Improving Customer Service Efficiency Using Demand Forecasting with Leagile and Lean Six Sigma Concepts: A Case Study

Phraewa Thatphet and Panutporn Ruangchoengchum*

College of Graduate Study in Management, Khon Kaen University, Thailand

ABSTRACT

Background and Objectives: The coffee industry is a highly competitive business, especially for coffee shops that provide fresh coffee. Prolonged service times in such establishments can significantly impact activity-based costing. Although previous research has addressed issues related to extended waiting times, there is a gap in understanding how demand forecasting, combined with Leagile and Lean Six Sigma methodologies, can improve service processes in small coffee shops. This study seeks to identify the maximum increase in beverage demand periods through demand forecasting and implement Leagile and Lean Six Sigma strategies to enhance customer service, decrease activity-based costs, and improve overall efficiency.
Methodology: The data on product sales throughout the year 2022 during operating hours were collected from January 1st to December 31st. Python and Autoregressive Integrated Moving Average (ARIMA) were employed for sales forecasting to find the maximum increasing period of demand, and the accuracy of predictions was evaluated using metrics such as Mean Absolute Percentage Error (MAPE), Mean Square Error (MSE), Mean Absolute Error (MAE). The in-depth interviews were conducted with key informants. The application of Leagile and Lean Six Sigma concepts, with various tools such as service blueprint, process flow chart, activity value analysis, and Cause-and-effect diagram, took place over the period from March 1st to April 31st, 2023 to improve the customer service process.
Results: The main findings of the study revealed that peak demand occurred during two specific periods: 07:45-08:00 a.m. and 12:45-01:00 p.m., with increases of 73.2% and 76.8%, respectively. The research identified and addressed five non-value-added activities in the service process which are queuing for ordering, writing down the order on paper, asking for the customer's name and writing it down on the receipt, folding the tissue paper onto the cup, and choosing the proper straw. Decreasing those processes resulted in a notable 20.71% reduction in lead time (equivalent to 87 seconds per cup). Additionally, four out of five activities (80%) that cause idle time, consist of writing down the order on paper, asking for the customer's name and writing it down on the receipt, folding the tissue paper onto the cup, and choosing the proper straw, were successfully eliminated. These improvements contributed to an estimated daily reduction of 2,350 baht in activity-based costs, translating to a monthly saving of 61,110 baht.
Discussions: Entrepreneurs should consider using demand forecasting to identify peak times of demand, aiming to enhance the efficiency of customer service processes in conjunction with the Leagile and Lean Six Sigma concepts. This involves collecting and analyzing data, identifying the root causes of problems, selecting an appropriate decoupling point to modify the workflow, and utilizing forecast-driven principles in the Lean model. The workflow is then transformed using order-driven principles in the Agile model. Eliminating non-value-added activities is a crucial method to enhance the efficiency of customer service processes, reducing customer waiting times and minimizing unnecessary business activity-based costs.
Conclusions: Integrating demand forecasting with Leagile and Lean Six Sigma principles proves beneficial for fresh coffee shops, enhancing operational efficiency and reducing unnecessary activity costs.

ARTICLE INFO

Article history:
Received 27 August 2023
Received in revised form 19 January 2024
Accepted 24 January 2024
Available online 27 June 2024

Keywords:
Fresh coffee business,
Demand forecasting,
Leagile,
Lean Six Sigma,
Efficiency

**Corresponding author*
E-mail address: rpanut@kku.ac.th

Introduction

Coffee is one of the most popular beverages globally and a significant business (Moldvaer, 2021). According to data from the International Coffee Organization in 2022, approximately 3 billion cups of coffee are consumed daily worldwide. The global coffee market was valued at a staggering $433.6 billion in 2022, with an expected annual growth rate of 7.64% from 2022 to 2025. In Thailand, the fresh coffee shop business has experienced continuous growth. According to Sethithorn (2019), the number of fresh coffee shops in Thailand increased from 7,671 in 2016 to 8,025 in 2017. The market value of the fresh coffee shop business also rose from 26,670 million baht in 2016 to 28,510 million baht in 2017, as reported by the Thai Kasikorn Research Center (2018). The fresh coffee shop business has been categorized into franchised shops, which include both local and international brands, and standalone shops. The standalone shops offer a variety of products, services, and store designs that can be quickly adapted to meet the consumers' needs as they are not controlled by larger parent companies. This makes them highly popular among the Thai population and accounts for about 94.4% of the market share in Thailand.

Based on the market value and growth trends, it is evident that the fresh coffee shop business faces significant competition. Timely service is one of the most important factors for customers in choosing a coffee shop. It also enhances sales numbers and profits, in addition to decreasing activity-based costs (ABC). The Leagile concept, also known as Hybrid supply chain strategies, is a management approach that combines Lean and Agile methodologies. Lean focuses on reducing waste and unnecessary steps, while Agile emphasizes flexibility and responsiveness to customer demands (Naylor et al., 1997). The Leagile concept needs a decoupling point, which is the point that the service will change from Lean to Agile. Demand forecasting allows business owners to anticipate the volume of customers during each period and acknowledge the turning point of surging demand from low and normal volume to high volume. This allows the business to prepare for proper and efficient service during each period. Although there are various benefits of Leagile, streamlining for the purpose of providing timely service might lead to process variations and a drop in quality standards. Lean Six Sigma is a combination of Lean and Six Sigma methodologies, aimed at minimizing waste and reducing process variation. Lean focuses on eliminating waste, and Six Sigma utilizes statistical tools to remove process variations that may cause waste (Pepper & Spedding, 2010). Therefore, the combination of using demand forecasting, Leagile, and Lean Six Sigma enhance the improvement of service processes more than using each tool individually.

