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The Electrification of Motorsports

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ABSTRACT

The human urge for competition rises above all other subconscious feelings and is one of the main reasons motorsports are as popular as they are today. Whether it is the speed or tight battles for the leading position, automotive racing is considered one of the most entertaining worldwide sports. Since 1887, race cars have utilized the gasoline-powered internal combustion engine as their method of propulsion. Fans and viewers identify these engines with the sound they produce, as well as the driver skills necessary to operate them properly. Over the past century, new technology has been altering the racing industry, changing the dynamics of the sport. The Formula series has invited this technology into their sport by creating the world's most modern and advanced racecars. On the other hand, the National Association for Stock Car Auto Racing (NASCAR) has maintained its roots, making only minor changes to the way its cars operate. However, due to a desire to decrease carbon emissions, the idea of battery-powered race cars has gained immense popularity in the past decade. In 2014, the Formula Racing Series launched its new electric division, Formula E. As this series quickly gained popularity, it led people to ponder if all motorsports could eventually become fully electrified.

Introduction

World-famous inventor Henry Ford once said, “auto racing began 5 minutes after the second car was built” (Jones 2010). The human urge for competition rises above all other subconscious feelings and is one of the main reasons motorsports are as popular as they are today. Whether it is the speed or tight battles for the leading position, automotive racing is considered one of the most entertaining worldwide sports. Since 1887, race cars have utilized the gasoline-powered internal combustion engine as their method of propulsion. Fans and viewers identify these engines with the sound they produce, as well as the driver skills necessary to operate them properly. Over the past century, new technology has been altering the racing industry, changing the dynamics of the sport. The Formula series has invited this technology into their sport by creating the world's most modern and advanced racecars. On the other hand, the National Association for Stock Car Auto Racing (NASCAR) has maintained its roots, making only minor changes to the way its cars operate. However, due to a desire to decrease carbon emissions, the idea of battery-powered race cars has gained immense popularity in the past decade. In 2014, the Formula Racing Series launched its new electric division, Formula E. As this series quickly gained popularity, it led people to ponder if all motorsports could eventually become fully electrified. Because of this consideration, my research will involve surveys and an interview to thoroughly gather a wide spectrum of information from various motorsport fans. This quantitative data will allow me to truly discover and analyze how the majority of motorsport fans view the idea of electrification and whether or not this would affect their perception of the sport. Through interviews, I plan to gather direct information from a motorsport professional. Incorporating a professional point of view will allow me to gain qualitative data from someone directly involved in the industry who will feel the effects of electrification firsthand. I hypothesize that if this mass conversion to electric power were to occur, major negative changes in both racing popularity and its demographic would be seen.

Literature Review

The following review will identify information regarding the history of racing, the appeals of racing, and the origins of Formula E.

History of Racing

Before the establishment of official automobile racing, skilled drivers pushed the limits of their cars on roadways at night, fleeing from law enforcement. Author Maureen Byko, who has a BSBA in industrial communications, of the automotive journal *Materials World* agrees with Ford writing, "since cars have existed, so has the desire to prove who is faster" (Byko 2003). One of the first official car races was organized in 1894 by the French Newspaper *La Petit Journal* and had twenty-one racers. This race went through France, from Paris to Rouen, spanning roughly 80 miles. This event served as the stepping stone to what is now known as Formula 1, a huge milestone in racing history (Bai et al. 2023). During the following years, races were held in towns and highways, emphasizing the skills of the drivers rather than the performance of the engines. In the 20th century, after the Second World War, there was a societal urge for official racing under uniform rules, establishing the Fédération Internationale de l'Automobile (FIA), the governing body of Formula racing. A study by IEEE authors on the future of vehicles and racing defines the formula series by claiming, "a series of racing rules at different levels were formulated, known as "formula"(Bai et al. 2023). In 1950, the FIA set up a worldwide championship called Formula 1 (F1) by integrating the Grand Prix races in seven countries"(Bai et al. 2023). The first official F1 race was held in 1950 on the Silverstone circuit in the U.K., which is still raced today. However, over the last seventy-three years, the series has witnessed changes far beyond the formula rules. The most prominent ones are the ban on ground effects, the ban on electronic driver aids, and added safety measures. The ban on ground effects applies not only to the structure of the car but also to the drivers' safety. The rule is described as "cars must have at least 6cm of clearance between their skirts and the ground while in the pits" (Bai et al. 2023). A prohibition that directed a lot of focus onto the driver was the ban on electronic driver aid, which is described as, "in the early 1990s, F1 relied heavily on electronic driver aids such as automatic gearboxes, Anti-lock Braking System (ABS), traction control, and active suspension. However, in 1994, the FIA banned these aids as they were seen to overshadow a manual driver's skill"(Bai et al. 2023). These changes throughout the years prove how the rules and regulations of F1 have been changing and adapting to new technologies, which will extend into the future. The most recent and relevant of F1 changes is the introduction of a hybrid drive train. In 2009, the FIA introduced hybrid technology under the title KERS (Kinetic Energy Recovery System). KERS works by harnessing the kinetic energy produced by braking and storing up to the allowed 400kJ, kilojoules, of energy (Schoeggl et al. 2012). This system was the first introduction of electric power into Formula Racing.

