

Title: Data analysis report to improve Assetto Corsa game player performance

Author: Jon Ramangwana

Date: 21 September 2022

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## 1. Introduction

### 1.1 Background

This report was written to help a game player get better at winning a video game. Assetto Corsa a driver racing video game that gets a game player to play like they are driving a real car was played many times with no win. Statistical analysis was a possible solution to get to win this difficult video game.

A message at the beginning of this car racing video game was noticed that does not allow software for any purpose similar to public entertainment, promotions, training, education, commercial, either paid or free with no written permission that Kuno Simulazioni a company that design this game provides.

Assetto Corsa support team got contacted by email there was no reply to email for weeks until this research began. Fact that this message does not allow public, promotional, entertainment, training, educational, commercial work, while this report does not include any of these, allowed experiment to proceed. Games had to get won. Reason for writing this report was to improve a game player's personal performance.

There are 8 variables that can get switched on when playing Assetto Corsa. These variables include traction control, stability control, ABS, fuel consumption, tyre wear etc. It's claimed that each one affects game play. Getting to look at how these variables affect game play was expected to prove this claim at the end improve Assetto Corsa game player's performance.

Agarwal (2021) argue that doing correct statistical analysis to collected data has lots of importance. Ideas that are not verified are not reliable. People depend on accurate analysis of data to make decisions. In the past statistical null hypothesis testing was invented to test claims, hypothesis testing has become a common research practice at present (Meyer et al., 2017). A hypothesis test was done to complete this report by collecting numerical data, this data was analyzed to get insights that can help to win races.

### 1.2 Aim

1. To improve Assetto Corsa game player performance.

### 1.3 Objectives

1. To produce a hypothesis test.
2. To ask relevant questions that can provide solutions.

3. To collect numerical data from game races.
4. To clean collected data.
5. To make tables from collected data.
6. To plot graphs.
7. To analyze data.
8. To get to conclude how to improve game player performance.

#### 1.4 Research question

A game player can't win a driver racing game. This game player decide to improve his game by a statistical analysis. There are 8 variables that can get switched on that can affect driving a car. Each variable has a 50% chance of affecting game player performance. Lots of confidence exist that at least one variable can improve game player performance.

1. Can at least one variable improve game player performance to help this game player win races?
2. How does each variable affect game play?

#### 2. Method

A sum of 9 trials were done, each trial was repeated 5 times to increase accuracy. To test how a variable affects game play each variable got switched on while others were switched off. Game would get played 5 times with one variable switched on. Race time was recorded for each race. Races were completed driving an Abarth 500 SS, a car that's easy to control. Races were completed at Vallenga club race track. Trial 1 was done with each variable switched off to look at how these variables were affecting game play by comparison. Variables that were switched on are:

1. Traction control.
2. Stability control.
3. Tyre blankets.
4. ABS.
5. Fuel consumption.
6. Tyre wear.
7. Slipstream.
8. Mechanical damage.

A hypothesis test was done to confirm that each variable can affect game player performance. Questions were asked, data was collected, prepared, cleaned, processed, then shared online. Data collected on tables in a book then stored on spreadsheets to get processed by making tables, scatter plots, bar graphs, pie charts etc. A one way Anova test was performed to look at any significant differences to race time whenever a variable got changed. At the end results were analyzed to get to a solution to questions raised at the beginning of research.

### 3. Results

Race number, race time, lap time, etc. were recorded for each race on tables on spreadsheets. Graphs were then plotted. This section contains this information. Time was recorded in a format of minutes: seconds: milliseconds. Outliers were discarded to keep data unbiased.

A hypothesis test provides with a prediction to look at how relevant this experiment was before getting at the beginning of any test. This hypothesis test can help answer a research question. A null hypothesis with an alternative hypothesis for this particular experiment are stated at the bottom. Research question can get looked at as a binomial distribution.

$H_0$ :  $p = 0.5$ , No variable can improve game player performance.

$H_1$ :  $p > 0.5$ , At least one variable can improve game player performance.

When  $H_0$  true, then  $X \sim B(8, 0.5)$

A one tailed upper tailed test at 95% significance level.

Test value  $x$  gets in a critical region, i.e. upper tail 5% of distribution when  $P(X \geq 1) > 95\%$

Reject  $H_0$  when  $P(X \geq 1) > 95\%$

#### Equation 1

$$P(X \geq 1) = 1 - P(X = 0)$$

$$= 1 - 0.5^8$$

$$= 0.996$$

$$= 99.6\%$$

#### 3.1 Each variable switched off

##### Table 1

##### Race number with time

Race Number	Lap 1 Time	Lap 2 Time	Race Time
1	01:39.221	01:14.045	02:53.266
2	01:26.172	01:15.293	02:41.465
3	01:37.691	01:10.437	02:48.128
4	01:19.917	01:13.251	02:33.168
5	01:23.039	01:12.313	02:35.352

This table was recorded when game was played with each variable switched off. Time to finish laps was recorded for each race number. There are 2 laps for each race. Sum of 2 laps was recorded as race time this was time taken to finish race.

Table 2

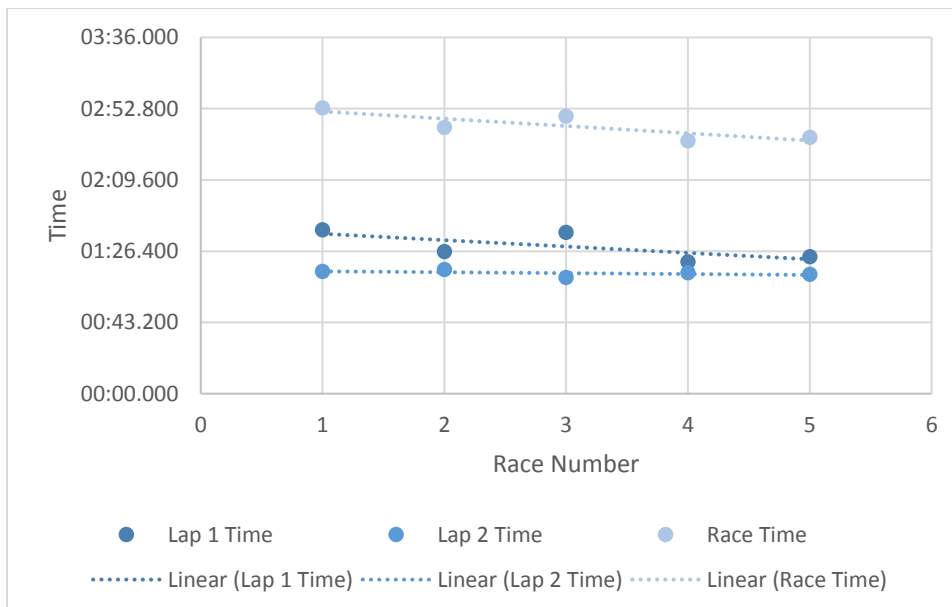
Table for statistics calculations

Summary value	Numeric value
Average race time	02:40.813
Standard deviation	9.04E-05
Correlation coefficient lap1, lap2	-0.255
Slow lap time	01:39.221
Fast lap time	01:10.437
Sum of race time	13:31.379

Statistics calculations were completed when each variable was switched off. Values were recorded on this table. Calculations were for average race time, standard deviation, correlation coefficient between laps, slow lap time, fast lap time, sum of race time when each variable was switched off etc.

Graph 1

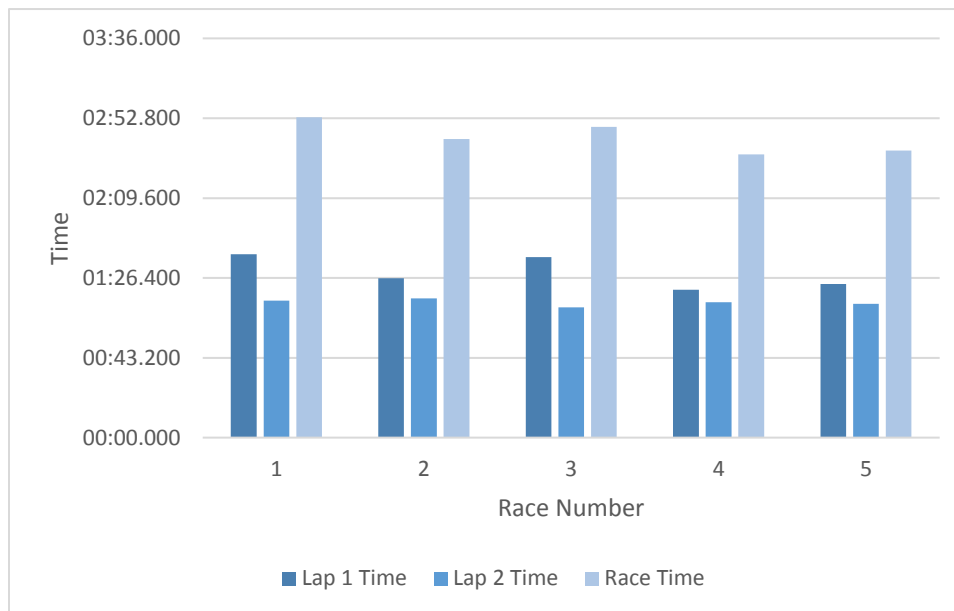
Scatter plot for time with race number



Graph above shows a scatter plot when each variable was switched off. Graph was plotted to look at how fast each lap was for each race when variables were switched off.

Graph 2

### Bar graph for time with race number



Comparisons were made for 3 race times for each of these 5 races that were completed when each variable was switched off. This bar graph visually shows these comparisons.

### 3.2 Traction control switched on

Table 3

#### Race number with time

Race Number	Lap 1 Time	Lap 2 Time	Race Time
1	01:46.052	01:16.858	03:02.910
2	01:49.905	01:22.818	03:12.723
3	01:46.196	01:14.077	03:00.273
4	01:36.657	01:16.711	02:53.368
5	01:25.497	01:11.973	02:37.470

This table was recorded when game was played with traction control switched on. Time to finish laps was recorded for each race number. There are 2 laps for each race. Sum of 2 laps was recorded as race time this was time taken to finish race.

