Hot Sub Express

Overview

HotSubExpress is a carry-out sandwich restaurant chain located in the Midwest. Illinois district office had come under scrutiny for their poor financial performance in the fiscal year. There are 5 HotSubExpress stores in Illinois district operating 343 days an year, each of which sells around 200 sandwiches every day.The district manager found out that the reason for the poor financial performance was an ill-planned promotion started by the Illinois corporate marketing called '15 or it is free' which guaranteed free sandwiches to all customers if the wait period was more than 15 minutes. The district manager was told by the store managers that there were 1300 sandwiches given away for free in the last 2 weeks out of the 14350 sandwiches sold. The manager has approached a sig sigma team to work out ways to improve the situation. He is also skeptical about the numbers provided to him by the store managers.

Define

The objective of this six sigma project is to study and analyse the cooking processes based on observational, point out existing flaws and suggest appropriate improvements and control measures to minimise the cooking time of the HotSubExpress stores. This involves extensive study and analysis of historical sales data. The report also focusses on quantifying the benefits of implementing the improvements/suggestions in terms of DPM as well as in financial terms

Project Charter

Project Information	
Project #	1234
Project Name	Cooking time reduction.
Project Start Date	xx-xxx-2021
Project End Date	xx-xxx-2022

Resources	
Project Leader	William B
Black Belt:	Steven A
Champion:	John R
Process Owner	HotSubXpress

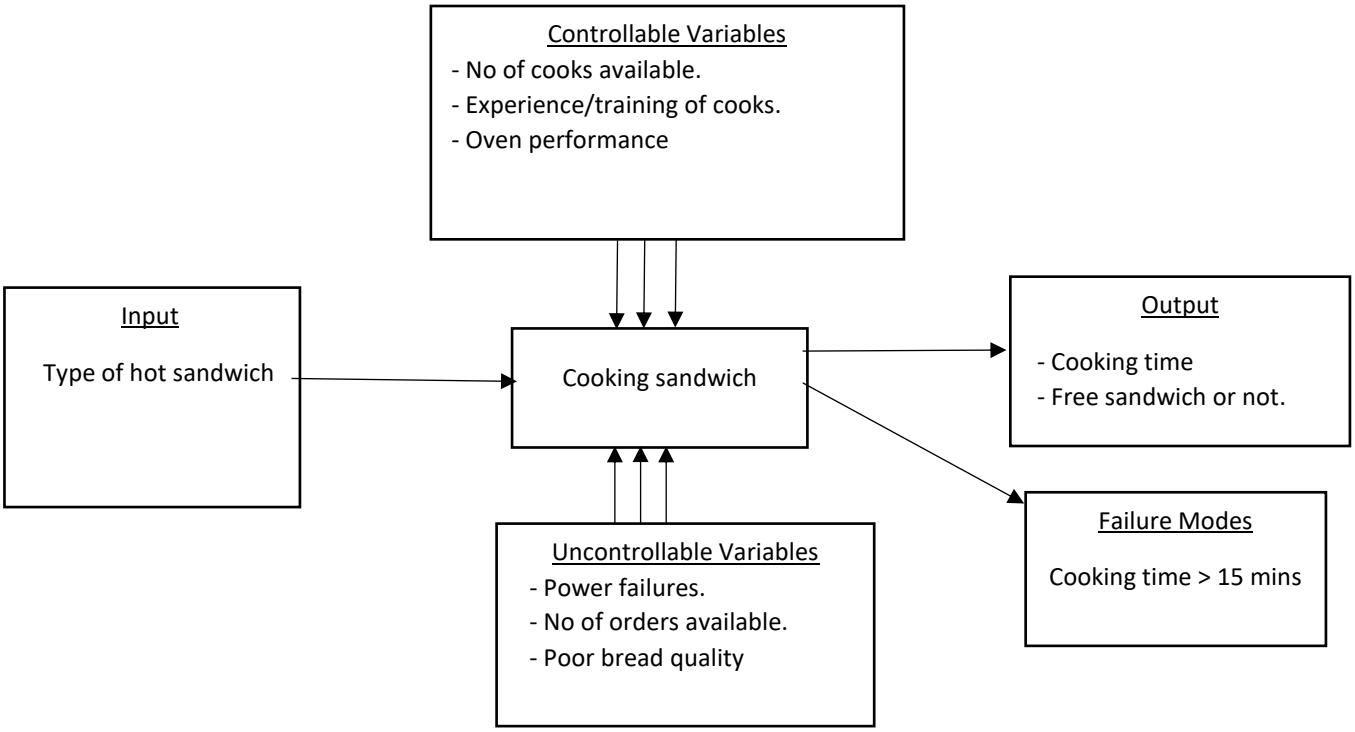
Team Members	Stuart, Allan, Son, Jake

Problem Statement:
The cooking time of sandwiches at HotSUbXpress ranges from 10-19 mins with an average of 12 mins. With the '15 or it is free' promotion, sandwiches that take more than 15 days to prepare have to be given free of cost to the customer. We need to reduce the number of sandwiches taking longer than 15 mins to reduce the cost of free giveaways.
Goal Statement:
The objective of this project is to reducet the average cooking time to less than 10 mins
Project Scope:
This project will focus on the 5 HotSubXpress stores in Illinois District. We will not consider other stores of HotSubXpress as they are not part of the '15 or it is free' promotion.