On the other hand, in NASCAR, rules and regulations have remained relatively unchanged. Byko claims that this is because "NASCAR, whose officials like cars to be made of good, old-fashioned steel and look as though they were bought from a dealer rather than pieced together by a team of engineers" (Byko 2003). Former director of NASCAR Gary Nelson states, "we're under the belief that NASCAR is a driver series"(Byko 2003). The idea for NASCAR came from moonshiners, highly skilled drivers, during the prohibition era. After the prohibition was removed, these drivers had no purpose and began to organize contests between themselves. Then, when a man named Bill France moved to Daytona Beach, he had the idea to industrialize these races and offer prize money to the winners. The series had the name stock car racing, as the cars were practically the same as when they rolled off the production line. However, this is very different today. Authors of the International Journal of Applied Sports Sciences, Sanghak Lee and Paul M. Pedersen, state, "today, however, drastic changes occur to a stock car before it even leaves the auto manufacturer. In fact, today's stock car is nothing at all like

the car it represents; only the shell of the car resembles the factory model"(Lee & Pederson 2009). Due to the fact that NASCAR races involve an oval-shaped circuit, their races are much less technical since every track is relatively similar, while in F1, no two race tracks are driven the same. This allows NASCAR to be a more driver-focused race and, therefore, does not allow much change to be made within the cars themselves. The history of both F1 and NASCAR led to not only changes in the sport in the past but also how it will continue in the future.

Appeals of Racing

Suspense and excitement are key characteristics felt by viewers of any sporting event, and the racing world is no different. Known as the international auto racing sport, Formula 1 is one of the most fast-paced and unpredictable sports broadcast worldwide. Viewers around the world eagerly wait for Sunday to roll around and queue in as, there's a sense of anticipation in the air, everyone eagerly waiting for a match to start. The camera switches from the pit to where the crew is rolling out, helping the drivers get situated in the cars aligned upon the starting line. A thumbs up is given, and the crew moves away: it's time. The camera shows flashing traffic lights. Red. Yellow. A slight pause. Green. The race has officially begun. (Bukhari 2023)

This thrill of emotion is what drives fans to continue their loyalty to racing. Although the majority of fans are not in direct attendance at the race, almost every major sports television network broadcasts these races. NASCAR is the United States' most popular racing series. A sports marketing article written by Christie Amato et al, researchers from the University of North Carolina, discusses the culture of NASCAR fans specifically. According to statistics by Amato, "in 2003, thirteen million spectators purchased tickets to the 2,200 races in NASCAR's different divisions. NASCAR's larger events attract more than 186,000 visitors" (Amato et al. 2005). When it comes to sports, Americans are recognized for their unyielding support for their team. When discussing appeals, the authors state, "the 'need for speed' is a core characteristic tying members to the community"(Amato et al. 2005). As quoted from Bukhari, the excitement and anticipation of speed is what drives viewers of Formula 1; this same trend is seen and stated by Amato in NASCAR. These appeals do not directly lead to increased viewership, but they attract a new demographic that would not be found without them.

