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Improvement Model to Increase Operational Efficiency in a Pizzeria Using SLP, TOC and 5S

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Abstract

The global fast food restaurant industry reached an approximate value of USD 473.52 billion. According to analysts, this figure is expected to grow by 4.6% between 2024 and 2032. In Peru, the services sector recorded an average growth of 2.31% between June 2023 and June 2024, despite the political instability affecting the country. The objective of this research is to improve the cycle times and the efficiency of the production process in the fast-food restaurants by reducing transportation, rework, and waiting times, to achieve faster production and reduce order handling issues. The improvement proposal integrates a layout model based on Systematic Layout Planning (SLP), the Theory of Constraints (TOC), and the 5S methodology. Simulation results obtained using Arena software showed a reduction of 12.97% and 18.91% in the production process cycle time with the implementation of SLP and TOC, respectively. In addition, a 50.09% increase in transactions was observed with the application of SLP, and a 40.59% increase with TOC, compared to the results prior to the improvements.

Keywords
Systematic Layout Planning, Theory of Constraints, 5S, Cycle Time and Efficiency.

1. Introduction
Fast-food companies strive to provide good service and customer care in response to growing demand. According to INEI, the restaurant industry grew by 2.57% between mid-2023 and the first half of 2024. More specifically, INEI reported that the fast-food restaurant sub-industry experienced an increase in the opening of new establishments in Peru during the current semester compared to the last semester of 2023. Currently, the fast-food restaurant under study has an average cycle time of 18.55 minutes per transaction or completed order compared to the 15-minute standard established by the franchise. This creates a technical gap of 3 minutes and 33 seconds per order.

Among the factors contributing to the high order cycle time are long waiting times, inadequate workstation distribution, a bottleneck in the dough-kneading station, and disorganization of tools in the same station.
To address the first and second issues, the use of the Systematic Layout Planning (SLP) methodology is proposed. This methodology is employed to optimize facility design, improve material flow operations, and maximize the utilization of available space (Sampath et al., 2023).

For the third issue, the implementation of the Theory of Constraints (TOC) is recommended. This methodology is used to identify bottlenecks and provides appropriate management strategies to achieve higher performance (Wieslaw et al., 2020). Finally, to address the fourth issue—tool disorganization—the implementation of the 5S methodology is proposed. This methodology is composed of the initial letters of five Japanese terms: Seiri, Seiton, Seiso, Seiketsu, and Shitsuke (Fernández et al., 2021), and its purpose is to maintain order within the workstation and reduce tool search times.

1.1 Objectives

- Increase operational efficiency in the production of a pizzeria through the integrated application of SLP, TOC, and 5S.
- Redesign the layout of the work area using the SLP methodology to establish a linear flow and reduce supply travel distances.
- Implement the Theory of Constraints (TOC) to maximize workflow and manage the bottleneck.
- Implement the 5S methodology to reduce tool search times and waiting times.

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2. Literature Review

2.1 Systematic Layout Planning

Systematic Layout Planning (SLP) is a methodology employed to optimize facility design, improve material flow operations, and maximize the utilization of available space (Sampath et al., 2023). In this regard, Munive et al. (2022) indicate that optimizing plant layout requires considering two main aspects: activity analysis, which entails a detailed examination of all operations prior to defining the layout, and situational analysis, in which the movement and flow of activities are the central elements for plant redesign.

Supporting this approach, Starecek (2023) points out that poor space and material flow layout can generate unnecessary movements, which was corrected by redesigning the layout and simplifying worker movements, resulting in a significant reduction in travel distance.

2.2 Theory of Constraints

The Theory of Constraints (TOC) is a methodology used to identify bottlenecks and provide appropriate management to achieve higher performance (Wieslaw et al., 2020). In line with this approach, Orue et al. (2020) defines a constraint or bottleneck as a factor that limits a system's ability to improve its performance relative to its objective. Furthermore, the Theory of Constraints proposes a five-step process consisting of identifying the system's constraint, determining the best way to exploit it, subordinating all other processes to that decision, increasing the capacity of the constraint, and finally restarting the cycle once a constraint has been overcome (Orue et al., 2020).

