Process Improvement Project: Increase Daily Water Intake

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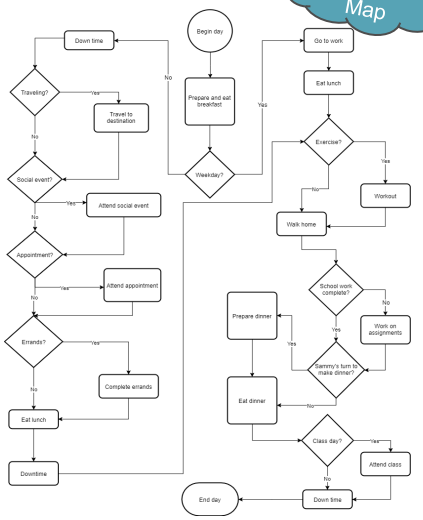
Key Dates:	Project Launch: 1/10/2020	Define: 1/10/2020	Measure: 1/10/2020 – 2/10/2020	Analyze: 2/11/2020	Improve: 2/11/2020 – 2/29/2020	Control: Ongoing

DEFINE

Problem Statement: I most typically consume about 32oz of water per day. Ideally, I should be drinking twice that amount. While I know that it's important, I find it difficult to remember to drink enough throughout the day and often neglect the task.

Business Impact: By increasing my water intake, and therefore having more energy, I estimate that I will be able to put forth an additional hour or two of significant effort per work day. **Over 5 years, this will save my company ~$82,125 ($30 x 1.5 hours x 365 days x 5 years).**

Process Map



MEASURE

Continuous variables: water intake, amount of coffee, amount of tea, amount of alcohol, amount of exercise, wake up time, bedtime, number of steps, temperature

Discrete variables: Date, day type, had class, number of meals, traveling

SQL = 3

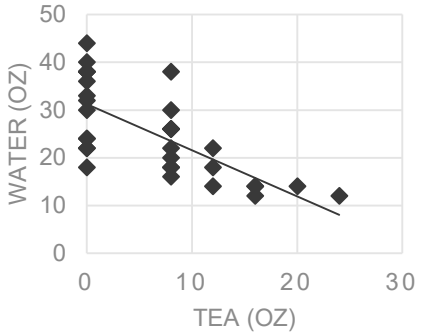
Descriptive Statistics

Descriptive Statistics	
Mean	24.96875
Standard Error	1.653127763
Median	23
Mode	38
Standard Deviation	9.351502812
Sample Variance	87.45060484
Kurtosis	-1.001797541
Skewness	0.40649183
Range	32
Minimum	12
Maximum	44
Sum	799
Count	32
Confidence Level(95.0%)	3.371576302

ANALYZE

Linear Regression

DAILY WATER VS. TEA CONSUMPTION



Correlation
Water vs. Tea
-0.711525179

Chi-Squared: 4.27

Regression Statistics	
Multiple R	0.700845593
R Square	0.491184545
Adjusted R Square	0.473639184
Standard Error	6.67003557
Observations	31

IMPROVE

Since p < alpha, reject Ho. The new average water intake per day after implementing a change to the process is greater than the original average.

Hypothesis Test

Ho: μ1 ≥ μ2
Ha: μ1 < μ2

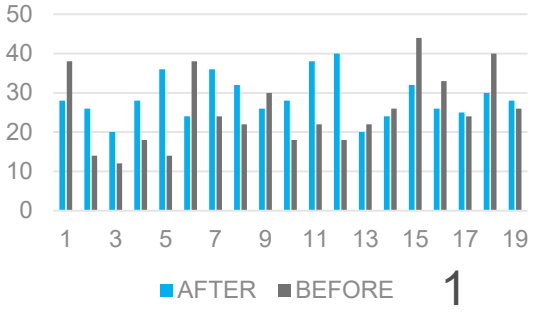
SQL = 3.2

CONTROL

Lowering the amount of tea I drink raises the amount of water I drink per day. Going forward, I will drink less tea to increase my daily water intake.