Origins of Formula E

The idea for an electric racing division based on the Formula racing style was thought of by Jean Todt, president of the FIA. In 2011, Todt wanted to capitalize on the recent growth and interest in the electrification of motorsports throughout Europe. Willem Standaert and Sirkka Jarvenpaa from the Ghent University in Belgium and the McCombs School of Business give supporting information from the FIA. The FIA claims, "this spectacular series will offer both entertainment and a new opportunity to share the FIA values and objectives of clean energy, mobility, and sustainability with a wider and younger audience as well" (Standaert & Jarvenpaa 2016). Todt used the attention to build an audience around an electric racing series, which had its first race in 2014 hosted in Beijing (Visram 2022). This inaugural event began a season with sixteen worldwide races, entertaining roughly 190 million viewers (Sylt 2016). Over the past nine racing seasons, the series has seen a viewer increase of almost 81%, with roughly 344 million views in 2023 (Wilde 2023). Damien Smith, an author who has been writing and following motorsports since 2009, discusses the reasons for the increase in popularity. Smith claims, in terms of pure racing excitement and genuine spectacle, Formula 1 has been knocked clean from its perch. Formula E – yes, the whining electric-powered series so many of you love to hate – is not only far more unpredictable (which has always been the case), it is also intrinsically better and far more engaging in terms of the core racing action. Yes, really. (Smith 2023)

Smith responds to claims regarding increased popularity by comparatively proving that Formula E is widely considered more active and entertaining than Formula's flagship series, Formula 1. While his claims may have bias and focus on his personal opinions regarding the sport, Smith discusses this point of view after publishing a variety of articles on the public's perception. Additionally, a key part of Formula E is its true effects on the environment. An article from the *Athens Journal of Sports*, written by Timothy Robeers and Hilde Van Den Bulck, discusses the true goals of the FIA and how they aim to benefit the environment. When discussing the FIA's plans, the article states, "a key step in this regard is the FIA's part in developing Formula E, a fully electric racing series which is meant to serve as a platform for research and development, education and promotion of more environmentally and socially sustainable modes of transport" (Robeers and Van Den Bulck 2018). The benefits of such a series are seen as, "the electric nature of the cars means lower noise levels and carbon dioxide emissions, allowing races to take place on temporary city-center circuits and audiences of all ages to attend races and (potentially) learn about the future and benefits of electric cars" (Robeers and Van Den Bulck 2018). The ability to host such races in contemporary locations is an advantage only available for such cars. The use of electric powertrains not only reduces emissions but also serves as a precedent for the future of electric vehicles as a whole.

Research Focus

The presence of automotive racing has had a huge impact in many societies and will continue to impact them in the future. Over the past centuries, racing has evolved with technology and grown to its most capable form, challenging the limits of both engineering and human capabilities. These challenges are what drive fans around the world to follow auto-racing due to their need for speed. These appeals, and many more, sprout from the basis of the car, the engine. The gasoline-powered combustion engine is what allows for such captivating speed and addictive sounds to be witnessed during races. However, in 2014, the Formula E series took the industry by storm and began something controversial; some fans are in awe of Formula E and support its evolution, while others rebel against the technological advancements Formula E sets a precedent for, in fear of the future. The gap in research is found here as the future of electric racing is unforeseen and has never been researched to this extent. This leads many to beg the question: to what extent would the electrification of motorsports affect the viewership and popularity of Formula 1 and NASCAR and impact the industry as a whole?

Methodology

For my methodology, I needed to collect a wide spread of quantitative information from fans of both Formula 1 and NASCAR. To accomplish this, I created a single survey for both racing series, questioning fans on the same topic. After contacting friends and relatives who are racing fans, I looked to social media for additional responses. I started out with Facebook and posted my survey in multiple Formula 1 and NASCAR forums. From these posts, I gained several responses, but still not enough to suffice. I then explored other social media platforms, the main one being Reddit, where I was successful and received the rest of my responses. In my survey, I first established my demographic by collecting respondents' region and age in order to locate where my results stem from. Then, in order to establish a baseline for how many fans watch each series and how often, I listed three questions gauging how often respondents watch Formula 1, NASCAR, and Formula E. Based on these questions, I will be able to determine which racing series are most popular among my respondents and therefore which series my results will apply to in terms of the impact of electrification. Next, I asked two straightforward questions: on a scale from 1-3, how do respondents support the rise in civilian electric vehicles and the same scale for their support for the rise of electric racing. This will allow me to establish the opinions of the respondents on electric vehicles as a whole, which would then be a driving factor for their views on

