Increase 100-Meter Sprint Speed

Process Owner: Tesslyn Knapp

Key Dates --->	Team Launch: April 9	Define: April 9	Measure: April 23	Analyze: April 26	Improve: April 29	Control: June 5

DEFINE

Problem Statement

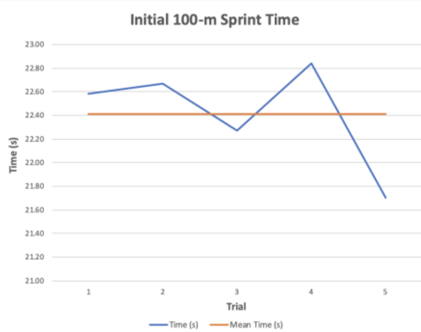
Average running time for a 100-meter sprint is 22.41 seconds, or 4.46 meters per second, which is too slow.

Business Impact

Sprinting increases metabolism and heart health. According to CDC, the cost of obesity-related absenteeism range between $79-132 annually for the individual. Consistent sprinting and keeping weight low can save that money.

MEASURE

Initial 100-m Sprint Time/Speed		
Trial	Time (s)	Speed (m/s)
1	22.58	4.43
2	22.67	4.41
3	22.27	4.49
4	22.84	4.38
5	21.70	4.61

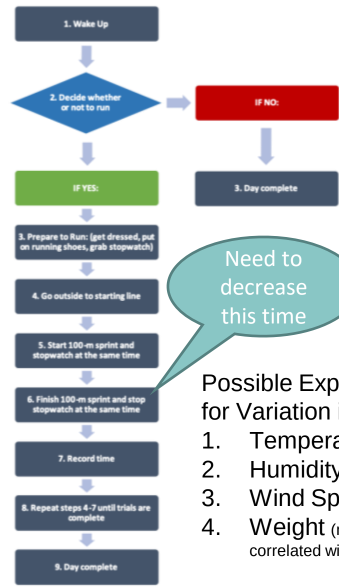


Average time is too high

Average Time (s)	22.41
Median (s)	22.67
Mode (s)	N/A
Standard Deviation (s)	0.449
Average Speed (m/s)	4.46

Average speed is too slow

ANALYZE



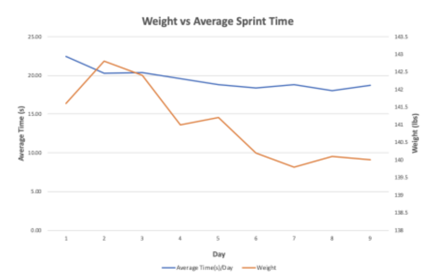
Need to decrease this time

Possible Explanations for Variation in Speed:

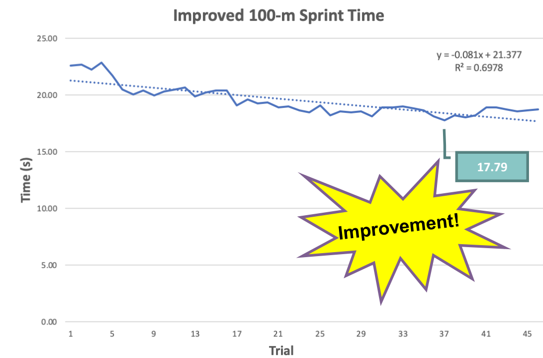
1. Temperature
2. Humidity
3. Wind Speed
4. Weight (most correlated with sprint time)

Regression Statistics	
Multiple R	0.67047942
R Square	0.44954266
Adjusted R Square	0.37090589
Standard Error	1.06876114
Observations	9

Despite being most correlated, still not the strongest predictor of sprint time

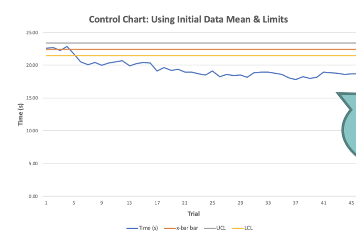


IMPROVE

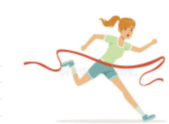


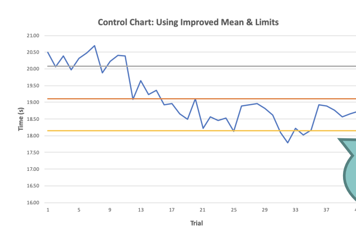
Despite the lack of identification of being able to pinpoint the precise indicator of what caused the improvement of our process, we still see a decrease in sprint time as a result of increased sprint speed. From our initial mean of 22.41 seconds, we reached our goal of decreasing 3 seconds from the 100-m sprint with a personal record time 17.79 seconds.