Histogram

First 19 Days of Water Consumption Before and After Process Change



Define

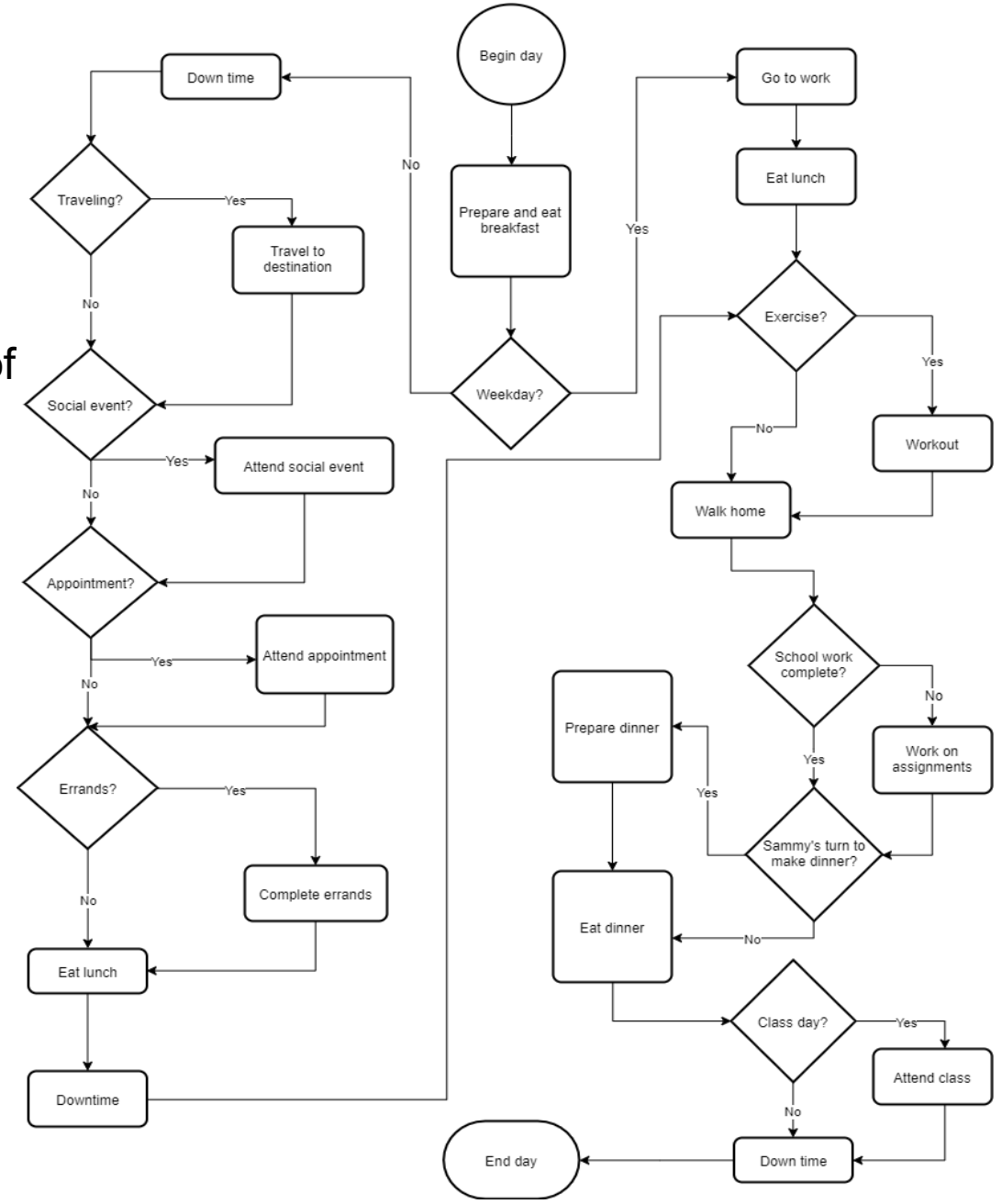
- **Problem Statement:** I most typically consume about 32oz of water per day. Ideally, I should be drinking twice that amount. While I know that it's important, I find it difficult to remember to drink enough throughout the day and often neglect the task.
- **Business Impact:** By increasing my water intake, and therefore having more energy, I estimate that I will be able to put forth an additional hour or two of significant effort per work day. Over 5 years, this will save my company ~$82,125 ($30 x 1.5 hours x 365 days x 5 years).
- **Goal/Measure of success:** My goal is to increase water consumption by at least 12% from my baseline. I will calculate my baseline by monitoring my average daily water intake over several weeks.

