7th Bangladesh Conference on Industrial Engineering and Operations Management
December 21-22, 2024
Publisher: IEOM Society International, USA DOI: 10.46254/BA07.20240119
Published: December 21, 2024

Application of Standardized Work and CVRPTW to Increase the OTIF Index in the Outbound Logistics of a Fruit Distribution SME

Ricardo Oré Zumarán, Ricardo Fuertes Pintado and José Antonio Taquía Gutiérrez
Facultad de Ingeniería
Universidad de Lima
Lima, Perú
ricardoorezum@gmail.com, rafuertes21@gmail.com,
jtaquia@ulima.edu.pe

Abstract

This article presents an operational model designed to mitigate the root causes of a low OTIF (On Time In Full) index within a fruit distribution company in Lima, Peru. This case study employed a hybrid approach that combines Standardized Work and CVRPTW to address these identified root causes. To achieve our objective, Standardized Work contributes to eliminating unnecessary time spent on non-value-adding activities, positively impacting the cycle time of the production process. On the other hand, the CVRPTW (Capacitated Vehicle Routing Problem with Time Windows) tool optimized routes, thus eliminating delays and inefficiencies in the transportation process. Subsequently, to validate the results of the indicators from the Standardized Work tool, a simulation was conducted comparing the initial situation and the proposed scenario. As a result of this validation, the components of the OTIF index, service level, and on-time order level increased to 91%, 96%, and 95%, respectively.

Keywords
Food Logistics, Standardized Work, CVRPTW, On Time In Full Index

1. Introduction
Currently, there is a positive trend toward the development of the logistics services market, which faces the complex challenge of balancing operational efficiency and quality amid the increasing volume of freight transportation (Garrido et al. 2022). The search for solutions to improve transportation efficiency while minimizing environmental impacts has become a strategic priority.In the Peruvian context, a distribution company encounters specific challenges related to the country's geography, transportation infrastructure, and the need to ensure efficient product distribution (Cusihuaman-Torres et al. 2023).

The company under study, like many others in the region, faces pressure to enhance its supply chain and minimize operational costs. Specifically, this company, dedicated to the wholesale procurement and distribution of fruits, struggles with operational inefficiencies that directly affect its OTIF (On Time In Full) index, currently at 70%.
One of the most critical issues identified in operations management is poor transportation planning, which causes delivery delays, resulting in lost sales and customer dissatisfaction. Inefficient fleet management also contributes to delays and product quality issues, affecting customer satisfaction. Prolonged order preparation times are another major cause, leading to incomplete deliveries that negatively impact customer satisfaction and sales. Moreover, inadequate handling of fruits and products that fail to meet technical specifications has a direct effect on product quality.

This detailed analysis demonstrates that the low OTIF index is not merely an operational problem but one with significant negative repercussions for the company. Addressing these root causes is essential to improve customer satisfaction, reduce financial losses, and maintain strong relationships with customers and contractual partners. This research focuses on implementing solutions based on Standardized Work and route optimization using CVRPTW technology to tackle these issues.

1.1 Objectives
General Objective: To improve the OTIF index in a fruit trading and distribution company through the use of the Standardized Work tool and the implementation of CVRPTW.

Specific Objectives:
Objective 1: Develop the background and state of the art of the project.
Objective 2: Conduct the analysis and diagnosis of the problem using information gathered from the company.
Objective 3: Design and develop the Standardized Work tools and the CVRPTW implementation.
Objective 4: Validate the solution and assess its impact on the OTIF indicator.

2. Literature Review
Currently, optimizing logistics and improving On Time In Full (OTIF) delivery index is crucial for companies seeking to maintain market competitiveness. This systematic review explores various strategies and techniques, particularly Standardized Work and CVRPTW, to enhance operational efficiency and delivery punctuality in the fruit distribution and transportation sector.

The Vehicle Routing Problem (VRP) is a combinatorial optimization problem classified as NP-hard, first introduced in 1959 by mathematicians Dantzig and Ramser. The goal of VRP is to find optimal routes for a fleet of vehicles that start from a depot, serve each customer once, and then return to the depot (Baldacci et al. 2012). Since its inception, research literature in this area has rapidly expanded, extending VRP to many variants to address real-world problems. Researchers have initially tested exact methods, followed by heuristic and metaheuristic approaches (Elatara et al. 2023). VRP has evolved into several variants, each tailored to different constraints and specific characteristics of distribution problems. In CVRP, vehicles have a limited capacity and must meet customer demands without exceeding this capacity, making it critical in scenarios where vehicle load constraints are significant (Baldacci et al. 2012). VRPTW adds the constraint that vehicles must make deliveries within specific time windows, particularly relevant for distributing perishable products where timely delivery is crucial for maintaining product quality (Cordeau et al., 2002).

