Augmented Reality and Live Racing: the future of the F1 Broadcasting Industry

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ABSTRACT

This dissertation investigated how Augmented Reality (AR) can disrupt F1 broadcasting in the next 5 to 10 years. It analyzed what factors affect its implementation, how customers will react, and their Willingness to Pay (WTP).

Qualitative data were gathered through experts interviews and aimed at identifying the main factors and stakeholders affecting the implementation process of this technology in F1 Broadcasting, as well as identifying the most probable scenario in the near future.

Quantitative data were gathered through a survey sent out to potential customers, that aimed to identify their WTP, factors/characteristics of people affecting it, and which bundle of features broadcasters should launch first.

F1 Broadcasters have the technical and financial capabilities to implement this technology. The development phase is influenced by initial investments and organizational costs. Other factors to consider are Interactivity and the creation of a Cross-Functional Agile Team. The stakeholders to build relationships with are the FIA, FOM and F1 Teams, with customers and technology providers still playing an important role.

This dissertation also identified the AR features package adding the most value to consumers, and the persona to target in order to maximize broadcasters' revenues as a passionate F1 Fan with familiarity with AR, enthusiast about new technologies and who prefer to use interactive technologies.

Overall, in the near future AR will redefine the live racing experience.

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ABSTRATO

Esta dissertação investigou como a Realidade Aumentada (RA) pode mudar a transmissão de F1 nos próximos 5 a 10 anos. Ela analisou que fatores afetam a sua implementação, a reação dos clientes e a sua Vontade a Pagar (VAP).

Informação qualitativa foi recolhida por entrevistas a peritos com o objetivos de identificar os principais fatores e partes interessadas que afetam o processo de implementação desta tecnologia na Transmissão de F1, tanto como identificar o cenário mais provável num futuro próximo.

Informação quantitativa foi recolhida por uma sondagem enviada a vários possíveis clientes com o objetivo de identificar a sua VAP, fatores/características das pessoas que a afetam e que pacotes de transmissão deveriam ser lançados inicialmente.

Os distribuidores de F1 têm tanto a capacidade técnica como a capacidade financeira para a implementação desta tecnologia. A fase de desenvolvimento é influenciada pelos investimentos iniciais e custos de organização. Outros fatores a considerar são a interatividade e a criação de uma Taskforce. As partes interessadas a construírem relações com a FIA, FOM e equipas de F1, clientes e fornecedores de tecnologia também irão ter um papel importante.

Esta dissertação também identificou as características do pacote de RA que adiciona mais valor para os consumidores e o público alvo para maximizar os lucros das transmissoras como um fã apaixonado por F1 familiarizado com a RA, entusiástico com novas tecnologias e com preferência pelo uso de tecnologias interativas.

No geral, num futuro próxima a RA vai redefinir a experiência de corridas em direto.

Título: Realidade Aumentada e Corridas em Direto: o futuro da Indústria da Transmissão de F1

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Palavras chave: Realidade Aumentada, Indústria da Transmissão, F1, Vontade a Pagar, Análise de cenário

To my family, my favorite Scuderia.

And to Gino, the race engineer of my life.

Ciao Nonno, ce l'ho fatta.

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1. INTRODUCTION

This dissertation investigates how Augmented Reality (AR) can disrupt F1 broadcasting in the next 5 to 10 years. It will focus on how this technology will be adopted by customers and on how consumers' Willingness to Pay (WTP) is going to change as a function of their individual characteristics and the AR functionalities offered.

The focus on the particular case of F1 is because it is a sport that uses a large amount of data that are functional to potential AR use cases in broadcasting. Moreover, F1 fans are very much interested in the technical details of the sport, making these features add a lot to broadcasters' value proposition. This incremental value offered to customers can create a new revenue stream for broadcasters, supposedly increasing profits if correctly priced.

This dissertation makes 3 main contributions about the implementation of AR technologies in broadcasting.

The first contribution relates to the impact of AR technologies in the F1 broadcasting sector and how it will likely evolve. It adds value to F1 broadcasters managers who want to know more about how AR can be leveraged through additional use cases and defines which are the major investments and operational costs to be sustained. Moreover, expert interviews defined the most likely scenario happening in 5 to 10 years in terms of stakeholders' behaviors. It will be useful to broadcasters to develop their future strategy.

The second one relates to how this dissertation can further extend the literature related to AR. It provides information on how this technology can be leveraged by broadcasters in the short and long term, and which will be the most relevant stakeholders involved in the process.