racing. Following on this idea, I asked if racing completely discarded gas-powered engines, would respondents continue their current level of viewership in the series. The options included are an improvement in interest, a marginal loss of interest, a stop of live race attendance (if applicable), and a complete loss of interest. These changes would have a direct impact on the viewership level and, therefore, sales when it is extended onto a larger scale. After establishing what their actions following the change would be, I listed four of the main aspects of racing that would be altered as a result of electrification. These aspects were speed, sound, engineering technicalities, and driver skills. Since I am focusing on viewership and popularity, losing or maintaining these aspects are driving factors in respondents' opinions. With these results, I am able to piece together the opinions of Formula 1 and NASCAR fans as well as their views and how they might contrast with one another.

In order to establish a more internal view, I interviewed the CEO of a major Formula 1 ticket seller in Europe, as they would directly witness the decrease or increase in popularity as a result of electrification. After establishing the background of my interviewee, I began with what Formula 1 racing was like when she first began in the industry. Her response is what then leads to my follow-up question, which is how the Formula 1 demographic has changed over her tenure. The change in demographics from recent years can then be assessed to determine whether it was a positive or negative change, allowing me to analyze history. This response from my interviewee allowed me to gauge her response on a larger scale, correlating to sales and interest in the sport today. Following this, I shifted towards the FIA's goal for environmental sustainability and Formula E. This allows me to see if electrification is a goal the FIA is striving to reach and whether or not it is feasible. Then in order to establish, from a professional standpoint, what aspects of racing are the most vital, I asked my interviewee how significant the internal combustion engine is to the average viewer, and what the key features of racing motivate fans to remain loyal to the racing series. This will allow me to gauge which aspects currently contribute to fan involvement and interest in the sport, as well as which would be lost as a result of electrification. The reason this interview will be effective is due to the value of interviewing someone in an informal environment. Stuart Hannabuss, a professor at Robert Gordon University in the UK, found that informal interviews have a much higher success rate due to the mental effects the environment has on the interviewee. Hannabuss backs these effects by stating, "the purpose of interviewing has been defined by Patton[2] as being "to find out what is on someone's mind…. We interview people to find out from them those things we cannot directly observe"" (Hannabuss 1996). In order for the interviewee to express their feelings that cannot be observed, I conducted an interview that was below the average formality, allowing for a more comfortable and honest environment.

Results

Survey

For the survey described in the previous section, I collected 200 responses from the various aforementioned sources. After an initial analysis of the results, accurate assumptions regarding electrification can be made. A large majority of survey respondents would either maintain interest or lose marginal interest in the racing series as a result of electrification, seen in the chart below.

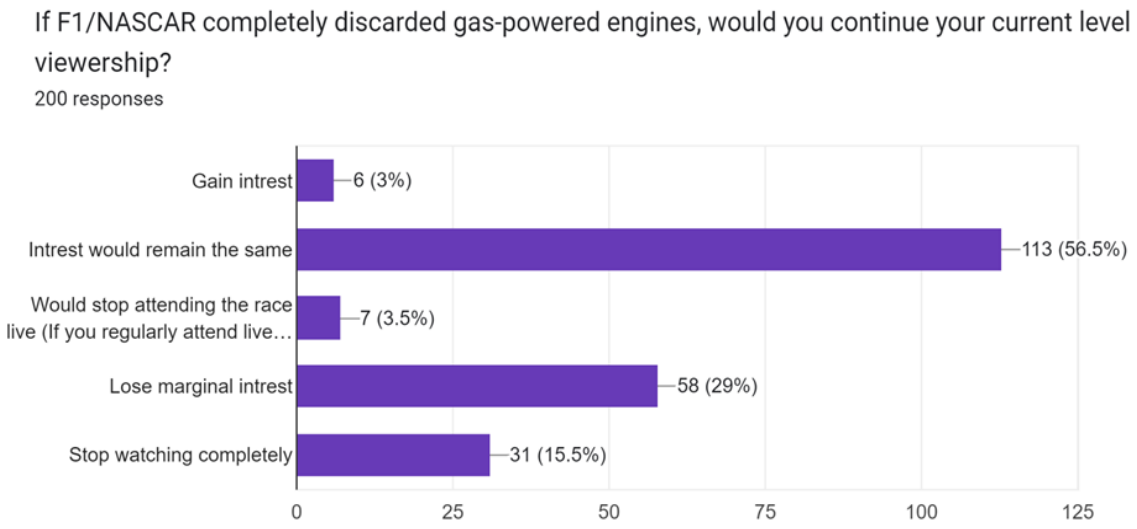

Figure 1.

