IMPLEMENTATION OF SIX SIGMA IN A RESTAURANT

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ISE 250: Leading the Six Sigma Improvement Project

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Abstract

This project presents a study in which the DMAIC concept of Six Sigma was implemented for a process of operation of a restaurant to satisfy the customers and reduce the errors in the process. During this study ,the problem with long wait times and inaccurate orders were examined as per voice of customer (VOC) which was drawn through customer feedback forms over a period of four weeks. The study analyzes the root cause of the problems and based on the root cause an improvement plan was developed through layout changes. At the end of investigation few solutions are in the process of implementation and the order lead time is expected to reduce from 45 min to 30 min with zero percent error in order mismatch.

Introduction:

Six sigma is a set of tools and techniques which uses data for process improvement primarily focusing on reducing the variability and improving quality. It follows statistical approaches and methodologies which targets to reduce the defects up to 3.4 defects per million opportunities. It is done by increasing the effectiveness and efficiency of all operations to meet customer demands and expectations[1].Six sigma was established in the 1980's by an engineer at US telecommunication company Motorola and was mainly used in manufacturing industries. Although this method was majorly used for improving productivity it gained popularity in the service organizations as it focused on improving the quality of service and hence directly improving customer satisfaction.

Six sigma initiatives are built by manufacturing organizations on a foundation of quantifiable processes and quality control systems. However, by focusing on teamwork and using statistical data to make decisions, the framework of implementing the initiatives could be adjusted to suit the core business of service organizations[5]. A key component in a successful six sigma introduction in services would be the company's ability to assess their organizational readiness for a six sigma program along with their ability to choose proper tools to begin to build the six sigma system.[2]

 A few points which are quite challenging in the service industry are that measurement is often overlooked and hence improvements in quality are not adequately addressed. In manufacturing ,it is quite common to have process maps , analysis of work processes whereas in services these are not clearly defined and the system mostly depends on employee performance and human behavioral factors such as friendliness , eagerness to help etcetera which are intangible products.[5] When the emphasis is on improvement of timeliness characteristics (delivery time) and service non-conformity characteristics the service businesses should be able to attain many of the same outcomes as manufacturing firms.

Literature Review:

1.[Hensley RL, Dobie K (2005)]Assessing readiness for six sigma in a service setting. :This paper studies the goals to create a methodology to assess service firms' readiness for a six sigma program and to offer ideas for implementing the six sigma process. The organizational preparedness model is used in a real service environment.

2. [Nishant Bhasin, Harkrit Chhatwal, Aditya Bassi & Shubham Sharma(2021)] Implementation of Six-Sigma Tools in Hospitality Industry: A Case Study :The paper presents a case study where six sigma concept was implemented in a restaurant to meet the customer expectation as per voice of customer. The focus was on reducing the pick up order lead time using DMAIC and the solutions increased the sigma level from 0 to 2.2 sigma indicating a positive result.

3. [Hsi-Tien Chena and Kuen-Suan Chen (2016)]A paired-test method to verify service speed improvement in the Six Sigma approach: a restaurant's case study : The goal of their study was to suggest a non-parametric statistics methodology called the paired-test method of order statistics to fill the knowledge gap in Six Sigma projects' measure phase. A campus restaurant was selected to show how the suggested approach and Six Sigma procedures would be used.It compared the service speeds before and after six sigma implementation.

4. [Kivela J, Kagi J (2008)]Applying six sigma in foodservice organization-The paper points at the effective implementation of the Six Sigma quality system into a big foodservice organization's environment .Main focus was on contributions made by various organizational levels to the implementation and perceived significance of such a system inside the organization.

Methodology:

The study was conducted at Kabab and Curry's restaurant located in Santa Clara, San Jose since 1990's and they are well known to offer collective culinary journeys to explore the delightful tastes of the east. The research adopted a case study approach using DMAIC (define-measure-analyze-improve-control) phases to improve the dining experience for the customers.

The framework and processes of the Six Sigma DMAIC in the current study started when we visited the restaurant for dinner and observed scope for improvement to increase customer satisfaction. The study is mostly limited to weekends when there are high walk in's for dining and many orders placed over various delivery applications for takeaway with same manpower in the kitchen and two extra staff along with regular waiters to face the customers.

We started gathering customer complaint data from google reviews to define (D) a primary critical to quality (CTQ) problem. During the measure (M) stage, based on the CTQ problem , a questionnaire was designed to investigate and measure current CTQ performance. A cause and effect diagram and brainstorming were subsequently used to analyze (A) the core causes of the CTQ problem. In the improve (I) stage , countermeasures were brainstormed and suggested for implementation. After a period of implementation of the improvement strategies and measures , the questionnaire investigation method will be conducted again to collect data after improvement and the effectiveness of solutions will be verified .Finally to ensure stability of improved process Standardized operation procedures will be prepared to control (C) the CTQ problem.

Define Phase:

The Voice of customer is a crucial reference for defining the CTQ problems[3].In our current study ,customer ratings and comments show the customer's deep concern towards delayed orders and missing items on order. They were initially obtained through online reviews or on location. A discussion with Restaurant manager reconfirmed the issues that often occurred and limited costs ,time and human resource the primary CTQ characteristic was defined as long wait time and missing items in the order.

Subsequently , a SIPOC diagram [Supplier , Input ,Process, Output, Customer] was drawn to map the stakeholders of the overall operations in the restaurant .

SIPOC Diagram

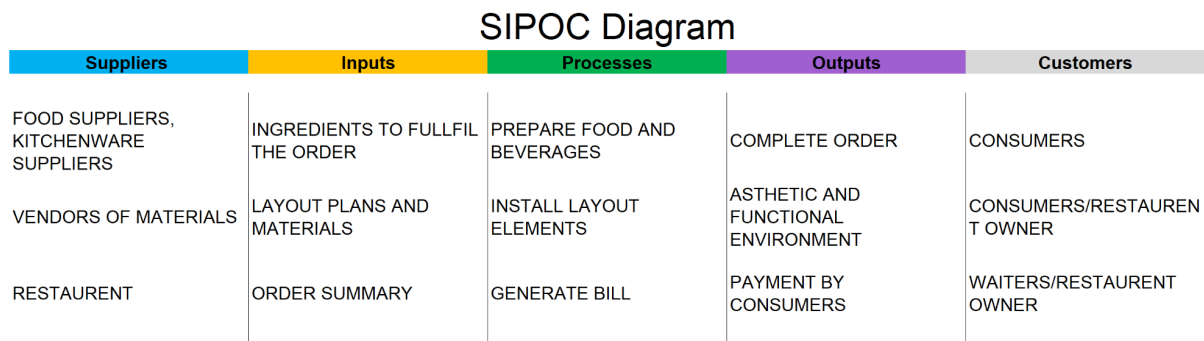| Suppliers	Inputs	Processes	Outputs	Customers
FOOD SUPPLIERS, KITCHENWARE SUPPLIERS	INGREDIENTS TO FULLFIL THE ORDER	PREPARE FOOD AND BEVERAGES	COMPLETE ORDER	CONSUMERS
VENDORS OF MATERIALS	LAYOUT PLANS AND MATERIALS	INSTALL LAYOUT ELEMENTS	ASTHETIC AND FUNCTIONAL ENVIRONMENT	CONSUMERS/RESTAURENT OWNER
RESTAURENT	ORDER SUMMARY	GENERATE BILL	PAYMENT BY CONSUMERS	WAITERS/RESTAURENT OWNER

