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Redesign of Production and Retail Activities at Flower Shop, Inc. in Puerto Rico

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***Abstract* – Flower Shop, Inc is a luxury flower shop located in Puerto Rico. In 2020, it experienced a 603% increase in demand, which resulted in moving from a kiosk to a full-size establishment. As business increased, several opportunities related to service time and material waste were identified. Some alternatives to improve the process included a Flower Price Calculator, Facility Re-layout, elimination of non-value-added activities, and others. With the alternatives selected, an 85% reduction in scrap and a 9.9% reduction in service time was achieved.**

***Keywords*—process improvement, simulation, industrial engineering, lean six sigma**

I. Introduction

Flower Shop Inc (FSI), founded in 2018, is a high-end establishment providing services like flower arrangements, plants, vases, and others. In 2020, an increase in demand of 603% was experienced, motivating the owner to move from a kiosk to a full retail store. With the move, several areas of opportunity to increase the value proposition to its customers emerged.

This paper will describe the success of improvement initiatives in the areas of planning, production, service, and warehouse using Lean/Process Improvement tools in a service setting. DMAIC, the lean six sigma structure, is defined [1] as a "disciplined, data-driven approach and methodology for eliminating defects". The definition is expanded further, as DMAIC is applied to enhance value and eradicate all non-value activities. Marques, Carvalho, and José [2] show another successful application of process improvement tools to improve retail operations, while considering sustainability. This principle is also important for FSI, as most materials are perishable organic components, such as leaves and flowers.

Key areas for improvement involve minimizing waste from organic materials and service duration, taking into account the time required for crafting arrangements and managing the checkout queue. Time studies can be employed to measure the standard time for each task. Existing time study methodologies comprise direct observation using a stopwatch and indirect assessment through work sampling [3].

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Besides calculating standard times, identifying, and removing non-value-added activities can also contribute to increased work efficiency. One tool to make this evaluation is a Waste Walk, this has been successfully applied in manufacturing and service industries [4] to identify execution errors, excessive motion, and other wastes that reduce productive time.

Applying Lean Six Sigma in service sectors presents unique challenges, particularly concerning the necessary cultural shifts for successful implementation. Two important elements mentioned include [5]: training and teamwork. Training ought to concentrate on lasting, sustainable transformations, while teamwork should motivate others in the organization to adopt the necessary actions for ongoing process improvement.

The methodology for this paper is inspired in the Interpretive Structural Modelling (ISM) technique [6] for a customer centric, value-added, profitable process. The steps included are:

1. Define problem – identify opportunities, stakeholders, and processes. In the paper, it is demonstrated that a CTQ tree and a SIPOC are utilized to achieve a deeper understanding of the process.
2. Perform historical data analysis – find baseline for response variables, identify independent variables, classify value added and nonvalue added activities. Pareto charts, time studies and a waste walk is presented to corroborate the process baseline.
3. Root cause analysis – find relationships and causalities between response and independent variables. Some tools for root cause analysis included in this paper are the fishbone and five why's [7] [8]. Additional root cause analysis can be performed with statistical inference tools such as linear regression and analysis of variance [8].
4. Decision analysis and alternatives selection – design alternatives, evaluate and select using a structured criterion. A weighted decision matrix is employed for choosing the most effective solutions to address issues. Comparable tools have proven valuable in service industries [9], including car dealerships.
5. Results – depict achieved and proposed results from improvements. These were validated with a simulation model [9] of FCI to compute headcount.
6. Conclusions – financial analysis, objective calculations, project closing. Project results are shown at the end of the paper.

7. Next Steps – implementation plan considering training and sustainability.

In Fig. 1, a CTQ tree was developed to translate business aspirations into quantifiable metrics. The utmost significance for the business lies in having a versatile design and profitability. As this is a creative business, customer interest varies, requiring spaces to be flexible. Rentability, as expected, is vital to any business and will determine its continuity.

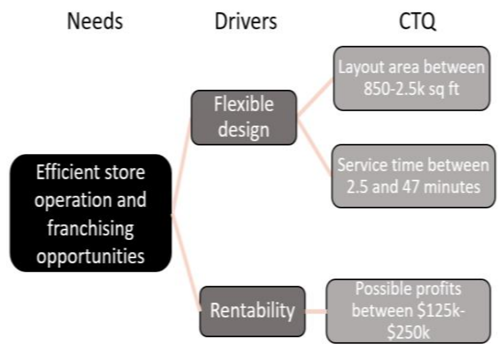


Fig. 1: Critical to quality diagram for FSI

After translating the process definition into measurable components, the following objectives were established:

- Reduce scrap percentage by at least 20%.
- Reduce service time by at least 5%.