More than half of the respondents (56.5%) would not alter their viewership of Formula 1 and NASCAR if they eliminated the gasoline engine from their cars. In terms of attending races live, only 3.5% of respondents would stop attending live races; however, this result is limited as I did not poll how many respondents view races live.

Taking a look at the racing aspects, which would be most pertinent to the electrification of racing, many had varying outcomes. The responses were recorded on a scale from one to three, 1 being no change to their opinion on the racing aspect, 3 being a complete change to their opinion on the aspect. Speed, arguably one of the most intriguing aspects of racing, had minimal to no change, as seen in Figure 2.

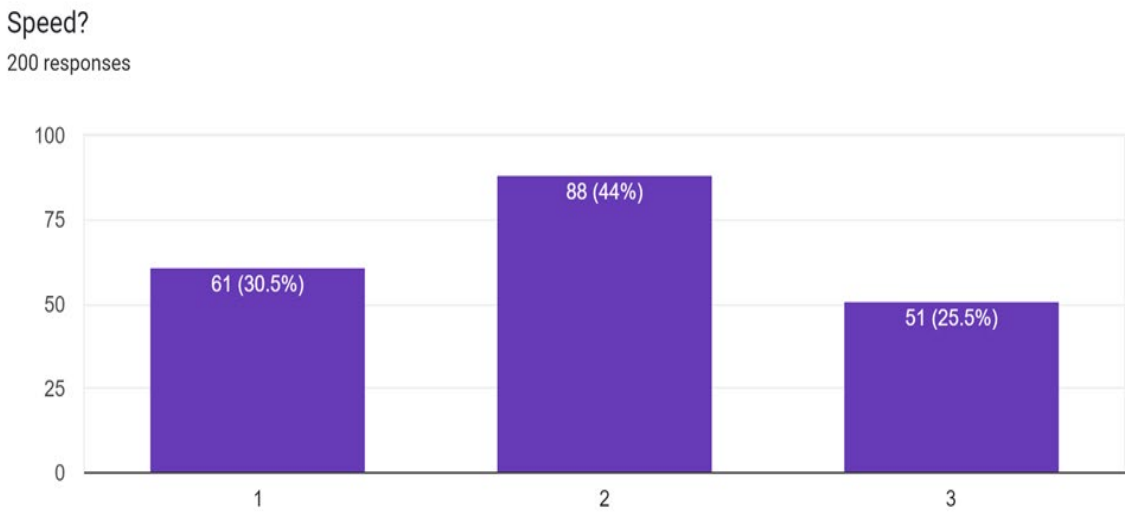

Figure 2.

Almost half of the respondents (44%) selected 2, meaning a slight difference, but not to a point where it would completely change their opinion on the aspect of the sport.

One of the most vital and prominent aspects of a gasoline engine is the sound it produces. Evidently, this would be completely lost as a result of electrification. Participant opinions on the loss of that aspect are presented in Figure 3, surveying a change in sound using the aforementioned scale.