There are some researchers who used demand forecasting, Leagile, and Lean Six Sigma for big companies and plants (Leechaianan, 2013; Phansangwan et al., 2021; Thatphet & Ruangchoengchum, 2019; Thonglor et al., 2012; Zhang et al., 2012). But to our knowledge, there are few pieces of research that adopted demand forecasting combined with Lean Six Sigma principles to improve service efficiency and reduce waiting time for customers in small fresh coffee businesses.

Therefore, this study aims to explore the application of demand forecasting combined with Laegile and Lean Six Sigma principles in improving customer service efficiency by reducing customer waiting time and minimizing ABC in a standalone fresh coffee shop.

Case study

“XYZ Fresh Coffee” is a 20-seat stand-alone type of fresh coffee shop situated in an office building. Due to the coffee shop's location within an office building, the majority of customers are office workers who have relatively fixed work hours and break times that are closely aligned. The periods just before work, around 07:45 - 08:30 AM, and the lunch break, around 12:30 - 13:00 PM, experience the highest customer densities. There are two staff per day, one branch manager or head of employees, along with one employee. The branch manager or head of employees prioritizes taking orders and cashiering. This leads to waiting times in the customer service process that extend up to 7 minutes per cup, which is significantly longer than the recommended standard time of 2.5 - 4.5 minutes (OpEx Learning Team, 2010) (Vasisht, 2018). Consequently, XYZ Fresh Coffee's business operators cannot promptly meet customer demands, particularly during peak hours. This situation prompts customers to opt for services from competing establishments, especially other nearby fresh coffee shops and convenience stores with faster service processes. This has led to XYZ Fresh Coffee incurring ABC. XYZ Fresh Coffee was selected for this case study as it is a model of a small size, stand-alone coffee shop, representative of the majority of the market share in Thailand (Thai Kasikorn Research Center, 2018). Its location within an office building with customer profiles will enhance the effect of adapting Leagile and Lean Six Sigma in rush hour service processes.

Research Objectives

1. To study the time periods in the customer service process with the highest demands for beverage purchases using demand forecasting.
2. To propose improvements in customer service efficiency through the application of Leagile and Lean Six Sigma concepts.

Literature Review

Demand forecasting helps in production planning, reducing customer backlog problems, and improving business competitiveness, which has been proved in various previous studies. For example, Thonglor et al. (2012) used ARIMA forecasting to find the most frequent and critical tasks to improve and enhance operational efficiency for school management. Supanakorn (2011) used time series forecasting with methods such as two-layered exponential smoothing, simple exponential smoothing, and Box-Jenkins (ARIMA) to plan the production of bearing parts. Phansangwan et al. (2021) used demand forecasting to calculate the order quantity for each time and applied it to warehouse management. All the studies found demand forecasting helps with operational management.

There were some benefits highlighted in the research regarding the use of Leagile and Lean Six Sigma in the industry. Leechaianan (2013) studied the application of Leagile Supply Chain principles along with simple exponential smoothing in the production process of thick wires. They reduced 87% of transportation distances and cut 2 production steps, and also reduced the waiting time for raw materials. Zhang et al. (2012) studied the application of Leagile principles in the supply chain and found it improved warehouse management by reducing warehouse inventory, enabling quick responses to market demands, leading to increased customer satisfaction, as well as reducing the length of the supply chain, which lowered costs and lead time. Thatphet and Ruangchoengchum (2019) studied the application of Lean principles to eliminate unnecessary activities and movements to improve the process of coffee production. The results showed a reduction of working distance from 23.2 meters to 12.06 meters or 1,114 meters per day and a reduction of working time from 3.01 minutes to 2.15 minutes or 76.40 minutes per day, resulting in increased coffee production, income, and efficiency. Pugna et al. (2016) studied the application of Six Sigma principles in car assembly activities and found that it improved activity efficiency by increasing process capability from 0.96 to 1.72, increasing Sigma Level in the short term from 2.9 to 5.2, and increasing Sigma Level in the long term from 1.4 to 3.7. It also reduced defects per million opportunities (DMPO) from 81,000 to 108. Smętkowska and Mrugalska (2018) studied the application of Six Sigma principles in production activities and found that it reduced the time required for machine changeovers, employee training, and standardizing operations, as well as improved equipment maintenance. This helped increase production efficiency, resulting in benefits such as increased profits, reduced risk of delays in production, cost reduction, and increased customer satisfaction.

In conclusion, various studies have highlighted the effectiveness of using the demand forecasting technique, Leagile, and Lean Six Sigma principles. By implementing these strategies together, businesses should achieve tangible benefits, including increased production, reduced costs, enhanced customer satisfaction, and improved overall competitiveness. However, to our knowledge, there is no research adapting demand forecasting with Leagile and Lean Six Sigma to improve service processes in small coffee shop businesses, and thus, constitutes the research gap for this study.