Additionally, a SIPOC diagram was used to understand the relations between process activities and stakeholders. As seen in Fig. 2, the process is divided in 7 high level operations, from Customer Contact to Delivery. A similar approach of both CTQ tree and SIPOC to improve the city logistics processes in Poland was found in literature [10].

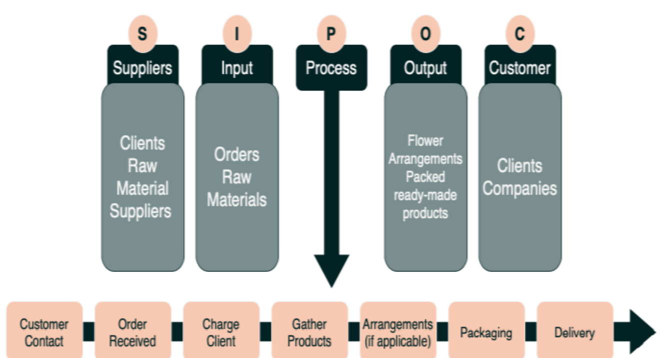


Fig. 2: SIPOC diagram for FSI

II. Historical Data Analysis

An important step of this project is collecting and analyzing data from the two response variables: (1) service time and (2) scrap, as well as from (3) some of the independent variables. To reduce the scrap, data of the most discarded items is required. Additionally, to collect the information related to the service time, an analysis of daily activities and the breakdown of value vs non-value-added was be performed. The demand is also considered, as different product families require different creative work. A pareto chart per product family, shown on Fig. 3, helps to understand the product family that is in greatest demand [11], in this case Fresh Ready-Made and then Dry / Preserved families.

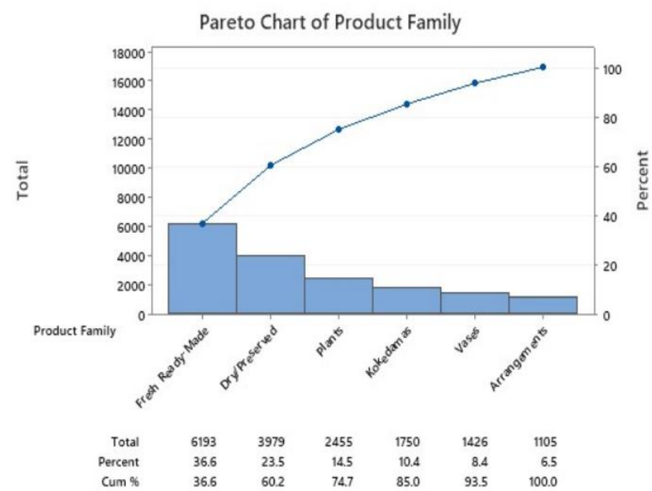


Fig. 3: Pareto of Demand vs. Product Family

One of the papers objectives is reducing the constant discarding of flowers. A pareto chart, shown in Fig. 4, was created to identify the top-discarded fresh products. The study suggested that 18.4% of flowers was scrapped.

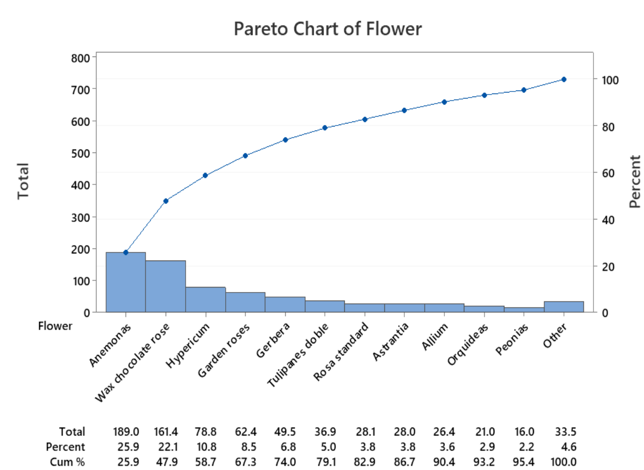


Fig. 4: Scrap per product family

Next, the process time for each of the shop activities is calculated. Considering that every task is not consistent or repetitive, a work sampling was performed to understand the most frequent activities in a workday. For this, 319 observations were collected, as shown on Table I, where 11.40% are classified as idle time, 9.89% cleaning, 2.15% watering plants and 2.15% of product search for a total of 25% of nonvalue added activities. It can be concluded that 25% of time is spent on activities that do not transform the products or result in an item for which the client wants to pay or possess optimal quality.