In the context of a fruit distribution SME, implementing CVRPTW is particularly suitable due to the combination of capacity restrictions and specific time windows characteristic of perishable product distribution. The limited vehicle capacity requires precise planning to avoid overloads and ensure that each customer receives a complete order. Furthermore, strict time windows ensure that fruits are delivered fresh, maintaining product quality and customer satisfaction. CVRPTW optimizes vehicle routes, minimizes operating costs, and ensures deliveries are made within designated time windows. This not only enhances operational efficiency but also improves the OTIF index, a key performance indicator measuring delivery timeliness and completeness. Implementing CVRPTW in the fruit distribution SME in Lima, Peru, has proven to be an effective solution for addressing logistical challenges, enhancing both customer satisfaction and the company's market competitiveness.

The implementation of Lean Manufacturing across various industries has shown positive outcomes in terms of improved operational efficiency and waste reduction. Lopes et al. (2015) found that applying Lean tools in the food and beverage industry improved operational efficiency and production flexibility. This finding is relevant for the fruit distribution SME, where flexibility and efficiency are critical to meeting market demands. Standardized Work is a key Lean Manufacturing technique aimed at reducing variability and improving process efficiency. Fin et al. (2017) demonstrated that implementing Standardized Work techniques can significantly reduce assembly times and unnecessary operator movements, enhancing operational efficiency. Similarly, Shafeek et al. (2018) found that Standardized Work in assembly lines reduces cycle time and increases productivity, overcoming personnel resistance to standardization.

Pérez Zempoaltecatl (2022) extended these findings to the ceramic manufacturing context, showing that standardization not only improves product quality but also overall plant productivity. Morocho Ríos et al. (2023) applied these principles to the textile industry, improving quality and production efficiency of industrial clothing through process standardization and continuous improvement. Reducing setup and cycle times is another crucial area for improving logistical efficiency. Puvanasvaran et al. (2018) demonstrated that applying Standardized Work in the ceramics industry can significantly reduce setup times, thereby enhancing operational efficiency. This approach can be adapted to optimize cycle times in fruit transport logistics, reducing delivery delays or incomplete deliveries.

Patak et al. (2020) analyzed the components of a perfect order for fast-moving consumer goods deliveries, providing a detailed understanding of how to improve OTIF index by implementing logistics performance indicators. Adopting these indicators in the fruit distribution context can yield valuable insights for enhancing service punctuality and quality.The application of Standardized Work has a significant impact on service level indicators, especially in improving the OTIF index. Implementing this technique involves creating documented, repeatable procedures that minimize variations and errors. This methodological approach includes clearly defining each process step, creating standardized work instructions, and training staff to ensure consistent execution. Montoya et al. (2023) demonstrated that Standardized Work in small and medium-sized paint companies reduced delivery times by 33.6% and improved on-time delivery (OTD) rates by 17.85%, highlighting the relevance of this technique for enhancing operational efficiency.

Efficient route planning is critical to improving OTIF index. Cusihuamán-Torres et al. (2023) proposed an operations model based on Lean tools and route optimization to increase the perfect order rate in the consolidated cargo distribution sector, emphasizing the importance of route planning and process management. This approach is particularly relevant for the fruit distribution SME, where poor planning can lead to high loading and unloading times, negatively affecting OTIF indices.

3. Methods

Standardized Work is defined as the establishment of documented and repeatable procedures that ensure each task is performed efficiently and consistently, minimizing variations and errors (Fin et al., 2017; Puvanasvaran et al., 2018). The primary goal of this tool will be to reduce the production cycle time across the unloading, receiving, sorting, packaging, dispatch, and loading stations. Standardized procedures will be documented, and a continuous review cycle will be established. This cycle will ensure that processes are continually improved and adapted to new demands and changes in the operating environment, maintaining efficiency and quality over time. Figure 1 below presents the methodology for its application.