2.3 5S

According to Fernández et al. (2021), 5S is a methodology composed of the initial letters of five Japanese terms: Seiri, Seiton, Seiso, Seiketsu, and Shitsuke. In addition, it is widely recognized as a management strategy that supports organizational excellence by promoting and sustaining a high-quality work environment. Similarly, the study by Ramírez and Soler (2019) emphasizes that the absence of basic conditions of order, cleanliness, and discipline in the work environment contributes to operational delays and risks, proposing the implementation of the 5S methodology as an initial solution.

3. Methods

To address the low operational efficiency and variability in cycle times, an approach integrating Systematic Layout Planning (SLP), Theory of Constraints (TOC), and 5S is proposed to resolve this issue. The proposed solution is divided into four phases: diagnosis, proposed tools, solution development, and control (Figure 1).

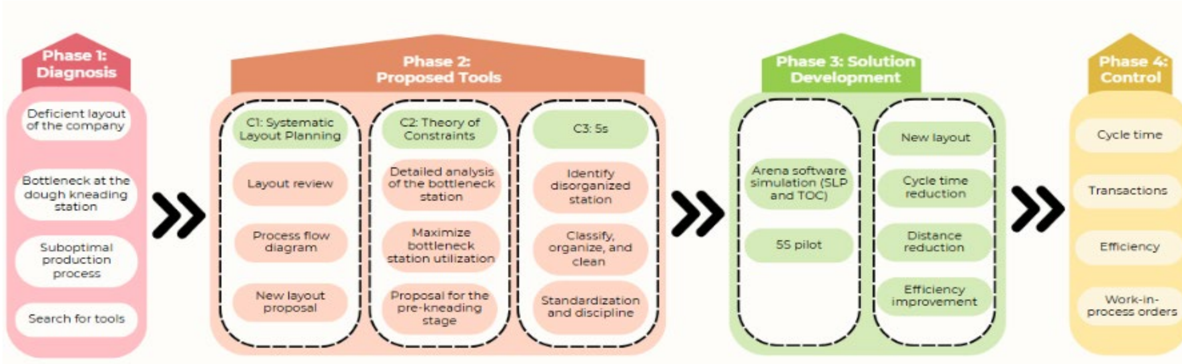

Figure 1. Solution Proposal Model

During the diagnostic phase, a visit was made to the pizzeria with the aim of observing the workflow and identifying the company's main problem, associated with the low operational efficiency of the production process. Accordingly, a time study was conducted at each workstation: Kneading, Sauce, Toppings, Complements, Oven, and Cutting and Finishing. The information obtained was recorded using time study formats designed for this evaluation.

In the second phase, the application of the 5S, SLP, and TOC methodologies was proposed. To support this proposal, a time study of the operators was previously conducted, since the activities at the workstations are performed manually. Therefore, in order to ensure uniform operational performance, only workers with at least three months of experience in the company were considered. The study population consisted of orders corresponding to the period from July 2023 to June 2024. However, due to the large number of transactions recorded, cycle time observations were selected for use as input data in the Arena simulation model. The sample size was calculated using a statistical formula, considering a 95% confidence level ($Z = 1.96$), a standard deviation of 3.7 minutes, an average cycle time of 18.55 minutes, and a relative error of 0.05, resulting in a sample of 62 observations.

For the SLP methodology, the reorganization of the store layout and the installation of an additional door in the refrigeration chamber were proposed. The analysis focused on the production flow, the relationships between workstations, and the routes followed by staff for supply replenishment. In this way, critical points, unnecessary routes, and poorly located stations within the process were identified. Subsequently, a flow diagram was developed using the company's floor plan, with emphasis on the Kneading and Toppings stations (Figure 2).