Table. I: Work Sampling Results

Task	General	
	Minutes	%
Packaging	28.51	5.20%
Arrangements	101.52	18.51%
Customer Service	118.81	21.66%
Watering Plants	11.81	2.15%
Idle	62.54	11.40%
Social media	36.86	6.72%
Checkout (Payment)	16.67	3.04%
Delivery	2.08	0.38%
Cleaning	54.26	9.89%
Merchandise	75.86	13.83%
Product Search	11.81	2.15%
Administrative	27.83	5.07%

A stopwatch time study was carried out to determine the standard time of the tasks that are performed frequently, such as checkout, arrangements, customer service, and packaging. For the study, shown in Table II, an α=0.05 confidence level was used and a total of 575 observations collected. These standard times will now be further analyze considering which activities are value added vs. those that do not add value.

Table. II: Stopwatch Time Study Results

Element	Average	Normal Time	Standard Time (sec)
Service	146.04	134.35	0
Checkout	100.4	92.37	104.38
Packaging	70.47	64.83	73.26
Arrangement pre-work	633.73	583.03	658.83
Arrangement	1198.67	1102.78	1246.14
Arrangement packaging	540.2	496.99	561.6

A Waste Walk (or TIMWOODS) analysis was conducted to understand key areas of opportunities in terms of nonproductive tasks at the establishment. As observed in Table III, the highest wastes are transportation, inventory, and skills. The historical data analysis confirmed the improvement opportunities and established the baseline for the objectives. The next section will relate these response variables with the independent variables within FCI.

Table. III: Waste Walk Results

Waste	Level	Description and Examples	Frequency
Over-production	MEDIUM	$48 standard bouquet that is in the fridge for more than 1 week.	4x / week
Transportation	**HIGH**	Searching for kraft paper and ribbon to pack items	103 trips/day
Inventory	**HIGH**	Purchasing excess flowers and other perishables	1 clean-up/day
Defects	MEDIUM	Rotten flowers in a recent order.	4.5x/week
Motion	MEDIUM	Looking for materials	56 times/day
Waiting	MEDIUM	Waiting for the water fountain to clean or hydrate plants.	16 times/day
Skills	**HIGH**	Employee not creating arrangements for expected customers	1 event/day

III. Root Cause Analysis

The root cause analysis will help to identify causality relationships between response and independent variables. This section includes the application of tools such as Fishbone and 5Why's. The analysis of each root cause will be performed separately for each problem:

1. Problem 1: 18.4% of flowers bought are disposed of because they were never used, and they perished. This is drilled down in these subproblems:
    a. No maintenance standardization
    b. No economic loss mitigation
    c. No demand estimation logic

Fig. 5 shows the development of both a fishbone diagram and a five why's for problem 1. With this further level of detail, the root cause for problem #1 is determined as "There is no purchasing plan / forecasting". With no logistics involved, there is no expectation of purchasing the right quantities or managing inventory to minimize perishable products.

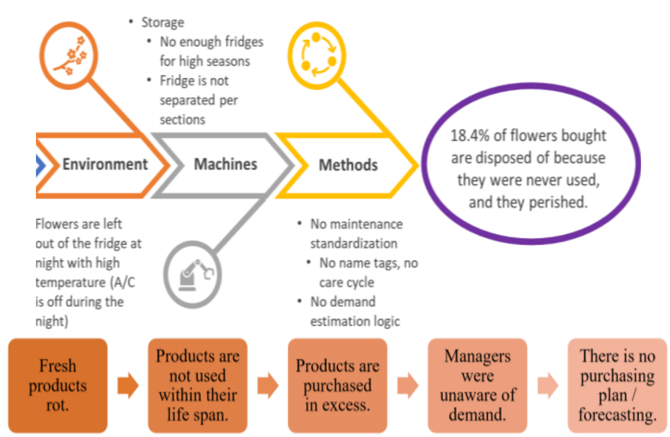


Fig. 5: Fishbone + 5Why for problem 1

2. Problem 2: 13.7% increase in service time after moving to a new location. This is further analyzed in these subproblems:
    a. Motion
    b. Transportation
    c. Waiting