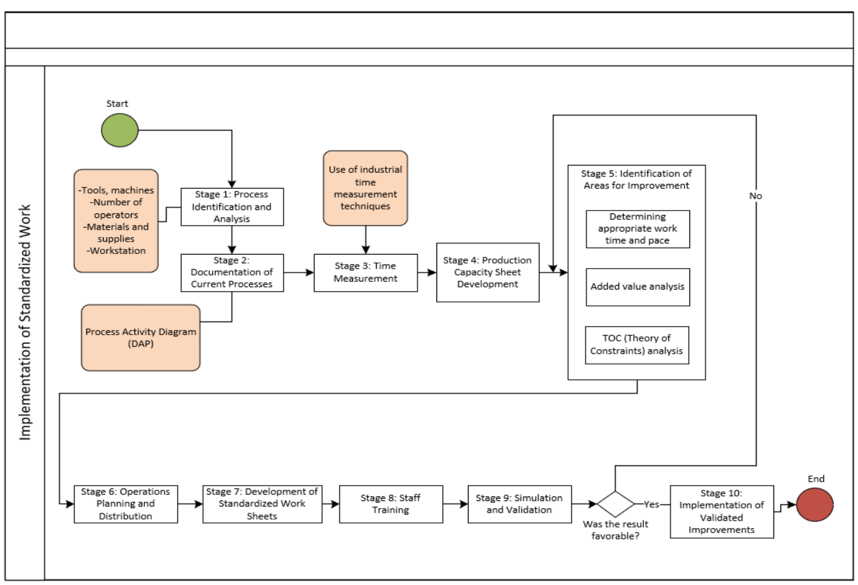

Figure 1. Methodology for Implementing Standardized Work

The second tool is CVRPTW, which is used to plan new transportation routes that optimize the use of available vehicles, reducing the distance traveled and improving delivery times. The implementation of CVRPTW involves the integration of specialized software that considers capacity constraints and time windows for each delivery, enabling more efficient and effective planning. The implementation procedure is shown in Figure 2.

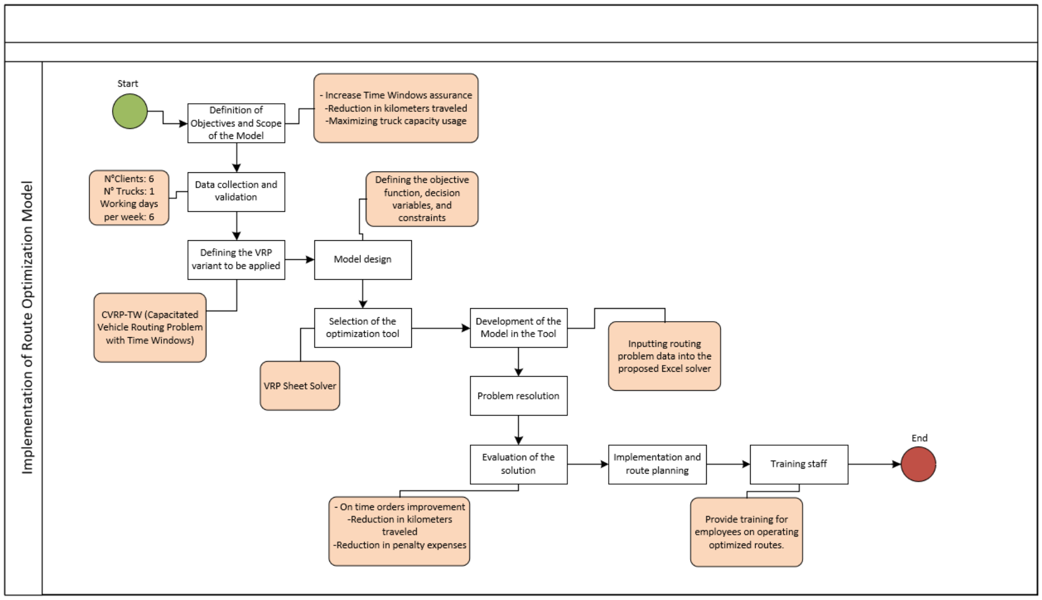

Figure 2. Methodology for Implementing CVRPTW

Regarding the selected tool to optimize the route used by the company, the VRP Spreadsheet Solver tool (Erdoğan, G. 2017) will be used. Data such as the number of depots, the number of locations to visit, information about the distances between points, time windows for customer deliveries, etc., will be entered. When the proposed model is run, the tool will provide an optimized routing sequence, ensuring compliance with the pre-set delivery time windows.

Additionally, the Mathematical Model for the Vehicle Routing Problem with vehicle capacity restrictions is presented, where the objective is to minimize time windows while keeping travel costs under control:

$$min \sum_{i \in V} M \cdot vi \in + \sum_{k \in K} \sum_{(i,j) \in A} cij\ xijk$$

Where:

- $M \cdot vi$: Penalty for any deviation from the time windows.
- $cij\ xijk$: Travel cost between nodes i and j, applied when vehicle k moves between these nodes.