Method

To study the time periods in the customer service process with the highest increase in demand for beverage purchases, the demand forecasting was used. The data were collected on product sales during the coffee shop's operating hours (7:30 a.m. to 6:00 p.m., Sunday to Friday) in the period of one year from January 1st to December 31st, 2022. The sales data were recorded by the shop's cash register system at 15-minute intervals. After collecting the data, unnecessary information was removed (data cleaning), and the data's mean and stationary properties were checked. Python under the Python Software Foundation License (PSFL), was used for data analysis with Autoregressive Integrated Moving Average (ARIMA), shown in Figure 1, as the tool for forecasting the sales data because of the characteristics of time dependency, stationarity, autocorrelation, seasonality and sufficient historical data (Box et al., 2016; Hyndman & Athanasopoulos, 2021)

```
-----Python version and required libraries-----
Python 3.11.4
-→pandas
-→numpy
-→matplotlib and seaborn
-→statsmodels
-→pmdarima
- scikit-learn

import pandas as pd
from statsmodels.tsa.arima.model import ARIMA

data = pd.read_csv('bev_demand_sales_dataset.csv', parse_dates=['datetime'], index_col='datetime')
demand = data['bev_demand_sales']
model = ARIMA(demand, order=(2,1,0))
model_fit = model.fit()
print(model_fit.params)
```

Figure 1 Commands to Use ARIMA in Python

The accuracy of the forecasting results was checked by comparing the forecasted demand with the actual demand. This was done using Mean Absolute Percentage Error (MAPE), Mean Square Error (MSE), and Mean Absolute Error (MAE) analysis methods (Ounmee, 2017) with the following formulas.

Mean Absolute Percentage Error (MAPE)

$$\mathrm{MAPE} = \frac{100\%}{n} \sum_{t=1}^{n} \left| \frac{A_t - F_t}{A_t} \right|$$

Mean Square Error (MSE)

$$\mathrm{MSE} = \frac{1}{n}\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2.$$

Mean Absolute Error (MAE)

$$\mathrm{MAE} = \frac{\sum_{i=1}^{n} |y_i - x_i|}{n} = \frac{\sum_{i=1}^{n} |e_i|}{n}.$$

The commands in Python were applied to calculate MAPE, MAE, and MSE, as in Figure 2.

```
mape = np.mean(np.abs((test - predictions) / test)) * 100
mae = mean_absolute_error(test, predictions)
mse = mean_squared_error(test, predictions)

print('Mean Absolute Percentage Error (MAPE):', mape)
print('Mean Absolute Error (MAE):', mae)
print('Mean Squared Error (MSE):', mse)
```

Figure 2 Commands to Calculate MAPE, MAE, and MSE in Python

To propose improvements in customer service efficiency through the application of Leagile and Lean Six Sigma concepts, in-depth interviews were conducted with key informants, including a branch manager, a team leader, and employees of the coffee shop, to gather information on customer service processes, identified issues, and other recommendations. The main key informants were coded as Table 1 and Table 2:

Table 1. Codes for Key Informants

Key Informants	Mean
M	Branch Manager
H	Head of employees
E	Employee

Table 2. Codes for Individual Key Informants

Key Informants	Individual Key Informants
M	M1
H	H1
E	E1 E2 E3

Additionally, analysis from related documents, such as sales records from the shop's cash register and observations of employee activities through security cameras, was also performed. Afterward, we conducted data analysis with the following tools:

- A Service Blueprint, which is a technique for analyzing processes that focuses on the interactions between customers and service providers in service-oriented businesses. The service blueprint illustrates potential work deficiencies and aids in understanding the connection between customer service and service providers (Heizer et al., 2017). A Service Blueprint was utilized to analyze the overall activities involved in the customer service process of beverage purchases at the XYZ coffee shop.

- A Process Flow Chart is a tool used to illustrate the flow of information by presenting the main activities of a process and showing the relationships between each activity using symbols in the form of a flowchart. This chart helps visualize the sequence of activities in a process, indicating which activities occur before or after others (Heizer et al., 2017). A Process Flow Chart was used to analyze the sequence of activities and the time spent on each activity to identify unnecessary steps in the process.
- Activity Value Analysis is a method for considering waste in operational processes. It categorizes activities as follows:
  1. Non-Value Added (NVA) activities are those that do not contribute benefits or value to the process and should be eliminated, such as errors and delays.
  2. Necessary but Non-Value Added (NNVA) activities are essential for the process to function smoothly but do not directly add value. These should be improved or redesigned.
  3. Value Added (VA) activities are crucial activities that directly contribute value to the process and are necessary for the business to proceed (Kurokawa, 2010). Activity Value Analysis was employed to understand the significance of each activity in the customer service process and identify activities that could be eliminated.
- A Cause-and-effect Diagram was created to identify the root causes of problems. The causes were categorized into Man, Machine, Method, Material, and Measurement issues.

To ensure the accuracy and credibility of the data, a triangulation method was employed, involving primary sales data collection, non-participatory observations of employee activities through security cameras, and in-depth interviews. Afterward, we applied Leagile and Lean Six Sigma concepts for the customer service process during the period from March 1st to April 30th, 2023. The outcomes were measured by observing employee activities through security cameras and focused on reducing customer waiting time (lead time) and minimizing activity-based costing.

Results

1. Results of the time periods in the customer service process with the highest demand for beverage purchases using demand forecasting.

Through data collection and analysis using Python and ARIMA tools, we found that the demand for products was highest during the time slots 07:45-08:00 a.m. and 12:45-01:00 p.m. These time slots correspond to the rush hours before work, as estimated. In the time slot 07:45-08:00 a.m., the demand increased from 3.78 to 6.55 cups, representing a 73.2% increase compared to the previous 15-minute interval. Similarly, in the time slot 12:45-01:00 p.m., the demand increased from 3.88 to 6.86 cups, indicating a significant 76.8% increase compared to the previous 15-minute interval as shown in Figure 3.