Table 4

#### Table for statistics calculations

Summary value	Numeric value
Average race time	02:57.349
Standard deviation	1.36E-04
Correlation coefficient lap1, lap2	0.711863921
Slow lap time	01:49.905

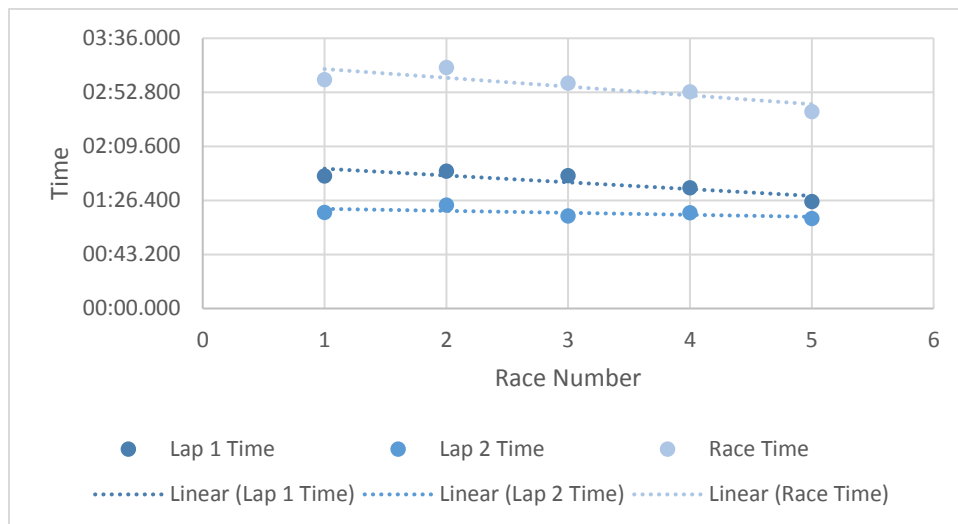


Fast lap time	01:11.973
Sum of race time	14:46.744

Statistics calculations were completed when traction control was switched on. Values were recorded on this table. Calculations were for average race time, standard deviation, correlation coefficient between laps, slow lap time, fast lap time, sum of race time when traction control was switched on etc.

### Graph 3

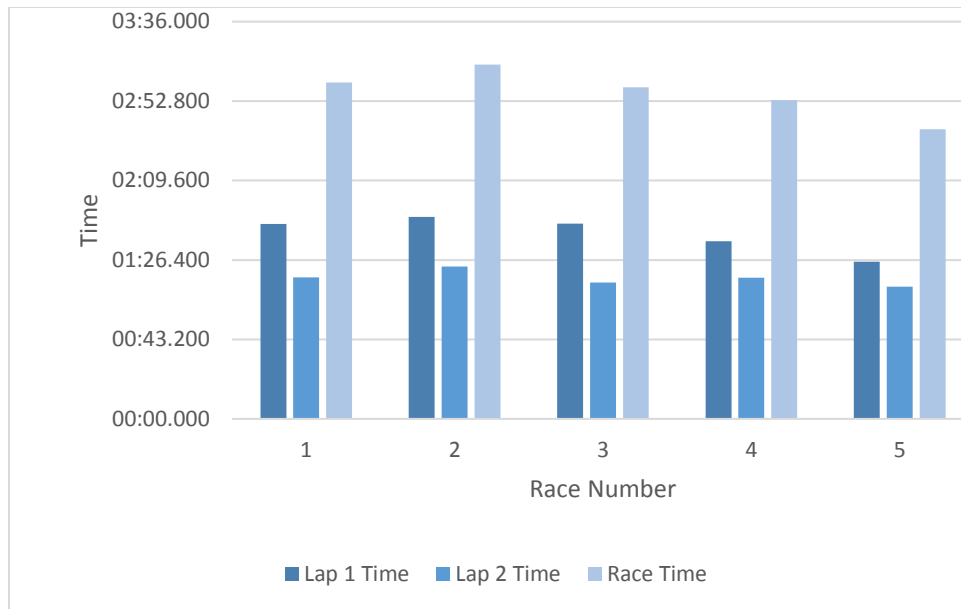
#### Scatter plot for time with race number



Graph above shows a scatter plot when traction control was switched on. Graph was plotted to look at how fast each lap was for each race when traction control was switched on.

### Graph 4

#### Bar graph for time with race number



Comparisons were made for 3 race times for each of these 5 races that were completed when traction control was switched on. This bar graph visually shows these comparisons.

### 3.3 Stability control switched on

Table 5

Race number with time

Race Number	Lap 1 Time	Lap 2 Time	Race Time
1	02:10.000	01:08.730	03:18.730
2	01:25.472	01:11.867	02:37.339
3	01:22.994	01:09.555	02:32.549
4	01:23.265	01:07.247	02:30.512
5	01:38.614	01:10.147	02:48.761

This table was recorded when game was played with stability control switched on. Time to finish laps was recorded for each race number. There are 2 laps for each race. Sum of 2 laps was recorded as race time this was time taken to finish race.

Table 6

Table for statistics calculations

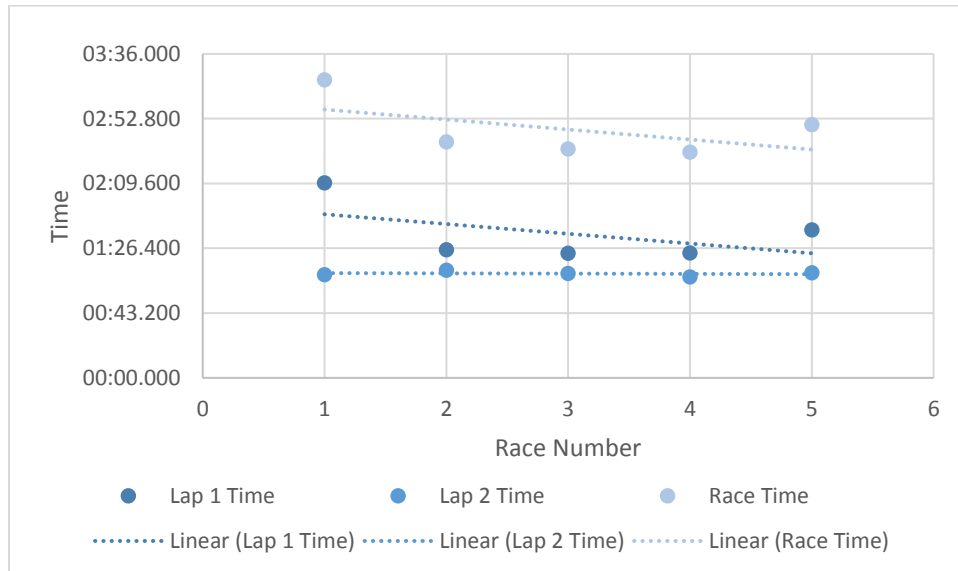
Summary value	Numeric value
Average race time	02:44.782
Standard deviation	2.29E-04
Correlation coefficient lap1, lap2	-0.156469623
Slow lap time	02:10.000
Fast lap time	01:07.247

Sum of race time	13:47.891
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Statistics calculations were completed when stability control was switched on. Values were recorded on this table. Calculations were for average race time, standard deviation, correlation coefficient between laps, slow lap time, fast lap time, sum of race time when stability control was switched on etc.

### Graph 5

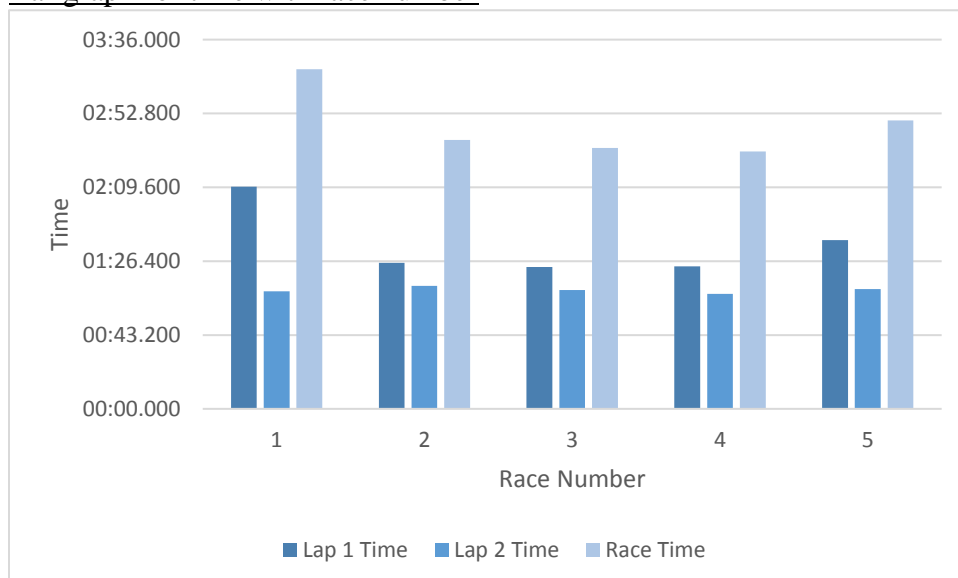
#### Scatter plot for time with race number



Graph above shows a scatter plot when stability control was switched on. Graph was plotted to look at how fast each lap was for each race when stability control was switched on.

### Graph 6

#### Bar graph for time with race number



Comparisons were made for 3 race times for each of these 5 races that were completed when stability control was switched on. This bar graph visually shows these comparisons.

### 3.4 Mechanical damage switched on

Table 7

Race number with time

Race Number	Lap 1 Time	Lap 2 Time	Race Time
1	01:32.903	null	#VALUE!
2	01:32.782	null	#VALUE!
3	01:33.947	null	#VALUE!
4	01:30.496	null	#VALUE!
5	01:31.940	null	#VALUE!