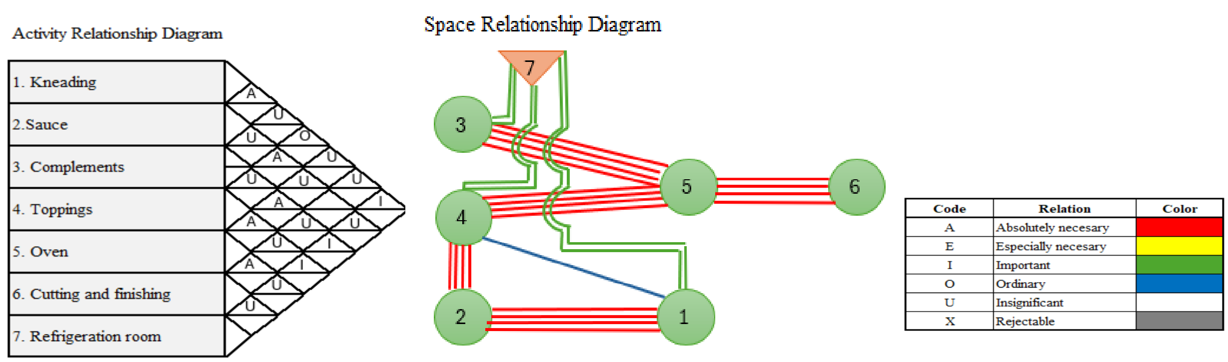

Figure 2. Activity Relationship Diagram and Space Relationship Diagram

Using the Activity Relationship Diagram and the Space Relationship Diagram, a new layout for the pizzeria was established. In this layout, the location of the additional ingredients station was modified, making it an independent station from the kneading and toppings stations. Additionally, an access door was added to the refrigeration room to reduce supply distances (see Figure 3).

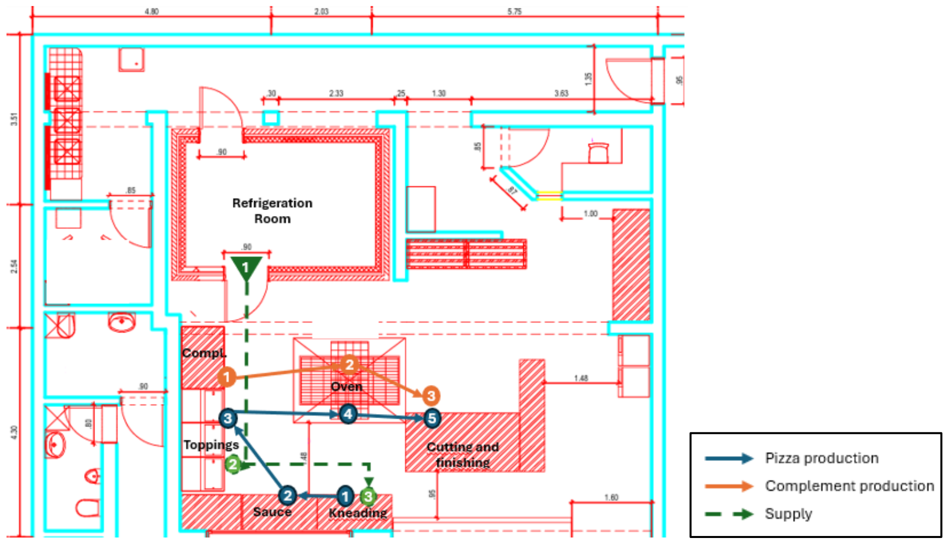

Figure 3. Production and Supply Flow of the Proposed Layout

In the case of the Theory of Constraints (TOC), the intervention directly targeted the bottleneck station, which in this company was the Dough Preparation station, where processing times vary depending on the size of the pizzas. In addition, this station presented a high utilization rate, which resulted in an increased workload for the operator. To address this issue, a buffer of pre-prepared dough balls was established at the Kneading station. This strategic stock focused on large and family-sized pizzas and would supply the process during peak demand hours.

In the third phase, the Arena Simulator software was used to validate the proposed implementation of SLP and TOC over a full working day, considering the five pizza sizes: personal, medium, large, family, and super family. For the SLP validation (see Figure 4), the Complements station operates independently and connects to the oven station.