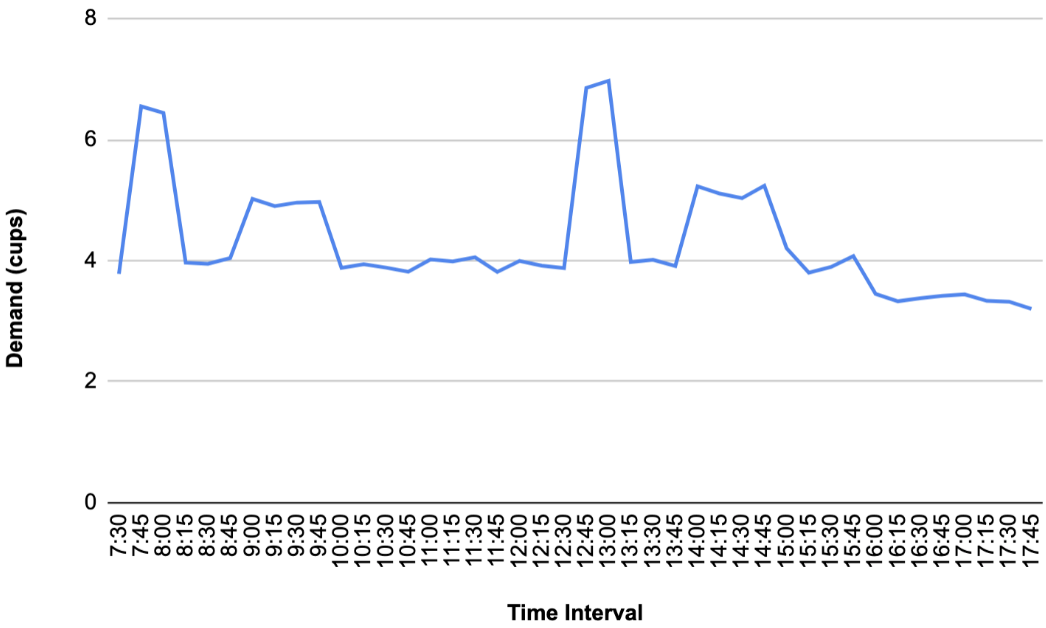

Figure 3 The Forecasted Demand for Products in Each Time Slot

Additionally, the forecast's accuracy was checked, revealing a Mean Absolute Percentage Error (MAPE) of 3.21%, Mean Square Error (MSE) of 1.35, and Mean Absolute Error (MAE) of 0.96. These low values indicate a high level of accuracy in the forecasting.

2. Results of Customer Service Process Improvement using Leagile and Lean Six Sigma Concepts

2.1 Data Collection Results

Through in-depth interviews with key informants, observation of employee activities through security cameras, and analysis of relevant documents, the researcher gathered the following data:

2.1.1 The Service Blueprint: The customer service process at the XYZ coffee shop was divided into three main sections: the customer section, the interaction section between service providers and customers, and the service provider section. The customer section involved queuing and ordering from the menu. The interaction section included receiving and verifying customer orders, recording orders on the computer, processing payments and providing change, inquiring about customer names, and recording names for order delivery. The service provider section involved beverage preparation, checking order accuracy, assembling the order, and delivering it to the customer. (Figure 4)

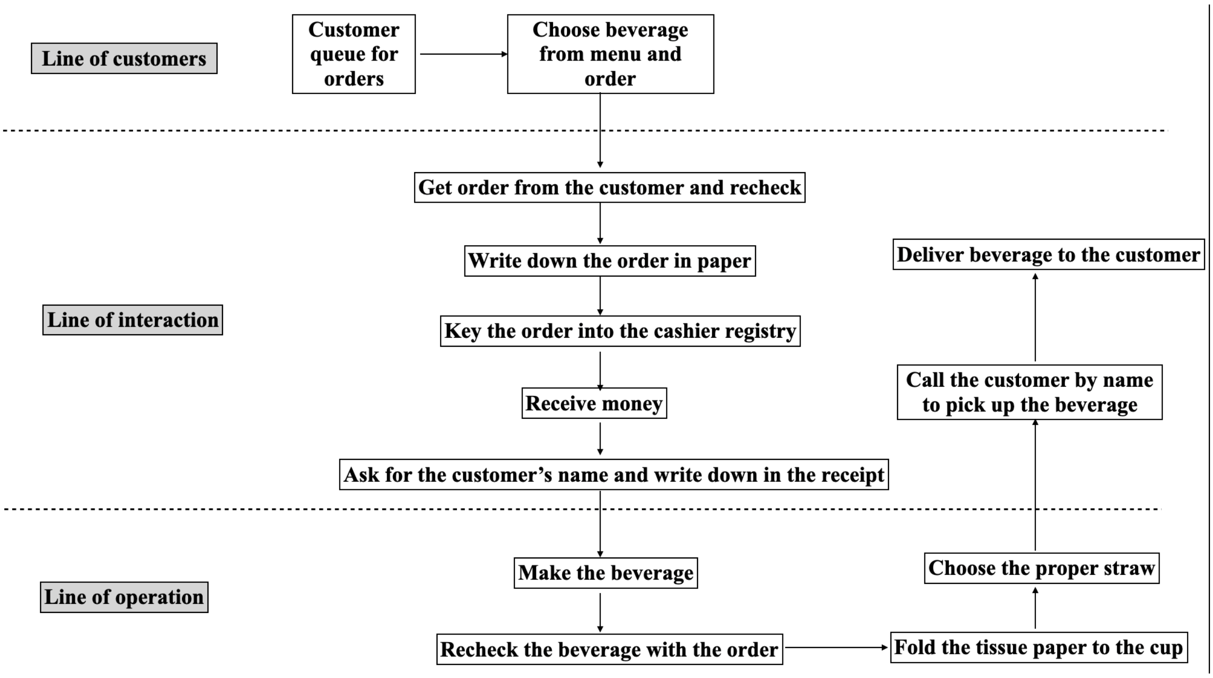

Figure 4 The Service Blueprint of XYZ Fresh Coffee Shop

2.1.2 The Process Flow Chart and Activity Value Analysis: We found that there are overall 13 activities in the customer service process which can be categorized as