Measure

Variables

There are multiple factors that influence the cooking time of sandwiches. Most important variables are identified and categorized into –(a) Input Variables, (b) Controllable Variables, (c) Uncontrollable Variables and (d) Output. These variables are shown in the P – Diagram



Data Collection

Cooking-time data is collected from each store for 10 days. Data of 3 sandwiches is collected at every 2 hours for each of the 5 stores.

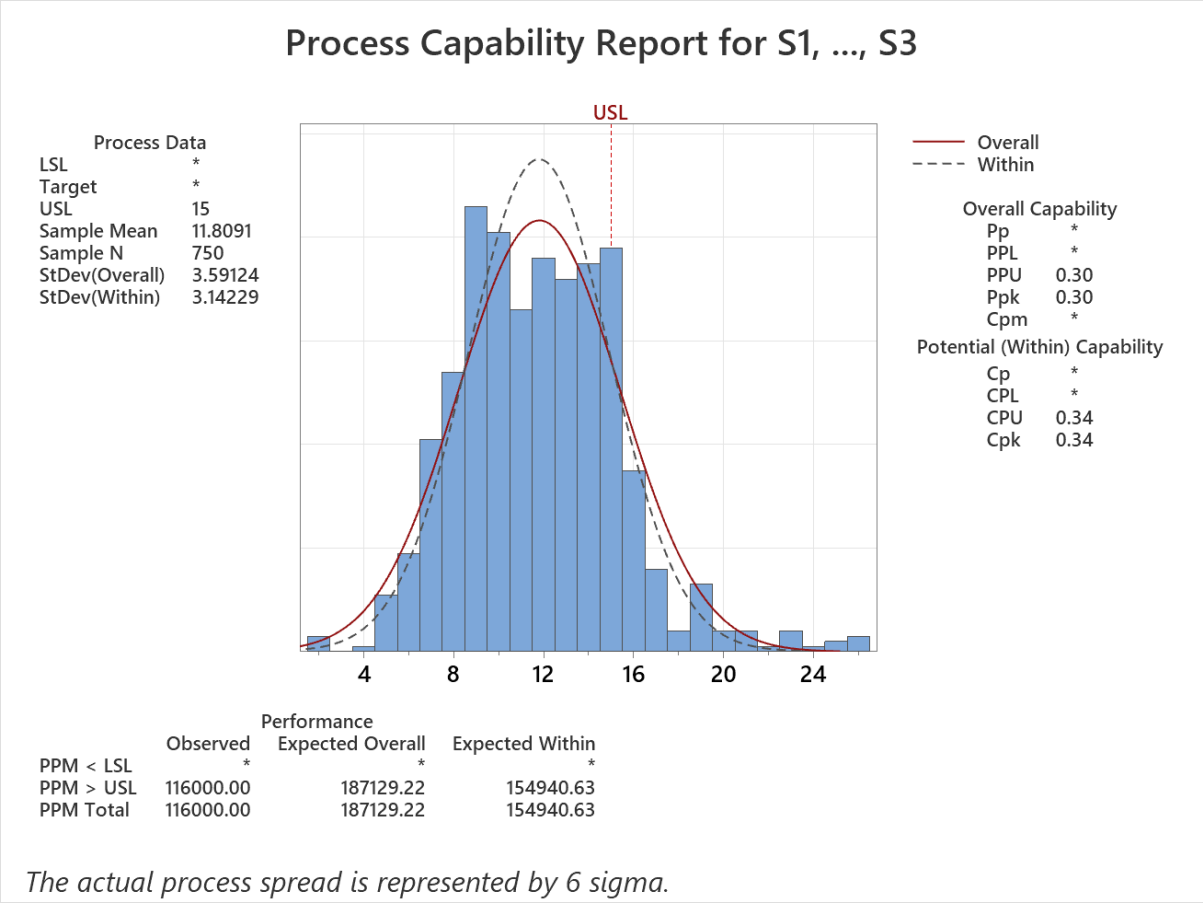
Descriptive Statistics:

The most decisive parameter of the process is the cook time, which determines whether the customer is eligible for a free sandwich or not.

Process Capability Analysis

The performance of cooking time w.r.t the target gives a clear picture about the capability of the existing process. Process capability analysis of the process was done, and the results are

displayed below. Each delivery that fails the *15 mins* upper specification limit is considered a defect.



The actual process spread is represented by 6 sigma.