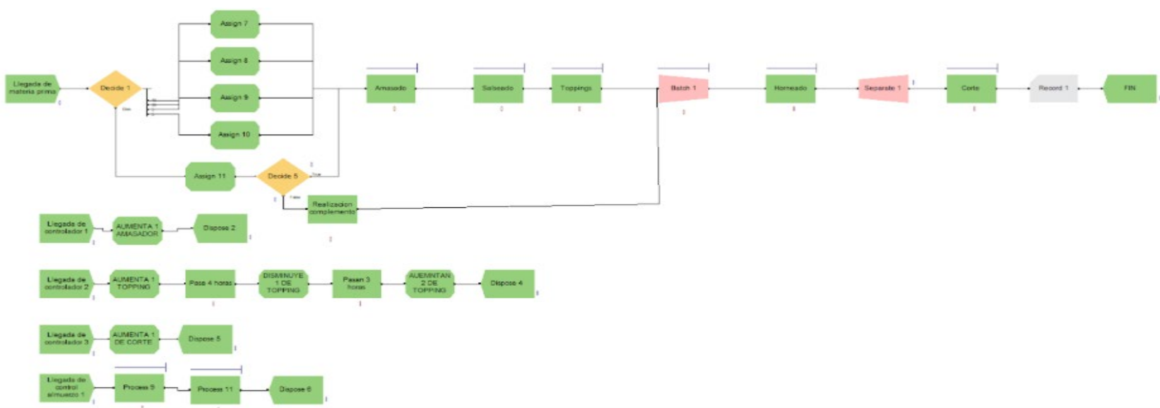

Figure 4. Validation of the Proposed SLP Layout in Arena Simulation

The TOC validation (see Figure 5), a pre-kneading process was introduced, which is activated during peak demand periods using a *Hold* module. This process functions as a dough buffer for large and family-size pizzas. Through the use of *Assign* modules, priority is given to the dough prepared during the pre-kneading process.

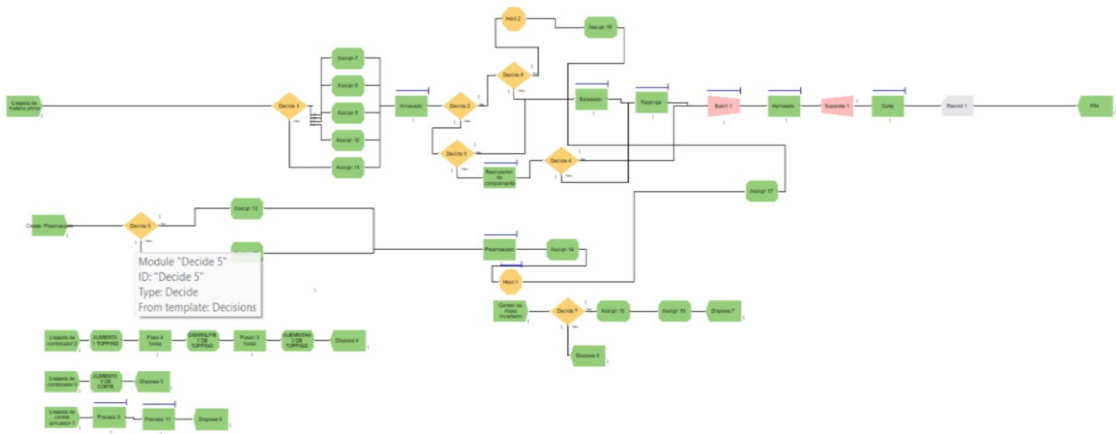

Figure 5. Validation of the Proposed TOC in Arena Simulation

A pilot implementation of the 5S (Seiri, Seiton, Seiso, Seiketsu and Shitsuke) was carried out in the kneading area to optimize the workspace. As shown in Figure 6, only useful tools were identified and retained; these tools were organized according to their frequency of use to facilitate access; and the workstation was subsequently cleaned. The implementation of Seiketsu and Shitsuke, a workstation order and a cleanliness checklist were established. It was defined that the station supervisor would conduct the inspection 15 minutes before the start of the shift, while the Store Manager would be responsible for verifying compliance at the end of the day.

Figure 6. 5S Pilot Implementation

For the fourth and final phase of the proposed solution, the implementation was monitored through indicators such as Cycle Time, Transactions, Efficiency, and Work in Process (WIP). These indicators can be observed in the results obtained from the Arena Simulator software and allow for an assessment of whether the pizzeria's performance has improved following the implementation of the proposed improvements.

4. Data Collection

After understanding the company's production process, information was collected to analyze inefficiencies in pizza production. Thus, it was identified that the average time per order is 18.55 minutes, which directly affects delivery time. However, when compared with the industry standard established at 15 minutes, a difference of 3.55 minutes per order is evident. Consequently, when processing five orders, the pizzeria loses 17.75 minutes, time that could have been used to prepare an additional order. Additionally, to identify the causes of this low efficiency, analysis tools such as the Pareto chart and the Ishikawa diagram were applied (see Figure 7). In this way, the Ishikawa diagram made it possible to identify key factors that affect process performance, among which the constant movements for supply replenishment, delays at the kneading station, and poor organization of work tools stand out.