Table 1. Constraints of the CVRPTW Model

Constraint	Description	Formula
Each node is visited once	Each node must be visited exactly once by some vehicle.	$\sum_{k \in K} yik = 1 \quad \forall i \in V$
Vehicle Flow	The flow of vehicles in and out of each node must match, ensuring that each vehicle enters and leaves a node it visits.	$\sum_{j \in V} xijk = yik \quad \forall i \in V, k \in K$
Flow conservation	To ensure continuous flow, the number of vehicles entering a node must be equal to the number of vehicles exiting the same node.	$\sum_{j \in V} xijk = \sum_{j \in V} xijk \quad \forall i \in V, k \in K$
Vehicle capacity	Each vehicle has a maximum capacity Qk that must not be exceeded by the sum of the demands of the nodes it visits (qi)	$\sum_{i \in V} qiyik \le Qk \quad \forall k \in K$
Time Windows	Each node must be visited within its specified time window.	$ai \le tik \le bi \quad \forall i \in V, k \in K$
Transported load	The amount of load transported must reflect the node's demand, adjusted to the vehicle's capacity.	$wijk \ge qiyik - Qk(1 - xijk)$ $\forall (i, j) \in A, k \in K$

4. Data Collection

For the implementation of the standardized work tool, a time study was conducted in the order preparation process (fruit crates). The continuous industrial timing method was applied to collect time observations for each activity. Subsequently, with these observations, the standard time for each activity was calculated.

Table 2. Standard Time per Activity of the Process

Activity	To	V	Tn	Al	Standard Time	Unit
1 Material unloading	7,47	90%	6,73	123%	8,27	sec/box
2 Reception and weighing	32,01	90%	28,81	123%	35,43	sec/box
3 Transport to selection	15,60	90%	14,04	123%	17,27	sec/box
4 Selection	88,63	90%	79,76	123%	98,11	sec/box
5 Packaging and weighing	85,86	90%	77,28	123%	95,05	sec/box
6 Transport to warehouse	1,45	90%	1,30	123%	1,60	sec/box
7 Dispatch	9,50	90%	8,55	123%	10,51	sec/box
8 Loading	8,77	90%	7,90	123%	9,71	sec/box

Abbreviations: Average time of observations (To), Work rate evaluation (V), Normal time (Tn), Allowances or slack for fatigue or personal and unavoidable delays (Al).

The routing problem and the development of the solution will consider one truck from the fleet, with a capacity of 15 tons. The start of this activity is marked by the departure of the truck from the fruit processing plant, once it has been loaded with the quantity processed during the day. According to company data, this truck completes the described route daily, typically leaving at 7:00 AM, Monday through Saturday.

As seen in Figure 3, the truck starts its journey with 13.78 tons, which are distributed among the various sales points. It is also important to note that the points generating the highest demand (in tons) for the company are the Tottus hypermarket collection center (Sales Point 1) and the Supermercados Peruanos collection center (Sales Point 4), with 4.28 tons and 4.52 tons, respectively. The fruit with the highest volume of demand among all clients is the orange.

Table 3. Time Windows by Location

Location	Description	Time Window Start	Time Window End
0	Depot	00:00:00	23:59:00
1	Sales Point 1	10:00:00	15:00:00
2	Sales Point 2	07:00:00	12:00:00
3	Sales Point 3	07:00:00	12:00:00
4	Sales Point 4	16:00:00	21:00:00
5	Sales Point 5	07:00:00	12:00:00
6	Sales Point 6	07:00:00	12:00:00

Table 3 indicates the start and end of the time window for order deliveries based on the visited location, starting from the company's distribution center to visit the 6 customers daily and return to the starting point. If an order is not delivered within a customer's time window, the company faces a monetary penalty.

Table 4. Location and Demand by Location

Location	Description	Latitude (y)	Longitude (x)	Delivery (tons)
0	Depot	-12.073	-77.00367	0
1	Sales Point 1	-11.9973	-76.9000584	4.3
2	Sales Point 2	-12.0162	-76.992671	1.4
3	Sales Point 3	-12.0050697	-77.057198	1.2
4	Sales Point 4	-12.2121174	-76.968172	4.5
5	Sales Point 5	-12.1741776	-77.0193483	1.4
6	Sales Point 6	-12.1485966	-77.0092647	1

Table 4 shows the location and the quantity of orders in tons to be delivered daily. The visited customers are represented by locations 1-6.

With the data collected regarding the CVRPTW, the initial routing sequence followed by the company was obtained:

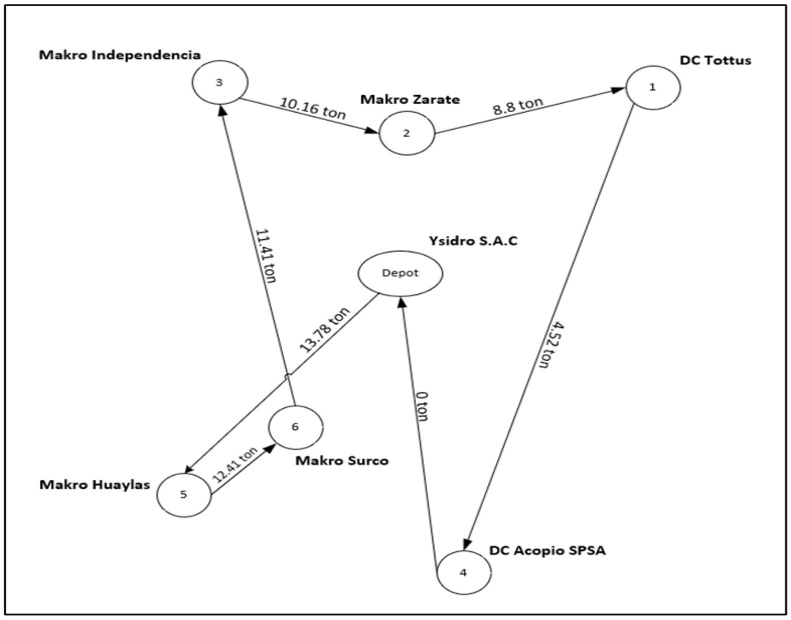

Figure 3. Representation of the Initial Routing Sequence of the Company

5. Results and Discussion

5.1 Numerical Results and Proposed Improvements

Through the Standardized Work tool, two key areas for improvement were identified in the order preparation processes: the operator's transfer to the selection area and the operator's transfer to the dispatch area. These activities generated unnecessary movements by operators and long waits for subsequent activities. Therefore, it was suggested to implement a conveyor belt that operates at a rate of 5 seconds per crate, which is a suitable speed for balancing the production line. To minimize disruptions during installation, non-operational hours were recommended, along with operator training to ensure a smooth transition.

Additionally, using the Production Capacity Sheet, it was identified that the packaging and weighing activity was the bottleneck of the process. To increase capacity, it was necessary to add 2 packaging machines and two electronic scales in this area, as well as incorporate two operators into the activity.

The improvement in the packaging and weighing area not only directly impacts its operational capacity but also generates a significant effect on the cycle time of the entire process. This effect is validated by the simulation results (Table 5). As it is a bottleneck, any increase in the capacity of this stage reduces product build-ups and waiting times in the previous areas. This results in a smoother workflow, preventing interruptions that could slow down the overall performance of the system.

Furthermore, by optimizing the performance of the packaging and weighing area, the efficiency in the use of downstream resources, such as unloading and dispatch stations, is increased by receiving products in a more regular and consistent sequence. This cascading effect potentially reduces idle times and improves synchronization between stages, contributing to a shorter total cycle time and more efficient resource utilization.

Finally, according to the proposed methodology, standardized work sheets were developed that clearly define each step of the process, standard times, and specific procedures, taking into account the previously proposed actions.

With these purposed changes, the results presented in Table 5 were obtained.

Table 5. Results obtained from the Standardized Work tool

Indicator of the diagnostic phase	Explanation of the indicator	As is	Obtained	Improvement /Savings
Service Level (%)	$\frac{Number\ of\ boxes\ processed}{Number\ of\ boxes\ demanded} \times 100\%$	71.50%	96.15%	24.65%
Cycle Time of the Process	Average total time of a box in the system (in minutes)	38.91	28.93	26%
Cycle Time of Unloading	Average total time of a box in the unloading area (in minutes)	6.87	4.07	41%
Cycle Time of Selection	Average total time of a box in the selection area (in minutes)	8.67	7.71	11%
Cycle Time of Packaging and Weighing	Average time of a box in the packaging and weighing area (in minutes)	13.86	13.05	6%
Cycle Time of Dispatch	Average time of a box in the dispatch area (in minutes)	4.2	2.4	43%

Next, Table 6 presents the results from the vehicle routing tool. First, the improvement in the compliance rate of customer time windows (On-time order level) is shown. Second, there is a significant reduction in the number of late deliveries. Third, the savings from penalties paid for late deliveries are presented. Finally, there is a reduction in the total distance traveled by the 15-ton truck.

Table 6. Results obtained from the CVRPTW tool

Indicator of the diagnostic phase	Explanation of the indicator	As is	Obtained	Improvement /Savings
On-time order level	$\frac{Number\ of\ Orders\ Delivered\ on\ Time}{Total\ Number\ of\ Orders}\ x\ 100\%$	74%	95.34%	21.34%
Number of orders delivered late	Number of Orders Delivered Outside Customer Time Windows	106	19	87
Penalty expense	Total Penalty Expense Calculated for Each Order Delivered Late	$ 5 768	$ 1 034	$ 4 534
Total daily distance traveled	Total Daily Distance Traveled, Approximate	148.45 km	139.39 km	9.06 km

As a result of the implemented improvements, the OTIF index experienced a significant increase, rising from 70% to 91.65%. This improvement was achieved by combining a service level of 96.15% obtained from the Standarized Work tool and an on-time delivery rate of 95.34% calculated using the CVRPTW tool. These results demonstrate the effectiveness of the proposed solutions in enhancing both delivery reliability and order fulfillment.

