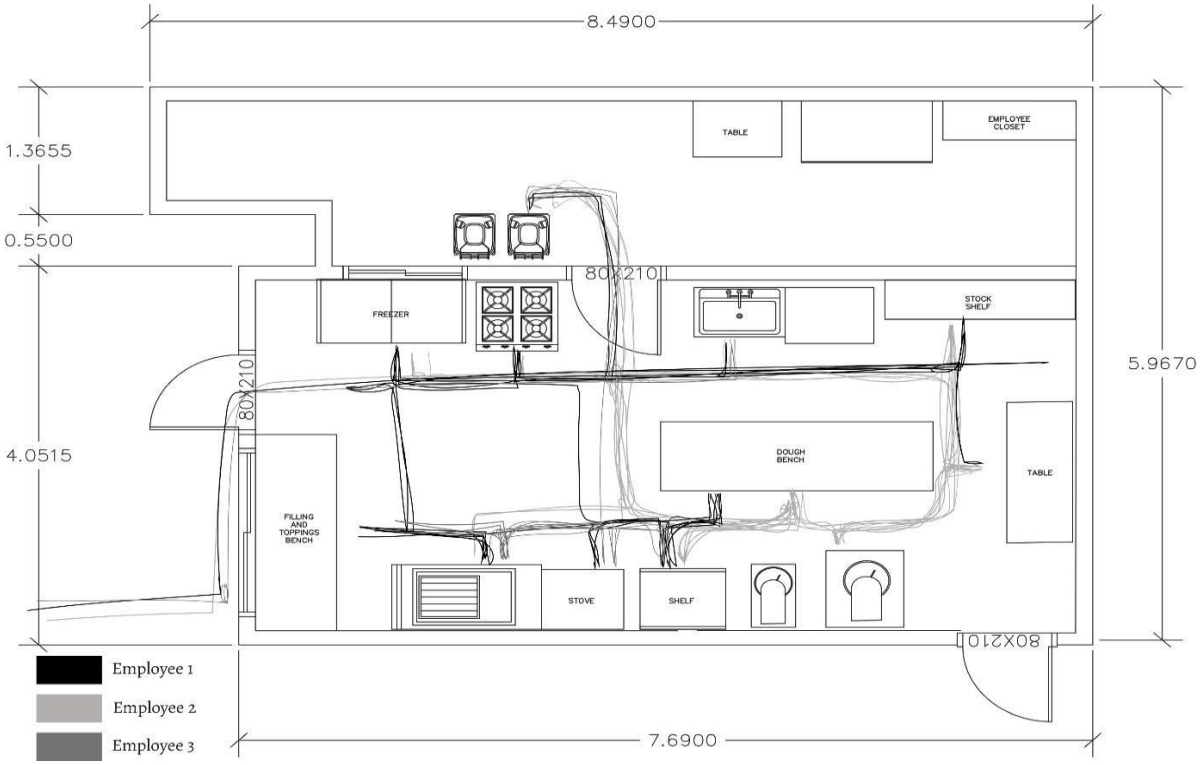

Figure 6 - Spaghetti diagram in the proposed layout

Table 4
Approximate distance traveled by employee in the suggested layout

Employee	Travelled distance
Employee 1	70.67 m
Employee 2	117.72 m
Employee 3	32.08 m

It can be observed that there were fewer crossings, and the movements of people have a more sequential flow, but there is still a discrepancy between the values referring to the distances covered by each one, because there is not an adequate distribution of functions between them, requiring a redistribution through a new timeline. It was also noticed that the new values, related to distance, after the simulation, showed a reduction of approximately 18.84% for employee 1, 26.97%

for employee 2 and for employee 3 there was no significant change. By relating the value of the distance traveled and the salary of each employee, considering the average salary as R$1350.00 and the total reduction of the distance being 21.31%, it was possible to notice an optimization in the productivity of the employees' salary, in the amount of R$863,055.

4.6 Standardization

According to Peinado & Graeml, (2007), in order to make the standardization possible, it is necessary to carry out an analysis of the mapping of a process, allowing a better evaluation and thus facilitating the identification of problematic points or areas, which were not perceived in everyday life. Through meetings, in which the data collected during visits to the establishment were analyzed, it was possible to observe six main problems related to the lack of standardization, namely:

- There is no weighing standardization in all manufacturing processes and the scale is not accurate;
- Lack of cleanliness and organization in the kitchen;
- Lack of employee training;
- High staff turnover;
- Raw material not correctly identified and without a single place for storage;
- Bad distribution of shelves.

With the help of tools such as 5W2H, an action plan was made to help solve the problems encountered.

Regarding the lack of standardization in weighing, kitchen assistants must insert, according to the standardization documents, the weighing process in the routine from the preparation of the dough to the completion of the donut in order to avoid waste, maintain quality, standardization and customer satisfaction. With regard to the scale that is not accurate, the proposal is to buy calibrated scales suitable for weighing food.

For the problem of lack of cleanliness and organization in the kitchen, it was proposed to carry out a 5S program, with the objective of guaranteeing the well-being of employees, increasing productivity and results. Among the actions highlighted to comply with the program are:

- keep kitchen accessories clean and organized;
- place a sanitizing mat in front of the door that connects the kitchen to the outdoor area;
- organize production supplies thinking about strategic places;
- laminate the instructions and train the team regarding its cleaning and handling;
- place a cutlery organizer support on the pasta counter;
- buy a digital clock with a legible number and an appropriate place to dry dishes.

One of the causes for the high rate of employee turnover is the lack of training, as new employees are hired, go through all the functions of the production process only with subjective and not pre-planned training. A solution to this issue would be to create an employee manual with accessible language, as most of them are foreigners. Another cause would be the lack of communication between management and employees, a culture of continuous feedback would help in this matter.

Regarding the organization of the raw material and the location of the shelves, it was proposed to purchase standardized containers and with the use of labels with expiration dates and names, being arranged in the stock shelf to facilitate the location and access.

5. FINAL CONSIDERATIONS

This article aims to analyze the production process in a donut establishment as well as the layout of its kitchen. To achieve this objective, the processes, layout and production times were evaluated, through chronoanalysis, timeline, tools and concepts of process standardization. The chronoanalysis pointed out that the process referring to the longer time than the others, is the use of the mixer and a possible solution would be to analyze if it is being used properly or if it is necessary to acquire a new machine. The timeline brought benefits in a way that made it possible to supervise and coordinate the daily activities of each employee and the current state of the production line. The design of a new layout, with the help of relationship and spaghetti diagrams, enabled a decrease in the distance traveled of approximately 21.31% in relation to the previous physical arrangement and a better use of the available area, people and material flow. Aiming at improving the quality and performance of the production process, suggestions were proposed, such as the development of a weighing process routine,

implementation of the 5S program in the kitchen and the creation of an employee training manual. In this way, the processes would be standardized and organized, and the layout would be more efficient, therefore, it is believed that the objective of the article was achieved. The next step would be the agreement and implementation of the proposals by the owners of the donut establishment.

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