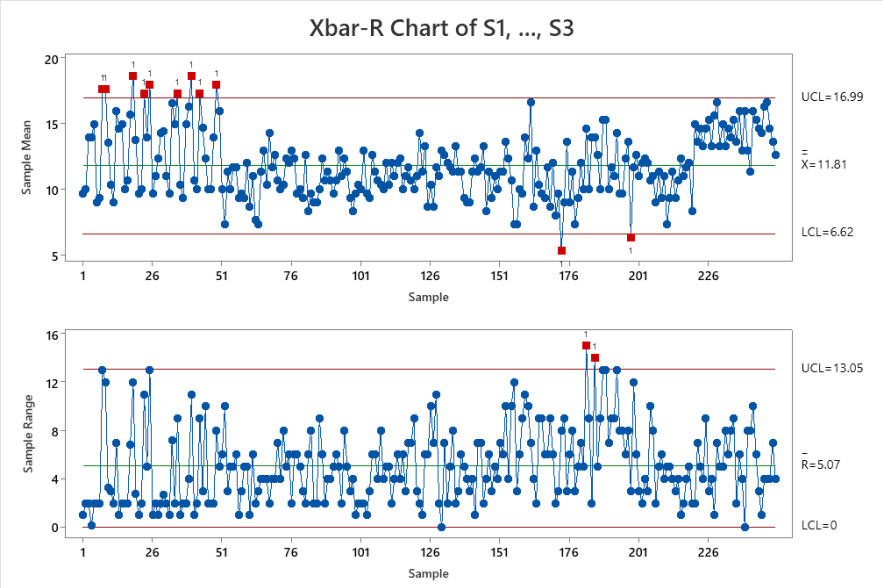
The analysis shows that mean cooking time is 11.8 minutes and Standard Deviation is 3.59. The Box Plot shows the spread of cooking time. While the desired upper limit of IPT is 15 minutes, a mean value of 11.8 with a St Dev of 2.516 gives us a rough picture that the performance is far from satisfactory

The capability analysis is done based on Normal distribution model and the DPM level of the observed data is **116000**. 116000 free sandwiches/defects per 1Million will amount to around 23 free sandwiches per day.

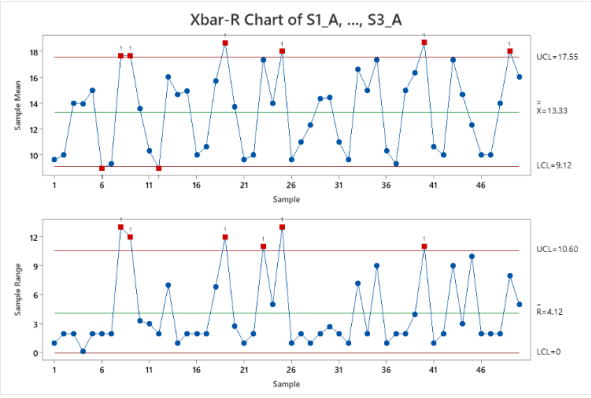
So, the managers' claim of giving away 1300 free sandwiches out of 14350 is factually wrong , as in fact, they had given away even more- about 1665 sandwiches. The loss to the company because of the free giveaways at the rate of $3.20/- per sandwich is 116000/1M * 200*5*3.2 = **$371.2 per day**.

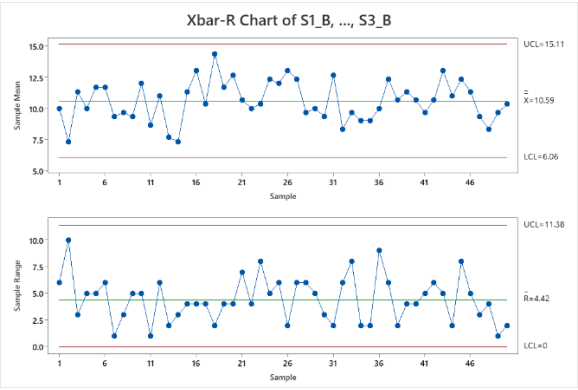
Stability Analysis

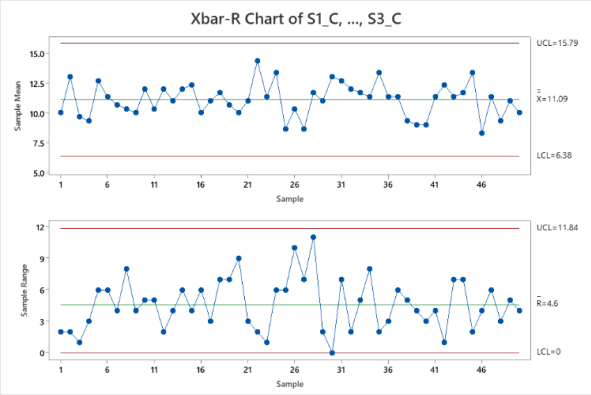
Stability of the invoicing process is checked next, to ascertain whether the process is in control or not. This helps to identify any special causes in cooking which could mean a major shift from standard operating levels. Stability of the process, measured by plotting the control chart (Xbar - R), is done for individual vendors, as well, for comparison. The outcomes plotted are appended below:

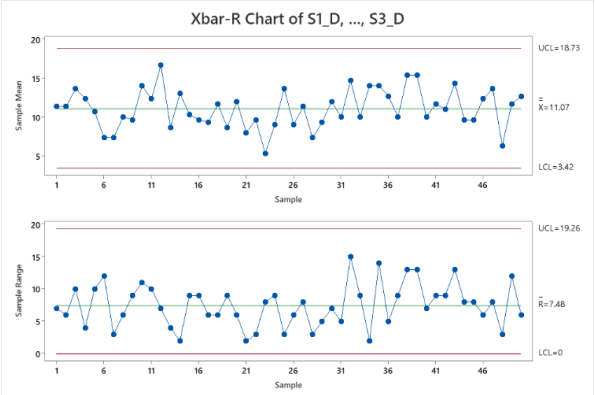


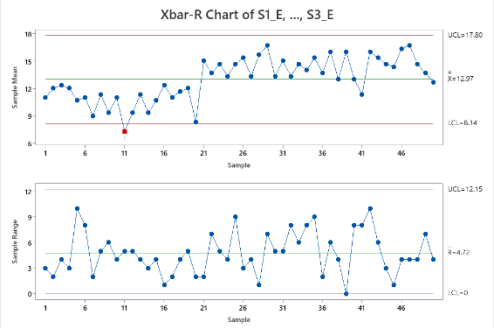
The control chart shows that the process is out of control confirming a shift in standard operating levels or special causes in the cooking process.











Stability analysis is done for individual stores as well, which reveals the fact that while Stores B, C & D are stable, cooking at Store A & E are unstable.

Analyze

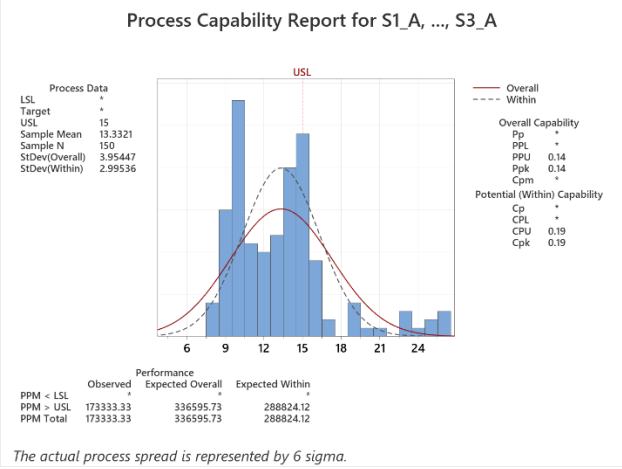
The data measured with the help of statistical tools were analyzed deeper to get store wise and shift wise performance to check the validity of the causes listed out from the first look of the problem.

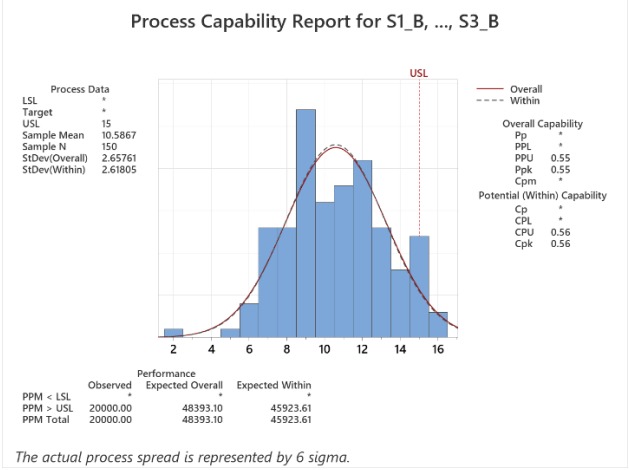
Stratification Analysis

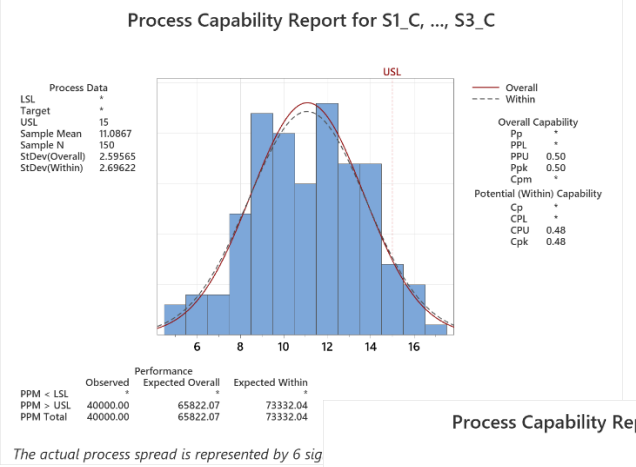
For analyzing store-wise performance, cook time of each store is compared and analyzed separately from the collected data.