Figure 1: SIPOC Diagram for stakeholder mapping

A project charter was developed which consists of the business case, project goal , scope , limitations ,milestones, CTQ's and Roles.
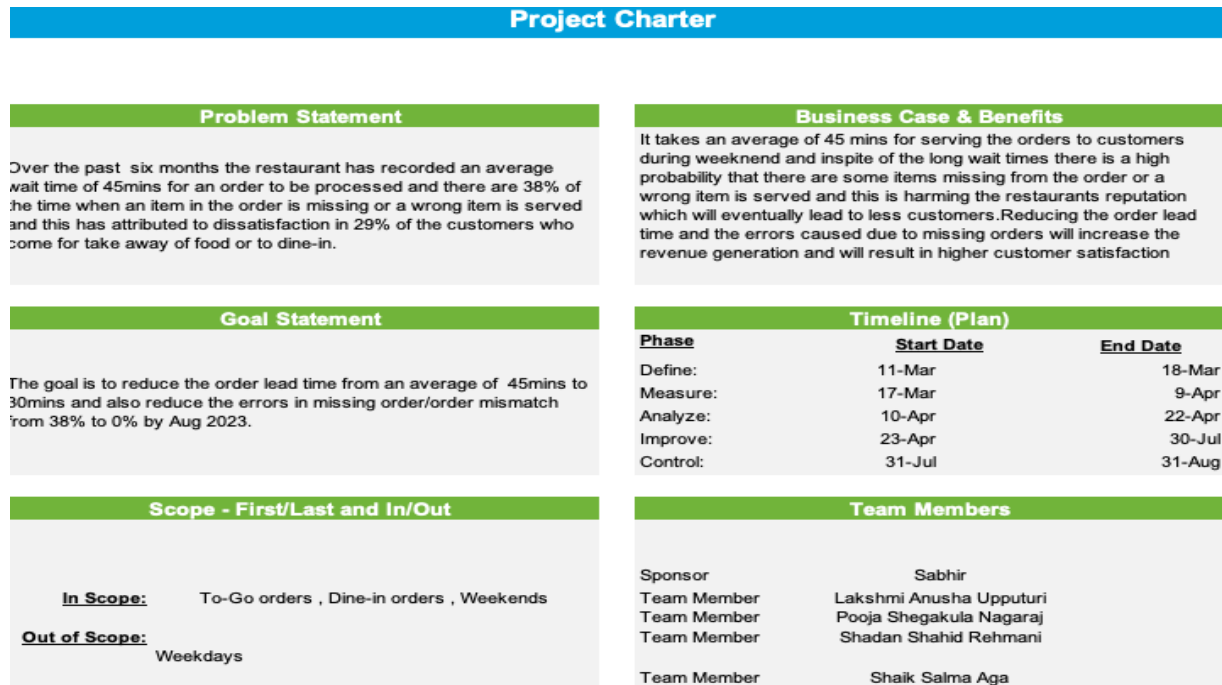
Project Charter

Problem Statement

Over the past six months the restaurant has recorded an average wait time of 45mins for an order to be processed and there are 38% of the time when an item in the order is missing or a wrong item is served and this has attributed to dissatisfaction in 29% of the customers who come for take away of food or to dine-in.

Business Case & Benefits

It takes an average of 45 mins for serving the orders to customers during weeknend and inspite of the long wait times there is a high probability that there are some items missing from the order or a wrong item is served and this is harming the restaurants reputation which will eventually lead to less customers.Reducing the order lead time and the errors caused due to missing orders will increase the revenue generation and will result in higher customer satisfaction

Goal Statement

The goal is to reduce the order lead time from an average of 45mins to 30mins and also reduce the errors in missing order/order mismatch from 38% to 0% by Aug 2023.

Timeline (Plan)

Phase	Start Date	End Date
Define:	11-Mar	18-Mar
Measure:	17-Mar	9-Apr
Analyze:	10-Apr	22-Apr
Improve:	23-Apr	30-Jul
Control:	31-Jul	31-Aug

Scope - First/Last and In/Out

In Scope: To-Go orders , Dine-in orders , Weekends

Out of Scope: Weekdays

Team Members

Sponsor	Sabhir
Team Member	Lakshmi Anusha Upputuri
Team Member	Pooja Shegakula Nagaraj
Team Member	Shadan Shahid Rehmani
Team Member	Shaik Salma Aga

Figure 2: Project Charter

Measure Phase:

Although complainers are only a minority of dissatisfied customers , the existence of other dissatisfied customers may negatively influence business.[3] It was important to identify the perception of the customer regarding the wait times and missing items in order. These problems were mostly observed during the weekends which constituted Friday evenings ,the whole of Saturday and Sunday.

So ,for the measure phase a google form with attributes as per figure 5 was created with questions which focused on gathering data regarding the speed of service ,quality of food ,courteousness, order correctness and overall experience. This questionnaire was pilot tested by the participants of our group and the staff of the restaurant to ensure simplicity and to avoid ambiguity. Comments were included in the final questionnaire to get exact idea of what the issue is. On an average 319 customers visited or ordered from the restaurant over a weekend . The sample size was determined from figure 4 as 296 to collect data from the questionnaire for the population size of 1275 customers with 95% Confidence interval , Margin of error was 0.05 and proportion was set to 0.5 .

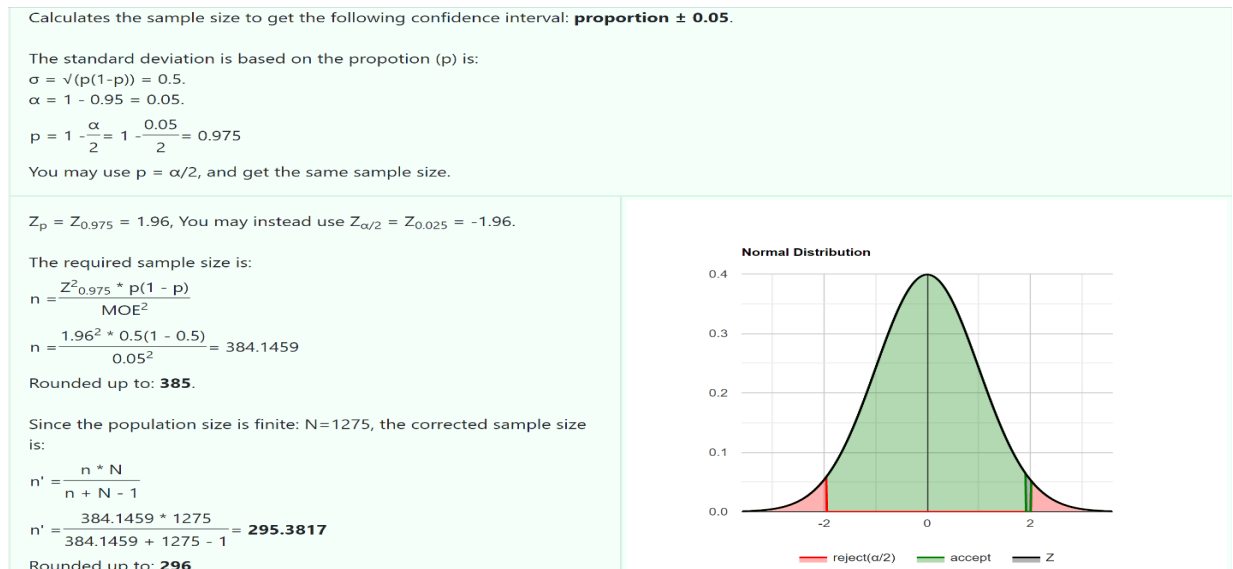Figure 3 : Variables for Sample size calculation