CONTROL



Lots of signals – appears there was a large shift within the data





Less signals – appears that the improved process has more consistency!

Team Members: Tesslyn Knapp

About this Project

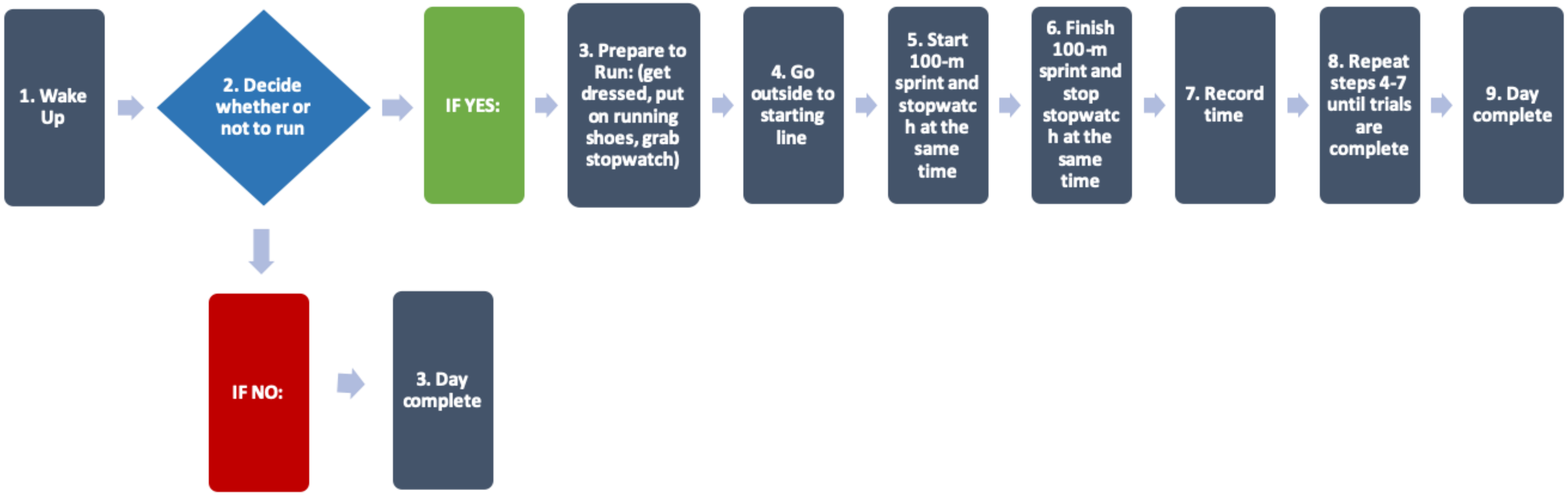
Background:
Recently I have been getting back into frequent exercise, including running. I identified that my sprint-speed, in particular, was sub-par and needed to increase due to the difficulty and toll it took on my body.

Business Impact:
Sprinting has been proven to increase metabolism and hearth health. According to the CDC, the cost of obesity-related absenteeism range between $79-132 annually per individual. This money could be saved though proper maintenance of diet and exercise, such as sprinting.

How will we fix this problem?

This project aims to increase my sprint speed by decreasing 3 seconds off of my initial sprint time. We will devise a plan to determine the factors most-correlated with sprint-time through a series of trials.

Process Flow Chart and Business Rules



Each day of the process started with Step 1 of the flow chart.

I obtained 5 sprint data point trials of continuous time data for each day that I decided to run.