This table was recorded when game was played with mechanical switched on. First lap alone was recorded, that's how far car could go with this variable switched on.

### 3.5 Tyre blankets switched on

Table 8

Race number with time

Race Number	Lap 1 Time	Lap 2 Time	Race Time
1	01:28.664	01:12.731	02:41.395
2	01:22.364	01:09.748	02:32.112
3	01:24.858	01:07.428	02:32.286
4	01:48.280	01:09.539	02:57.819
5	01:20.029	01:07.029	02:27.058

This table was recorded when game was played with tyre blankets switched on. Time to finish laps was recorded for each race number. There are 2 laps for each race. Sum of 2 laps was recorded as race time this was time taken to finish race.

Table 9

Table for statistics calculations

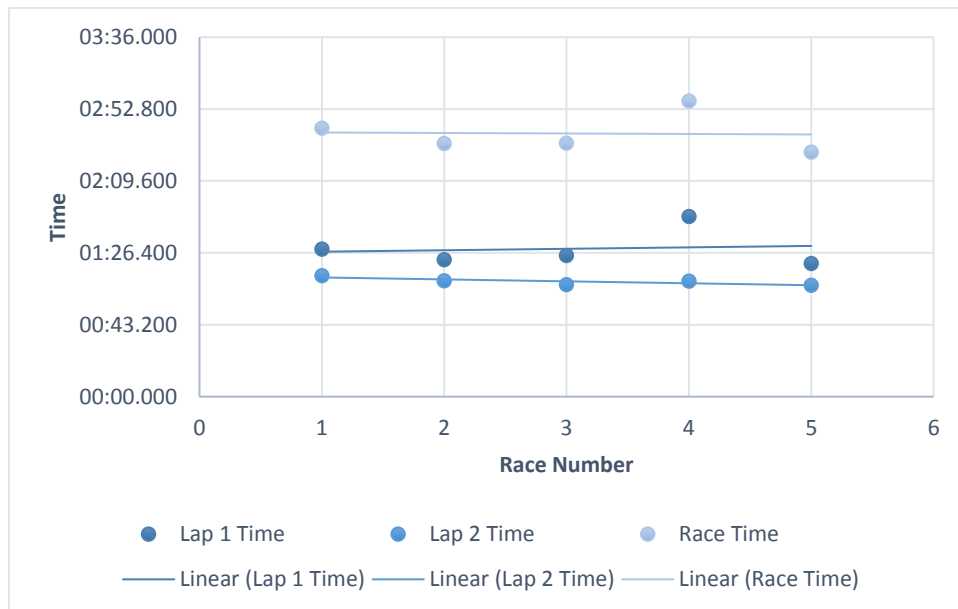
Summary value	Numeric value
Average race time	02:33.213
Standard deviation	1.26E-04
Correlation coefficient lap1, lap2	0.277544981
Slow lap time	01:48.280
Fast lap time	01:07.029
Sum of race time	13:10.670

Statistics calculations were completed when tyre blankets was switched on. Values were recorded on this table. Calculations were for average race time, standard deviation, correlation

coefficient between laps, slow lap time, fast lap time, sum of race time when tyre blankets was switched on etc.

### Graph 7

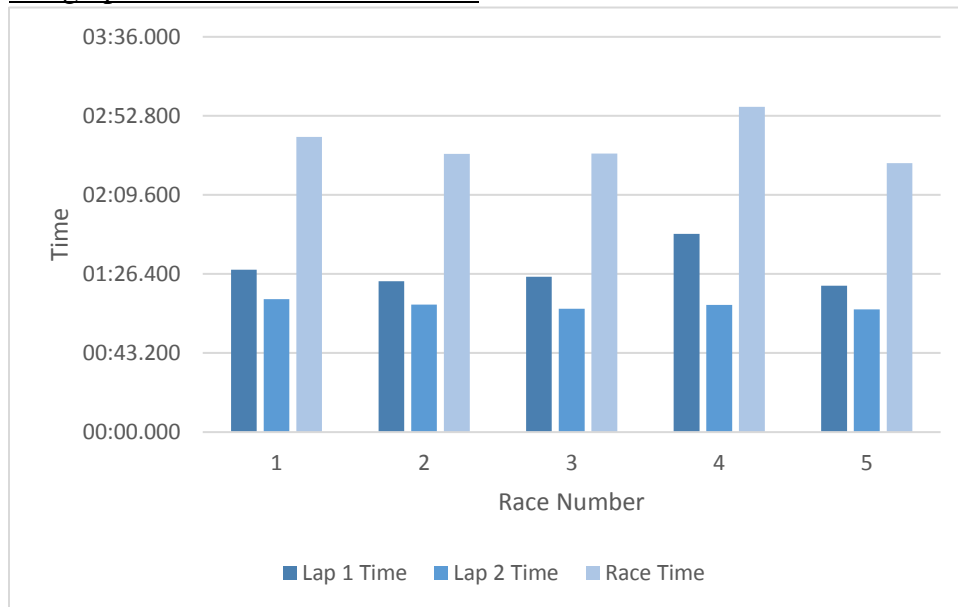
#### Scatter plot for time with race number



Graph above shows a scatter plot when tyre blankets were switched on. Graph was plotted to look at how fast each lap was for each race when tyre blankets were switched on.

### Graph 8

#### Bar graph for time with race number



Comparisons were made for 3 race times for each of these 5 races that were completed when tyre blankets were switched on. This bar graph visually shows these comparisons.

### 3.6 ABS switched on

Table 10

#### Race number with time

Race Number	Lap 1 Time	Lap 2 Time	Race Time
1	01:27.853	01:11.852	02:39.705
2	01:34.295	01:15.184	02:49.479
3	01:22.999	01:06.916	02:29.915
4	01:19.669	01:09.598	02:29.267
5	01:23.975	01:07.975	02:31.950

This table was recorded when game was played with ABS switched on. Time to finish laps was recorded for each race number. There are 2 laps for each race. Sum of 2 laps was recorded as race time this was time taken to finish race.

Table 11

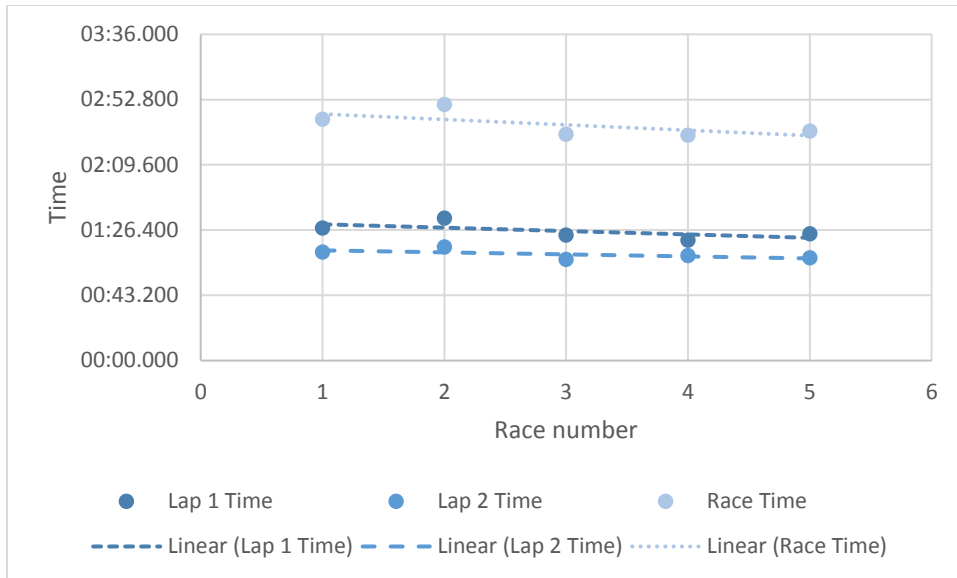
#### Table for statistics calculations

Summary value	Numeric value
Average race time	02:36.063
Standard deviation	8.88E-05
Correlation coefficient lap1, lap2	0.848771206
Slow lap time	01:34.295
Fast lap time	01:06.916
Sum of race time	13:00.316

Statistics calculations were completed when ABS was switched on. Values were recorded on this table. Calculations were for average race time, standard deviation, correlation coefficient between laps, slow lap time, fast lap time, sum of race time when ABS was switched on etc.

### Graph 9

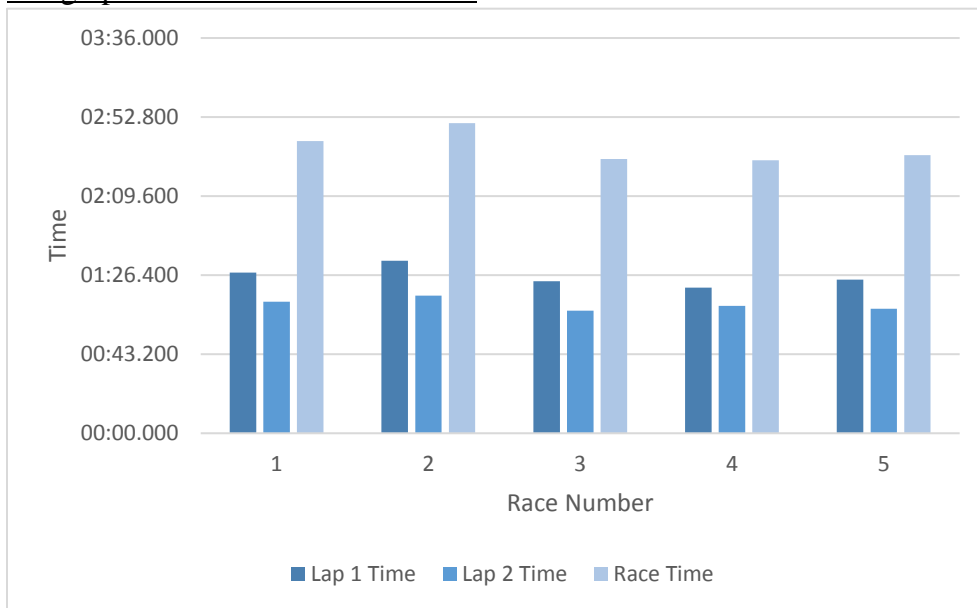
#### Scatter plot for time with race number



Graph above shows a scatter plot when ABS was switched on. Graph was plotted to look at how fast each lap was for each race when ABS was switched on.