Figure 4: Sample size calculation

The respondents of the survey were the customer who came for dine in and those customer who came to pick their to-go orders and the period of survey was from 17th March to 2nd April 2023.To avoid any interruption of the restaurant operation and customer dining two of our team members were stationed at the

exit during these weekends and customers were asked to complete the forms randomly. The data was summarized using an excel sheet and results were shown in a pareto chart in figure 7 and according to 80/20 principle 80% of the problems were due to longer wait times and missing items/order mismatch in an order and if these issues were resolved most of the service quality problems would be eliminated.

	Agree	Neutral	Disagree.If why
I was seated promptly	○	○	○
Speed of service is fast	○	○	○
Quality of food is good	○	○	○
My order is always correct	○	○	○
My overall experience is good	○	○	○

Figure 5: Attributes collected from questionnaire

	G	H	I	J	K	L	First Nan
	Please answer below '	Please answer below '	Please answer below '	Please answer below '	Please answer below '	If you chose disagree for the any of the qu	
	4/30/2023 14:20:40	4/30/2023 14:20:40	4/30/2023 14:20:40	4/30/2023 14:20:40	4/30/2023 14:20:40	4/30/2023 14:20:40	4/30/
	Neutral	Disagree.If why	Agree	Agree	Neutral	The process of making food is very slowly	Salma
	Neutral	Agree	Neutral	Disagree.If why	Neutral	I have ordered Chicken Tikka but they gave	Rushi
	Agree	Neutral	Agree	Agree	Agree		
	Neutral	Disagree.If why	Neutral	Neutral	Disagree.If why	I am really upset with the food because it to	Mubeen
	Agree	Disagree.If why	Neutral	Agree	Disagree.If why	Service is pathetic owners stand in the fron	Shamsha
	Agree	Disagree.If why	Disagree.If why	Agree	Disagree.If why	This was our first time coming here and I di	Ayaz
		Disagree.If why	Neutral	Agree	Neutral	Poor service and long wait	Bharathi
	Agree	Disagree.If why	Agree	Agree	Disagree.If why	Horrible service. Server lied blatantly about	Sowmya
	Neutral	Disagree.If why	Disagree.If why	Agree	Neutral	Inadequate packing for to go order. The oil	Ashfaq
	Agree	Disagree.If why	Neutral	Neutral	Disagree.If why	Customer service minus/negative 100... Th	vennela
	Agree	Disagree.If why	Neutral	Disagree.If why	Disagree.If why	Called and placed to go order. Was told it v	Prachi
	Agree	Disagree.If why	Neutral	Neutral	Neutral	Literally Had to wait 15 min for just a simple	Mohana
	Agree	Disagree.If why	Disagree.If why	Agree	Disagree.If why	I have tried their food quite a few times. foc	kaushik
	Disagree.If why	Disagree.If why	Agree	Agree	Disagree.If why	seating arrange is not good and I have ord	Chanaky
	Agree	Disagree.If why	Neutral	Neutral	Neutral	Service is too slow	Komal
	Disagree.If why	Disagree.If why	Neutral	Disagree.If why	Neutral	Order mismatched Some items were missin	VS
	Disagree.If why	Neutral	Neutral	Agree	Neutral	I had to wait for 30-45 mins	
	Agree	Agree	Agree	Agree	Agree		
	Agree	Disagree.If why	Neutral	Disagree.If why	Disagree.If why		
	Agree	Disagree.If why	Neutral	Agree	Neutral	I have ordered seekh kabab chicken and b	Manisha
	Agree	Agree	Agree	Agree	Agree		Shilpi
	Agree	Neutral	Neutral	Agree	Agree	N/A	Dheeraj
	Agree	Agree	Neutral	Disagree.If why	Neutral	When I asked for Seekh Kabab chicken, th	Nandha
	Neutral	Neutral	Neutral	Disagree.If why	Disagree.If why	I ordered Seekh Paneer Tikka, but they ser	Nasariya
	Neutral	Neutral	Neutral	Agree	Neutral	No	Butul
	Agree	Neutral	Agree	Neutral	Agree		Mallesh
	Agree	Agree	Agree	Agree	Agree		Mohan
	Agree	Neutral	Neutral	Agree	Agree		Shaista I
	Neutral	Neutral	Disagree.If why	Neutral	Agree		Rida
		Disagree.If why		Neutral		Wait time is more .... Waited around 1hour	Anusmrit
	Agree	Disagree.If why	Agree	Agree	Disagree.If why	Wait time is more	Shreya
	Agree	Neutral	Agree	Disagree.If why	Neutral	I asked for tandoori fish and goat biryani, b	Vyshnav
	Agree	Disagree.If why	Neutral	Agree	Neutral	All I had was chicken biryani. They took a v	Sharooq
	Neutral	Disagree.If why	Agree	Agree	Neutral	Chef took their time in cooking the food, wh	Gupta
	Agree	Disagree.If why	Agree	Agree	Neutral	I waited for around one hour for one item.	venkat
	Agree	Neutral	Neutral	Agree	Neutral		Sai
	Agree	Agree	Agree		Agree		
	Neutral	Neutral	Neutral	Disagree.If why	Neutral	Some items were missing	Monica
	Agree	Disagree.If why	Agree	Neutral	Disagree.If why	At least five times that I visited the restaura	Rachana
	Agree	Neutral	Agree	Disagree.If why	Neutral	Both times I ordered from the restaurant, m	Saishaile
	Neutral	Disagree.If why	Neutral	Agree	Disagree.If why	I had to wait a while to have dum biryani wi	Ravi
	Agree	Agree	Agree	Agree	Agree		Sourabh
	Disagree.If why	Disagree.If why	Disagree.If why	Disagree.If why	Disagree.If why	Late service to serve food	
	Neutral	Disagree.If why	Disagree.If why	Disagree.If why	Disagree.If why	N/A	Prachi
	Neutral	Disagree.If why	Agree	Disagree.If why	Disagree.If why	I'm furious with the staff and chef. I placed	Ravi
	Neutral	Disagree.If why	Neutral	Neutral	Neutral	The taste was unexpected and unappealin	Mohamm