Define

- **Scope:** The sole process that needs fixing is the amount water I drink per day. I will not consider tea, coffee, or seltzer as water. I will not be altering my diet or my amount of exercise.
- **SQL:**
  - Defect Opportunity Per Unit (D) = 9 continuous variables
  - Units (U) = 32 samples
  - Actual Defects (A) = 21 days where total water < 12% average water (27.755 oz)
  - DPO = A/DU = 21/(9*32) = 0.072917
  - DPMO = 0.072917*10^6 = 72,917
  - **SQL = 3**
- **Data Measurement Plan metrics:** Measure Name *(what will be measured?)*, Data Type *(continuous or discrete?)*, Operational Definition *(specifications for measurement)*, Stratification Factors *(identify possible subgroups)*, Sampling Notes *(when measurements will be collected)*, How *(collection method)*

Define

- **Process Map**: outline the current steps of the process



Data Measurement Plan

Measure Name	Data Type	Operational Definition	Stratification Factors	Sampling Notes	How
Date	Discrete	The date of sample collection using the Gregorian calendar.	Day of week, day type	Specified at the beginning of the day, just after wake up time.	Calendar, cell phone, computer
Water intake	Continuous	The amount of water in ounces that I have consumed each day, from the time I have woken up to the time I have gone to bed.	N/A	Sample taken at the end of the day just before bed time	Water bottle with markers from 0 to 32 oz
Day type	Discrete	Binary indicator of whether the sample date is a weekday or a weekend. Weekdays are Monday, Tuesday, Wednesday, Thursday, and Friday. Weekends are Saturday and Sunday.	Weekday, weekend	Specified at the beginning of the day, just after wake up time.	Calendar, cell phone, computer
Amount of coffee	Continuous	The amount of coffee in ounces that I have consumed, rounded to the nearest whole number, on the specified day, beginning at midnight central and ending at 11:59 p.m. CT.	N/A	Sample taken at the end of the day just before bed time	Will determine amount of ounces for each individual container. If provided, will use the amount printed on the container.
Amount of tea	Continuous	The amount of tea I have consumed, in ounces, from the beginning of the day (12:00 a.m. CT) to the end of the day (11:59 p.m. CT).	N/A	Sample taken at the end of the day just before bed time	Will determine amount of ounces for each individual container. If provided, will use the amount printed on the container.
Amount of alcohol	Continuous	The amount of alcohol I drank during the sample date, in ounces, rounded to the nearest whole number. This measurement begins at 12:00 a.m. CT and ends at 11:59 p.m. CT on the sample date.	N/A	Sample taken at the end of the day just before bed time	Will determine amount of ounces for each individual container. If provided, will use the amount printed on the container.
Amount of exercise	Continuous	The number of minutes I excercised during the sample day. This includes any activity where my heart rate is increased for at least 10 minutes, rounded to the nearest 15 minute interval.	N/A	Sample taken at the end of the day just before bed time	Cell phone, Flyght app, Dragonfly app
Wake up time	Continuous	The time in Central Time at which I woke up on the sample date, rounded to the nearest 15 minute interval.	Day of week, day type	Determined at the beginning of the day, as soon as I wake up	Cell phone
Bedtime	Continuous	The time in Central Time at which I went to sleep on the sample date, rounded to the nearest 15 minute interval.	Day of week, day type	Determined at the end of the sample day, as soon as I go to bed	Cell phone
Had Class	Discrete	Yes or no answer indicating whether or not I had class, using the date of the sample.	Day of week, day type	Recorded at the end of the day, before bed time.	2SU
Number of meals	Discrete	Number of meals I have eaten during the specified day. Snacks are not included in this metric.	2 or more, less than 3	Recorded at the end of the day, before bed time.	Will calculate by hand
Number of steps	Continuous	The number of steps I have taken each day, from the time I have woken up to the time I have gone to bed.	More or less than 6,000	Recorded at the end of the day, before bed time.	Google Fit app
Temperature	Continuous	The highest temperature of the sample day in Farenheit.	At or above freezing	Sample taken in the middle of the day, when the temperature is at it's peak.	Google Weather app
Traveling	Discrete	Yes or no answer indicating whether or not I have traveled during the sample date. This includes spending the night at a destination outside of my home, flying in a plane, riding on a train or bus, and/or taking a car ride over 3 hours.	N/A	Recorded at the end of the day, before bed time.	Gmail calendar

Measure

- **Continuous variables:** water intake, amount of coffee, amount of tea, amount of alcohol, amount of exercise, wake up time, bedtime, number of steps, temperature
- **Discrete variables:** Date, day type, had class, number of meals, traveling
- New data collected beginning on 1/10/2020

Measure

- I collected 32 samples to allow for a large initial sample size (at least 30), at least a week for analysis, and approximately 20 sample sizes after the improvement.
- I was limited by the time constraints of this course.
- Ideal sample size: 83 samples
  - n = ((Z-star*sigma)/error)^2
  - Z* with 95% confidence = 1.960
  - σ = 9.351502812
  - E = 2 ounces
  - n = (((z*)(σ))/E))^2 = ((1.96*9.35)/3)^2
  - **n = 83.98756 samples**