In addition to the 100-m sprint time data, I also collected supplementary data to attempt to find which factor exhibited the greatest correlation with sprint speed. Such factors I included in this study were a mixture of discrete and continuous data including time of day, temperature, wind direction, wind speed, humidity, attire, weight, and terrain.

Initial Data Collection (Measure & Analyze)

Date	Time of Day? (Morning/Afternoon/Evening)	Temperature (F)	Wind Direction	Wind Speed (mph)	Humidity (%)	Shorts/Leggings	Weight (lbs)	Terrain	Trial	Time (s)	Speed (m/s)	Speed (mph)
4/23/20	Evening	81	WNW	6	25	Shorts	141.6	Dirt	1	22.58	4.43	9.906997343
									2	22.67	4.41	9.86766652
									3	22.27	4.49	10.04490346
									4	22.84	4.38	9.794220665
									5	21.70	4.61	10.30875576

Because exercise and physical improvement is difficult to model "in a vacuum," I only used one day of 5 trials to model the initial "Measure" phase in order to avoid skewing my initial data with possible "improvement." This made for a tricky "Analyze" phase because my external factors such as temperature, wind speed, humidity, weight, etc. were all constant in this initial collection. Therefore, it was not until I was into my "Improve" phase that I was able to reflect on these external factors and notice any correlation within the data.

Average Time (s)	22.41
Median (s)	22.67
Mode (s)	N/A
Standard Deviation (s)	0.449
Average Speed (m/s)	4.46

I obtained an Average (Mean) time of 22.41 seconds and a Standard Deviation of 0.23 seconds. In my analysis, I wanted to have a Margin of Error of 0.2 seconds and a 95% Confidence Interval. Therefore, my minimum sample size is as follows:

$$n = \left(\frac{z^* \hat{\sigma}}{E}\right)^2 = \left(\frac{(1.96*0.449)}{0.2}\right)^2 = 19.32 \text{ (rounded to 20)}$$

Therefore, I will need a minimum of 20 samples in order to perform my hypothesis test.

Hypothesis Testing (Analyze & Improve)

One-Sample Hypothesis Test for Continuous Data

(One-tail and Lower/Left-tail Test)

Hypothesis Statements:

H_0: $\mu \geq 22.41$

H_A: $\mu < 22.41$

$\mu_0 = 22.41$

$n = 46$ (calculate z-statistic)

$\bar{x} = 17.79$

$\hat{\sigma} = 0.449$

Calculations:

$$Z = \left(\frac{(\bar{x} - \mu_0)}{(\hat{\sigma})}\right) = \frac{(17.79 - 22.41)}{(0.449)} = -10.28$$

$$P < 0.0001$$

We can reject the null hypothesis that H_0: $\mu \geq 22.41$

The sprint speed of 17.79 is significant!

Regression Analysis (Analyze & Improve)

I performed regression analysis on continuous data factors such as temperature, humidity, wind speed, and weight.

Temperature vs Time

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.355281482
R Square	0.126224932
Adjusted R Square	0.106366407
Standard Error	1.230575159
Observations	46

Humidity vs Time

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.51592624
R Square	0.266179886
Adjusted R Square	0.249502156
Standard Error	1.127724786
Observations	46

Wind Speed vs Time

SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.207497871
R Square	0.043055366
Adjusted R Square	0.021306625
Standard Error	1.287809799
Observations	46