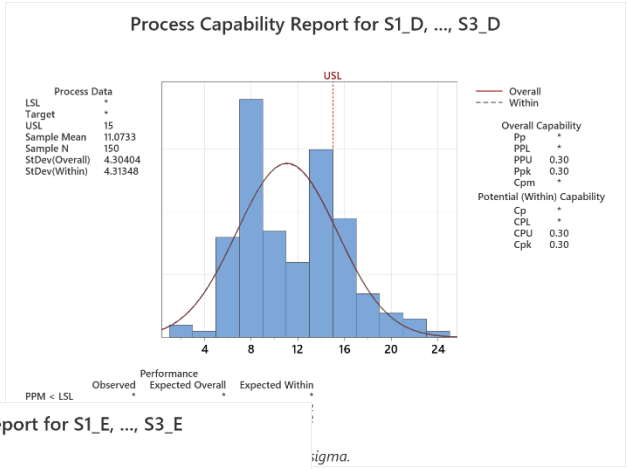
Store-wise DPM is given below:

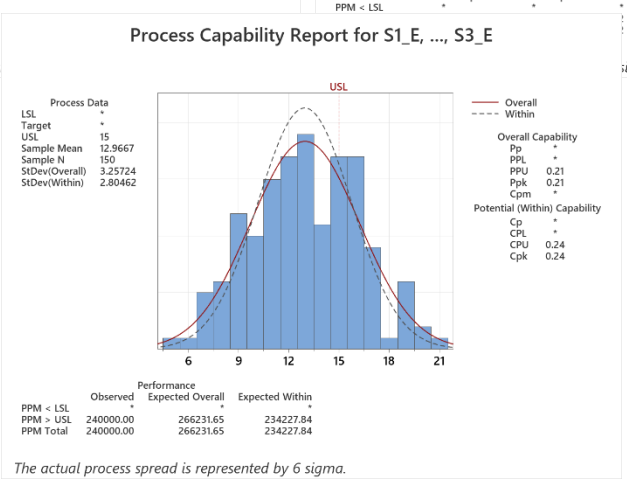
Store	A	B	C	D	E
Mean	13.33	10.58	11.09	11.07	12.96
St Dev	3.95	2.66	2.6	4.3	3.25
Observed DPM	173333	20000	575000	382352	481481
Expected DPM	336595	48393	604533	392406	594181





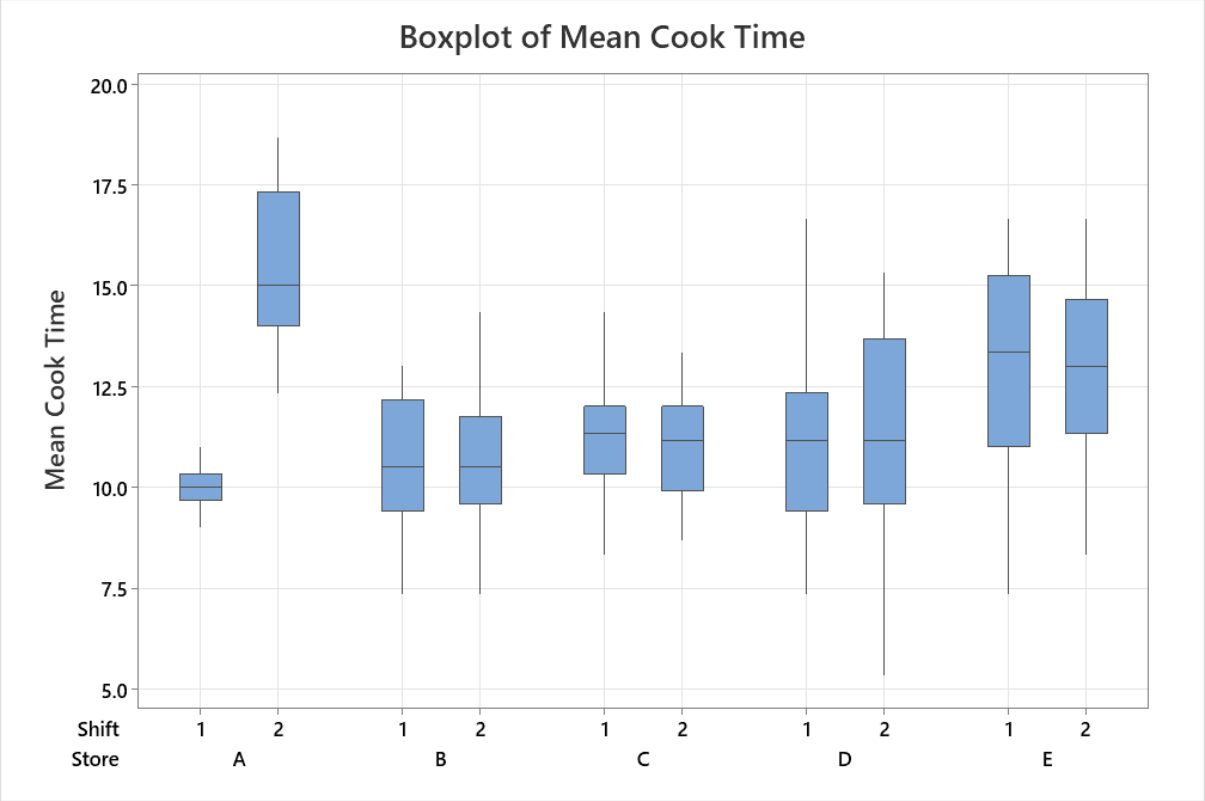






Store-wise data shows that **Store B** has faster cooking time than all other stores and **Store C and Store E** are having the worst DPMs. Also, **Store D** shows the highest St Dev out of all the stores.