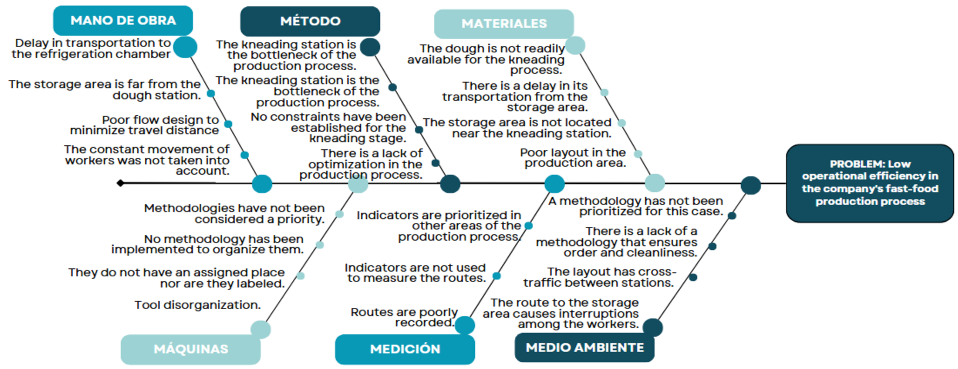

Figure 7. Ishikawa Diagram

The Pareto diagram (Figure 8) made it possible to identify the causes of these problems based on their frequency of occurrence. Two main components influencing this operational inefficiency were identified: the bottleneck at the kneading station and non-productive times. The first component was particularly significant, as this station requires the longest processing time and the greatest effort. The second component reflects waiting times for the supply of inputs during the work shift, as well as time spent searching for tools.

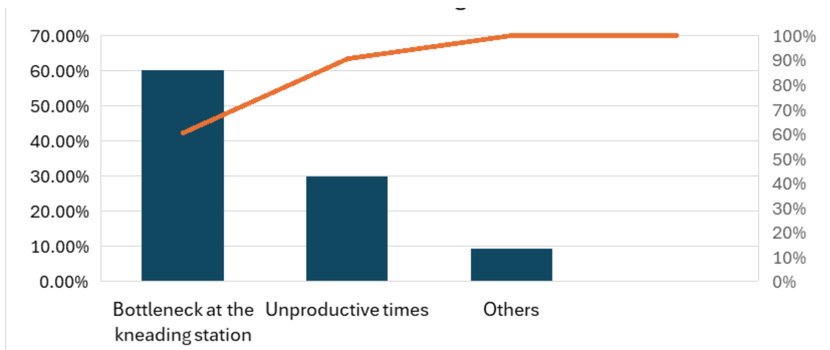

Figure 8. Pareto Diagram

Through on-site visits to the pizzeria, cycle times for each workstation were collected and used as input data for the simulation of the SLP and TOC implementation. After the study, the station with the longest processing time is the Kneading station (47.51 seconds per product), followed by the Toppings station (42.64 seconds per product). The transportation distances for supplying the kneading and toppings stations from the refrigeration room were measured, and the transportation effort was calculated (Table 1) by considering these distances and the transportation frequency.

Table 1. Current Distance and Effort

Origin	Destination	Current Distance (m)	Frequency (trips/day)	Effort
Refrigeration room	Kneading	12.10	16.00	193.60
Refrigeration room	Toppings	14.53	21.00	305.13
Total		26.63	37.00	498.73

The company operates with a partially linear production process, as the additional ingredients station is located between the sauce and toppings stations (see Figure 9). In addition, the figure illustrates the entire travel path followed by the worker to supply the kneading and toppings stations.