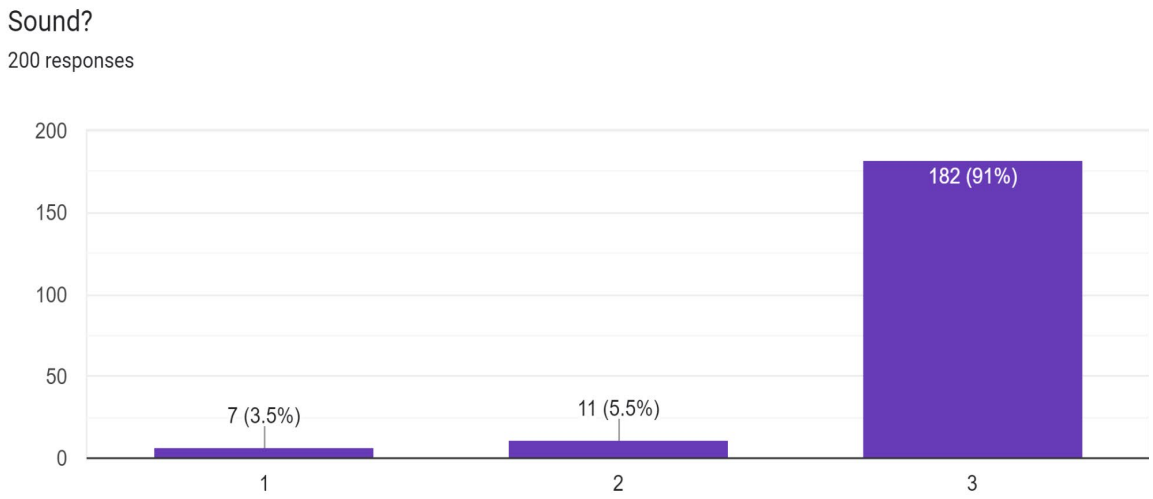

Figure 3.

If electrification of racing were to occur, the powerful motor they would be equipped with would have a distinct electrical sound; however, the sound would evidently differ from the gasoline engine.

One of the most vital aspects of racing that remains behind the scenes is the engineering technicalities that allow Formula 1 and NASCAR to compete at their level. The majority of engineering involved in a race car is related to the engine and all its specific, fragile 1 of 1 parts. With the removal of these engines, many of these technicalities would be simplified and/or replaced. The majority of respondents agree with this claim, as seen in Figure 4.

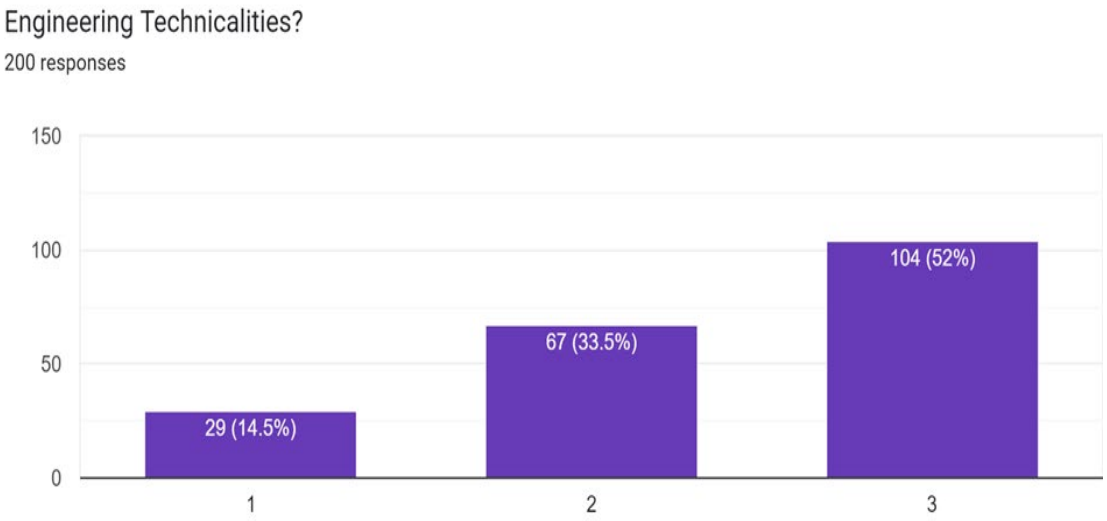

Figure 4.

Of the 48% of respondents who believe that the technicalities would either not change or see minimal change, they could be basing their opinions on the mechanical aspects that are not involved in the engine itself. This could be the aerodynamics of the car, which is dependent on the shape of the car, as well as the handling of the car, which is dependent on weight and center of gravity. The most variable part of racing is the abilities of the driver, as every aspect of the race is dependent on them. Many who are unfamiliar with racing likely assume that the entire roll of the driver is turning a steering wheel and pressing the pedals. However, many other vital roles depend on the racer throughout the race and are linked directly to the gas engine, such as manually changing gears. The majority of respondents believe that electrification would result in no change or minimal change in the presence of driver skills.