1) Non-Value-Added (NVA) Activities
2) Necessary but Non-Value-Added (NNVA) Activities
3) Value-Added (VA) Activities (Table 3)

Table 3. The Process Flow Chart and Activity Value Analysis

Order	Activity	Activity Value	Symbol*
	Queuing and Choosing beverage to order		
1	Queuing for ordering	NVA	○⇨☐ ◗▽
2	Choosing beverage from menu and order	NNVA	●⇨☐D▽
	Taking order from the customers		
3	Taking order from the customer and recheck	NNVA	○⇨■D▽
4	Write down the order on paper	NVA	●⇨☐D▽
5	Key the order into the cashier registry	VA	●⇨☐D▽
6	Receive money	VA	●⇨☐D▽
7	Ask for the customer's name and write it down on the receipt	NVA	●⇨☐D▽
	Making the beverage		
8	Making the beverage	VA	●⇨☐D▽
	Deliver beverage to the customer		
9	Recheck the beverage with the order	NNVA	○⇨■D▽
10	Fold the tissue paper onto the cup	NVA	●⇨☐D▽

Table 3. (Cont.)

Order	Activity	Activity Value	Symbol*
11	Choose the proper straw	NVA	●⇨☐D▽
12	Call the customer by name to pick up the beverage	NNVA	●⇨☐D▽
13	Deliver beverage to the customer	VA	●⇨☐D▽

Note: *Black symbols represent selected activity categories. White symbols represent unselected activity categories.

Circle symbol	●/○	means operation
Arrow symbol	➞/⇨	means moving
Square symbol	■/☐	means checking
Half-circle symbol	◗/D	means delaying/waiting
Downward triangle symbol	▼/▽	mean storage

The Activity Value Analysis reveals that there are five Non-Value-Added (NVA) activities (idle time), which are queuing for ordering, writing down the order on paper, asking for customer names and writing them down on the receipt, folding the tissue paper on the cup, and choosing the proper straw for each beverage.

2.1.3 The Cause-and-effect diagram: After conducting in-depth interviews with the staff, the causes of inefficient customer service during peak times were identified. The causes fall into the categories of Man (personnel), Machine (equipment), Method (process steps), Materials (inventory), and Measure (customer increase), as in Figure 5

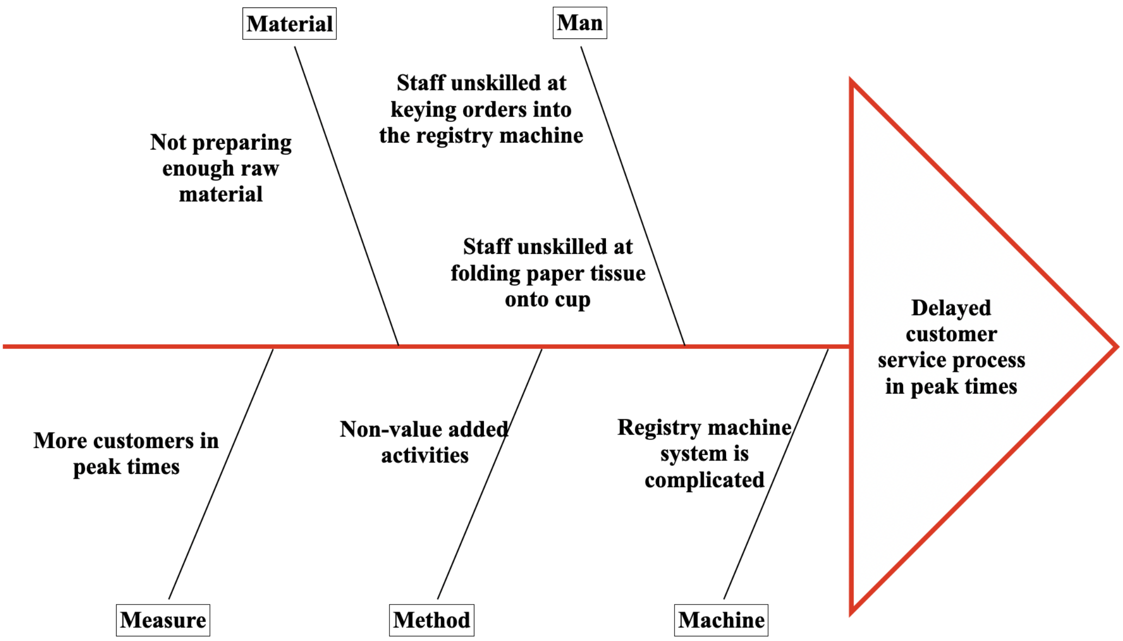

Figure 5 The Cause-and-effect Diagram

2.2 Applying Leagile principles to reduce customer waiting time and eliminate non-value-added activities.

Leagile principles were implemented in the customer service process. Leagile is a combination of Lean principles, aimed at reducing waste and improving efficiency, and Agile principles, which focus on responding to changing customer needs, especially during peak times. The decoupling point, which is the point in the process where forecast-driven operations, based on Lean principles, switch to order-driven operations, based on Agile principles, was set. Based on the demand forecasting results, the peak times with the highest demand were identified as 7:45-8:00 a.m. and 12:45-1:00 p.m., the start of those periods was selected to be the decoupling points.