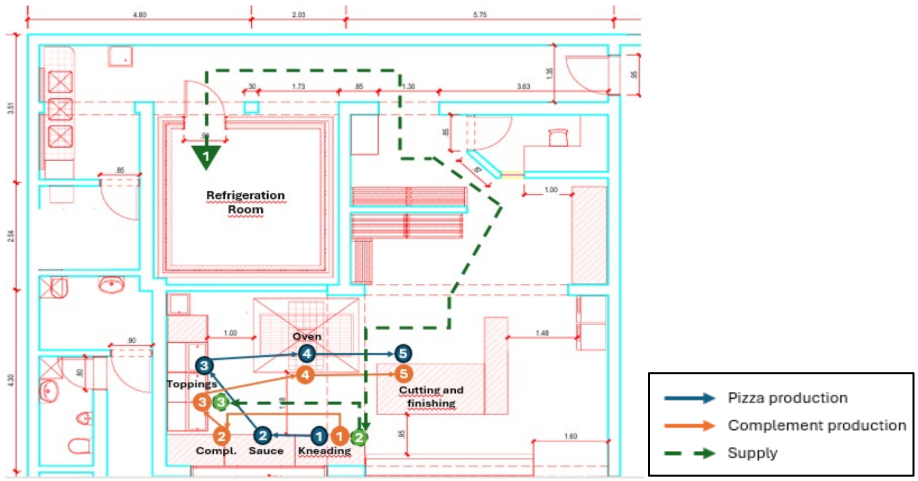

Figure 9. Current Pizzeria Layout

During the visits to the pizzeria for the measurement of processing times at all workstations, a high frequency and duration of tool-search activities by the operator at the kneading station were identified, as no defined locations for work tools existed. In addition, feedback was obtained from the station supervisor and the store manager regarding the loss of these tools before or during the work shift.

5. Results and Discussion

5.1 Numerical Results

A comparative analysis between the AS IS and TO BE scenarios is conducted to evaluate the impact of Lean Manufacturing tools specifically SLP, TOC, and 5S methodologies on the operational performance of a fast-food restaurant. The discussion focuses on cycle time reduction, process efficiency, and throughput.

Table 2 compares the total production cycle time obtained from the Arena simulations before and after applying Lean Manufacturing tools. The TO BE scenario shows a reduction of 4.837 minutes, equivalent to a 22.64% decrease compared to the AS IS model. This improvement is mainly due to the reduction of unnecessary transportation, better workstation layout, and the elimination of waiting times at the bottleneck station. These results confirm that the application of SLP and TOC contributes to improving process flow and operational responsiveness.

Table 2. Total Cycle Time Comparison

Scenario	Total Cycle Time (minutes)	Reduction (minutes)	Reduction (%)
AS IS	21.365	–	–
TO BE	16.528	4.837	22.64%

Table 3 compares the number of products (pizzas and complementary items) produced under both scenarios during the simulation horizon. The TO BE model generated 37 additional products, representing a 9.74% increase in production output. This increase demonstrates that reducing cycle time directly enhances system throughput. The decoupling of the complementary products station and the improved layout design reduced congestion at the kneading station, allowing a smoother and more balanced production flow.

Table 3. Production Output Comparison

Scenario	Products Produced	Increase (units)	Increase (%)
AS IS	380	–	–
TO BE	417	37	9.74%

Operational efficiency was calculated based on productive time versus total available time in the production process (See Table 4). The efficiency improvement of 14.62 % reflects the effectiveness of Lean tools in reducing non-value-added activities. The implementation of 5S reduced tool search times, while SLP minimized transportation distances. These changes collectively increased productive utilization of labor and resources, bringing efficiency levels closer to world-class operational standards.

Table 4. Operational Efficiency Comparison

Scenario	**Operational Efficiency (%)**	**Improvement (%)**
AS IS	76.14%	–
TO BE	90.76%	14.62%

The franchise requires an average delivery time of 15 minutes per transaction. Table 5 compares compliance levels before and after improvement. While the AS IS model exceeds the franchise standard by more than 6 minutes, the TO BE scenario reduces the gap to approximately 1.5 minutes. This result confirms that Lean Manufacturing is an effective strategy to align operational performance with franchisor requirements.

Table 5. Compliance with Franchise Time Standard

Scenario	**Average Cycle Time (min)**	**Compliance Gap (min)**
AS IS	21.365	+6.365
TO BE	16.528	+1.528

The numerical results demonstrate that the integration of SLP, TOC, and 5S yields significant operational benefits (See Table 6). The reduction in cycle time and the increase in performance confirm that layout redesign and bottleneck management are key to improving performance in fast food production. These findings are consistent with previous studies in Lean Manufacturing applied to food industries, reinforcing the validity and applicability of the approach.

