Motivation:

This experiment will measure the time it takes to receive various messages for both the Apple iPhone 10 and the Samsung S9+, as these are two comparable phones in terms of their release date. Therefore, the population in this study consists of all individuals who currently use either an Apple iPhone 10 or a Samsung S9+ phone.

There are three different factors that will be analyzed closely. First and foremost will be the factor that coincides precisely with the central question of this study; Of these two competing phone brands, which is the fastest or most efficient at receiving messages? This outlines the "main factor" of the study and will be labelled as the "Brand Effect" in the analysis. This main factor represents the effect that the iPhone has on the response variable which is the time it takes to receive various messages in comparison to the Samsung phone. The second factor that will be analyzed is if there is a difference in receiving messages when the given phone is connected to a Wifi network in comparison to only using cellular data. This secondary factor will be labelled the "Connection Effect" in the analysis. The impact that Wifi connection has in comparison to the Data connection may play an integral role in how a given phone receives messages. If one of the phones is slower than the other, it should be considered whether this can be credited to significant differences in the type of connection used within that phone brand. Lastly, the third factor pertains to the variety in messages a given phone can receive. This will be called the "Message Effect", which compares the time it takes to receive regular text messages, pictures, or videos.

With the rapid increase in technology over the past decade, there is more of an emphasis on speed with people always looking for the fastest phones, laptops and networks. More often than in years past there are people who are impatient even with the slightest inconvenience with their phones such as a file taking an extra few seconds longer to load. So, the main purpose of this study is to determine if there is a phone brand that receives messages faster than another brand. With this in mind, it seems most appropriate to compare the brands that are widely recognized to be the "top 2" in the cell phone industry [1], iPhones and Samsung. The objective of this study is to give iPhone and Samsung users a strong sense of how they compare against each other in terms of the speed they receive a message. In choosing these two brands, it creates a study with as large of an overall impact as possible, compared to say, conducting a study between two much less popular brands, such as Motorola and LG.

Overall, there is high interest in analyzing the differences between phone brands that impact a wide ranging population and the speed at which they perform. Note that in 2019, Samsung held 31.38% of the Global Market Share in the cell phone industry while Apple held 22.4% [1]. As expected, these were the top 2 marks when compared to any other company in the industry. Therefore, the thought process behind designing this study was to fit these interests and objectives listed above. These interests and objectives are met in the experiment because more than half of cell phone owners use iPhones or Samsung, and the receiving of messages on cell phones is one of the more obvious and integral aspects in the world of technology. People are always on their phones and so it is important for many to search for the "latest and greatest" technology to keep up to date with their families, friends, finances, sports, and other hobbies. For better or for worse, cell phones have become our most important possession due to their wide-ranging functions and their incredible ability for global interconnectedness with the touch of a finger.

The statistical hypothesis that will be tested in this experiment is:

H0: The average amount of time (in seconds) it takes to receive a message is approximately the same for an Apple iPhone 10 and a Samsung S9+. There is no "Brand Effect".

Ha: The average time it takes to receive a text message is significantly different between the two phones. There is a "Brand Effect"

Two tests which are secondary of importance is the statistical hypothesis:

H0: The average amount of time it takes to receive a message is approximately the same between Wifi and Data connection within each phone brand. There is no “Connection Effect”.

Ha: The average amount of time it takes to receive a message is significantly different between Wifi and Data connection within each phone brand. There is a “Connection Effect”.

The other test is:

H0: The average amount of time it takes to receive a message is approximately the same for the text message, pictures, and video within each connection. There is no “Message Effect”.

Ha: The average amount of time it takes to receive a message is significantly different between the three message types within each connection. There is a “Message Effect”.

Prior to the collection of the data it is unknown as to which brand of phone will be faster at receiving messages. If other experimental studies are openly available to the public, they have not been looked at prior to the implementation of this study. Furthermore, it is difficult to tell which connection type will be faster (Wifi or Data). We can say, however, that one can predict that cellular data might be faster, especially if multiple users are connected to the Wifi network. Lastly, it is almost guaranteed that regular text messages (with words and emojis) will be received faster than that of the pictures and videos. One may also predict that pictures will be faster to receive than videos since the file size of videos are usually larger than pictures. It is good to note that in this experiment, the "pictures" level incorporated into the "Message Effect" consists of thirty pictures sent in one message, whereas the "video" level only consists of one video sent at a time. This leads to more uncertainty as to which message type will be faster. Although it can be important to have a strong prediction before the data is collected in order to verify it through experiments, it can also be very useful to be uncertain about what the final results will be in an effort to learn something new in a neutral and unbiased setting.

Design:

How will you collect the data?

Data will be collected through the use of Zoom Video Communications (Zoom). There will be three members on the Zoom call, one of which sends the messages, two of which receive messages. One of the two people receiving messages will have an iPhone 10 and the other will have a Samsung S9+. There will be a person next to the sender to record the time it takes for the receiver on the Zoom call to get the message. Note that there is no infringement on any human rights or any experimentation on humans in this design. The people included in this design are simply the experimenters who conduct the experiment. The timer will start immediately as the sender taps their phone to deliver the message, and the timer will stop as soon as a loud notification sound is heard over the Zoom call, indicating the receiver has gotten the message. This process will be done one at a time, that is, one message is sent only to one brand of phone for each “trial”. There will be 60 trials in total, 30 for each brand of phone. For each brand of phone, there will be 15 messages sent while the receiver’s phone is connected to Wifi and 15 messages sent while the receiver’s phone is connected to cellular data. Lastly, there will be three categories of messages sent. The first is a standard text message with approximately 150 words/emojis, the second is a collection of thirty pictures, and the third is a video approximately one minute in length. Overall, there will be a total of 5 messages sent at each combination of phone brand, connection type, and message category. A visual summary for the breakdown of this data is provided below.