Further analysis is done by stratifying the stores' performance in each shift. A boxplot is plotted comparing performance of every store shift-wise. DPM levels are also analyzed for each shift.



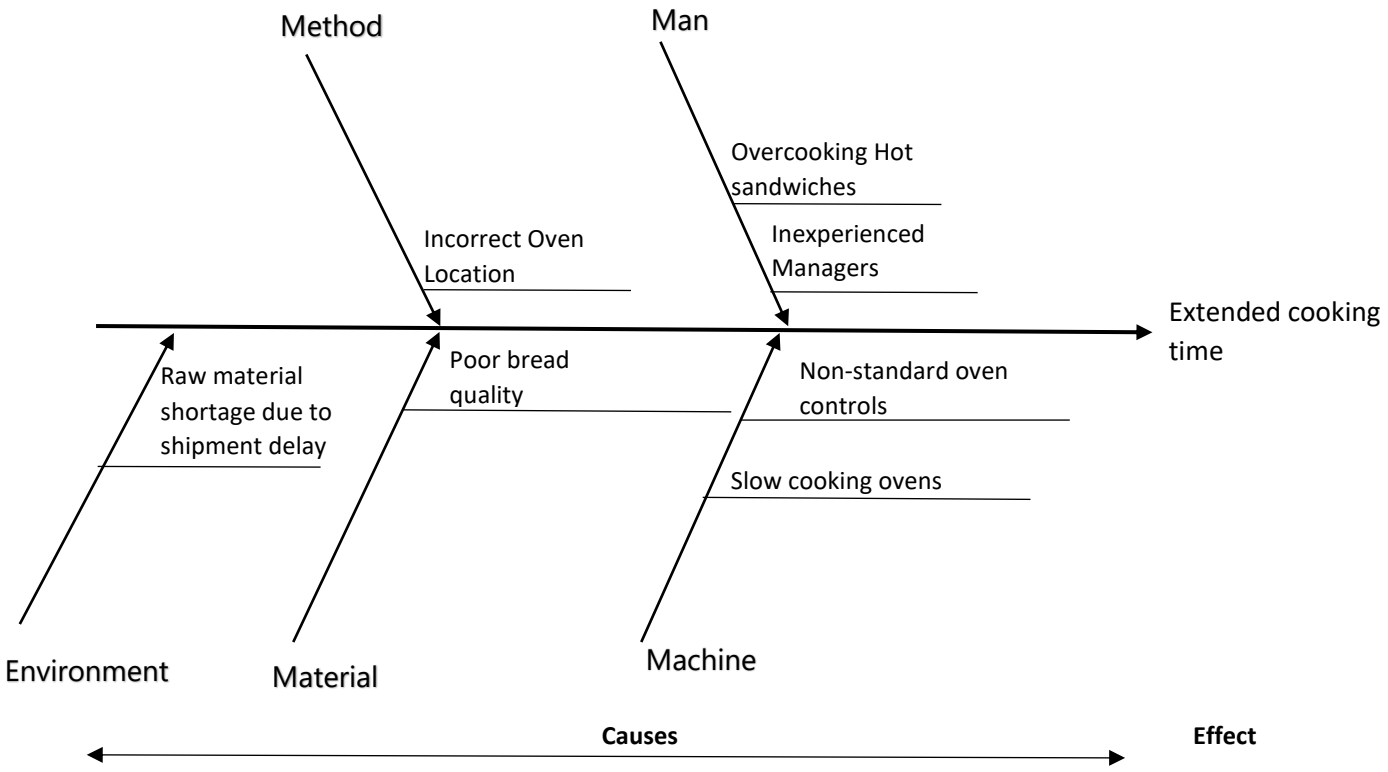
Store	Shift	Mean	StDev	Minimum	Median	Maximum
Store A	1	9.967	0.581	9.000	10.000	11.000
Store A	2	15.576	1.811	12.333	15.000	18.667
Store B	1	10.583	1.596	7.333	10.500	13.000
Store B	2	10.589	1.609	7.333	10.500	14.333
Store C	1	11.167	1.400	8.333	11.333	14.333
Store C	2	11.033	1.391	8.667	11.167	13.333
Store D	1	10.967	2.384	7.333	11.167	16.667
Store D	2	11.144	2.590	5.333	11.167	15.333
Store E	1	12.933	2.664	7.333	13.333	16.667
Store E	2	12.978	2.092	8.333	13.000	16.667

The stratified data reveal that:

1. Shift 2 of store A has abnormally poor performance compared to shift 1. This coupled with the fact that a new cook operates Shift A raises questions regarding performance capability of new cooks.
2. Store E has the worst mean cooking times. Store E also works with a 110V power supply compared to 220V supply of all other stores.
3. Store D has the highest variation in cooking time. Incidentally, Store D does not have digital electronic oven controls .