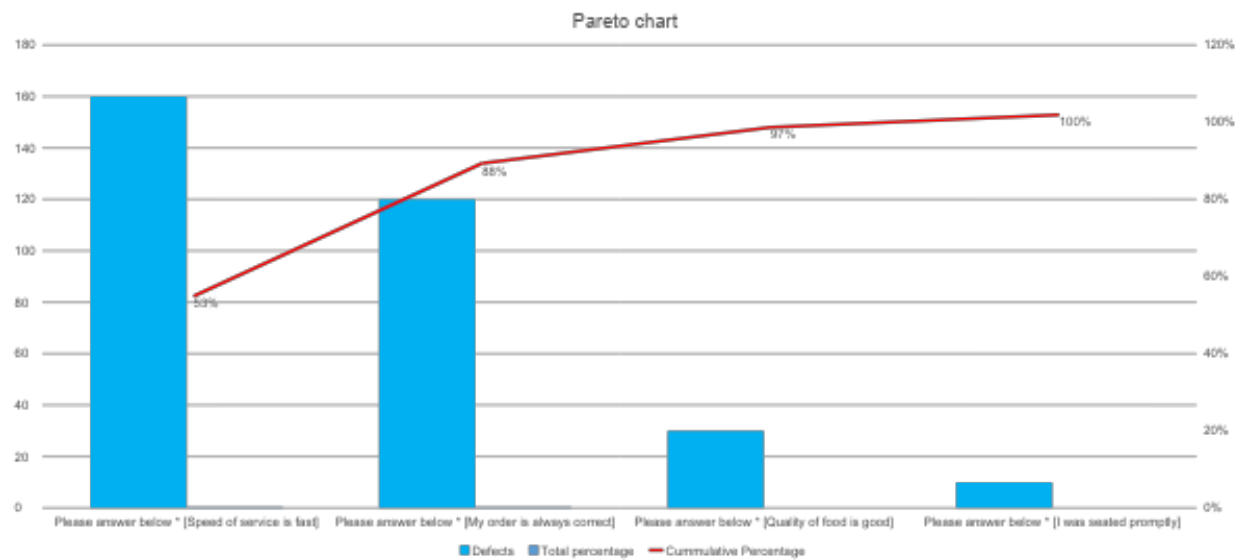Figure 6: Sample feedback obtained from customers during survey

Figure 7 : Pareto chart based on responses from customers

As per the current standard process defined by the restaurant for food preparation and service it took 25 to

35 mins on an average for a particular dish but during the weekend it took 40 – 50 mins and in spite of the

wait there were missing items or order mismatch . This aggravated the customers to give negative feedback

affecting the restaurant's reputation and customer retention. Further, data was collected by recording the time taken to cater the order of 240 random customers in both to-go and dine-in sections with varying types of dishes and number of dishes in each order. This data was recorded over two weeks where the population size was 636 based on previous average customers visiting each weekend with 95% confidence interval 0.05 being the margin of error and 0.5 proportion.

From the recorded data the mean time to cater the orders was calculated as 44.96 min and a process capability analysis was performed in Minitab by setting the USL as 30mins which would be an acceptable time to prepare the food and serve the customer as per restaurant processes. The results obtained in figure 8 indicate that the mean is more than USL and the process needs centering as the graph lies outside the specification.
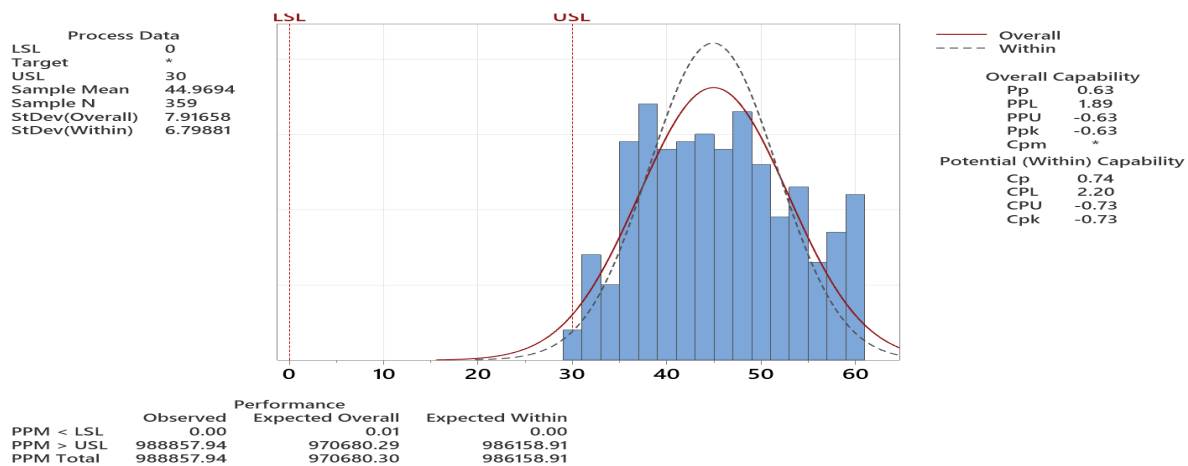
Figure 8:Process capability chart

The next step was to prepare a process flow chart to examine the processes closely to understand which areas had scope for improvement. The process is a little different for the dine in orders and the to-go orders. For dine-in orders, the customers were greeted as they came and they were seated comfortably. The front