### Graph 10

#### Bar graph for time with race number



Comparisons were made for 3 race times for each of these 5 races that were completed when ABS was switched on. This bar graph visually shows these comparisons.

### 3.7 Fuel consumption switched on

#### Table 12

#### Race number with time

Race Number	Lap 1 Time	Lap 2 Time	Race Time
1	01:21.698	01:11.076	02:32.774
2	01:26.396	01:08.254	02:34.650
3	01:16.407	01:08.859	02:25.266
4	01:21.033	01:12.000	02:33.033
5	01:22.022	01:07.071	02:29.093

This table was recorded when game was played with fuel consumption switched on. Time to finish laps was recorded for each race number. There are 2 laps for each race. Sum of 2 laps was recorded as race time this was time taken to finish race.

Table 13

Table for statistics calculations

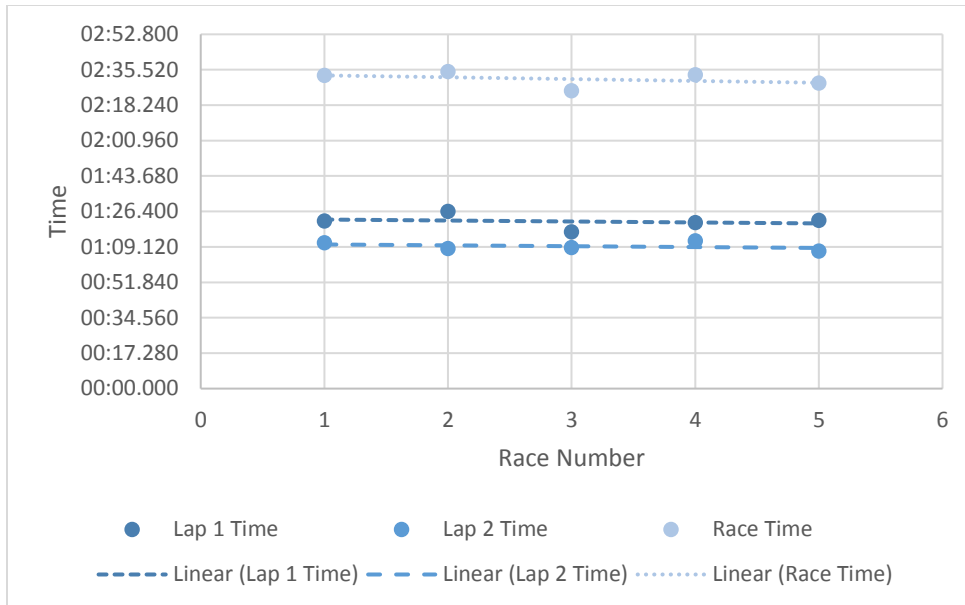
Summary value	Numeric value
Average race time	02:30.963
Standard deviation	3.91E-05
Correlation coefficient lap1, lap2	-0.171366982
Slow lap time	01:26.396
Fast lap time	01:07.071
Sum of race time	12:34.816

Statistics calculations were completed when fuel consumption was switched on. Values were recorded on this table. Calculations were for average race time, standard deviation, correlation coefficient between laps, slow lap time, fast lap time, sum of race time when fuel consumption was switched on.

Graph 11

Scatter plot for time with race number

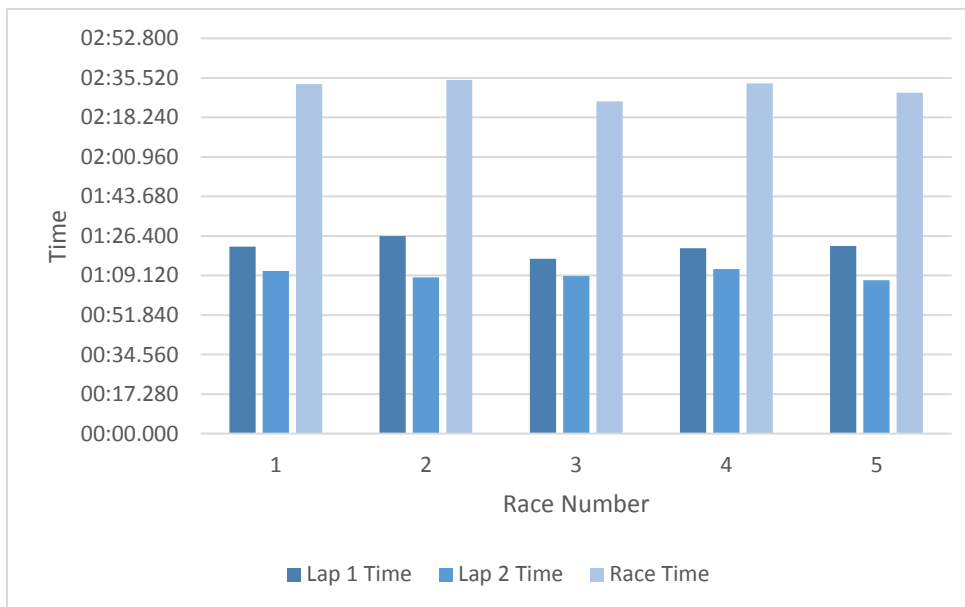




Graph above shows a scatter plot when fuel consumption was switched on. Graph was plotted to look at how fast each lap was for each race when fuel consumption was switched on.

### Graph 12

#### Bar graph for time with race number



Comparisons were made for 3 race times for each of these 5 races that were completed when fuel consumption was switched on. This bar graph visually shows these comparisons.

### 3.8 Tyre wear switched on

#### Table 14

#### Race number with time

Race Number	Lap 1 Time	Lap 2 Time	Race Time
1	01:21.707	01:05.279	02:26.986
2	01:25.136	01:04.983	02:30.119
3	01:22.068	01:08.373	02:30.441
4	01:27.040	01:13.851	02:40.891
5	01:26.009	01:15.701	02:41.710

This table was recorded when game was played with tyre wear switched on. Time to finish laps was recorded for each race number. There are 2 laps for each race. Sum of 2 laps was recorded as race time this was time taken to finish race.

Table 15

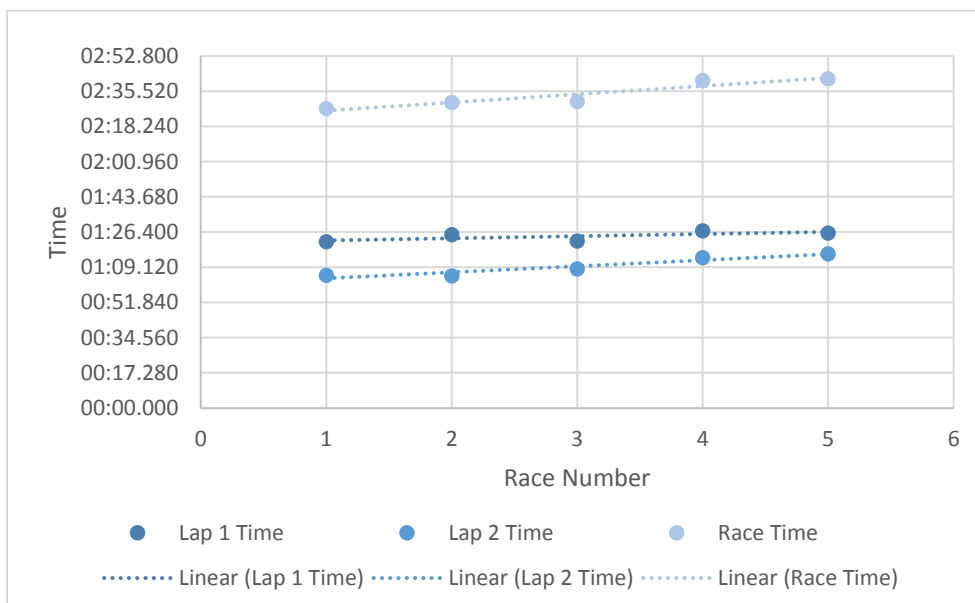
Table for statistics calculations

Summary value	Numeric value
Average race time	02:34.029
Standard deviation	7.02E-05
Correlation coefficient lap1, lap2	0.684358525
Slow lap time	01:27.040
Fast lap time	01:04.983
Sum of race time	12:50.147

Statistics calculations were completed when tyre wear was switched on. Values were recorded on this table. Calculations were for average race time, standard deviation, correlation coefficient between laps, slow lap time, fast lap time, sum of race time when tyre wear was switched on.

Graph 13

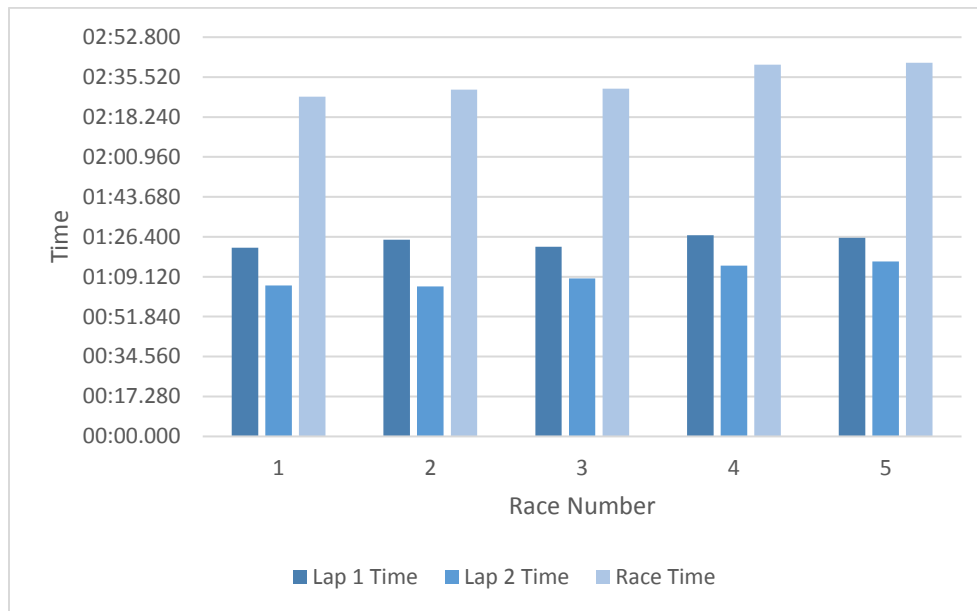
Scatter plot for time with race number



Graph above shows a scatter plot when tyre wear was switched on. Graph was plotted to look at how fast each lap was for each race when tyre wear was switched on.