The fishbone and five why's diagrams for problem 2 are shown in Fig.6. A 5why analysis breaking down the "Longer time in transportation" problem is also displayed. The root cause for problem #2 is "Lack of engineering tools during design". With no strategic planning involved, expediting the move was the only motivation, not customer service or efficiency.

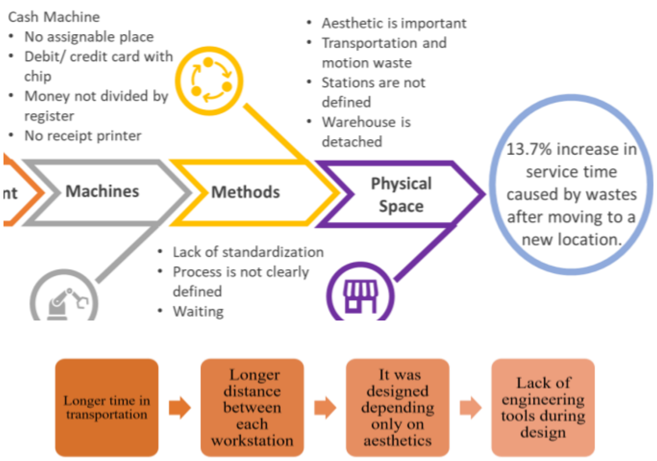


Fig. 6: Fishbone + 5Why for problem 2

This section successfully performed a root cause analysis. With the information gathered, corrective actions can be proposed and evaluated. These are demonstrated next.

IV. Evaluation Criteria & Decision Analysis

Problem 1 was divided into 3 subproblems and several alternatives were presented. The alternatives on Table IV focus on inventory management, from improving reorder points and order size with several inventory management system options. As the items sold are mostly perishable, an align inventory management system considering requirements and shelf life, can reduce the wastes on flowers and other vegetable materials.

Additional to determining adequate recorder points, an intuitive and automatic ordering system can facilitate the acquisition of materials by the stakeholders. All supply chain related alternatives can be implemented with very little lead time.

Table. IV: Alternatives for problem #1 – demand estimation sub problem

Sub problem	Alternative	Description	Implementation Time (days)
No demand estimation logic	Calculate reorder point and size	Determine fixed minimum unit quantity to trigger inventory replenishment.	2
	Forecasting tool in spreadsheet	Create a spreadsheet that can calculate the reorder size and point-based on updated demand.	2
	Forecasting software	Odoo MRP software	5

Table V shows a similar analysis for problem #2, this focusing on eliminating nonvalue added activities to reduce service time. Three alternatives of facility layouts will support standardization and reduce transportation and motion. The waiting problem required additional recommendations, including providing an additional water source, as well as standardizing locations and visual aids. For this problem, multiple solutions are feasible, thus considering "all the above" as a potential solution.

Table. V: Alternatives for problem #2 – flow sub problem

Sub problem	Alternative	Description	Implementation Time (days)
Transpor-tation	Layout design 1	Rearranging layout, shifting workstations, and reducing LDS.	1
	Layout design 2		1
Motion	Layout design 3		1
Waiting	Backup water source	Place additional water recipients near the workstations for easy access.	8
	5S - Packaging & Checkout	Assign areas for packaging tools	1
	Visual aids and tasks distribution	Task and planning set up to reduce idle time	1
	All the above	Implement all alternatives	2

A weighted decision matrix was used to evaluate the design alternatives for all problems. Table VI shows the decision criteria and weights for problem #2 (flow subproblem). The development of decision matrices for all problems can be applied in several applications [9] with the results from this paper discussed in the next section.

Table. VI: Alternatives criteria + weights: problem #2 – flow sub problem

Criteria	Weights
Investment	15%
Aesthetic	30%
Implementation Complexity	5%
Objective Contribution	25%
ROI	10%
Sustainability	15%

V. Results

Once the decision analysis is completed, Table VII describes the alternatives for each subproblem. The solutions are perfectly aligned with lean concepts, such as process improvement, 5S, visual controls, inventory management and many others.