Root Causes

After hours of brainstorming based on stratified data and input from the store managers, potential root causes are identified and have been represented in the form of a fish bone diagram. The validity of the causes will be verified after deeper analysis of cook time data collected store-wise and shift-wise.



Based on the analyses of the shift wise data of cooking time and observation of the stores system and personnel, it is concluded that the following special cause issues if addressed can save cooking times without replacing the ovens with new costlier ones.

1. Overcooking of hot sandwiches- Stores A, B & C employ new cooks in one more shifts. Additional training may be given to these new cooks to improve their performance at a cost of $180 each.

Table 1: New cooks at Stores A, B, and C

	# of New Cooks		
	Store A	Store B	Store C
Shift 1 (12:00 to 4:00)	0	1	1
Shift 2 (4:00 to 10:00)	2	0	1

2. Standard Oven Controls- Store D doesn't have a digital electronic oven control causing high variation in cooking times. A new electronic oven control may be installed at the store which will cost $500.
3. Oven Power Level- Store E works on a 110V power system which leads to high oven cool down time to safeguard the fuse. The store must be upgraded to a 220V system at a cost of $2500.
4. Manager Experience – Manager of Store B has only an experience of 1 year and needs additional full day training at a cost of $240.

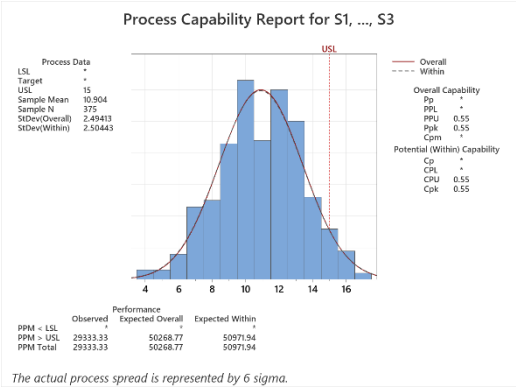
Improve/Control

Based on the analyses of the shift wise data of cooking time, the following actions were taken to address the special cause effects.

1. Overcooking of hot sandwiches – New cooks at Store A, Store B and Store C were given additional training of 4 hrs each at a total expense of $900. (180*5)
2. Standard oven controls were installed in Store D at an expense of $500.
3. Power level of Store E was enhanced to 220V after working with the power company and hiring an electrician at a total expense of $2500.
4. Inexperienced manager at Store B was given an additional training at an expense of $240.

Post implementation of the above, cooking data was taken from all stores for 5 days to check if the corrective actions were cost effective and whether additional corrective actions are required if the performance is not satisfactory.

Process Capability post modifications

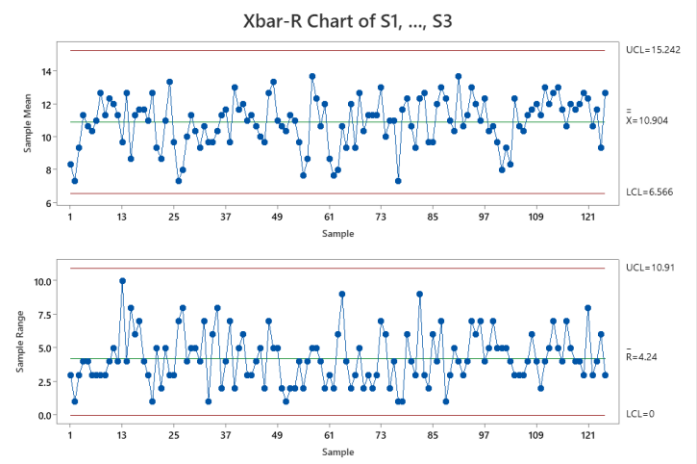


The observed DPM of the improved cooking process is 29333 which is 74.7% lower than the earlier DPM of 116000. Standard Deviation has also come down to 2.5 from the earlier level of 3.59. The mean cooking time is 10.90 minutes compared to the earlier mean of 11.8 minutes. We can confirm that there is a drastic reduction in the DPM though the mean cooking level has only improved by less than a minute.

In the new improved cooking process, HotSubExpress will give away ((29333/1M)*200) 6 free sandwiches per day at a cost of 5x3.2= **$19.2 per day** compared to the earlier cost of $317.2 per day.

With an average production of 200 sandwiches per store per day, the net savings per day is ((116000-29333)*200*3.2)/1M is $55. The total expenditure for improvement was (900+500+2500+240) = $4140.
The expenses can thus be recovered in 75 days (4140/55) or **2.5 months.**

Stability analysis post modifications
Again, while plotting the control chart of the improved process, we can see that cooking process has become stable.



from the post modification cooking data reveal that:

1. The cooking processes have become stable.
2. There is an improvement in DPM by 74.7% (from 116000 to 29333 as per observed data)
3. The amount invested in modifying the process can be recovered in just 2.5 months.