Before the decoupling point, Lean principles were used to create standard processes, reduce waste, and streamline workflows. For instance, we got rid of non-value-added activities, standardized the amount of coffee powder per cup to minimize waste, and optimized the workflow by eliminating unnecessary steps, focusing on essential processes to ensure smooth operations during non-peak times while still maintaining customer satisfaction. After the decoupling point, Agile principles were applied to increase agility and flexibility in the operations, specifically to cater to changing customer demands during peak times. The staff were encouraged to customize orders according to each customer's preferences to ensure that customer needs were met promptly. Materials and equipment required for order fulfillment were prepped to be readily available. For instance, iced beverage cups were prepared in advance to cater to the increased demand for cold beverages. This agile approach allowed the staff to quickly adjust to customer fluctuations. We also encouraged staff to have more role flexibility through task coaching. This switch happens during peak times to ensure better responsiveness to increased customer demand. (Figure 6)

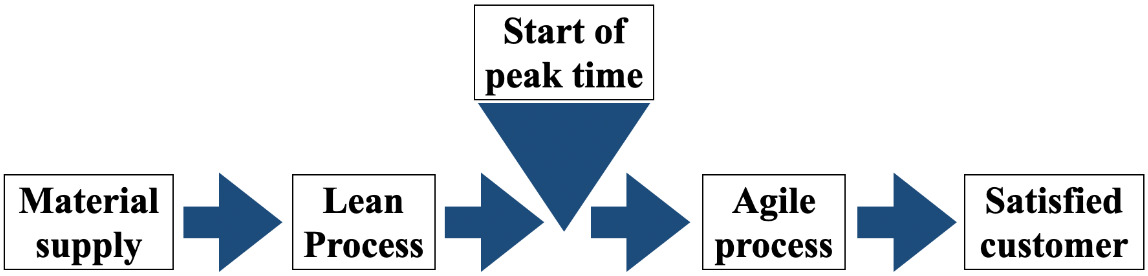

Figure 6 Implementation of the Leagile Principle

Additionally, the organization adopted a Hybrid Supply Chain approach, combining Lean and Agile principles. This approach allowed them to maintain efficiency in cost and responsiveness to customer demands throughout the process. During this study, the term "Hybrid Supply Chain" referred to using Lean principles for managing regular, stable demand items, such as coffee beans and milk. At the same time, Agile principles were applied for items with varying demands, like pastries, which were harder to forecast.

2.3 Applying Lean Six Sigma to reduce customer waiting time and eliminate wasteful activities.

From the Process Flow Chart and Activity Value Analysis (Table 3), it is evident that there are Non-Value Added (NVA) activities, causing idle time in five areas: queuing in line to place an order, writing down orders on paper, asking for customer names and writing them down, folding paper for coasters, and selecting appropriate straws for beverages. Along with the cause-effect diagram and the in-depth interview, we made several adjustments as follows:

1) Writing down orders on paper: It was found that employees needed to write down orders on paper before input to the registry machine because use of the machine was complex, and the items were scattered and difficult to find. We then created a code for each beverage, listed alphabetically and by group, which made it easier and faster for the staff to input. The groups of beverages were also re-arranged in the registry machine to make them easier to find.

2) The step of asking for customer names and writing them down on orders was eliminated since the order receipts already included order numbers for easy identification. When the beverage was ready, the staff called the order numbers instead of the customers' names.

3) The placement of coasters and straws was arranged near the counter, allowing customers to take them by themselves.

4) Although waiting queues themselves are challenging to directly modify, the improved efficiency in other processes reduced the waiting time during peak periods.

After incorporating customer demand forecasts, Leagile principles, and Lean Six Sigma concepts for two months, the organization created an improved service blueprint, (Figure 7) measured and analyzed the Process Flow Chart and the Value of Activities (Table 4) to demonstrate the effectiveness of the improved customer service processes.