desk staff noted the order and once the details were entered into the computer system and confirmed the order was sent to the kitchen printer. The main chef received the order and allocated the order receipt to respective kitchen counters for food preparation and once the order was ready the food was placed on a dine- in desk from where the waiter picked the food and presented it to the customer with necessary cutlery. Once the order was completed the bill was presented for payment and the order was considered complete once the payment was processed by the customer. Similarly for to-go orders the order was received through phone and the order was entered in the computer system and the payment processing happens at the first unlike the dine in orders. The order receipt was printed and given at the takeout desk in the kitchen after which the food was prepared and placed on the takeout desk to be packed. Finally , the food was placed on the food ready desk outside the kitchen for the pick up.A process chart of the current state is drawn in figure 9 for To-go orders and figure 10 for dine in orders.
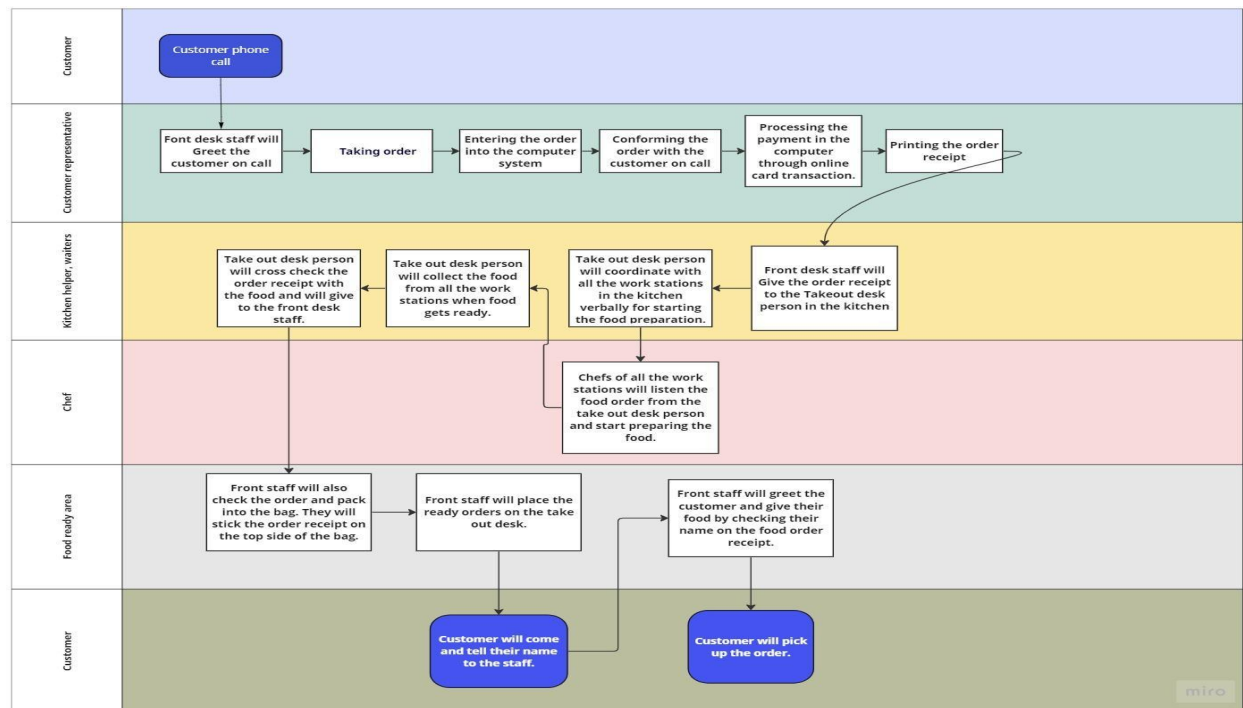
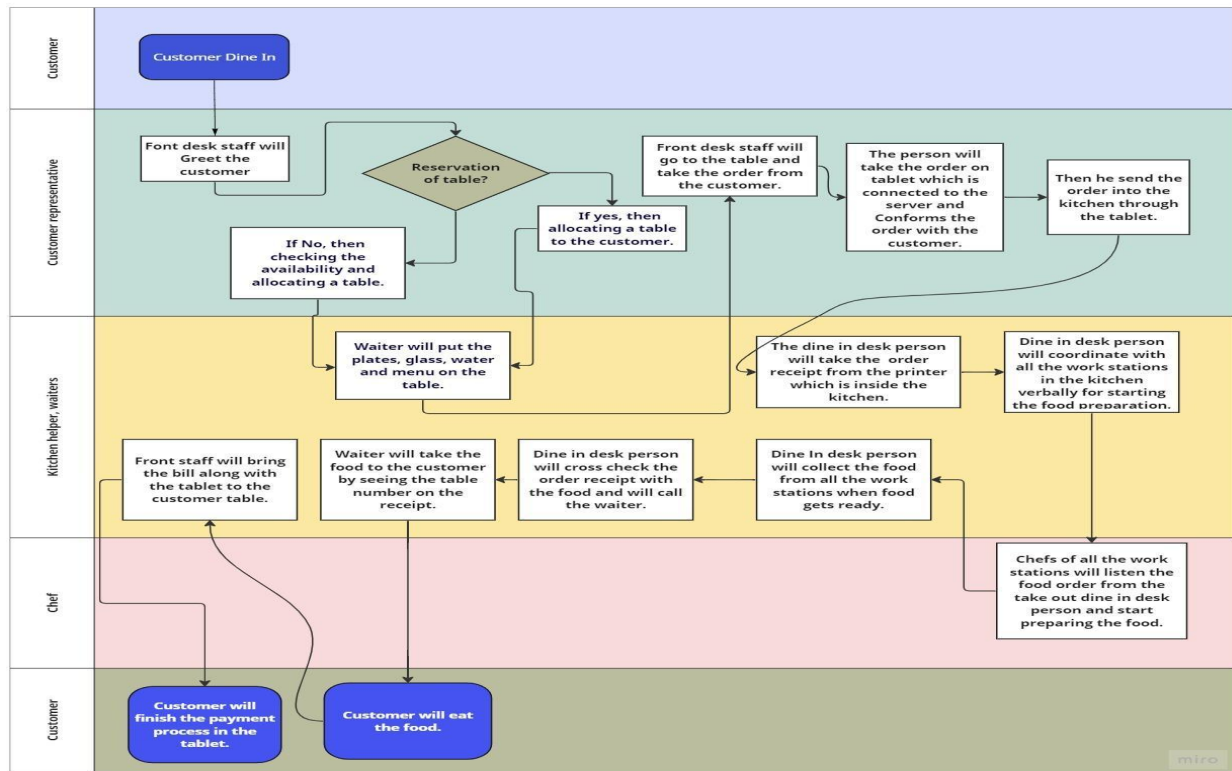Figure 9: Present process chart for To-Go orders
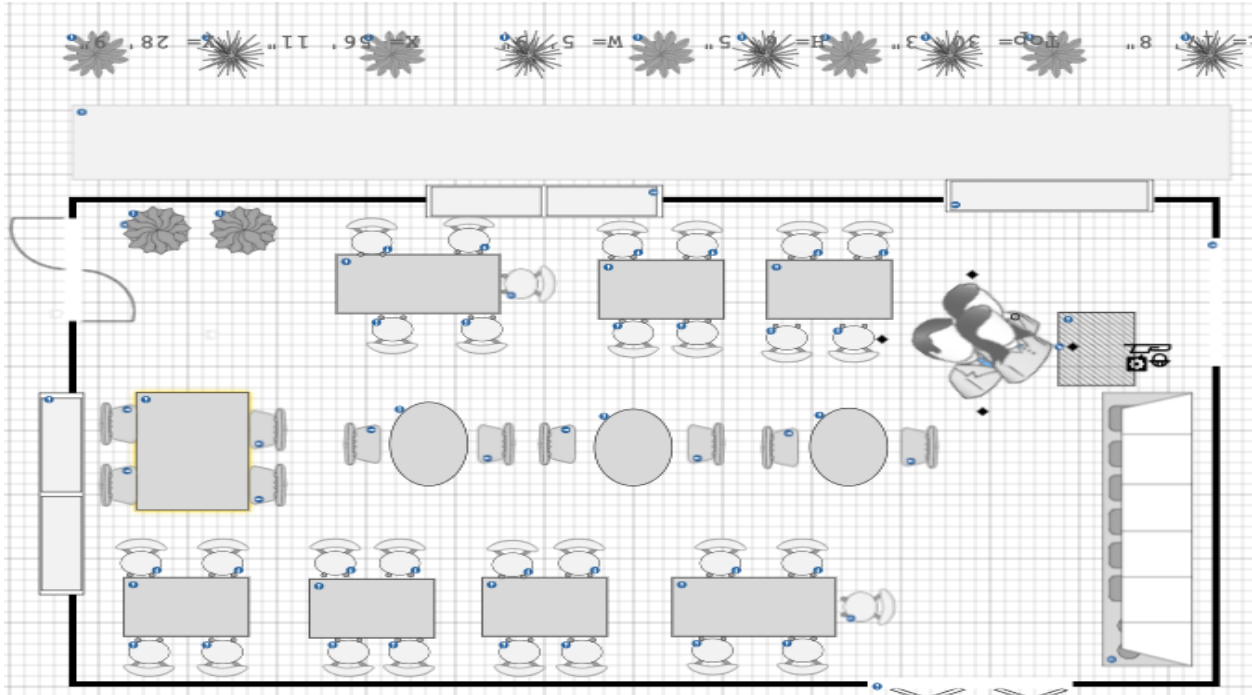
Figure 10: Present process chart for Dine in orders