5.2 Graphical Results

Figure 4 is a sketch of the optimized route proposed by the tool to solve the CVRPTW, including all locations, the quantity of the order to be delivered in tons, and the routing sequence. It is important to note that the number assigned to each client remains the same as in the initial situation to denote a new visiting order. The first location is Makro Surco (Sales Point 6).

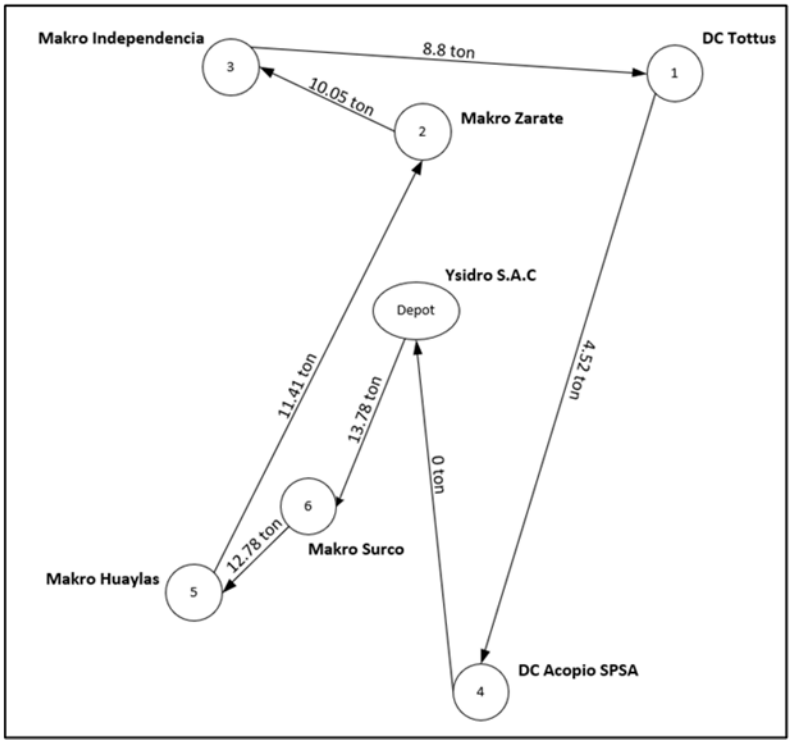

Figure 4. Representation of the final routing sequence situation of the company.

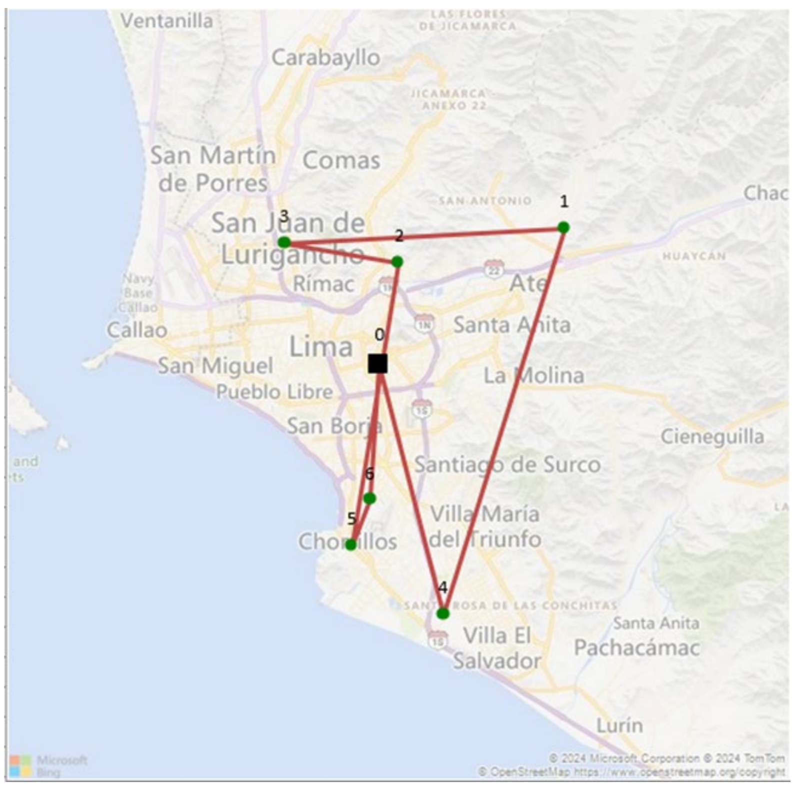

Figure 5. Visualization of the route proposed by the VRP Solver Sheet

In Figure 5, the actual optimized route proposed by the tool can be visualized on the map of the Lima province in Peru. Thanks to the Microsoft Bing engine, this type of visualization is made possible after running the Solver, based on the routing information and constraints entered in the case.