Graph 14

Bar graph for time with race number



Comparisons were made for 3 race times for each of these 5 races that were completed when tyre wear was switched on. This bar graph visually shows these comparisons.

### 3.9 Slipstream switched on

Table 16

Race number with time

Race Number	Lap 1 Time	Lap 2 Time	Race Time
1	01:23.094	01:10.388	02:33.482
2	01:20.501	01:14.986	02:35.487
3	01:39.456	01:07.396	02:46.852
4	01:33.489	01:14.317	02:47.806
5	01:35.266	01:10.399	02:45.665

This table was recorded when game was played with slipstream switched on. Time to finish laps was recorded for each race number. There are 2 laps for each race. Sum of 2 laps was recorded as race time this was time taken to finish race.

Table 17

Table for statistics calculations

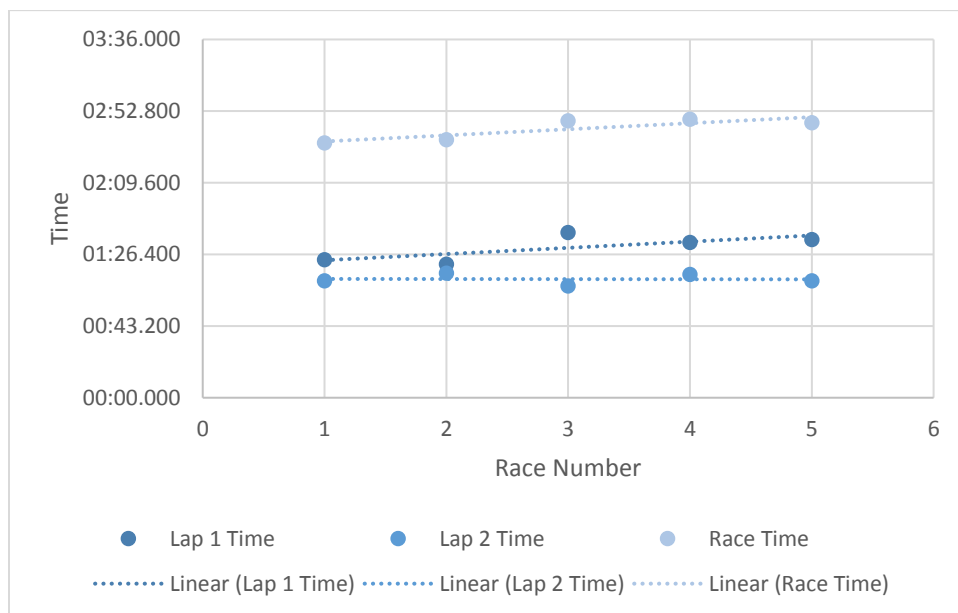
Summary value	Numeric value
---------------	---------------

Average race time	02:41.858
Standard deviation	7.05E-05
Correlation coefficient lap1, lap2	-0.587599709
Slow lap time	01:39.456
Fast lap time	01:07.396
Sum of race time	13:29.292

Statistics calculations were completed when slipstream was switched on. Values were recorded on this table. Calculations were for average race time, standard deviation, correlation coefficient between laps, slow lap time, fast lap time, sum of race time when slipstream was switched on.

### Graph 15

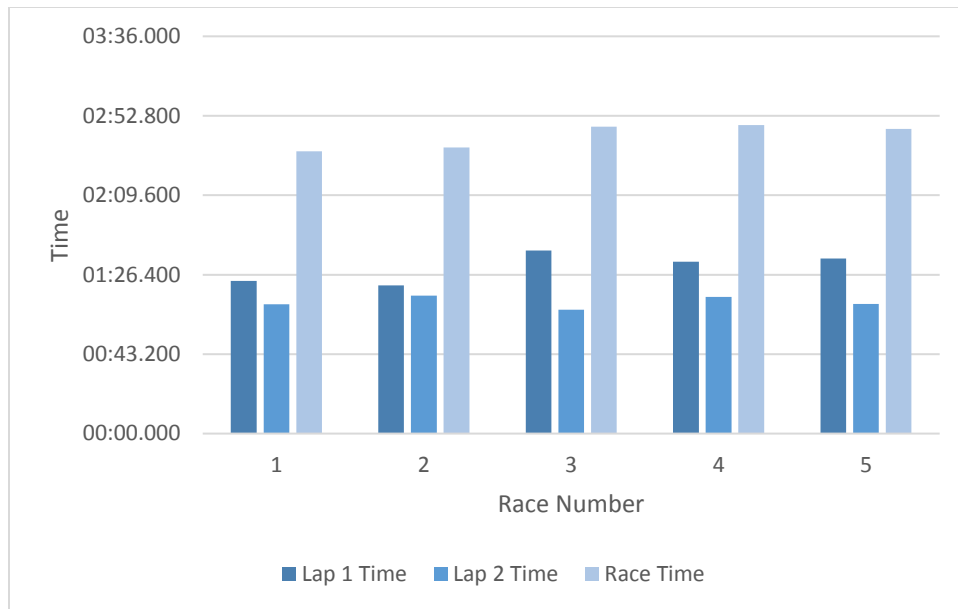
#### Scatter plot for time with race number



Graph above shows a scatter plot when slipstream was switched on. Graph was plotted to look at how fast each lap was for each race when slipstream was switched on.

### Graph 16

#### Bar graph for time with race number



Comparisons were made for 3 race times for each of these 5 races that were completed when slipstream was switched on. This bar graph visually shows these comparisons.

### 3.10 Race time percentage

Table 18

Race time percentage for each variable

Variable	Race time percentage
Each variable OFF	12.61618455
Traction control switched ON	13.78803981
Stability control switched ON	12.87293071
Tyre blankets switched ON	12.29417897
ABS switched ON	12.13318396
Fuel consumption switched ON	11.73668281
Tyre wear switched ON	11.97506552
Slipstream switched ON	12.58373366

This table describe time percentage for each variable out of total time this game was played. This can show what variable improved game performance better.

### Chart 1

Pie chart for race time percentage

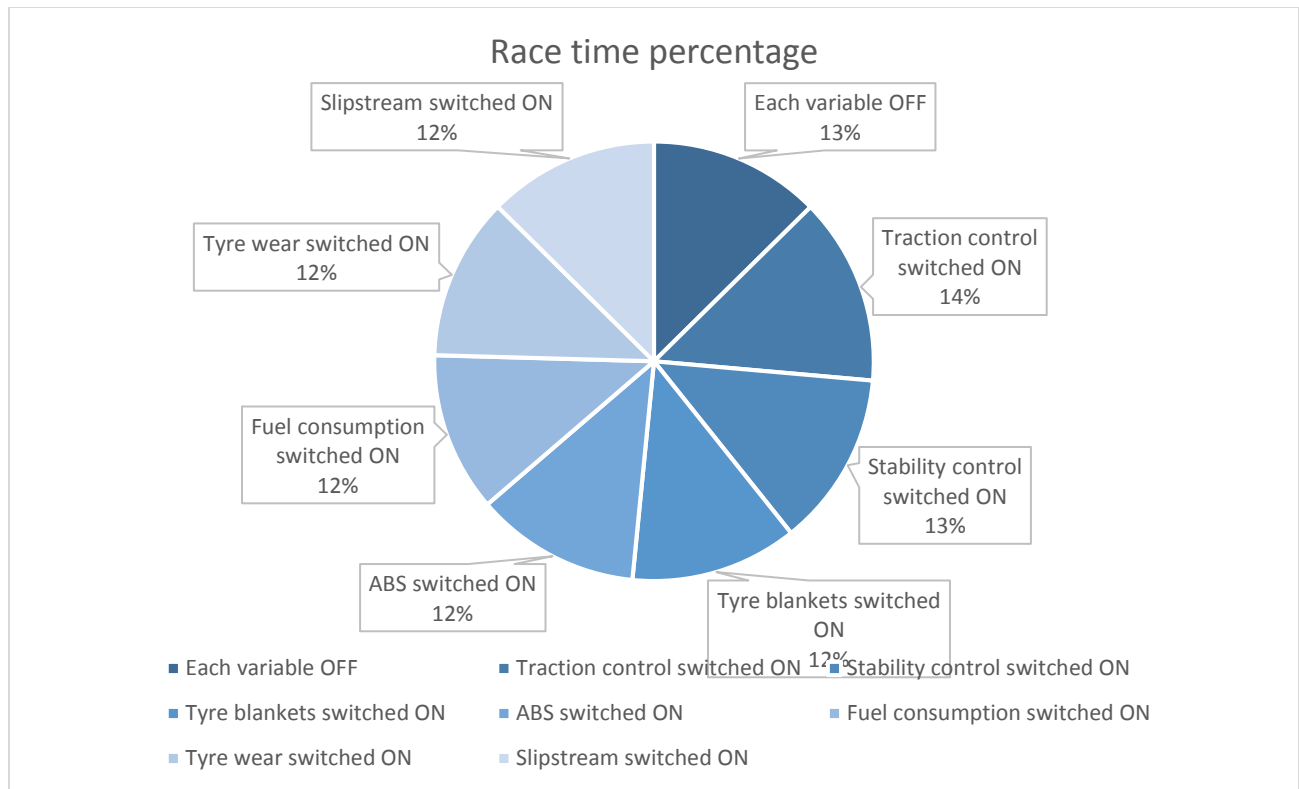


Chart 1 visually shows race time percentage on a pie chart.