Figure 11: Current layout of restaurant with seating and To-Go desk

The current layout was studied as per figure 11 to understand the scope of improvement .The location of the to-go desk was at the far end of the restaurant and all the customers had to walk past the tables where other customers dined .This created the appearance of a crowd , disturbed dine in customers and it also created confusion to waiters who had to attend both To-go and dine in customers. These facts highlighted that the layout had to be analyzed further for improvement.

Analyze:

The order lead time and incorrect order are the most crucial factors as per the Pareto Principle in figure 7 and therefore these Critical to Quality factors need to be analyzed further to determine the causes for the problems. There are various tools and techniques to identify the causes and the Ishikawa diagram in figure 12 was used to analyze the causes for CTQ's.

A brainstorming session was conducted within the team and the restaurant staff to list down the causes and the sub causes of the issues and a cause and effect diagram was developed for long wait time and incorrect orders as in figure 12 and figure 13 respectively.
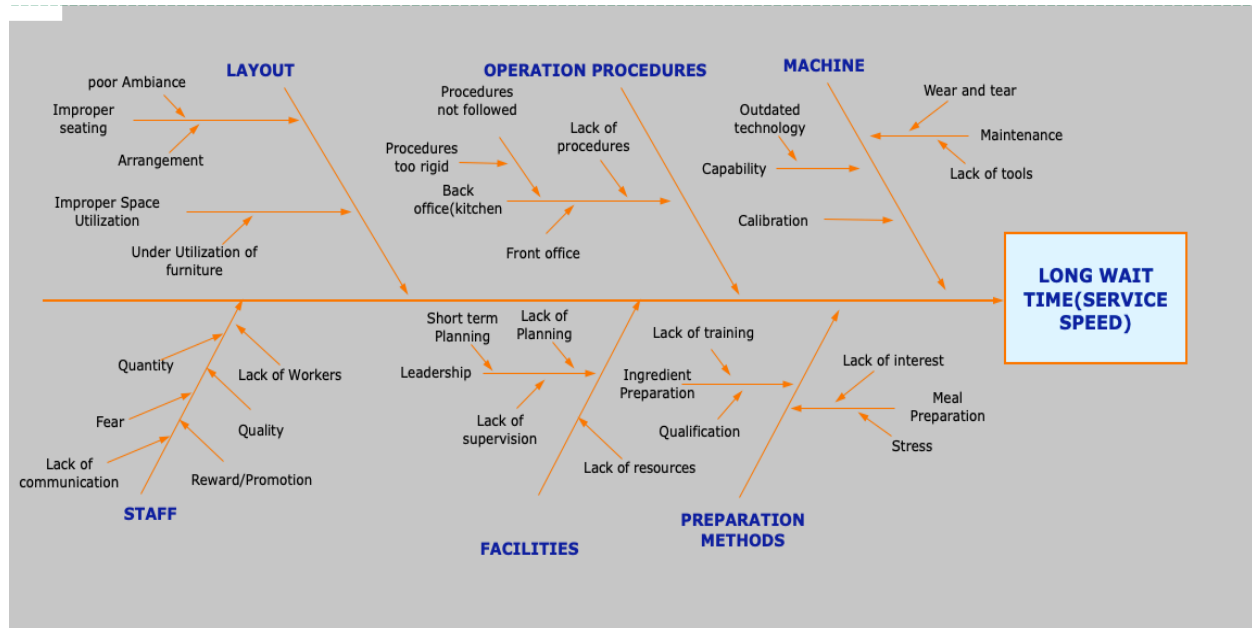

Figure 12: Ishikawa diagram for long wait time

The causes are verified further as described below:

1. **Staff :** They mostly consisted of fresh hires or part time workers who lacked professional knowledge and experience and also lacked empathy and energy towards meeting customer expectations. Lack of staff in the kitchen section caused poor supervision and most of the times there was confusion in the roles and responsibilities of staff members. Fear of communication also leads to poor performance. Reward and promotion system was absent and this led to demotivation in staff .

2. **Operation Procedures & Preparation Methods :** The operation procedures in the kitchen and the front office are not clearly defined and during weekends most of the procedures are not followed due to urgency and chaos. The kitchen prepares meals on a first come first serve basis and different meals require different production processes and time and hence there is still room for improvement

regarding procedures. Lack of knowledge in demand forecasting leads to under preparation of ingredients and the stress caused due to flooding orders leads to skip meal preparation steps.

3. **Facilities & Layout :** Lack of resources such as appliances , manpower , ingredients which are caused due to short term planning or poor leadership are main causes for delayed speed in service. The emphasis on forecasting and planning are ignored. The Layout looked clumsy and to-go customers walking in between created confusion in order fulfillment .The ambience was hampered and space was underutilized to manage the crowd. While waiting for orders both dine in and take away customers desire a comfortable waiting area with favorable waiting atmosphere however as to-go customers wait near the counter there is a lot of impatience.