\*INSERT DIAGRAM OF THE THREE STAGE NESTED DESIGN!

If you experience issues such as measurement error, how were these issues resolved?

Using Zoom to collect data can lead to potential problems in a given trial if there is a lag in the video and sound. To combat this, we made sure that the amount of people using the internet is the same in both houses. In this case, both houses had a total of two people using the internet including the recipient of the messages. Human error is possible when using a timer. To diminish this, we ensured that the same person is timing all the trials.

Did you ensure that every subject in your experiment was subjected to the same environment?

Careful measures were taken to ensure that every trial was subjected to the same environment, especially with regards to comparing the two phone brands. A crucial aspect in comparing the iPhone with Samsung is to choose phones that are similar in their release date to stores. The iPhone 10 was released in November, 2017 and the S9 was released in March, 2018, which creates a fair comparison between the two brands, iPhone and Samsung. A second vital aspect to create a similar environment is that both phones used a Shaw Wifi network during the trials that required them to be connected to Wifi, and both were connected to a Virgin Mobile cellular network during the trials that required Data connection. Since the sender is using an iPhone 8 to send the messages, there is a possibility that a bias will occur with the iPhone 10, the third party application “Messenger” will be used to ensure that the messaging platform used to send the messages is neutral. Furthermore, the sender kept their phone’s battery at a constant level and stayed in the same location throughout the 60 trials. A final reason the environment was the same is because everyone associated with the data collection was on the same Zoom call, so any short delay in audio would have been relatively constant across every trial.

You need to be careful and attempt to identify all factors which could affect your results. (Many of these factors may not be of interest in your study)

One factor that could affect the results of the study is how the receivers of the messages were not in the same location, meaning there could be differences in how fast the networks are running. We measured using the “Speed Test” tool from Google [2] and found that the wifi speed of the iPhone message recipient was faster by 40 megabytes per second (Mb. This may affect the average time in which a message is received between the iPhone 10 and Samsung S9+ since 15 out of the 30 trials within each phone brand uses wifi. There are also times when the loud notification sound did not go off even though the message was received and we were not able to precisely stop the timer on time. In this situation, we simply scratched that trial and did a rerun of the same trial with the same message re-sent. This factor may have caused a slight change in the average trial times that were recorded.

Das, S. (2020, Feb 14). Top 10 Best Mobile Phone Brands in the World. Retrieved from <http://www.mobilecellphonerepairing.com/top-10-best-mobile-phone-brands-in-the-world.html>

<https://www.google.com/search?q=google+speed+test&oq=google+spee&aqs=chrome.1.69i57j0l7.3259j0j7&sourceid=chrome&ie=UTF-8>

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Some R code (model and conditions)

$X\_{ijlm} = \mu + \tau\_{i} + \beta\_{j(i)} + \gamma\_{l(ji)} + e\_{ijlm}$

\begin{array}{ll}

\tau\_{i} & \text{represents the effect of the “Brand”}\:\:i, \:i = 1, 2 \\

\beta\_{j(i)} & \text{represents the effect of the “Connection”}\:\:j\:\:\text{nested within “Brand”}\:\:i, \: j = 1, 2; \:i = 1, 2 \\

\gamma\_{l(ji)} & \text{represents the effect of “Message Type”}\:\:l\:\:\text{nested within} \: \beta\_{ji} \:\: l = 1, 2, 3

\end{array}

The conditions of this model is that the e\_{ijlm}’s are normally distributed with a mean of 0 and a variance $\sigma^2\_{Common}$

CONCLUSION

In conclusion, based on the data for the Three-Stage Nested Design, a Brand Effect was found.

Earlier, we were not able to predict which phone brand will perform better but after the analysis, we have found that the difference between the average time in seconds in which an iPhone 10 and Samsung S9+ smartphone received a message was between 7.10 and 12.88 seconds with confidence of 95%. Therefore, we can say that a Samsung S9+ smartphone is faster at receiving messages than an iPhone 10.

We also found that there is no Connection Effect which means the average time for a message to be received was the same across Wifi and Data within iPhone and Samsung. This proves our initial thoughts wrong as we predicted that the Data Connection will result in shorter times when receiving messages. This might be in part due to how well Wifi and Cellular Data technology has gotten causing them to perform the same.

Lastly, there is a Message effect within each Connection and Brand and so the average time for a message to be received was not the same across Text, Picture and Video within each Connection and Brand. Specifically, the multiple comparison method showed that on average, for each Connection within the iPhone 10 and a Samsung S9+, Video Messages took the most amount of time while Text Messages took the least amount of time and Picture Messages in between. These results align with our earlier predictions since it is known that Text Messages are smaller files compared to Videos and Pictures.

Given all of these results, if a consumer was to solely base their purchase decision on the amount of time a Message is received between an iPhone 10 and a Samsung S9+ then we strongly suggest opting for a Samsung S9+.