Table 6. Summary of AS IS vs TO BE Results

Indicator	**AS IS**	**TO BE**	**Improvement**
Total Cycle Time (min)	21.365	16.528	−22.64%
Products Produced	380	417	+9.74%
Operational Efficiency	76.14%	90.76%	+14.62%
Bottleneck Impact	High	Controlled	Reduced

5.2 Graphical Results

Below are important graphs of the results obtained before and after the improvement. The total process time is reduced from 21.365 minutes to 16.528 minutes (see Figure 10), which represents an improvement of 22.64%. This reduction is due to: Elimination of downtime, operational flow optimization, and improved layout design. The TO BE proposal demonstrates a decrease in cycle time, increasing the system´s ability to produce more in less time.

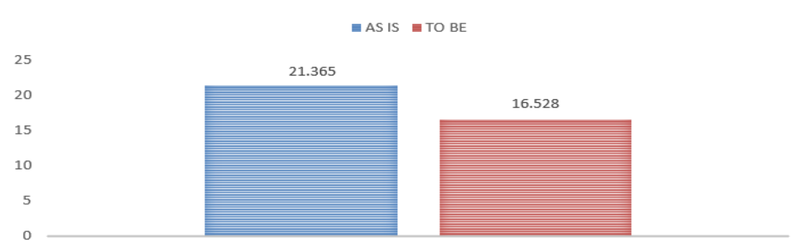

Figure 10. Cycle Time: AS IS vs TO BE

Under the AS IS model, 380 units are produced, while under TO BE 417 units are reached (see Figure 11). This represents a 9,74% increase in productivity. The new operational model allows for a greater volume of production without requiring more human resources, which increases overall efficiency.

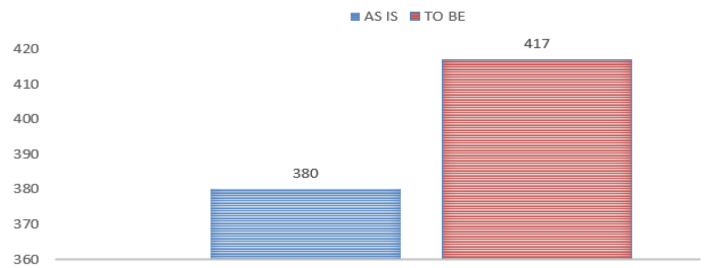

Figure 11. Production: AS IS VS TO BE

The efficiency comparison between the AS IS and TO BE models demonstrates substantial operational improvements across all critical process indicators. The TO BE design reduces total cycle time from 21.365 to 16.528 minutes (–22.6%) and increases system output from 380 to 417 units (+9.74%), while also improving overall efficiency from 76.14% to 90.76% (see Figure 12). These gains result from targeted interventions such as layout optimization, reduced operator movement and direct improvement of the bottleneck, lowering kneading time by 18%. Additionally, the TO BE model enhances the system's ability to meet higher demand, increasing estimated daily capacity from 380 to 417 transactions (+9.74%). The redesign strengthens process stability, reduces non–value-added activities, and increases throughput without requiring additional resources, validating the effectiveness of the proposed improvements.

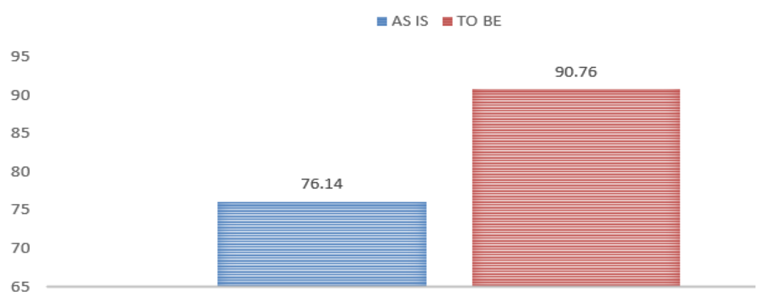

Figure 12. Efficiency: AS IS vs TO BE

5.3 Proposed Improvements

The first proposed improvement consists of redesigning the production layout using Systematic Layout Planning (SLP). The new configuration reduces unnecessary transportation distances between workstations, improving material flow continuity. The reduction of more than 56.81% in transportation distance directly contributes to shorter cycle times and lower operator fatigue.