5.4 Validation
To demonstrate the effectiveness of the improvement proposals through the Standardized Work tool, simulation models were designed for both the current and improved processes in order to identify areas for improvement through the comparison of both scenarios.
The simulation was carried out over a 1-day period, with each day consisting of 8 hours of simulation. This means that the simulation state will be finite, as the model stops after a predetermined period of time (Kelton, 2014).
The simulation model was applied with a 95% confidence level. The performance measures of the model focused on critical aspects of the process, such as cycle time, average wait time for a box of fruit in the queue, the number of boxes processed in a given period, and resource utilization, including labor and equipment.
To determine the optimal number of replications in the simulation procedure, a sample of 50 replications was selected. After calculating a minimum of 50 replications for both scenarios (current and proposed), the following results were obtained, as shown in Table 7. Analyzing the results, it can be concluded that for each of the indicators, the proposed model showed better results compared to the current model. It is important to note that these results were obtained with statistical validity at a 95% confidence level.

Table 7. Summary of Statistical Results for Scenario Comparison

Indicator for the Diagnostic Phase	Formula	Current Scenario	Improvement Scenario
Service Level (%)	(Qty of boxes Processed/ Qty of boxes Demanded)	[70.4% - 72.1%]	[95.1% - 97.2%]
Cycle Time of the Process	Average Total Time of a box in the System (in hours)	[0.644 – 0.653]	[0.610 – 0.617]
Cycle Time of Unloading	Average Total Time in the Unloading Zone (in hours)	[0.112 – 0.117]	[0.0675 – 0.0680]
Cycle Time of Selection	Average Total Time in the Selection Zone (in hours)	[0.144 – 0.145]	[0.128 – 0.129]
Cycle Time of Packaging and Weighing	Average Total Time in the Packaging and Weighing Zone (in hours)	[0.23 – 0.232]	[0.217 – 0.218]
Cycle Time of Dispatch	Average Total Time in the Dispatch Zone (in hours)	[0.637 – 0.645]	[0.0124 – 0.0158]

From an economic-financial perspective, the implementation of the proposed tools is profitable, supported by positive financial indicators. To assess the feasibility of the interventions, costs for the acquisition and installation of machinery and equipment (conveyor belts, commercial scales, and packaging machines) were considered, along with labor costs.

The analysis included a financial cash flow over a 3-year horizon, calculating the Net Present Value (NPV) and the Internal Rate of Return (IRR). The results show an NPV of 89,238 soles (Peruvian local currency), positive and above zero, and an IRR of 92.36%, exceeding the opportunity cost rate, confirming the profitability of the proposal.

The benefits obtained include a 60% reduction in penalty-related losses, thanks to route optimization tools that reduced the number of delayed orders. Additionally, the increase in the service level, achieved through standardized work tools, resulted in an estimated 37% increase in marginal revenue from sales compared to the initial scenario. These results demonstrate that the proposed solution is not only financially viable but also highly beneficial for the company.

6. Conclusion
This study proposes a model to increase the OTIF index in the outbound logistics of a fruit distribution SME through the implementation of tools such as standardized work and CVRPTW technology. The research has demonstrated that standardizing activities and optimizing routes are effective strategies for improving operational efficiency and reducing cycle times. The implementation of standardized work sheets and staff training helped reduce process

variability, achieving greater consistency and quality in daily operations. Furthermore, the use of simulation software to validate the proposed improvements, combined with route optimization through CVRPTW, enabled more efficient planning and increased compliance with delivery time windows. In summary, the integration of standardized work and CVRPTW technology has proven to be an effective solution for improving the OTIF index in a fruit distribution SME, contributing to the sustainability and competitiveness of the company in the market. The results of this research could serve as a foundation for future implementations and studies in the field of logistics and perishable food supply chain management in Peru.

References

Baldacci, R., Mingozzi, A. and Roberti, R., Recent exact algorithms for solving the vehicle routing problem under capacity and time window constraints, *European Journal of Operational Research*, vol. 218(1), pp. 1-6, 2012, https://doi.org/10.1016/j.ejor.2011.07.037.

Cordeau, J.-F., Desaulniers, G., Desrosiers, J., Solomon, M. and Soumis, F, VRP with time windows, *SIAM Monographs on Discrete Mathematics and Applications*, Philadelphia, PA, vol. 9, pp. 157-193, 2002, https://doi.org/10.1137/1.9780898718515.ch7.