Weight vs Time

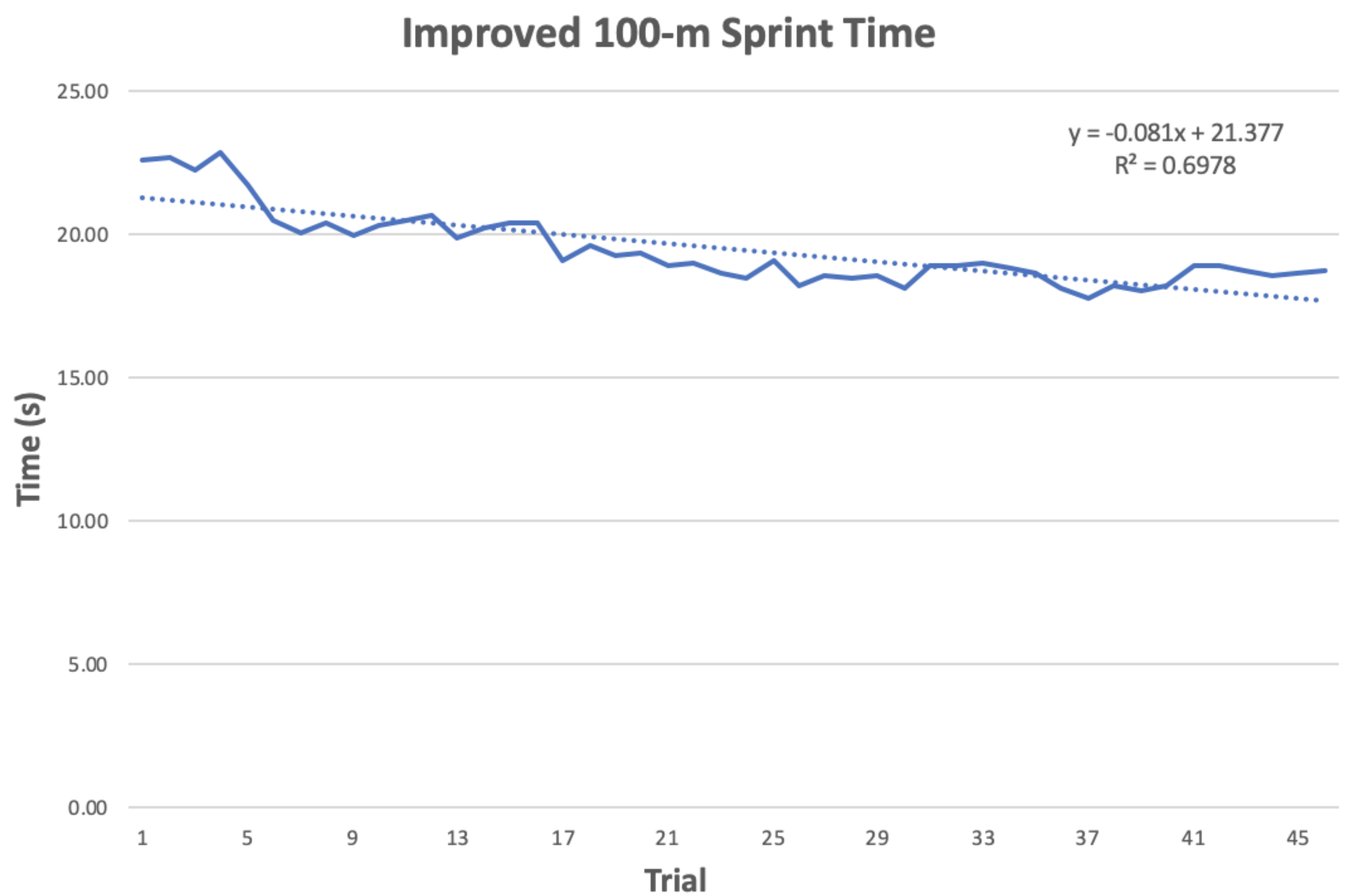
SUMMARY OUTPUT	
Regression Statistics	
Multiple R	0.659523616
R Square	0.4349714
Adjusted R Square	0.422129841
Standard Error	0.989563197
Observations	46

Comparing each R-squared value, it appears that none of these factors have a particularly strong correlation with the sprint speed. Weight seemed to have the most correlation with an R-squared value of 0.43.*

This may be due to the nature of exercise and the many external factors involved (such as fat loss/muscle gain, changes in fast-twitch muscle mobility over time, dietary choices, stretching, etc.)