4. **Machine :** Not having a preventive maintenance schedule leads to sudden breakdown of appliances causing unexpected wait times . Regular calibration and maintenance training to staff was lacking.
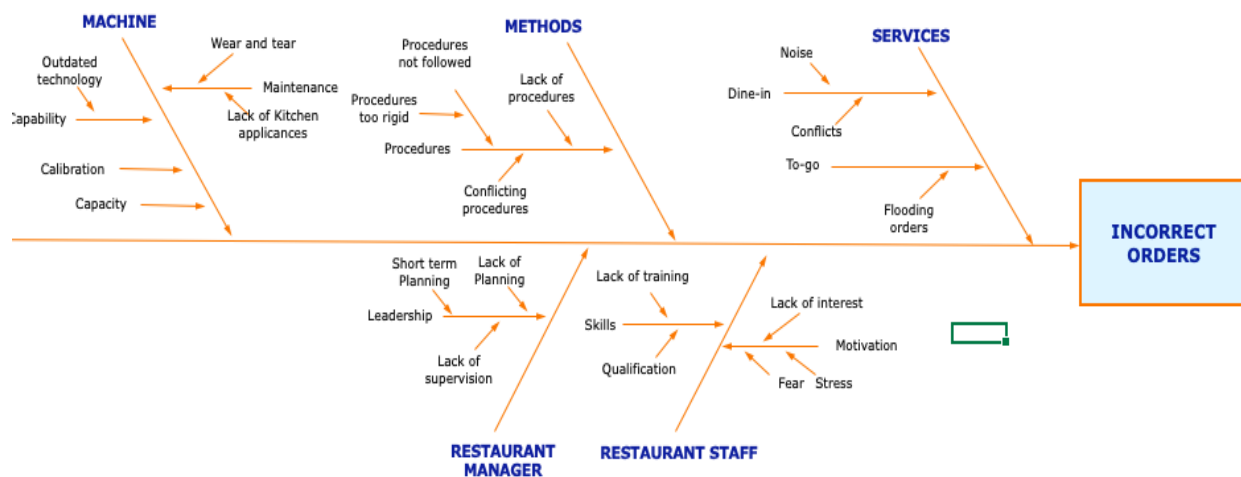

Figure 13: Ishikawa diagram for Incorrect orders

The main causes for incorrect orders are verified further

1. **Machine and Methods :** Lack of kitchen appliances and poor maintenance of the equipment created stress at the time of peak orders and also forced cases where procedures were not followed leading to incorrect orders.

2. **Services :** The flooding orders created confusion and the conflicts between To-go and Dine-in orders confused the front desk staff which led to missing orders or noting down incorrect orders. This was also due to under trained staff who were not experienced to face customers.

3. **Restaurant Manager & Staff :** No clear allocation of roles and responsibilities in staff members due to poor leadership and planning was a major reason for chaos and the situation going out of control.

Improve:

1. The first implementation that our team has decided after analyzing the data which was collected during the analyze stage is a sliding door near to the take away food desk inside the restaurant as the owner has allowed us to make small construction changes.

Before food pickup procedure

The customer has to enter the restaurant for their food pickup, then the staff member will handover the food to them by verifying their name and order. But if the customer has arrived before the estimated delivery time or food is not ready then they have to wait inside the dine-in area which can affect both the staff and the dine-in customers. It can confuse the staff members and make it difficult to coordinate with each other for the proper food delivery to the customer. Eventually it will lead to customer dissatisfaction by overcrowding and congestion in the restaurant.

After food pickup procedure

As you can see in figure 14 there is a wide window near to the take out desk inside the restaurant and a pathway is available outside that window.

Figure:14 The present view of the restaurant

Figure 15: Suggestion of sliding glass door for easier pick up

Then, the customer can directly walk towards the pick-up window as described in figure 15 and collect food which will eliminate overcrowding and congestion in the restaurant.
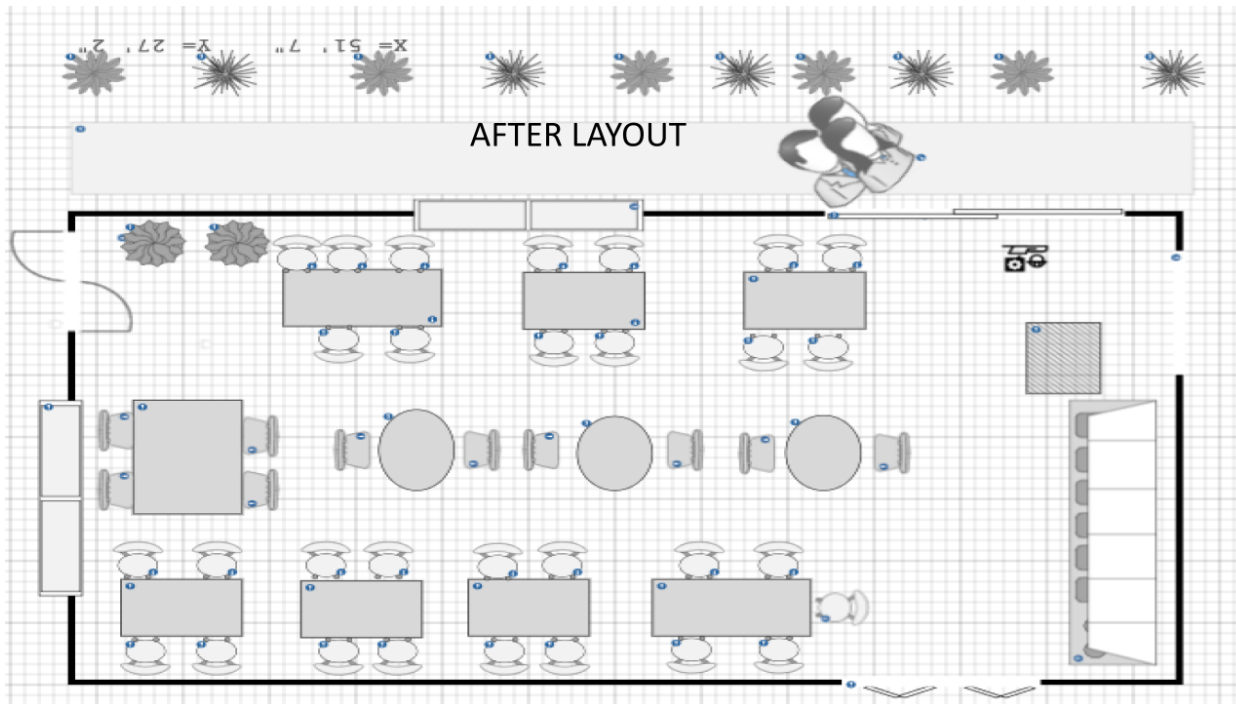
Figure 16: A view of the after layout where all the tables are used productively and To-Go desk has sliding door

To improve the flow and efficiency of a kitchen we will implement a POS(Point of sale), KDS(Kitchen Display system) and OSS(Order synchronize system).POS is the input of our overall system in which customers orders will be recorded then OSS will transmit this information to the KDS which is the output and displays all the orders in the kitchen. OSS will reduce the errors and improve the efficiency by transmitting the information in real time.

Before kitchen procedure

The concerned person has to take orders and put them into the computer, then he has to give the printed order receipt to the kitchen assistant.

The kitchen assistant will inform the chef about the order verbally, then the chef will start preparing the food.

Figure 17:Present photo of kitchen with no Kitchen display system

After Kitchen procedure

After implementing the new system, the customer order can be recorded in the POS then the OSS (order sync system) will transmit it into the KDS and if there is any change in order or its canceled so the OSS will update in the KDS quickly to ensure that the kitchen staff has the most up-to-date information.

KDS has one more additional feature that is colors in which green shows the new order and red will highlight the old order that needs to complete fast.