Descriptive Statistics	
Mean	24.96875
Standard Error	1.653127763
Median	23
Mode	38
Standard Deviation	9.351502812
Sample Variance	87.45060484
Kurtosis	-1.001797541
Skewness	0.40649183
Range	32
Minimum	12
Maximum	44
Sum	799
Count	32
Confidence Level(95.0%)	3.371576302

Measure

- There may have been more correlation between variables that needed more samples to identify. For example, I only collected data when the weather was cold. If I collected data throughout the year, perhaps I would have noticed a correlation between temperature and water.
- Possible sources of measurement error:
  - If I did not have my phone on my, my steps were not being counted.
  - It's possible I miscalculated exactly when I went to bed each night.
  - Rounding to the nearest 15 minutes and nearest oz for several variables may have resulted in rounding errors
- Possible way to minimize error:
  - Could have minimized measurement error by acquiring a water bottle with more precise measurements
  - Could have recorded wakeup time and bedtime first thing in the morning

Analyze

- What tools did you use to analyze the data?
  - Process Map
  - Descriptive Statistics
  - Chi-Squared Test for Independence
  - Linear Regression Analysis
  - Correlation Coefficient
  - Hypothesis Testing
  - Histogram
- Data indicates there is a relationship between the amount of tea that I drink and the amount of water I drink.
  - I discovered amount of tea is the most important variable in determining my daily water intake.
- The amount of coffee I drink, the number of steps I take, and the temperature high have little impact on the amount of water I drink in a day.
- Process improved: old SQL: 3; new SQL: 3.2

Analyze

Chi-Squared Test for Independence

Question: Is there a relationship between the amount of tea I drink in a day and the amount of water I drink in a day?

Ho: Tea and water are independent
Ha: Tea and water are dependent
Degrees of freedom: (2-1)(2-1) = 1
α = 0.05
P-value: CHISQ.DIST.RT(4.27, 1) = 4.128E-50

Chi-Squared: 4.27

Since p-value is less than α, reject Ho. Tea and water intake are not independent, there is a relationship.

Summarize into a 2-way table:

	Tea > avg (6.5 oz)	Tea <= avg (6.5 oz)	Totals
Water >= avg (25 oz)	5	9	14
Water < avg (25 oz)	13	5	18
Totals	18	14	32

Calculate observed and expected frequencies:

	f (observed)	F (expected)	(f-F)^2 / F
Water > 25 / Tea > 6.5	5	7.88	1.05
Water > 25 / Tea < 6.5	9	6.13	1.35
Water < 25 / Tea > 6.5	13	10.13	0.82
Water < 25 / Tea < 6/5	5	7.88	1.05
Totals	32		4.27

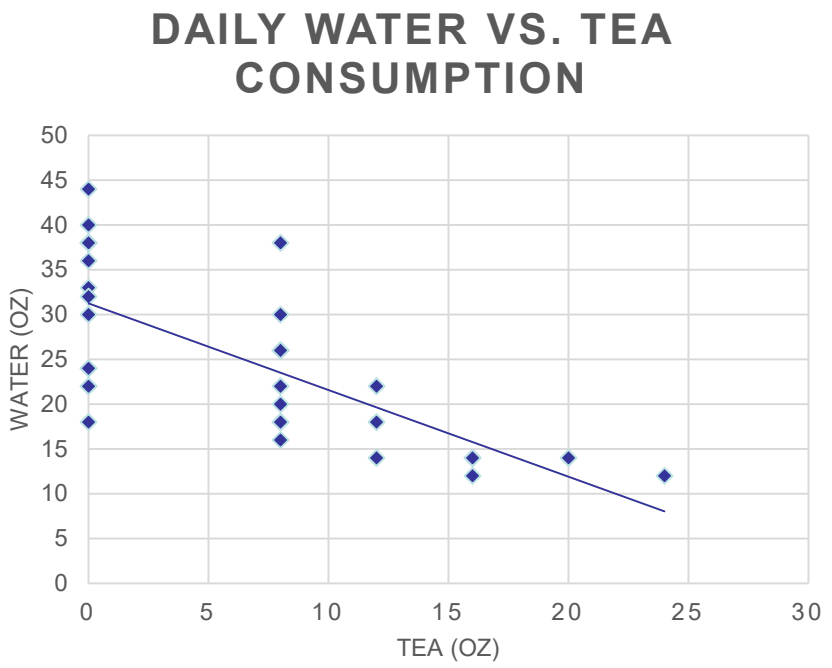
Analyze

Linear Regression

Correlation
Water vs. Tea
=CORREL(B2:B33,E2:E33)

Correlation
Water vs. Tea
-0.711525179

- Correlation coefficient, Multiple R > 0.7, therefore there is correlation between daily water intake and daily tea consumption.
- -1 < correlation < -0.7, therefore there is negative correlation between daily water and tea consumption.