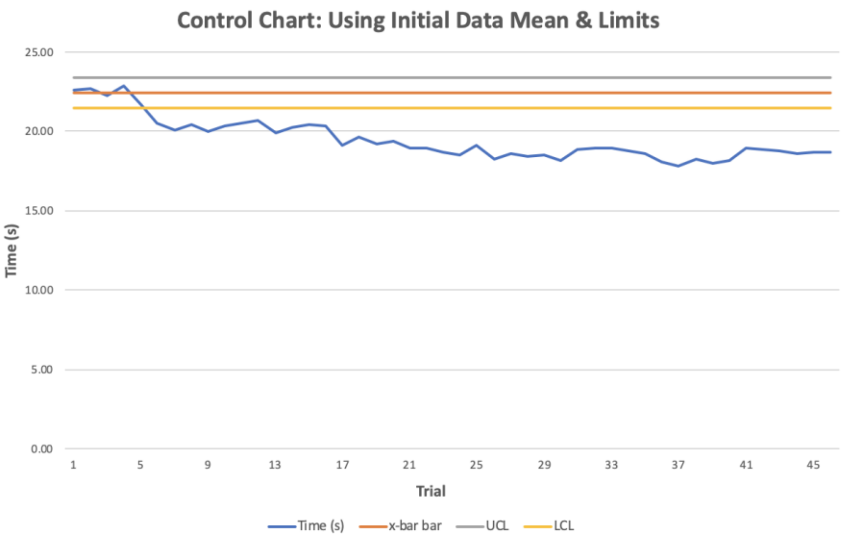
*this R-squared value is different from the Storyboard because the Storyboard features a regression of the averaged speed times each day in order to provide a more pleasing graph when displaying changes in weight.

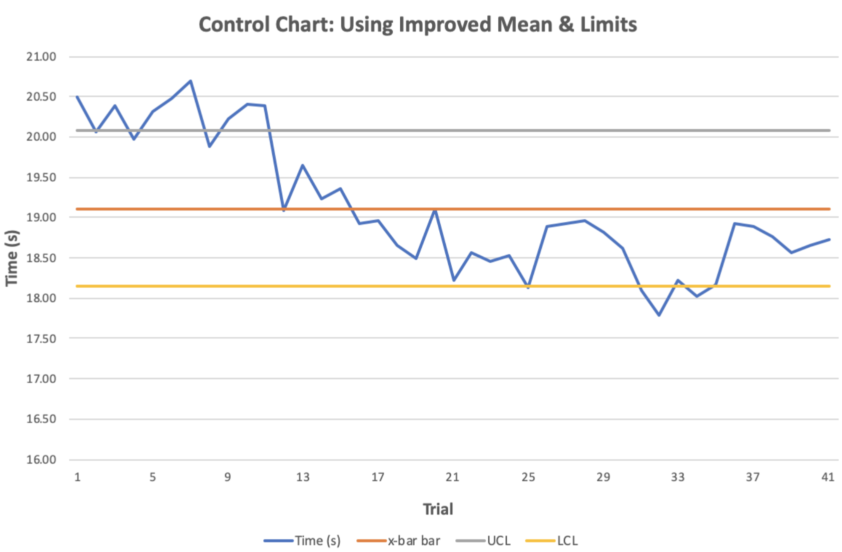
Regression Analysis (Improve)



Despite a lack in what particularly contributed to sprint-time variation, improvement can be clearly seen in this simple graph of the data. I obtained an R-squared value of 0.69, so this regression line appears to be a fairly decent fit for the data.

ImR Charts (Control)





These final ImR charts display the change in the process over time. The first chart shows the mean and limits of the initial data. We can see that the process changes almost immediately as seen as the data continues outside of the lower limits.

The second chart shows the mean and limits of the “improvement” data. We can see that while there is still much variation within the data, much more of the data is contained within the limits. Therefore, we can infer that our process did improve over time.

Overall Takeaway…

- I was able to perform both hypothesis testing and regression analysis to attempt to observe variation within the data
- I found that the change in sprint times was, in fact, statistically significant with a p-value less than 0.05
- Direct cause of improvement was not able to be observed within the data, probably due to external (and possibly difficult to obtain) data
- I found that my sprint times decreased over time, therefore seeing an overall increase in sprint speed
- My process was observed to have been improved as seen by my ImR charts