The last implementation that our team has decided is another OSS (Order status screen).It will display the status of every order by mentioning ready or its being prepared.It will reduce the errors by providing real time information about the orders and makes it easy for the restaurant order procedure. Customer satisfaction can be increased by keeping transparency of the orders and will build the trust with the customers.
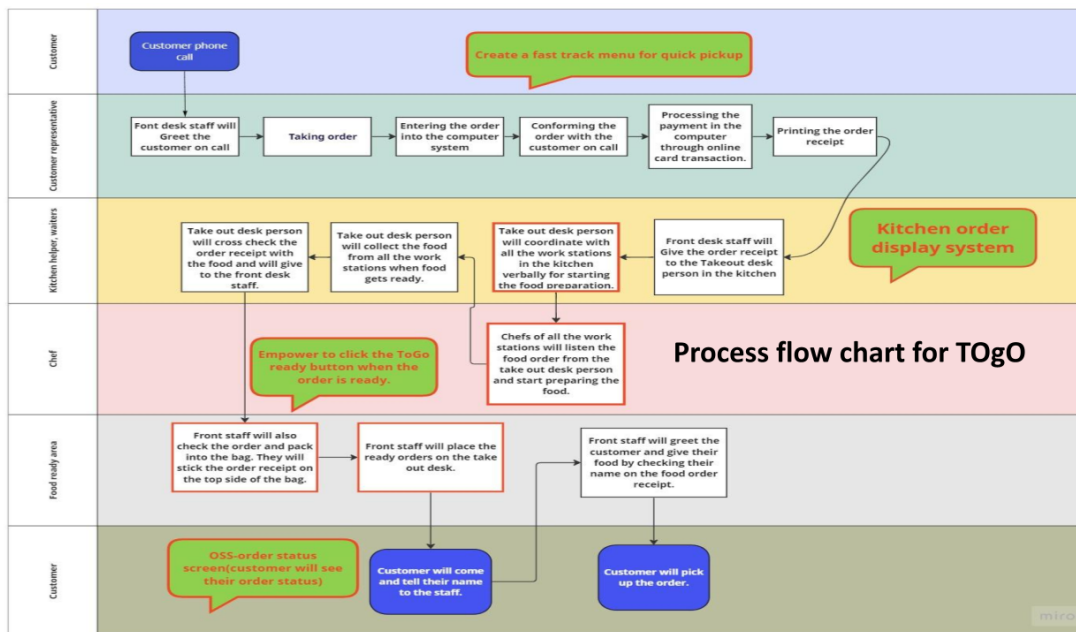
Figure 19: Expected future process map where the highlighted process are expected to be eliminated for to-go customers
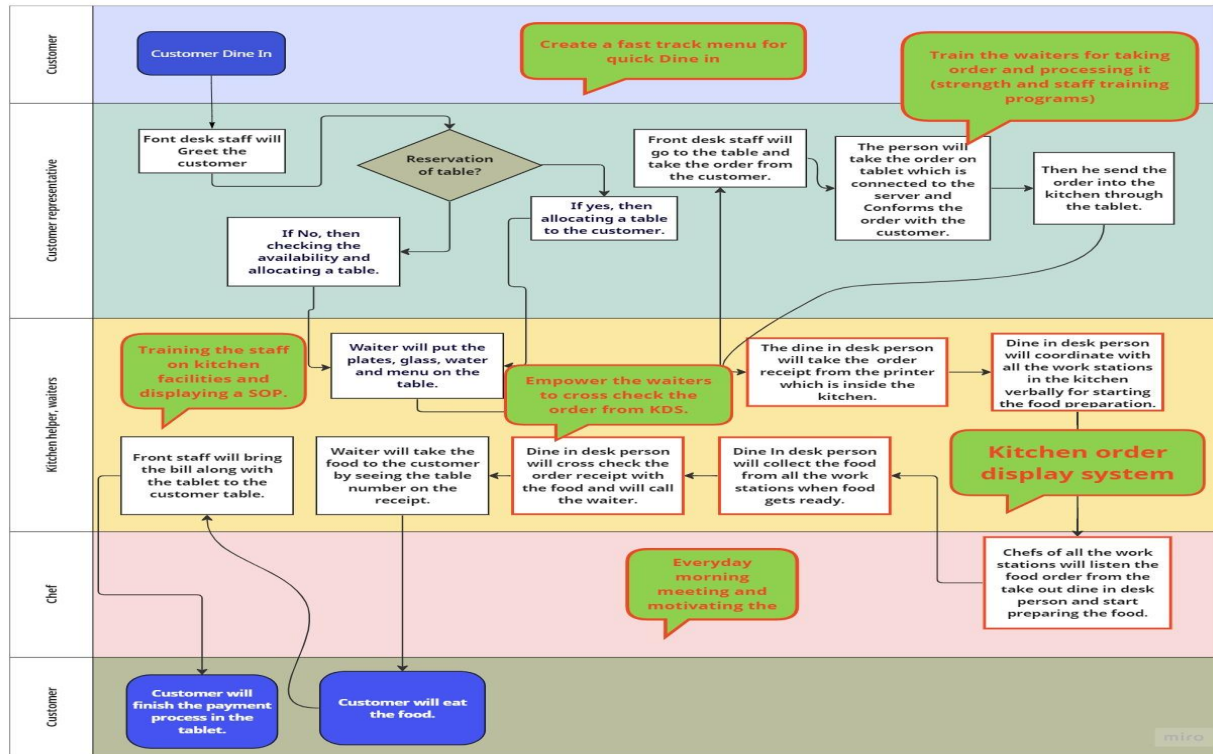
Figure 20:Expected future process map where the highlighted process are expected to be eliminated for dine-in customers

We had highlighted a few steps with the red border that can be eliminated by implementing a new system.

There are comments in the cloud that show the new systems.

Control:

During the control phase, it is essential to monitor Key performance indicators to ensure positive growth. After implementing the changes the survey is conducted again for the same sample size with the same questionnaire and pareto chart is drawn to understand the impact of changes. Feedback from the restaurant staff is collected to ensure their work has eased after the changes.

1.A process capability chart can be drawn similar to figure 8 to ensure that the means are centered after improvements are implemented.

2.Further , a control chart can be used to check if there are incorrect orders or long wait times and if the point falls beyond the limits immediate study can be conducted to check for deviations in the process.

3. Tools like Poka-Yoke (mistake-proof), SPC (statistical process control) charts, SOP (standard operating procedure) training programs, and documentation are typically used in the processes with regard to elements found in prior phases.

Conclusion

As six sigma is always concentrated on deliverables and stability, the two problems mentioned in the projects are properly analyzed by measuring real data. Data used was collected from restaurant staff , manager and also using some feedback forms. Six sigma techniques like fish bone diagrams were used to sort the causes. Before and after layouts were designed to portray the difference .We have highlighted a few improvement points in the updated kitchen process diagram for both dine-in and To-go to enhance the process. If the mentioned improvements can be implemented then error percentage can be reduced and minimize wait time, which will lead to overall customer satisfaction.

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