Regression Statistics	
Multiple R	0.700845593
R Square	0.491184545
Adjusted R Square	0.473639184
Standard Error	6.67003557
Observations	31

Improve

- Implemented solution: stop drinking tea
- **SQL:**
  - Defect Opportunity Per Unit (D) = 9 continuous variables
  - Units (U) = 19 samples
  - Actual Defects (A) = 8 days where total water < 12% average water (27.755 oz)
  - DPO = A/DU = 8/(9*19) = 0.046784
  - DPMO = 0.046784 *10^6 = 46,784
  - **SQL = 3.2**
- Process improved, SQL went from 3 to 3.2

SQL = 3.2

Improve

Hypothesis Test

Two-Sample Hypothesis Test – one-tail, lower/left-tail:
Ho: μ1 ≥ μ2
Ha: μ1 < μ2

Sample size: n1 + n2 = 32 + 19 = 51 ≥30

Test statistic:
Z = (xbar1 – xbar2)/sqrt((s1^2/n1)+(s2^2/n2))
Z= (24.781-28.789)/sqrt((9.352^2/32)+(5.663^2/19))
Z= -1.817

P-value: area left of Z
Using lookup table p-value = 0.0322

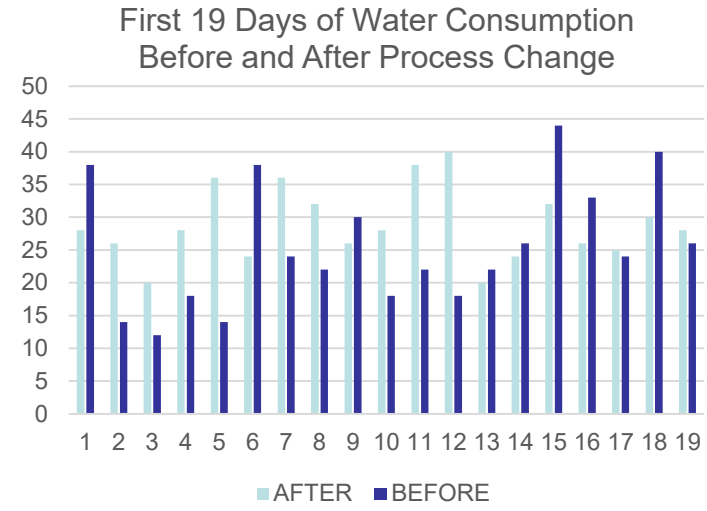
- **μ1** = Original average water intake per day
  - n2 = 32 samples
  - s1 = 9.352
  - xbar1 = 24.781 oz
- **μ2** = Average water intake per day after implementing a process change
  - n2 = 19 samples
  - s2 = 5.663
  - xbar2 = 28.789 oz
- **Alpha** = 0.05

Therefore, reject Ho. Since p < alpha , the new average water intake per day after implementing a change to the process is greater than the original average.

Control

- After implementing the process change of eliminating tea, the mean, median, and minimum of daily water consumption have increased.
  - Mean1 = 24.97 oz ; Mean2 = 28.79 oz
  - Median1 = 23 oz; Median 2 = 28 oz
  - Min1 = 12 oz; Min2 = 20 oz

Descriptive Statistice - After Process Change	
Mean	28.78947368
Standard Error	1.299075126
Median	28
Mode	28
Standard Deviation	5.662537195
Sample Variance	32.06432749
Kurtosis	-0.403601437
Skewness	0.447546773
Range	20
Minimum	20
Maximum	40
Sum	547
Count	19
Confidence Level(95.0%)	2.729255565



Conclusion

- The process change of eliminating tea has been successful in increasing the amount of water I drink in a day. **I have reached my goal of drinking at least 12% more water than with my original process.**
- Further analysis with more samples may be conducted to determine if other variables contribute to my daily water intake. For instance, I only traveled for four days during this project, but I drank the most amount of water on those days. Next time I travel, I will take note of the amount of water I drink.
- This project has heightened my awareness of my daily water intake. I am now armed with the knowledge that even a small change in my daily process can continue to support my efforts to drinking more water!