### 3.11 Anova race time significance test

One way Anova was performed on an Excel spreadsheet to test whether there are any significant differences to average race time when a variable got changed.

$H_0: \mu_0$  = There are no significant race time differences when variables change.

$H_1: \mu_1$  = There are significant race time differences when variables change.

Table 19

#### Anova test results

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	3.2E-07	7	4.5E-08	2.79637	0.02176	2.31274
Within Groups	5.2E-07	32	1.6E-08			
Total	8.3E-07	39				

Excel one way Anova provide with SS meaning sum of squares, df meaning degrees of freedom, MS meaning mean square, an F statistic value, a P value, F critical value among other values.

### 3.12 Race time for each variable

Table 20

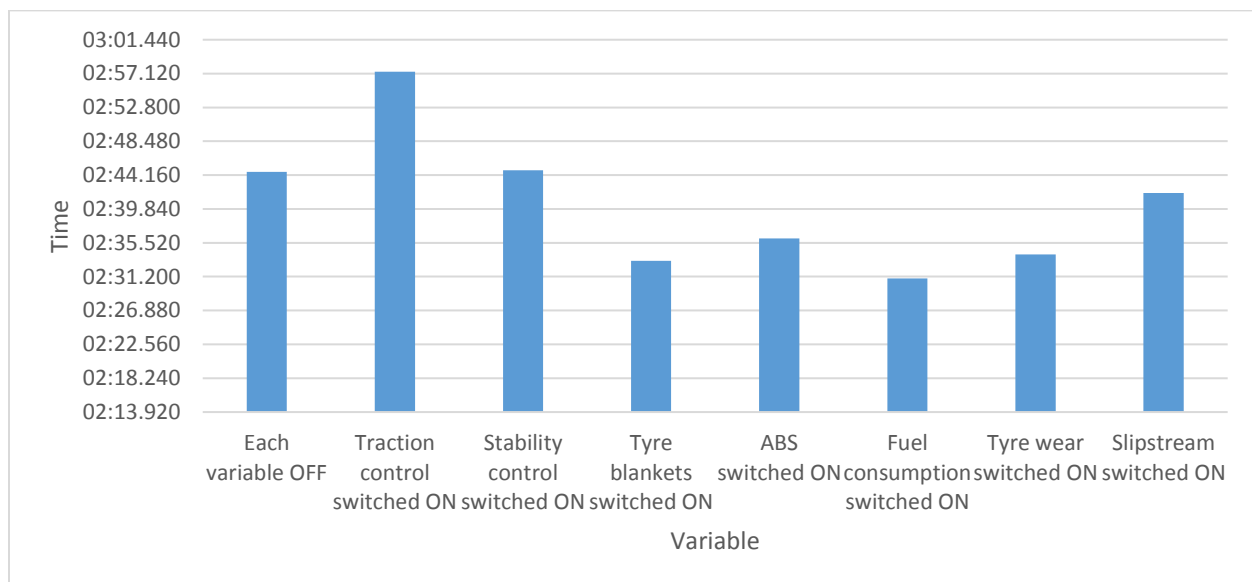
Average race time, fast lap time for each variable

Variable	Average race time	Fast lap time
Each variable OFF	02:44.557	01:10.437
Traction control switched ON	02:57.349	01:11.973
Stability control switched ON	02:44.782	01:07.247
Tyre blankets switched ON	02:33.213	01:07.029
ABS switched ON	02:36.063	01:06.916
Fuel consumption switched ON	02:30.963	01:07.071
Tyre wear switched ON	02:34.029	01:04.983
Slipstream switched ON	02:41.858	01:07.000
Mechanical damage switched ON	Null	Null

Average race time together with fast lap time for each variable was recorded on this table.

### Graph 18

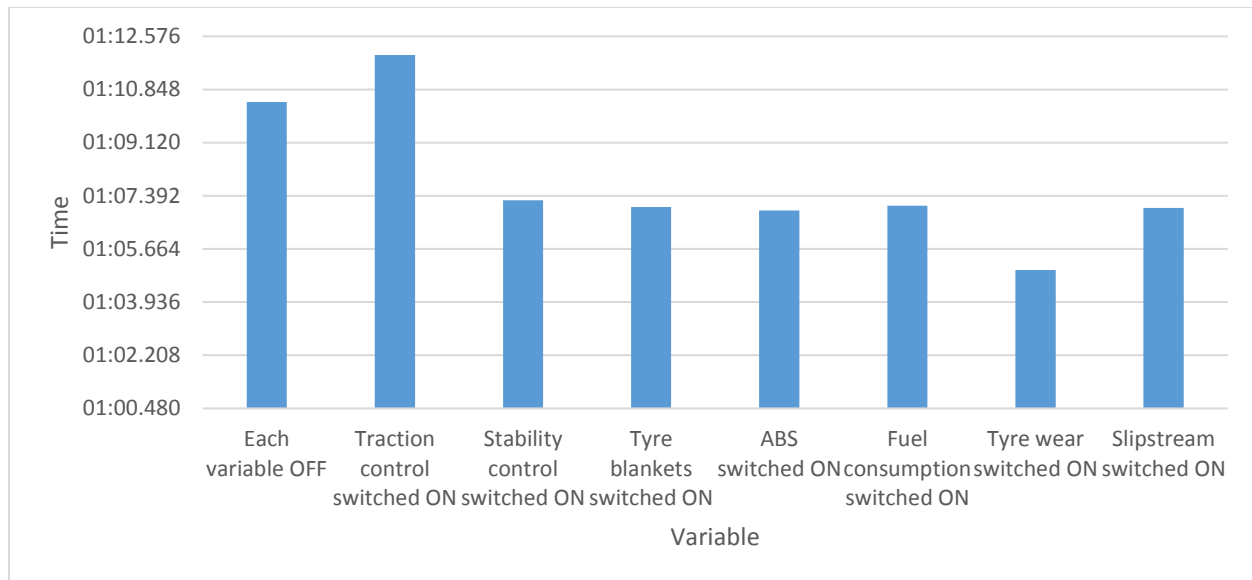
#### Bar graph for average race time



This bar graph shows average race time for 5 races played for each variable.

### Graph 19

#### Bar graph for fast lap time



This bar graph shows fast lap time for each variable.

#### 4. Analysis

This section explains each result described in this report in results section. Analysis shall provide insights that can help to make decisions to improve game player performance. Game player mistakes with help of game lag were cause of outliers that were discarded to remove any bias.

##### 4.1 Research Question

From equation 1, results section,  $P(X \geq 1) = 99.6\%$  this means  $P(X \geq 1) > 95\%$ , test value  $x = 8$  can be in critical region. This can be enough evidence to reject  $H_0$ .

Null hypothesis test proves that this experiment can provide relevant results.  $H_0$  was rejected to accept  $H_1$ . Research question was answered. It's true that at least one variable can improve game player performance to help this game player win races. Analysis of results shall tell how each variable affect game play, this shall get explained next subsections.

##### 4.2 Each variable switched off

When each variable was switched off expectation was that there shall be slow race time since there was nothing to help improve driving. Car lost control to get off track many times when each variable was switched off. Table 1 first row contains race number, lap 1 time, lap 2 time, with last column containing race time for five races. Trends on this table are not easy to look at, better to observe trends on graphs,.

Graph 1 visualize information on table 1 as a scatter plot. Graph 2 visualize information on table 1 as a bar graph. Something slow take a long time to finish at the same time something fast take a short time to finish. Graph 1 shows trend lines with a descending slope. Three trend lines on graph 1 show a similar trend. Cause of this was an improvement on driver skill each time a race got finished. Driver was capable of better driving at the time race number 5 got raced.

Improvement happened slowly from race number 1 to race number 5. This can be seen visually on graph 1.



Looking at graph 2, lap 2 was fast compared to lap 1. Lap 2 has a short bar. At the beginning of a race an engine can be cold this makes a car move slow. When a car moves for some time its engine gets warm, petrol burns better, this causes an increase in speed. Similar to an engine, tyres need to get warm for them to do good on a road. Warm tyres grip a road better this gives a driver better control of a car. Driving for some time makes tyres warm. For this reason lap 2 when each variable was switched off was fast. Race time was long for each of five race numbers because it's a sum of two laps.

There are statistics calculations on table 2 that were completed when each variable was switched off for 5 races. These include:

1. An average race time of 2 minutes 40 seconds 813 milliseconds.
2. A small standard deviation of 0.0000904. This small value shows similar driving skills each lap. Driver was consistent
3. A correlation coefficient between two completed laps of -0.255. Value gets close to 0 this shows no relationship between laps. Laps were independent of each other. What happened to lap 1 did not affect what happened to lap 2.
4. A slow lap time among 5 completed races of 1 minute 39 seconds 221 milliseconds.
5. A fast lap time among 5 completed races of 1 minutes 10 seconds 437 milliseconds.
6. A sum of 5 completed races of 13 minutes 31 seconds 379 milliseconds.

Comparisons shall be made between some of these results with results of 8 variables that can get switched on to look at how each variable affect game play. Question shall be whether a variable makes racing better or worse.

#### 4.3 Traction control switched on

When traction control was switched on, car was easy to control. There was a little swerving.

Table 3 first row contains race number, lap 1 time, lap 2 time, with last column containing race time for five races.

Graph 3 visualize information on table 3 as a scatter plot. Graph 4 visualize information on table 3 as a bar graph. Graph 3 shows trend lines with a descending slope. Three trend lines on graph 3 show a similar trend. Cause of this was an improvement to driver skill. Improvement happened slowly from race number 1 to race number 5. This can be seen visually on graph 3.

