FH JOANNEUM - University of Applied Sciences
Bachelor's Degree Program Business Informatics

From Turbos to Hybrids: A Comparative Analysis of Car Failures in Formula 1

Expose of the Bachelor Thesis

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Problem Statement

The world of F1 underwent a lot of changes from the 1950's. Constantly evolving sport with different additionalities like aerodynamics, which led the sport to their first era in the 1960s until the 1970s. In this era the importance of aerodynamics, like spoilers and wings have risen and teams made a lot of changes to the cars, for example the transition from front-engine to rear-engine cars and several aero parts. This Era continued to evolve in the next decade where teams discovered the importance of downforce. Engineers developed underbody tunnels, which helped the cars to have more grip, which again enabled the drivers to drive around the track and take corners at higher speeds without losing control.

One of the most famous eras of Formula 1 is the Turbo Era in the 1980's, where engine manufacturers like Renault, Ferrari and Honda started producing turbocharged engines, which had substantially higher horsepower and led to even higher speeds. But because of higher consumption and higher horsepower, there were new and more frequent engine problems, like turbocharger failures, engine blowouts, fuel consumption challenges and much more other issues, which increasingly raised safe concerns and eventually in the year of 1989 turbocharged engines have been banned for the sport.

As the sport started further developing, innovative technologies came into the world of F1. Some of these were active suspension, where the driver could change the hydraulic systems settings to adjust the car's suspension or active electronics, where several options like traction control, Anti-lock Braking System (ABS), automatic gearboxes, engine management systems and data telemetry could be adjusted in real-time. Nonetheless in the late 1990's there was another engine change, where the V12 engines have been slowly pushed out of the sport and got replaced by the V10, followed by another adjustment in 2006, where the V8 was put as the only viable power source. Those decades a lot has changed, but it had a significant impact on car performance, car handling and driver safety.

The last and biggest change in Formula 1 was in 2014 as the Hybrid engines have been introduced to the sport. This was an extraordinarily complex and efficient hybrid power unit, combining a turbocharged V6 internal combustion engine with energy recovery systems. It was designed to be more fuel-efficient and environmentally friendly.

This study aims to provide a deep understanding by conducting a comparative study of the failure types in the 1980's, also known as the Turbo Era and the last 9 years of sport, where the Hybrid Era was introduced. Additionally, it looks for a correlation between the timelines and hidden relationships of mechanical breakdowns or tire problems with different grand prix, where unique conditions test all the teams, cars, and drivers. However, this study is not aiming to discuss car reliability, safety protocols or any technological advancements within Formula 1.

Objectives

The purpose of this bachelor's thesis is to conduct a comprehensive analysis of the failure types in two specific Eras of Formula 1. The selected two specific and well-known eras are the Turbo and Hybrid Era, where the study focuses on analyzing the historical change of only car failures like engine failure, tire problems, and other mechanical breakdowns. Additionally, its purpose is to uncover hidden relationships between specific malfunctions with specific grand prix. By achieving this goal, we aim to improve our understanding of how F1 car failures have evolved across eras and get an insight on correlation of failure types with some grand prix.

Although this study focuses on the failure types of two eras, it is not trying to assign fault to specific teams, drivers, or part manufacturer for car failures, rather focusing on the analysis of two specific eras and finding hidden correlations between them. Furthermore, this study does not aim to address the financial aspects of car failures or to highlight the financial consequences for teams resulting from the magnitude of diverse types of failures.

Contents

This thesis focuses on the following research questions:

1. Which failure types were predominant in these time series?
2. To what extent is there a correlation between the two eras?
3. Are there any correlations or patterns between specific tracks and failure types?

Good Scientific Practice

The guidelines adopted by FH JOANNEUM for "Ensuring good scientific practice and avoiding misconduct in science" were discussed between the author and the supervisor. The author is committed to respect these guidelines when writing the paper.

Procedure

Examining the quality of the data, which is open to the public with free license managed by several F1 enthusiasts. Extracting the needed data from the two Era timelines and conducting statistical analysis and data science methods, like correlation, trends, and patterns. Highlighting the key differences and correlation between Eras and Circuits and calling attention to track and failure type relations.

Literature and References

[Martinetti et al. 2021]
Martinetti, A.; Awadhpersad, P.; Singh, S.; Dongen, L.: Gone in 2s: a deep dive into perfection analysing the collaborative maintenance pitstop of Formula 1. In: Journal of Quality in Maintenance Engineering. ahead-of-print., 2021, DOI: 10.1108/JQME-07-2020-0062.

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[2] Technical Regulations;
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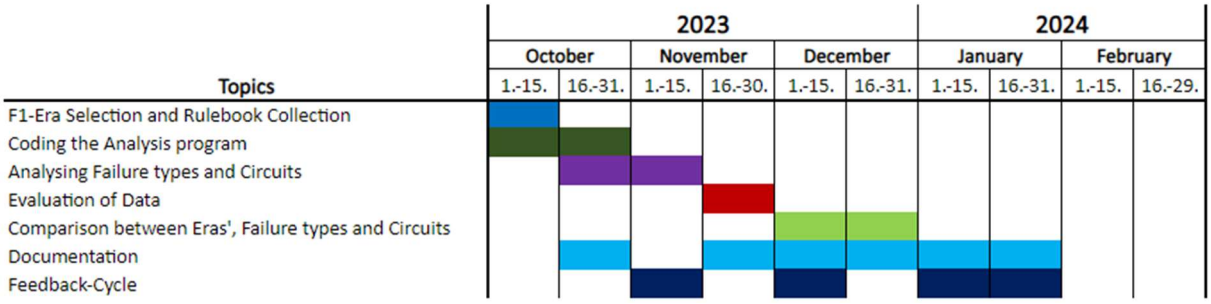
[https://www.f1technical.net]
[1] F1 rules and stats 1980-1989; https://www.f1technical.net/articles/26

Chapter structure

1. General overview of F1 Failure types
   1.1. Present state of Formula 1
   1.2. Current Regulations
   1.3. Importance of Safety Regulations
2. Era selection
   2.1. Reason of the selection of Eras
   2.2. Turbo Era (1980 – 1990)
   2.3. Hybrid Era (2014 – present)
3. Case Study & Data analysis
   3.1. Analysis of Turbo Era
   3.2. Analysis of Hybrid Era
   3.3. Correlation Analysis of Eras
   3.4. Correlation Analysis of failure type with circuits
4. Comparison between the two Eras
   4.1. Outlining historical development
   4.2. Explanation and Reasoning of bigger differences
   4.3. Circuit Comparison between Eras
5. Explaining Methods
   5.1. Statistical Methods
   5.2. Data Science Methods
6. Conclusion

Schedule



Supervision Concept

The preparation and timely submission of the bachelor thesis, as well as compliance with all relevant standards and guidelines, is the responsibility of the student.

It is the student's own responsibility to request, accept and implement feedback in a timely manner. The supervisor will endeavor to provide constructive feedback at short notice and on an individual basis (preferably in a personal discourse).
Ongoing supervision is only possible if there is also continuous progress in writing the bachelor's thesis, so regular submissions and feedback rounds should take place. At least two submissions before the final submission are recommended.

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