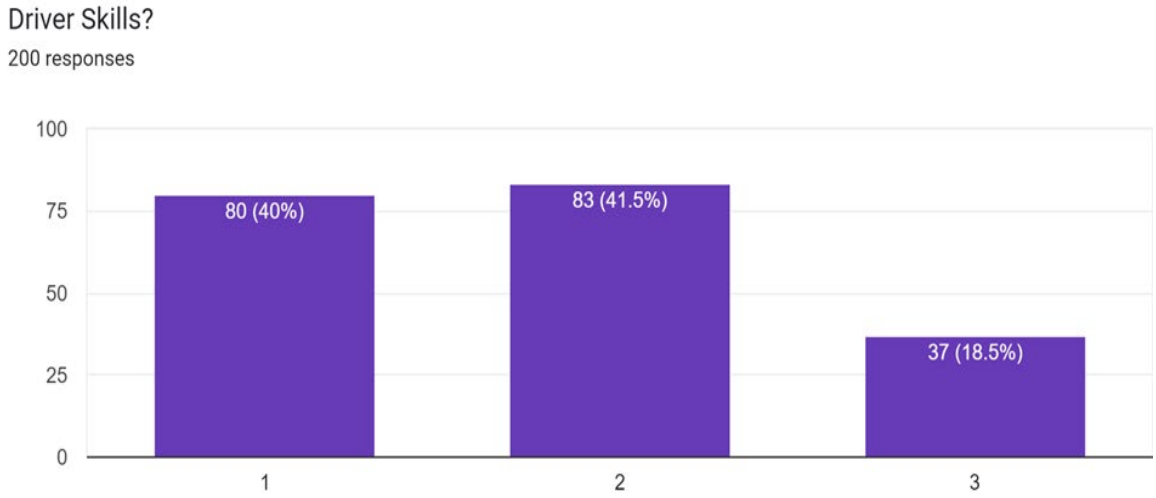

Figure 5.

These four aspects clearly line the basis of racing from a viewer's perspective, and their presence is very volatile in examination with electrification.

Interview

Through my interview, I gained information from someone who has worked in the field for almost twenty years. Through her responses, I am able to gauge how the Formula 1 fan base has changed over her tenure, as well as how electrification will affect popularity. Below are the questions asked during the interview, as well as her responses:

1. When you first started working in the industry, what was the racing like?
    a. The racing was very exciting.
    b. It was during the Michael Schumacher era. (Schumacher is considered the greatest racer of all time)
    c. The engines were fully gas-powered before the FIA mandated a hybrid engine.
2. In your opinion, how has the F1 demographic changed over the recent years?
    a. Over recent years, the demographic has become much younger.
    b. It is becoming more family-oriented and very female-inclusive compared to its previous stereotypical all-male population.
3. Is this a positive or negative change?

   a. This is a positive change as it allows Formula 1 to have a more diverse and inclusive demographic.
4. Has this change affected sales and interest in the sport?
   a. This has improved sales as while the availability of racing has not changed, tickets are becoming much more desirable, especially in the newer race locations.
5. To the best of your knowledge, is environmental sustainability a significant goal for the FIA?
   a. Yes, it is a significant goal for the FIA, and they are experimenting behind the scenes with more environmentally friendly technology.
6. Can this be achieved through complete electrification of the racecars?
   a. In my opinion, it is not achievable as there is much more involved with Formula 1's emissions than just the race cars. The majority of the emissions coming from Formula 1 are related to the transportation of the cars, teams, and gear necessary for each race.
7. In your opinion, how does Formula E compare to F1?
   a. The two series are completely different. Formula 1 is considered the pinnacle of racing worldwide and is known to be the best of the best.
   b. Formula E is a much smaller and, in my opinion, boring race. Formula E is a small Formula racing niche designed to test newer technology.
8. How significant is the combustion engine to F1 fans?
   a. It is very significant to the fans, especially those interested in Formula 1 for the racing itself.
9. What are the key features of this element of racing that motivate fans?
   a. The key features of the gas engine are mainly the ones that appeal to vital senses. Sound is considered one of the most important, as well as smell.
10. Would these be lost with a conversion to a fully electric powertrain?
   a. These would be lost with conversion as electric cars don't make the same distinct sound or smell.
11. Would this cause viewer numbers to decrease?
   a. In my opinion, yes, this is because the hybrid engine is very complicated, and the loss of this would lead to a disinterest in viewers.
12. In your opinion, do you see this happening in the near future, and how accomplishable is this conversion?
   a. No, I do not see this happening in the future, as it is not a goal for the FIA. Unless European governments mandate the removal of gas-powered engines in Formula racing, the FIA will stay in its current hybrid era.