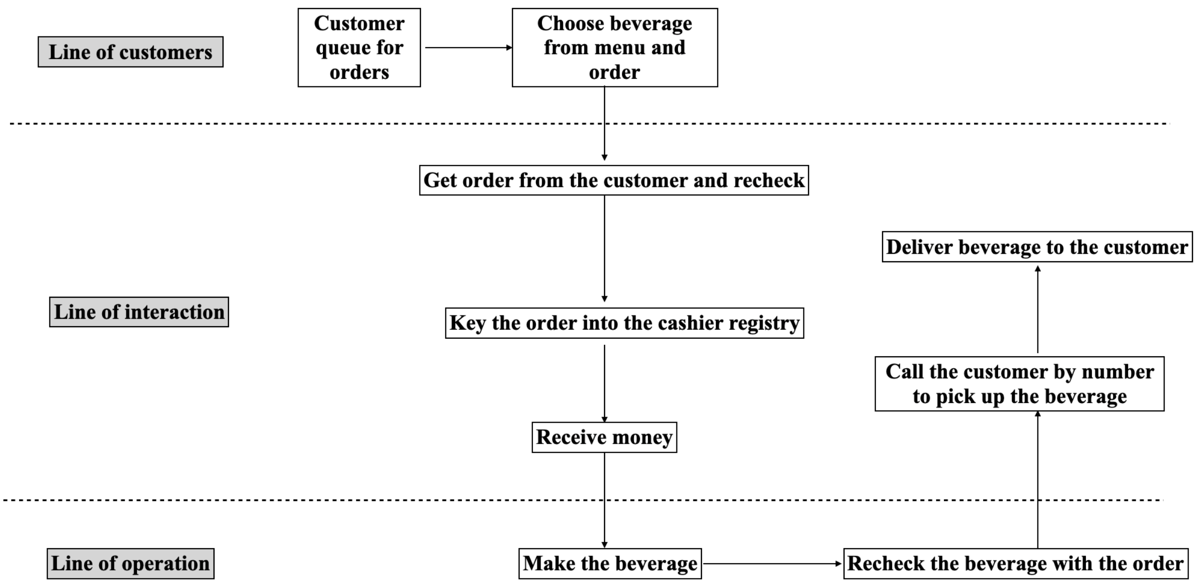

Figure 7 An Improved Service Blueprint

Table 4. The Process Flow Chart and Value of Activities After Improvement

Order	Activity	Activity Value	Symbol*	Time after improvement (sec/cup)
	Queuing and Choosing beverage to order			
1	Queuing for ordering	NVA	○⇨☐ ◗▽	18.03
2	Choosing beverage from menu and order	NNVA	●⇨☐D▽	12.03
	Taking order from the customers			
3	Taking order from the customer and recheck	NNVA	○⇨■D▽	3.96

Table 4. (Cont.)

Order	Activity	Activity Value	Symbol*	Time after improvement (sec/cup)
4	Write down the order on paper	NVA	●⇨☐D▽	[redacted]
5	Key the order into the cashier registry	VA	●⇨☐D▽	4.67
6	Receive money	VA	●⇨☐D▽	36.20
7	Ask for the customer’s name and write it down on the receipt	NVA	●⇨☐D▽	[redacted]
	Making the beverage			
8	Making the beverage	VA	●⇨☐D▽	241.79
	Deliver beverage to the customer			
9	Recheck the beverage with the order	NNVA	○⇨■D▽	6.91
10	Fold the tissue paper onto the cup	NVA	●⇨☐D▽	[redacted]
11	Choose the proper straw	NVA	●⇨☐D▽	[redacted]
12	Call the customer by name to pick up the beverage	NNVA	●⇨☐D▽	4.67
13	Deliver beverage to the customer	VA	●⇨☐D▽	4.79
Total				**333.03**

Note: *Black symbols represent selected activity categories. White symbols represent unselected activity categories.

Circle symbol	●/○	means operation
Arrow symbol	➞/⇨	means moving
Square symbol	■/☐	means checking
Half-circle symbol	◗/D	means delaying/waiting
Downward triangle symbol	▼/▽	mean storage

By reducing the lead time by 87 seconds, or 1.45 minutes per cup, it results in a 20.71% reduction. Furthermore, the idle time was reduced by moving from 5 to activities to 4, resulting in an 80% reduction.

We calculate that for one day, considering approximately 181 cups of beverages are sold per day, the reduced lead time would save 15,747 seconds or 262.45 minutes, allowing a total of 47 additional customer services per day. Assuming a standard beverage price of 50 baht per cup, this efficiency improvement could save up to 2,350 baht per day, or 61,100 baht per month in wasted activity costs.

In summary, when comparing before and after the improvement of customer service processes using Leagile and Lean Six Sigma principles, the differences are as follows:

Table 5. Comparison Before and After Improvement of Customer Service Processes Using Leagile and Lean Six Sigma Principles

Indicator	Before	After	% change
Lead time (sec)	420	333.03	20.71
Non-value added activity (activity)	5	4	80
Activity-based costing (Bath/month)	61,100	0	100

Discussions

The study analyzed the customer service process and identified the peak time for beverage purchases. It found that the demand for products peaked at 7:45-8:00 a.m. and 12:45-1:00 p.m., which were rush hours before work and during lunchtime. The application of Leagile and Lean Six Sigma principles to the coffee shop's customer service process revealed five non-value-added activities (NVA) resulting in idle time: waiting in line to order, writing orders on paper, asking for customer names and recording them, putting lids on cups, and selecting appropriate straws for beverages. These activities consumed a total of 87 seconds or 1.45 minutes per cup, contributing to customer service delays.

The study found that forecasting demand using the ARIMA method can reveal the buying patterns of customers in different time intervals and identify peak times, which are crucial for initiating improvements and enhancing operational efficiency to satisfy customer needs during purchasing and was set as the decupling point to switch from Lean management to Agile management in the Leagile principle. This aligns with the research of Thonglor et al. (2012), Supanakorn (2011) and Phansangwan et al. (2021).

By applying the concepts of Leagile and Lean Six Sigma, the customer service system becomes more efficient. This corresponds with the studies of Leechaianan (2013) and Zhang et al. (2012), which found that Leagile principles enable rapid and efficient responses to customer demands. Additionally, Thatphet and Ruangchoengchum (2019) discovered that eliminating unnecessary activities and movements reduces waste, consistent with the research of Pugna et al. (2016) and Smętkowska and Mrugalska (2018), who demonstrated the application of Lean Six Sigma to reduce process variability in production and improve the standardization of coffee preparation processes.

The improved efficiency in customer service processes reflects the benefits and success of combining demand forecasting with Leagile and Lean Six Sigma principles in enhancing operational efficiency, reducing waste, and lowering unnecessary activity costs in stand-alone fresh coffee shop businesses.