The kneading station was identified as the system bottleneck. Applying the Theory of Constraints (TOC), workload was redistributed, and complementary products were separated from the critical resource. The reduction in bottleneck utilization improves system stability. Lower queue times indicate smoother flow and reduced variability (Table 7-Table 11).

Table 7. Transportation Distance Comparison

Scenario	Total Distance (meters)	Reduction (%)
AS IS	26.63	–
TO BE	11.50	56.81%

The proposed improvements demonstrate that Lean Manufacturing tools can significantly enhance operational performance in fast food environments. The combination of SLP, TOC, and 5S provides measurable benefits in efficiency, responsiveness, and service quality, validating the proposed approach.

Table 8. Bottleneck Performance Indicators

Indicator	AS IS	TO BE
Utilization (%)	96.80	82.40
Average Queue Time (min)	6.12	2.01

Table 9. Overall Impact of Proposed Improvements

Indicator	Improvement
Cycle Time	−22.64%
Throughput	+9.74%
Transportation Distance	−56.81%
Bottleneck Queue Time	−67.16%

5.4 Validation

Hypothesis testing was conducted to determine whether the implementation of Lean Manufacturing tools produced statistically significant improvements in the operational performance of the system. The following hypotheses were defined for its validation: the null hypothesis (H_0) states that the implementation of Lean Manufacturing tools does not produce a significant reduction in the total cycle time, whereas the alternative hypothesis (H_1) proposes that the implementation of these tools leads to a significant reduction in the total cycle time of the process. The hypothesis test focuses on total cycle time, as it represents the main performance indicator of the system.

Table 10. Descriptive Statistics of Cycle Time

Scenario	Mean (min)	Standard Deviation (min)	Number of Observations
AS IS	21.365	2.14	30
TO BE	16.528	1.87	30

Table 11. Paired t-Test Results

Statistic	Value
Mean Difference (AS IS – TO BE)	4.837
t-value	9.46
p-value	< 0.001
Significance Level (α)	0.05

The statistical analysis confirms that the reduction in total cycle time achieved in the TO BE is statistically significant. The results validate that the improvements observed are not due to random variation but are a direct consequence of the implementation of Lean Manufacturing tools. Furthermore, the reduction in standard deviation indicates improved process stability, reinforcing the effectiveness of bottleneck control, and layout optimization. These findings support the robustness of the proposed solution and confirm its applicability in real operational environments.

6. Conclusion

The main objective of this research was successfully achieved, as operational efficiency in the pizzeria was significantly improved through the integrated application of Systematic Layout Planning (SLP), Theory of Constraints

(TOC), and the 5S methodology. Simulation results showed a reduction in total production cycle time from 21.365 to 16.528 minutes, representing a 22.64% improvement and bringing the operation closer to the time standards required by the franchise.

The layout redesigned, based on the SLP methodology, optimized material flow and reduced transportation waste, achieving a 56.81% reduction in operator travel distances. This improvement directly contributed to shorter cycle times, lower operator fatigue, and a more continuous and efficient production flow, particularly in the kneading and Toppings workstations. As a future line of research, it is recommended to implement the proposed solution in real-world environments, particularly in companies with the capacity to modify their layout. This would allow the validation of the simulation results and the evaluation of the actual impact of the proposed Lean tools, while also serving as a reference for other organizations in the sector seeking to improve their operational efficiency.

The application of the Theory of Constraints effectively addressed the main bottleneck at the kneading station, reducing its utilization level and average queue time. The introduction of a pre-kneaded dough buffer during peak demand periods stabilized the system, reduced process variability, and increased daily production capacity without requiring additional labor or equipment.

The pilot implementation of the 5S methodology improved workstation organization and standardization, significantly reducing tool search times and non-value-added activities. As a result, overall operational efficiency increased from 76.14% to 90.76%. Statistical validation using a paired t-test confirmed that the observed improvements in cycle time were statistically significant, demonstrating that the proposed Lean Manufacturing approach is effective, robust, and applicable to fast-food production environments.

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