Table. VII: Alternatives criteria + weights: problem #1 – reduce service times

Problem	Subproblem	Short Reference	Alternative
1 - Scrapped flowers	No maintenance standardization	P1S1	Labeling + Maintenance cycle +5S - Refrigerator
	Economic loss mitigation	P1S2	Drying products + Discounts + Prepare standard bouquets
	No demand estimation logic	P1S3	Excel tool to automate forecasting
2 – Service Time	Transportation and motion	P2S1	Layout design 3
	Waiting	P2S2	Backup water source + 5S of Packaging and Checkout +Visual aids & tasks distribution

All selected alternatives in Table VIII have short payback periods with large Return of Investment (ROI) [12], These results will result attractive to stakeholders, that can obtain a large return, in a short time.

Table. VIII: Alternatives criteria + weights: problem #2 – Wasted flowers

Problem	Short Reference	Payback Period (years)	ROI%
1 - Scrapped flowers	P1S1	0.05	5146%
	P1S2	0.33	973%
	P1S3	0.03	3549%
2 – Service Time	P2S1	0.32	646%
	P2S2	0.31	71%

A more detailed description for the alternatives and some displays of the improved system are shown next. The first problem was that 18.4% of flowers bought are disposed of. The alternative selected to counteract subproblem #1 was to create a reference guide, establish a label system, create maintenance cycles, and perform a 5S on the refrigerator. This alternative has a percentage of contribution to the scrap objective of 21%.

For the subproblem #2 the alternative selected was all the above which refers to practices of dry products, discounts, and prepare standards bouquets. This helping to obtain a contribution to the objective of 10%. Lastly, the subproblem #3 alternative selected was the creation of a forecasting tool in spreadsheet. This tool was an MPS created and contributes to the objective with 54%. As seen in Fig. 7, the MPS will help the company buy the necessary products to meet current demand.

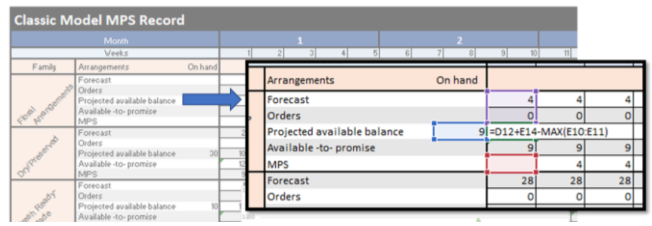


Fig. 7: Inventory System in MS Excel

The second problem that was identified showed a 13.7% increase in service time after moving to a new location. For this problem, the three subproblems identified were transportation, motion and waiting. The alternative selected to counteract the subproblem #1 was the layout design 3, show in Fig. 8. This layout manages to reduce the LDS to 54% promoting a more efficient workflow in the store.

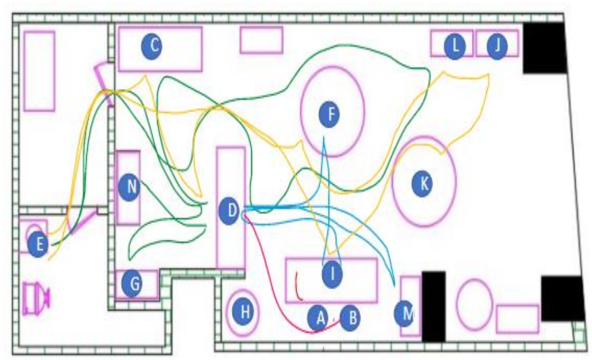


Fig. 8: Layout alternative #3

Table. IX: Tasks duration with new layout

Task	Current Distance (ft)	Future Distance (ft)	Total Difference	% Re-duction (ft)	Current Time (sec.)	Future Time (sec.)
Admin	57	3	263	53%	10.9	0.6
Merch	180	109			34.3	20.8
Social	115	18			21.9	3.4
Water	124	93			23.7	17.7
Clean	18	8			3.4	1.5

The tasks included administrative (Admin), arrangement and management of merchandise (Merch), social media (Social), watering (Water), and cleaning activities (Clean). The alternative contributes 7.5% to the proposed objective. The duration of these tasks is improved with the layout alternative, as seen in table IX facilitating the service time reduction objective. Lastly for the second sub problem the alternative selected was having a backup water source, 5S and visuals, and task distributions. This alternative will help reduce the wait for information and resources in the company by 2.4% of the objective.