Looking at graph 4, lap 2 was fast compared to lap 1. Lap 2 has a short bar. At the beginning of a race an engine can be cold this makes a car move slow. When a car moves for some time its engine gets warm, petrol burns better, this causes an increase in speed. Similar to an engine, tyres need to get warm for them to do good on a road. Warm tyres grip a road better this gives a driver better control of a car. Driving for some time makes tyres warm. For this reason lap 2 when each variable was switched off was fast. Race time was long for each of five race numbers because it's a sum of two laps.

There are statistics calculations on table 4 that were completed when each variable was switched off for 5 races. These include:

1. An average race time of 2 minutes 57 seconds 349 milliseconds.

2. A small standard deviation of 0.000136. This small value shows similar driving skills each lap. Driver was consistent.
3. A correlation coefficient between two completed laps of 0.711. Value gets close to 1 this shows a relationship between laps. Laps had to rely on each other. What happened to lap 1 affected what happened to lap 2. Traction control technology had to learn how this car drives on this track on first lap. Second lap traction control technology understood each turn to correct any decrease in grip. This might be a cause of correlation between these 2 laps.
4. A slow lap time among 5 completed races of 1 minute 49 seconds 905 milliseconds.
5. A fast lap time among 5 completed races of 1 minutes 11 seconds 973 milliseconds.
6. A sum of 5 completed races of 14 minutes 46 seconds 744 milliseconds.

Car stayed on race track when traction control was switched on. Traction has a relationship with grip. Traction control corrects a decrease in grip on each wheel. This made driving easy at the same time traction control was a cause of reduction in speed. There were automatic brakes to correct any decrease in grip, this caused a long race time.

#### 4.4 Stability control switched on

When stability control was switched on, driving was easy. There was no swerving. Table 5 first row contains race number, lap 1 time, lap 2 time, with last column containing race time for five races. Trends on this table are not easy to look at, better to observe trends on graphs.

Graph 5 visualize information on table 5 as a scatter plot. Graph 6 visualize information on table 5 as a bar graph. Graph 5 shows a trend lines with a descending slope. Three trend lines on graph 5 show a similar trend. Cause of this was an improvement on driver skill with this variable.

Improvement happened slowly from race number 1 to race number 5. This can be seen visually on graph 5.

Looking at graph 6, lap 2 was fast compared to lap 1. Lap 2 has a short bar. At the beginning of a race an engine can be cold this makes a car move slow. When a car moves for some time its engine gets warm, petrol burns better, this causes an increase in speed. Similar to an engine, tyres need to get warm for them to do good on a road. Warm tyres grip a road better this gives a driver better control of a car. Driving for some time makes tyres warm. For this reason lap 2 when each variable was switched off was fast. Race time was long for each of five race numbers because it's a sum of two laps.

There are statistics calculations on table 6 that were completed when each variable was switched off for 5 races. These include:

1. An average race time of 2 minutes 44 seconds 782 milliseconds.
2. A small standard deviation of 0.000229. This small value shows similar driving skills each lap. Driver was consistent.
3. A correlation coefficient between two completed laps of -0.156. Value gets close to 0, this shows no relationship between laps. What happened to lap 1 had did not affect what happened to lap 2.
4. A slow lap time among 5 completed races of 2 minute 10 seconds.

5. A fast lap time among 5 completed races of 1 minutes 7 seconds 247 milliseconds.
6. A sum of 5 completed races of 13 minutes 47 seconds 891 milliseconds.

Stability control improved control when this car was moving slow, at the same time there was lots of understeer. Understeer causes a steering wheel to turn a car a little when a driver tries to turn a lot. Stability control technology was designed to make turning at corners easy. This had to work at low speed. When car was fast stability control did not help. This may show stability control technology that's not as good as expected on an Abarth 500 SS.

#### 4.5 Mechanical damage switched on

In life you can't switch off mechanical damage. Switching mechanical damage on caused a racing disaster when this game was played. No race was completed. Car often had a break down on second lap. Damage was caused when driving off road, when doing gear change down at high speed, when driver crashed into walls, etc. Table 7 first row contains race number. Lap 1 time, lap 2 time, with last column containing race time for five races. Car was breaking down in the middle of lap 2, races were not completed there are no values for neither lap 2 nor race time. Lap 1 alone was recorded that's as far as this car can go with this driver while mechanical damage was switched on. No graphs were plotted here. There was proof that mechanical damage was not good for racing. No need for further analysis.

#### 4.6 Tyre blankets switched on

Tyre blankets improved driving a lot. Car handling was good at high speed. Table 8 first row contains race number. Lap 1 time, lap 2 time, with last column containing race time for five races. Trends on this table are not easy to look at, better to observe trends on graphs.

Graph 7 visualize information on table 8 as a scatter plot. Graph 7 visualize information on table 8 as a bar graph. Graph 7 shows trend lines with a descending slope. Three trend lines on graph 7 show a similar trend. Driver was capable of better driving at the time race number 5 got raced. Improvement happened slowly from race number 1 to race number 5. This can be seen visually on graph 7.

Looking at graph 8, lap 2 was fast compared to lap 1. Lap 2 has a short bar. At the beginning of a race an engine can be cold this makes a car move slow. When a car moves for some time its engine gets warm, petrol burns better, this causes an increase in speed. Similar to an engine, tyres need to get warm for them to do good on a road. Warm tyres grip a road better this gives a driver better control of a car. Driving for some time makes tyres warm. For this reason when each variable was switched off lap 2 was fast. Race time was long for each of five race numbers because it's a sum of two laps.

There are statistics calculations on table 6 that were completed when each variable was switched off for 5 races. These include:

1. An average race time of 2 minutes 33 seconds 213 milliseconds.
2. A small standard deviation of 0.000126. This small value shows similar driving skills each lap. Driver was consistent

3. A correlation coefficient between two completed laps of -0.278. Value gets close to 0, this shows no relationship between laps. What happened to lap 1 had did not affect what happened to lap 2.
4. A slow lap time among 5 completed races of 1 minute 48 seconds 280 milliseconds.
5. A fast lap time among 5 completed races of 1 minutes 7 seconds 29 milliseconds.
6. A sum of 5 completed races of 13 minutes 10 seconds 670 milliseconds.

When tyre blankets were switched on grip was increased. When grip increases a car does not slide off track. There was no swerving because this car got easy to drive fast. This provided fast race time.

#### 4.7 ABS switched on

ABS was a cause of difficulties to racing. Though car did not get off race track often, top speed was not reached. Table 10 first row contains race number. Car swerved a little on race number 2, this was a mistake by driver. Lap 1 time, lap 2 time, with last column containing race time for five races. Trends on this table are not easy to look at, better to observe trends on graphs.

Graph 9 visualize information on table 10 as a scatter plot. Graph 9 visualize information on table 10 as a bar graph. Graph 9 shows trend lines with a descending slope. Three trend lines on graph 9 show a similar trend. Cause of this was an improvement on driver skill with this variable. Improvement happened slowly from race number 1 to race number 5. This can be seen visually on graph 9.

Looking at graph 10, lap 2 was fast compared to lap 1. Lap 2 has a short bar. At the beginning of a race an engine can be cold this makes a car move slow. When a car moves for some time its engine gets warm, petrol burns better, this causes an increase in speed. Similar to an engine, tyres need to get warm for them to do good on a road. Warm tyres grip a road better this gives a driver better control of a car. Driving for some time makes tyres warm. For this reason lap 2 when each variable was switched off was fast. Race time was long for each of five race numbers because it's a sum of two laps.

There are statistics calculations on table 11 that were completed when each variable was switched off for 5 races. These include:

1. An average race time of 2 minutes 36 seconds 63 milliseconds.
2. A small standard deviation of 0.0000888. This small value shows similar driving skills each lap. Driver was consistent
3. A correlation coefficient between two completed laps of -0.849. Value gets close to -1, this shows an inverse relationship between laps. What happened to lap 1 had an opposite effect to lap 2. Slow lap 1 was automatically corrected to produce a fast lap 2.
4. A slow lap time among 5 completed races of 1 minute 34 seconds 295 milliseconds.
5. A fast lap time among 5 completed races of 1 minutes 6 seconds 916 milliseconds.
6. A sum of 5 completed races of 13 minutes 316 milliseconds.

ABS caused car to slow down. ABS means Anti-lock braking system. This technology improves safety when emergency breaks are applied. Breaks won't lock wheel this prevents any skidding.

This technology can be safe at the same time technology slows down a car as seen on this experiment.

#### 4.8 Fuel consumption switched on

When fuel consumption was switched on there was an increase in speed with a decrease in control. Car handling was not good at high speed, control had to depend on driver skill. Table 12 first row contains race number. Lap 1 time, lap 2 time, with last column containing race time for five races.

Graph 11 visualize information on table 12 as a scatter plot. Graph 11 visualize information on table 12 as a bar graph. Graph 11 shows a trend lines with a descending slope. Three trend lines on graph 11 show a similar trend. Improvement happened slowly from race number 1 to race number 5. This can be seen visually on graph 11.

Looking at graph 12, lap 2 was fast compared to lap 1. Lap 2 has a short bar. At the beginning of a race an engine can be cold this makes a car move slow. When a car moves for some time its engine gets warm, petrol burns better, this causes an increase in speed. Similar to an engine, tyres need to get warm for them to do good on a road. Warm tyres grip a road better this gives a driver better control of a car. Driving for some time makes tyres warm. For this reason lap 2 when each variable was switched off was fast. Race time was long for each of five race numbers because it's a sum of two laps.

There are statistics calculations on table 13 that were completed when each variable was switched off for 5 races. These include:

1. An average race time of 2 minutes 30 seconds 963 milliseconds.
2. A small standard deviation of 0.0000391. This small value shows similar driving skills each lap. Driver was consistent
3. A correlation coefficient between two completed laps of -0.171. Value gets close to 0, this shows no relationship between laps. What happened to lap 1 had did not affect what happened to lap 2.
4. A slow lap time among 5 completed races of 1 minute 26 seconds 396 milliseconds.
5. A fast lap time among 5 completed races of 1 minutes 7 seconds 71 milliseconds.
6. A sum of 5 completed races of 12 minutes 34 seconds 816 milliseconds.