Entrepreneurs can consider using demand forecasting to identify peak times of demand, aiming to enhance the efficiency of customer service processes in conjunction with the Leagile and Lean Six Sigma concepts. This involves collecting and analyzing data, identifying the root causes of problems, selecting an appropriate decoupling point to modify the workflow, and utilizing forecast-driven principles in the Lean model. The workflow is then transformed using order-driven principles in the Agile model. Eliminating non-value-added activities is crucial as these issues can enhance the efficiency of customer service processes, reducing customer waiting times and minimizing unnecessary business activity-based costs.

Conclusions

Demand forecasting, along with Leagile and Lean Six Sigma principles reflects the benefits and success of improving customer service processes by enhancing operational efficiency and lowering unnecessary activity costs in stand-alone fresh coffee shop businesses.

Acknowledgements

This research was supported by the College of Graduate Study in Management, KhonKaen University, Thailand.

References

Box, G. E. P., Jenkins, G. M., Reinsel, G. C., & Ljung, G. M. (2016). *Time series analysis: Forecasting and control* (5th ed.). John Wiley & Sons, Inc.

Heizer, J., Render, B., & Munson, C. (2017). *Principles of operations management: Sustainability and supply chain management* (10th ed.). Pearson.

Hyndman, R. J., & Athanasopoulos, G. (2021). *Forecasting: principles and practice* (3rd ed.). OTexts.

International Coffee Organization. (2022, April 20, 2023). *Annual review coffee year 2021/2022.* https://www.ico.org/documents/cy2022-23/annual-review-2021-2022-e.pdf

Leechaianan, S. (2013). Hybrid supply chain (leagility) application in barbed wire manufacturing process: A case study. *TNI Journal of Business Administration and Languages. 1*(1). 1-5.

Kurokawa, Y. (2010). *M&A for value creation in Japan* (6th ed.). World Scientific.

Moldvaer, A. (2021). *The coffee book.* DK Publishing.

Naylor, J. B., Naim, M. M. & Berry, D. (1997). Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain masts working paper no. 47. Republished in *International Journal of Production Economics* (1999), 62, 107-118. Cited in Goldsby, T. J., Griffis, S. E., & Roath, A. S. (2006). Modeling Lean, Agile, and Leagile supplu chain strategies. *Journal of Business Logistics, 27*(1), 57–80. https://doi.org/10.1002/j.2158-1592.2006.tb00241.x

OpEx Learning Team. (2010, April 20, 2023). *Starbucks waiting time and lean operations.* Opexlearning. https://opexlearning.com/resources/starbucks-queueing-theory-constraints-lean/7768

Ounmee, T. (2017). *Forecasting and inventory planning to reduce the problem of delayed shipment: A case study of lens manufacturer*. Thammasat University.

Pepper, M. P. J., & Spedding, T. A. (2010). The evolution of lean six sigma. *International Journal of Quality & Reliability Management, 27*(2), 138–155. https://doi.org/10.1108/02656711011014276 cited by Gupta, S., Modgil, S., & Gunasekaran, A. (2020). Big data in LeanSix sigma: A review and further research directions. *International Journal of Production Research, 58*(3), 947–969. https://doi.org/10.1080/00207543.2019.1598599

Phansangwan, P., Suthikarnnarunai, N. & Janpong, S. (2021). Inventory management efficiency improvement: A case study of retail company. *Journal of Nakhonratchasima College (Humanities and Social Sciences), 15*(3), 391–405.

Pugna, A., Negrea, R., & Miclea, S. (2016). Using six sigma methodology to improve the assembly process in an automotive company. *Procedia - Social and Behavioral Sciences, 221*, 308–316. https://doi.org/10.1016/j.sbspro.2016.05.120

Python. (n.d.). *History and license.* Retrieved April 20, 2023, from https://docs.python.org/3/license.html

Smętkowska, M. & Mrugalska, B. (2018). Using Six sigma DMAIC to improve the quality of the production process: A case study. *Procedia - Social and Behavioral Sciences, 238*, 590–596. https://doi.org/10.1016/j.sbspro.2018.04.039

Supanakorn, J. (2011). Time series forecasting for production planning of bearing parts. *The Journal of King Mongkut's University of Technology North Bangkok, 21*(3), 595–606.

Sethithorn, S. (2019, April 20, 2023). *Thailand food market report; Coffee shop business in Thailand.* http://fic.nfi.or.th/upload/market_overview/Rep_Cafe_15.01.62.pdf

Thai Kasikorn Research Center. (2018, April 5, 2023). *How to manage coffee shop business.* https://www.kasikornbank.com/th/business/sme/KSMEKnowledge/article/KSMEAnalysis/Documents/Coffee-Shop-Management.pdf

Thatphet, K. & Ruangchoengchum, P. (2019). An elimination of non-value added movement by organizing production process layout: A case study of fresh coffee shop business in Khon Kaen Province. *Journal of Management Science, Ubon Ratchathani University, 10*(2). 1-24.

Thonglor, N., Anusasansnun, S., & Anegasukha, S. (2012). A need assessment by using forecast equation for school administration planning. *Phranakhon Rajabhat Research Journal, 7*(2), 124–141.

Vasisht, P. (2018, April 20, 2023). *The 9-minute takeaway coffee.* Medium. https://medium.com/designrover/the-9-minute-takeaway-coffee-67045d359b57

Zhang, Y., Wang, Y. & Wu, L. (2012). Research on demand-driven leagile supply chain operation model: A simulation based on anylogic in system engineering. *Systems Engineering Procedia, 3*, 249–258. https://doi.org/10.1016/j.sepro.2011.11.027