FCI currently has a spacious warehouse that serves as a potential working space when needed, however, the space was not in the necessary conditions for people to be in it. The 6S analysis was performed and as seen in Fig. 9 and Table X, resulting in an open space concept that can serve as a diverse functional area depending on the season necessities of the business.

Table. X: 6S Implementation for warehouse + working space

6S Element	Activities
Sort	Analysed tools, materials, equipment, and boxes in warehouse, determined needs / what could be removed.
Set in Order	Grouped the objects based on the frequency, type and purpose of the tools or materials, and when are the materials needed.
Shine	Cleaned the work area (sweeping, mopping, dusting, wiping down surfaces, and putting tools and materials away). Planned maintenance for future shining events.
Standardize	Assigned tasks, schedules, and posted instructions. Created work instructions and weekly 5S checklist.
Sustain	Designed trainings with management support, progress audits, and performance evaluations.
Safety	Set up ergonomic workstations, labelling the storage cabinet for cleaning chemicals to prevent potential hazards, and provide stairs to reach high objects.

Part of the sustainability of this 6S was creating a layout of the warehouse that indicates deposition and location of different types of materials inside. Additionally, there is a guide accompanying this layout that explains where to find the tools and materials that employees could need.

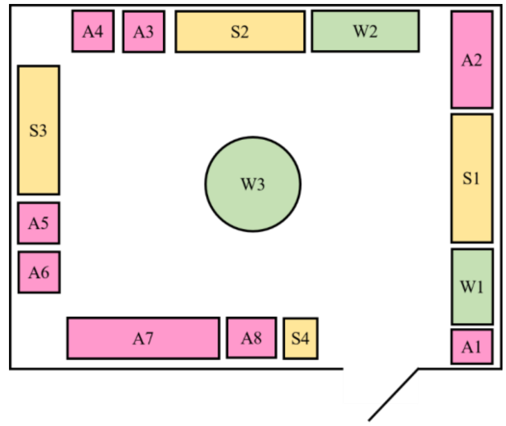


Fig. 9: Layout to support 6S warehouse + working space

To ensure the optimum utilization of the process and ensure objectives were achieved, a simulation was developed with SIMIO [13] software to maximize the utilization of the resources in the system. A model for estimating the correct staffing levels considering scenarios based off the work required or demand was created. As the logistic components of the model were set, the physical appearance of the model was also refined. It included a detailed layout with animated and static symbols, labels, and correct proportion from two and three-dimensional congruence, seen in Fig. 10.

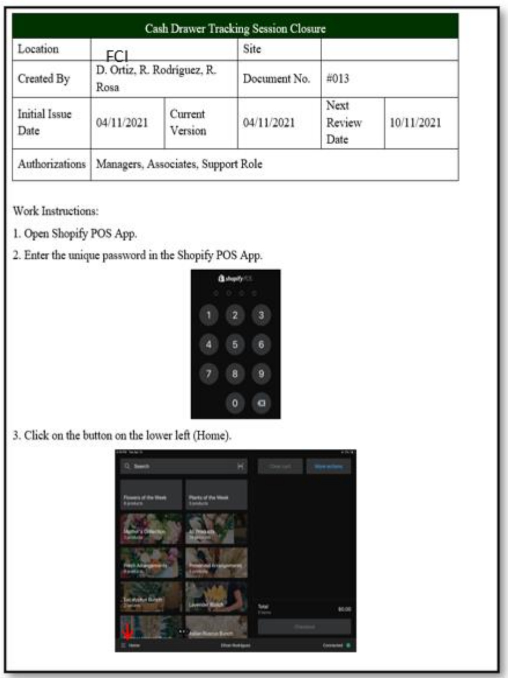
Fig. 10: Simulation model screenshot

The layout and routes in the design of the model were based of the alternatives of this paper. As responses, the total resources (FloristCapacity + SalesCapacity) must be minimized, while the utilization is maximized, while not exceeding 100%. The results from the simulation on Table XI, show the required staff for weekends, weekdays, and peak dates, considering the previous design recommendations. Additional details of the model development can be observed in this paper dedicated to the FCI staffing simulation [14].