Fuel consumption means there was a decrease in petrol when car was moving. This happens in real life. When a car gets a decrease in petrol, weight decreases. Small weight makes a car move fast, an engine has small weight to carry. This was a reason for a big increase in speed when fuel consumption was switched on.

#### 4.9 Tyre wear switched on

Lap 2 was difficult to drive when tyre wear was switched on. This configuration increased speed at the same time. Table 14 first row contains race number. Lap 1 time, lap 2 time, with last column containing race time for five races.

Graph 13 visualize information on table 14 as a scatter plot. Graph 13 visualize information on table 14 as a bar graph. Graph 13 shows trend lines with a descending slope. Three trend lines on

graph 13 show a similar trend. Improvement happened slowly from race number 1 to race number 5. This can be seen visually on graph 13.

Looking at graph 14, lap 2 was fast compared to lap 1. Lap 2 has a short bar. At the beginning of a race an engine can be cold this makes a car move slow. When a car moves for some time its engine gets warm, petrol burns better, this causes an increase in speed. Similar to an engine, tyres need to get warm for them to do good on a road. Warm tyres grip a road better this gives a driver better control of a car. Driving for some time makes tyres warm. For this reason lap 2 when each variable was switched off was fast. Race time was long for each of five race numbers because it's a sum of two laps.

There are statistics calculations on table 15 that were completed when each variable was switched off for 5 races. These include:

1. An average race time of 2 minutes 34 seconds 29 milliseconds.
2. A small standard deviation of 0.0000702. This small value shows similar driving skills each lap. Driver was consistent
3. A correlation coefficient between two completed laps of 0.684. Value gets close to 1, this shows a relationship between laps. What happened to lap 1 had an affect on what happened to lap 2. Wearing of tyres on lap 1 was a cause of slippery tyres on lap 2. This caused correlation between these 2 laps
4. A slow lap time among 5 completed races of 1 minute 27 seconds 40 milliseconds.
5. A fast lap time among 5 completed races of 1 minutes 4 seconds 983 milliseconds.
6. A sum of 5 completed races of 12 minutes 50 seconds 147 milliseconds.

When tyre wear was switched on tyres were degrading as this car moved. This would make tyres slippery with time. Lap 2 was difficult to drive tyres had lost grip they had at the beginning at the same time an increase in speed was seen when tyre wear switched on. This increase in speed was difficult to explain since no grip means decrease in control. There can be 2 reasons for increase in speed. First reason can be a decrease in friction this can increase straight line speed. Grip gets needed for speed at corners. Second reason can be decrease in weight as the tyres wear this might increase speed.

#### 4.10 Slipstream switched on

When slipstream was switched on there was a small increase in speed with a decrease in control. Table 16 first row contains race number. Lap 1 time, lap 2 time, with last column containing race time for five races.

Graph 15 visualize information on table 16 as a scatter plot. Graph 15 visualize information on table 16 as a bar graph. Graph 15 shows a trend lines with a descending slope. Three trend lines on graph 15 show a similar trend. Improvement happened slowly from race number 1 to race number 5. This can be seen visually on graph 15.

Looking at graph 16, lap 2 was fast compared to lap 1. Lap 2 has a short bar. At the beginning of a race an engine can be cold this makes a car move slow. When a car moves for some time its engine gets warm, petrol burns better, this causes an increase in speed. Similar to an engine, tyres

need to get warm for them to do good on a road. Warm tyres grip a road better this gives a driver better control of a car. Driving for some time makes tyres warm. For this reason lap 2 when each variable was switched off was fast. Race time was long for each of five race numbers because it's a sum of two laps.

There are statistics calculations on table 18 that were completed when each variable was switched off for 5 races. These include:

1. An average race time of 2 minutes 41 seconds 858 milliseconds.
2. A small standard deviation of 0.0000705. This small value shows similar driving skills each lap. Driver was consistent
3. A correlation coefficient between two completed laps of -0.588. Value gets close to 1, this shows a relationship between laps. What happened to lap 1 affected what happened to lap 2.
4. A slow lap time among 5 completed races of 1 minute 39 seconds 456 milliseconds.
5. A fast lap time among 5 completed races of 1 minutes 7 seconds 396 milliseconds.
6. A sum of 5 completed races of 13 minutes 29 seconds 292 milliseconds.

Slipstream causes low pressure in the back of a moving car. Any car moving behind another fast moving car can experience low drag. When drag gets low a car can move fast because nothing opposes its movement.

#### 4.11 Race time percentage

There was no mechanical damage on chart 1. Mechanical damage was removed from analysis. Sum of 5 race times for each variable was calculated. These sums were converted to percentages of time that this game was played. Table 18 first column has variables. Second column has race time percentage. This information gets visualized on a pie chart i.e. chart 1. To look at how variables affected game player performance each variable was compared to trial when each variable was switched off. Time percentage when each variable was switched off was 13%. Traction control had a time percentage of 14% this was more than time percentage when each variable was switched off. Traction control was not good for racing. This variable made races slow. Stability control had a time percentage of 13% on pie chart. This was similar to time percentage when each variable was switched off meaning there was no improvement to game player performance. Stability control was not necessary to improve game player performance. Slipstream, tyre wear, fuel consumption, ABS, tyre blankets etc. each had a 12% race time percentage. An improvement to 13% when each variable was switched off. When racing small time differences matter. A race can get won by a few milliseconds. This fact makes further analysis necessary.

#### 4.12 Average race time Anova

When Anova hypothesis test was done  $H_1$  was desired to be certain that there were race time differences when variables changed. This shows how important each variable was to this experiment. Table 19 has 5 columns with numbers. To reject  $H_0$  three values on table 19 had to get looked at. First value was p value this was 0.02176. Second value was F value with a value of 2.79637. Last value was F crit with a value of 2.31274. When  $p \leq 0.05$   $H_0$  shall get rejected.

When  $F \geq F_{crit}$   $H_0$  again get rejected.  $P = 0.02176$  this value was less than 0.05.  $P \leq 0.05$  this means  $H_0$  shall get rejected.  $F = 2.79637$  this was greater than 2.31274  $F$  critical value meaning  $F \geq F_{crit}$ . This was further evidence to reject  $H_0$ .  $H_0$  got rejected to favour  $H_1$ . There were significant time differences when variables changed.

#### 4.13 Race time for each variable

Table 20 has a column for variables, average race time with a column for fast lap time at the end. Graph 18 shows a bar graph for average race time when each variable was switched on. Traction control was slow compared to when each variable was off. Stability control has a bar similar to when each variable was off. Tyre blankets, ABS, fuel consumption, tyre wear, slipstream etc. had short bar graphs compared to when each variable was off. These results show that traction control need to get switched off when racing. Stability control improved nothing. Fuel consumption caused a big improvement, followed by tyre blankets, tyre wear, ABS then slipstream respectively. Graph 19 shows a bar graph for fast lap time. Among 5 races for each variable. Race with fast time was recorded. Tyre wear had a short bar showing a fast lap time compared to other variables. This was followed by ABS, tyre blankets, slipstream, fuel consumption, stability control, with traction control showing a long bar compared to when each variable was off.

#### 5. Conclusion

Assetto Corsa was proved to be a true racing simulator. Car drives like a real life car. Winning was difficult because racing can get difficult in real life. Traction control, mechanical damage, stability control were switched off to switch on 5 remaining variables that improved game player performance. When game was played with this configuration, races were won. At the moment these experiments were completed stage 2 of the game had been unlocked. This analysis improved game player performance. Wonder of analysis, numbers became visualizations, visualizations became conclusions, decisions were made that improved game player's performance.

#### 6. Recommendations

Winning this game requires a few simple steps that were tested by this experiment. These steps are to:

1. switch off traction control
2. switch off stability control
3. switch off mechanical damage
4. turn sharp corners with gear number 2
5. avoid crashing
6. practice driving skills

Simple steps with a big difference.



## 7. References

1. Agarwal, S.A., (2021). Statistics in research, *International journal for modern trends in science*, 7(11), 98-103, <http://doi.org/10.46501/IJMTST0711017>
2. Meyer, K.E., van Witteloostuijn, A., Beugelsdijk, S., (2017). What's in a p? Reassessing best practices for conducting and reporting hypothesis testing research, *Journal of international business studies*, 48, 535-551, <http://doi.org/10.1057/s41267-017-0078-8>

## 8. Appendix

### Table A1

#### Conversion of time to milliseconds

Minutes	Seconds	Milliseconds	Milliseconds Sum
13	31	379	811379
14	46	744	886744
13	47	891	827891
13	10	670	790670
13	0	316	780316
12	34	816	754816
12	50	147	770147
13	29	292	809292
		Sum of game time	6431255

This table was to convert time produced at the end of a race to milliseconds when chart 1 was created.

### Table A2

#### Anova summary

<i>Groups</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
Column 1	5	0.00939	0.00188	9.6E-09
Column 2	5	0.01026	0.00205	2.3E-08
Column 3	5	0.00958	0.00192	5.3E-08
Column 4	5	0.00915	0.00183	2E-08
Column 5	5	0.00903	0.00181	9.9E-09
Column 6	5	0.00874	0.00175	1.9E-09
Column 7	5	0.00891	0.00178	6.2E-09

Column 8	5	0.00937	0.00187	6.2E-09
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Anova analysis on excel provide two tables. This table was one of these two. Its values were not needed to analyze.

Table A3

Slow lap time

Variable	Slow lap time
Each variable OFF	01:39.221
Traction control switched ON	01:49.905
Stability control switched ON	02:10.000
Tyre blankets switched ON	01:48.280
ABS switched ON	01:34.295
Fuel consumption switched ON	01:26.396
Tyre wear switched ON	01:27.040
Slipstream switched ON	01:39.456

This table shows slow lap time for each variable.