Cusihuamán-Torres, L. A., Quispe-Rodriguez, L. and Quiroz-Flores, J. C., Operations Model Based on Lean Manufacturing to Increase the Perfect Order Rate in SMEs in the Consolidated Freight Distribution Sector, *ICIBE '22: Proceedings of the 8th International Conference on Industrial and Business Engineering,* pp. 115-122, 2023, https://doi.org/10.1145/3568834.3568843.

Elatara, S., Abouelmehdi, K. and Riffi, M. E., The vehicle routing problem in the last decade: variants, taxonomy and metaheuristics. *Procedia Computer Science*, vol. 220, pp. 398-404, 2023, https://doi.org/10.1016/j.procs.2023.03.051.

Erdoğan, G., An open source Spreadsheet Solver for Vehicle Routing Problems. *Computers & Operations Research*, vol. 84, pp. 62-72, 2017, https://doi.org/https://doi.org/10.1016/j.cor.2017.02.022.

Fin, J. C., Vidor, G., Cecconello, I. and de Campos Machado, V., Improvement Based on Standardized Work: An Implementation Case Study, *Brazilian Journal of Operations & Production Management,* vol. 14, no. 3, pp. 388-395, 2017, https://doi.org/10.14488/BJOPM.2017.v14.n3.a12.

Garrido-Silva, R., Marquezado-Yamunaque, K. and Quiroz-Flores, J. C, Production optimization model to increase order fulfillment by applying tools under the Lean Green philosophy and TPM in plastic manufacturing SMEs, *Proceedings of the LACCEI international Multi-conference for Engineering, Education and Technology, Vol. 2022-December, 2022,* https://doi.org/10.18687/LEIRD2022.1.1.60.

Kelton, W., Sadowski, R. and Sturrock, D. T., Simulation with Arena (4. edición.), *México: McGraw-Hill*, 2008.

Lopes, R., Freitas, F. and Sousa, I., Application of Lean Manufacturing Tools in the Food and Beverage Industries, *Journal of Technology Management & Innovation*, vol. 10, no. 3, pp. 120-130, 2015, http://dx.doi.org/10.4067/S0718-27242015000300013.

Montoya, L., Avalos, M. and Macassi, I., Reduction of delivery times for orders in small and medium-sized paint businesses based on Standard Work and Raw Material Management, *Proceedings of the LACCEI international Multi-conference for Engineering, Education and Technology*, vol. 1, no. 8, July 2023, https://doi.org/10.18687/LACCEI2023.1.1.1263.

Morocho Ríos, C. J., Zambrano, D. and Hernández Nariño, A., Standardization of Industrial Clothing Production Processes In The City Of Pelileo, Ecuador As A Factor To Influence Productivity, *Ingeniería Industrial*, no. 44, pp 15-35, 2023, https://doi.org/10.26439/ing.ind2023.n44.6142.

Patak, M., Branska, L. and Pecinova, Z., Perfect Order and Its Components: Application for Deliveries of Fast Moving Consumer Goods to Retail Stores. *Engineering Economics,* vol. 3, no. 2, 2020, https://doi.org/10.5755/j01.ee.31.2.22480.

Pérez Zempoaltecatl, Á. Systematic Review Of A Standardized Work Methodology of a Ceramic Production Plant, *Revista de Administraçãao da UNIMEP*, vol. 19, no. 9, pp.169-187, 2022.

Puvanasvaran, A., Ab Hamid, M. and Yoong, S., Cycle Time Reduction for Coil Setup Process Through Standard Work: Case Study in Ceramic Industry, *ARPN Journal of Engineering and Applied Sciences*, vol. 13, no. 1, pp. 210-220, 2018.

Shafeek, H., Bahaitham, H. and Soltan, H., Lean Manufacturing Implementation Using Standardized Work. *Journal of Computational and Theoretical Nanoscience*, vol. 15, pp. 1814-1817, 2018, https://doi.org/10.1166/jctn.2018.7316.

Biographies

Ricardo Oré is a Bachelor of Industrial Engineering from the Universidad de Lima.

Ricardo Fuertes is an Industrial Engineering student at the Universidad de Lima.

José Taquía holds a Ph.D. in Business Management from the Universidad Nacional Mayor de San Marcos, through the Graduate School of the Faculty of Industrial Engineering (2023), and has a Master's degree in Industrial Engineering from the Universidad de Lima. He has extensive experience in the development and implementation of predictive analytics systems, as well as research in topics such as Industry 4.0 and production engineering. He is a member of the Scientific Research Institute at the Universidad de Lima and has a strong background in optimization and quantitative methods applied to operations, logistics, service management, and marketing management.