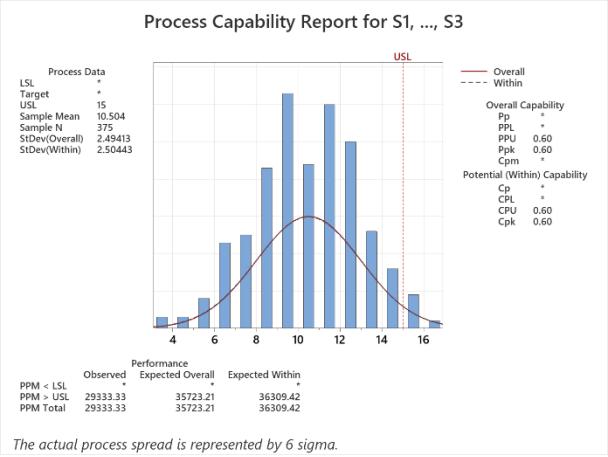
Hence it can be concluded that the actions taken are **cost justified.**

While the special causes pulling the performances down have been addressed, the mean cooking time is still at 10.9 minutes which if brought closer to 9-9.5 can improve the process drastically. We have 2 options available for reducing the mean time:

1. Installing new ovens at all 5 stores at a total cost of $ 100K (20x5)- reduces mean time by 0.4 minutes.
2. Checking if changing the position of sandwich towards central portion of the oven brings down mean cooking time. This option comes at no cost but slight inconvenience to the cooks.

Option 1- Installing new ovens.

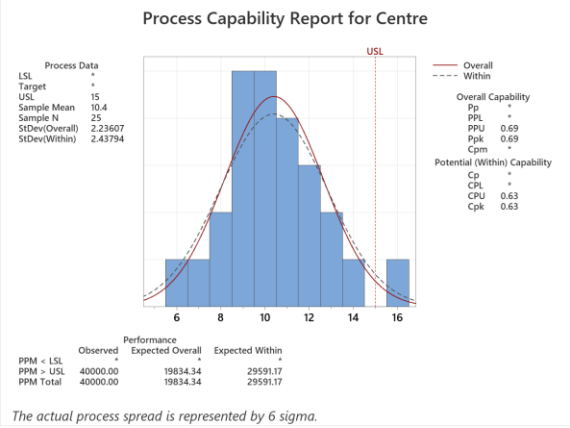
On carrying out capability analysis of the modified system with a reduced mean of 0.4minutes and no change in variance we find that:

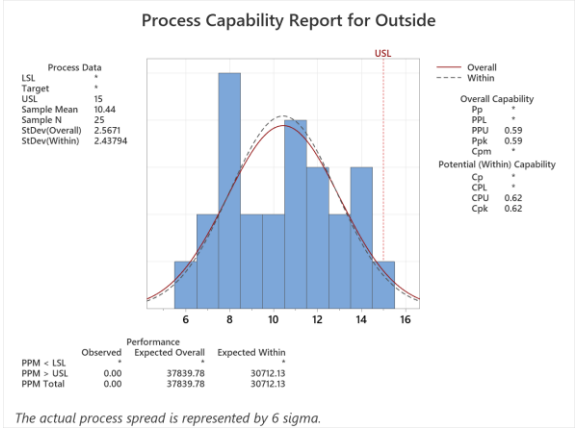


1. There is a reduction in expected overall DPM from 50268 to 35723 and mean cooking time reduces to 10.5 minutes.
2. While calculating the return of investment for $100K expense on new ovens, for an average sales of 200 sandwiches per day at $3.2/sandwich it takes 100000/(0.05268-0.35723)*200*3.2*5) = 1951 days or 5.6 years to recover the investment.
3. The ROI is very low and hence it is not advisable to buy expensive ovens to reduce the mean cooking time.

Option 2- Changing sandwich position in oven:

On comparing data collected by cooking sandwiches at the centre and outside of the ovens we find that:





1. There is no major reduction in mean cooking time by either keeping the sandwiches at centre or outsides of the oven.
2. Hence this recommendation may also be neglected as this will create inconveniences to the cooks at no gain.

So, with the available options, the cost-effective way is to keep the modified cooking process without installing new ovens or changing oven locations.

Before modifying the stores, HotSubExpress had an annual additional revenue of $150K- brought in by the new promotion. The total cost of giving away free sandwiches for this period was ((Expected overall DPM/1M) *200 sandwiches*343 operating days*$3.2 per sandwich*5 stores) which is equal to **$205.39 K**.
(Expected overall DPM for the initial process was 187129).

Hence there was a net loss of 150-205= **-$55K** to the company before implementing the modifications. So the promotion had put the district to a loss.

Post modifying the stores, the total cost of free give away sandwiches would be **$39.209K**.
(Expected overall DPM for the initial process was 35723).

If the company had involved the six sigma team a year ago, the net profit would have been 150K -39.209- 4140(modification cost) = **$106.651K.**