Table XI Staffing Optimization Results

Simulation Scenario	Florists Required	Sales Staff Required	Utilization Percentage
Weekdays	0	1	55%
Weekends	1	1	93%
Peak Week	5	4	95%

To maintain the sustainability of an implementation, work instructions defining the tasks that were most performed were created. These include good safety practices to help prevent accidents in the future. The work instructions include visual aids to enhance learning and standardization, as the example in Fig.11. One additional suggestion is to create mobile apps for all or some of the work instructions. These have been useful for both manufacturing and service applications [15].



Cash Drawer Tracking Session Closure					
Location	FCI	Site			
Created By	D. Ortiz, R. Rodriguez, R. Rosa	Document No.	#013		
Initial Issue Date	04/11/2021	Current Version	04/11/2021	Next Review Date	10/11/2021
Authorizations	Managers, Associates, Support Role				

Work Instructions:

1. Open Shopify POS App.
2. Enter the unique password in the Shopify POS App.
3. Click on the button on the lower left (Home).

Fig. 11: Work Instructions Example

V. CONCLUSIONS

In conclusion, FCI increase in demand caused several opportunities to improve the existing operations. This required the team to perform various analyzes such as, CTQ, Fishbones, 5 Whys, time studies, layout analysis and collection of different historical data such as scrap metal data to know the main problems of the company. The objectives of the project were to reduce scrap by at least 20% and reduce service time by at least 5% To achieve the objectives, each problem was divided into 3 subproblems.

The first problem was that 18.4% of flowers bought are disposed of because they were never used, and they perished. For this problem, the subproblems identified were, no maintenance standardization, economic loss mitigation, and no demand estimation logic. The alternative selected to counteract the first subproblem was to create a reference guide, establish a label system, create maintenance cycles, and perform a 5S on the refrigerator. This helped to have a better control of the quality of the product that the company have and to be able to extend its life. This alternative contributed 21% to the scrap reduction objective. For the second subproblem the alternative selected was all the above which refers to practices of dry products, discounts, and prepare standards bouquets. This helping to obtain a contribution to the goal of 10%. Lastly the third subproblem alternative selected was the creation of a forecasting tool in spreadsheet and contributes to the objective with a 54% change. This tool allows the company to buy the necessary products to meet current demand.

The second problem was a 13.7% increase in service time after moving to a new location. For this, the three subproblems identified were transportation, motion and waiting. The alternative selected to counteract the first two subproblems was the layout design 3. This layout manages to reduce the LDS to 54% promoting a more efficient workflow in the store, while contributing 7.5% of the objective. Additional recommendations included having a backup water source, 5S and visuals, and task distributions, contributing 2.4% of the objective.

In addition to these proposed alternatives, additional recommendations were made to help the sustainability, standardization, and maintenance of the company. The first additional implementation is the Flower Price Calculator to create uniform prices and profit rates and decrease price analysis time. The second implementation is the future order entry system which is a system created to obtain a better organization with respect to the orders that must be delivered. The SIMIO simulation was created with the objective of maximizing the resources utilization. To support the changes, work instructions were created for the most common tasks and those that received some impact from the proposed changes.

Selecting implementing all recommendations, will result in the achievement of all project objectives, as seen in Table XII. The first problem had the objective of achieving a reduction of ≥20% in scrap, after the implementations it was possible to calculate an 85% reduction of scrap. The second problem was aimed at achieving a reduction in customer service time of ≥5%. Calculating the percentages contributed to the objective of the proposed alternatives, a reduction of 9.9% was calculated.

Table XII Project Results Summary

Problem	Subproblem	Objective Improvement Contribution	Total Objective Achievement	Proposed	Objective Achieved?
1 – Scrap	No maintenance standardization	21.0%	85%	≥20%	Yes
	Economic loss mitigation	10.0%			
	No demand estimation logic	54.0%			
2 – Service Time	Transportation and motion	7.5%	9.9%	≥5%	Yes
	Waiting	2.4%			

VI. Next Steps

An important future task is the development of an implementation plan. This will assign resources to complete all tasks required to achieve objectives. The completion of all implementation activities will take approximately two months from start to finish, as seen in Table XIII.

Table XIII Implementation Activities Duration

Problem	Start	End	Days	Overall Duration
#1	3/29	5/16	49	59 days
#2	5/16	5/26	10	

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