Discussion

Implications

The results from the survey, as shown in Figure 1, hint towards a decrease in popularity by over 37%. This is reflected on a larger scale; if we assume the same 37% decrease for the average number of people who watched Formula 1 races in 2023, numbers would decrease from 1.11 million to 699,000. In 2023, Formula 1 generated $1.83 billion from its twenty-one races, meaning $87 million per race. With these results, electrification would severely affect the income generation of Formula 1 and, therefore, the entire automotive industry. Of the 200 survey respondents, over 75% answered either a 3 or 2 on the 1 to 3 scale, 3 being the most consistent viewership. Comparing this to 42% of respondents who answered either a 3 or 2 on NASCAR viewership, the survey results have much more weight and significance to Formula 1 viewership and popularity than NASCAR. The interviewee's opinion backs the loss of sales as they agree electrification would cause disinterest. In the survey,

of the 75% of respondents who answered 3 or 2 on Formula 1 viewership, only 17% showed any interest in Formula E. This shows not only that the majority of Formula 1 fans have no interest in electric racing but also that the demographic of electric racing hardly exists. The interviewee shares the same belief, as she says that Formula E is just a small racing niche and does not have the essential aspects of racing to attract the same number of viewers as Formula 1. If this translates into an electrification of other racing sectors, the loss of attention would harm the entirety of the automotive industry.

Using the same analysis for the NASCAR results, of the aforementioned 42% of respondents who watch NASCAR regularly, 53% claimed either a complete loss of interest or a marginal loss of interest in the sport. In 2023, the Daytona 500, the founding NASCAR race, generated over $26 million, a record number for Daytona. Applying the 53% found due to the survey would reduce the $26 million to $12.2 million. NASCAR's teams are composed of real auto manufacturers who produce civilian vehicles. This means that the near halving of their income would affect the automotive industry down to the individual consumer. This proves that the electrification of motorsports should not be done as the means of environmental sustainability does not justify the ends of loss of viewership leading to a negative impact on the industry.

Limitations

Although my hypothesis has been proven correct, there are several limitations to the research methods and the results that stem from them. The most prominent limitation of the survey is the small sample size of 200 respondents. The respondents make up a mere fraction of worldwide racing fans; therefore, electrification results may differ for a different set of 200 respondents. A limitation already mentioned is that the survey did not poll the total number of respondents who watch races live, thus limiting the value of Figure 1's results of viewing races live. Another major limitation in many survey questions is the 1-3 scale used to gauge responses. At a stage where it was too late to correct, I noticed that this scale was too general and did not allow for enough flexibility with respondents' opinions and responses. If the survey had used a 1-5 scale instead, results could have been narrowed down, allowing for more specific results on how often fans watch the series and the questions referring to the racing aspects that would be changing due to electrification.

While the interview results are not limited, the professional point of view is. This is because I was only able to interview a single professional, which left the responses susceptible to bias. Although I attempted to contact professionals from NASCAR involved with the Daytona 500 race, I was unsuccessful, which limits my perspective to someone with only Formula 1 experience. However, to counteract this, I did not apply the interview results to my analysis of NASCAR; instead, I only allowed them to give insight into conclusions regarding Formula 1.

Future Research

In conclusion, my research has proven my hypothesis to be accurate, backed by results. The responses to my survey allowed me to use quantitative data to gain the perspectives of racing fans from Formula 1, NASCAR, and Formula E. These perspectives are reflected in the bigger picture when the losses are applied to the economic status of the motorsport industry. However, more research must be done on the topic in order to counteract the study's limitations and find a more accurate and replicable result. While 200 respondents are sufficient to reach an accurate conclusion, the probability of outliers in the study is extremely high. Future research will not be possible for the next few years as we must wait until experimental technology and government regulations adapt either towards or away from electrification. It will also have to gain the opinions of the decision-makers in Formula 1 and NASCAR to accurately predict the effects of electrification and its feasibility. A larger pool of survey respondents will gain a more accurate understanding of public opinion and, therefore, a more

cohesive result. With an accurate understanding of the effects of the electrification of motorsports, we will be able to set the future of racing in the most proactive way possible.

Acknowledgments

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