The third major contribution will be related to customers' WTP. The dissertation it provides broadcasters with a hypothetical customers' WTP for these features, and identifies the which are the individual characteristics positively affecting it.

2. LITERATURE REVIEW

The literature review is composed by 3 sections. The first one focuses on the main characteristics and the evolution of the competition in the Broadcasting industry. The second one on the AR technology, its main use cases and benefits in different industries. The last focuses on customers' WTP, and which are different methods that have been used over time to compute it.

2.1 Broadcasting

Television has been one of the major content distribution channels all over the world.

Studies have focused on broadcasting's effects on policy making and welfare, showing how multichannel television markets subtract consumers' surplus through bundling products in their current offering (Crawford & Yurukoglu, 2012).

Bundling has been under the lens of other studies as well; they have shown its potential to extract more profits with respect to component pricing, even in a situation of high demand asymmetry and when tastes are positively correlated across products (Chu et al., 2011). As an example, for a theater company bundle-size pricing has been shown to be 0.9 percent more profitable than component pricing (Chu et al., 2011). The cable TV industry competed with Direct Broadcast Satellites (DBS), resulting in an overall welfare gains as large as $7 billion (Goolsbee & Petrin, 2004) even if with some exceptions; in fact, consumers with lower preferences for quality were worse off, since cable TV providers faced the entry of this new technology by increasing quality in a disproportional way with respect to the reduction of prices (Chu, 2010). Moreover, introducing new products has been shown to have positive welfare effects (Petrin, 2002).

Increasing competition has been helped by the emergence of new technologies (eg. Over-the-top platforms), even if its effects have not been measured yet. These new technologies are disrupting multiple industries. One example is the advertisements industry, where companies have needed to reorganize their operations, since content can be accessed on-demand, and not only from a TV screen. Other studies have studied television's socio-economic impact, with a focus on family, labor markets, migration, health, environmental and public economics, crime, consumptions and attitudes (DellaVigna & La Ferrara, 2015).

Television is still one of the most important mean for advertising, predicted to reach 159 billion US dollars by 2022 (Statista). This is why studies have focused on identifying a profit maximization advertisements scheduling and pricing to avoid these negative audience

externalities (Wilbur et al., 2013). Other studies have proposed a method to find an optimal broadcast schedule to minimize the total flow time (Chan et al., 2006).

Over the years, broadcasting has moved toward a convergence, where new medias and technologies have empowered viewers during real time events (Montpetit, 2016). By now, broadcasters are moving toward a *Second Convergence* (Montpetit, 2016), where new technologies are expanding the boundaries of innovation and improving customers' engagement and connectivity with their content providers. This *Second Convergence* follows the *First* one related to the use of medias and networks in the cable TV era. Social media has allowed the real-time interaction between customers, allowing content creation on complementary platforms, as well as a higher level of attachment with the live sport distribution channel (Lim et al., 2015).

Other studies have focused on how to speed up the convergence process, with the possibility for users to configure their devices to support interaction in each moment being shown as one of the best strategic tools to have a faster convergence (Deliyannis, 2016).

The concept of interactivity reflects the objective of AR technologies, which involve viewers more and more during live events. Introducing highly valuable features will increase perceived interactivity (Kim et al, 2012). Moreover, *experience* operates as a moderator, meaning that a better visual experience positively affects customer interaction with the service provider (Kim et al, 2012).

Viewer-centered features powered by the Internet have been proven to be unavoidable in today's broadcaster industry (Tuomi, 2016), confirming the evolution of TV experiences from *Interactive*, to *Participatory* and finally to *Social*. This is reinforced by the same study, which shows how having multiple services connected to the broadcaster lead to a better viewers experience (Tuomi, 2016).

Other than social media, Over-the-Top (OTT) platforms have disrupted the market by providing users with a new way to consume content whenever and wherever they are. The emergence of such technology, together with the current pandemic have radically changed how people watch sports and broadcasted content in general.

Vertical disintegration has been shown to allow the entry of new firms and entrepreneurs in the industry (Funk, 2007). One example is the broadcasting industry itself. In the Italian market, the entries of Amazon Prime Video, Netflix and the most recent one of DAZN disrupted a sector that has been dominated by SKY for years. The recent acquisitions of Serie A rights by DAZN and exclusive Champions League matches by Amazon Prime Video raises questions about how sports broadcasting will evolve in the future (IlSole24Ore, 2021).

The current digital economy will require all types of businesses to continuously innovate, reaching a status of *hyper-competition* (Knudsen et al., 2021) to maintain or gain their competitive advantage. This is confirmed by theories of *temporary advantage* (D'Aveni et al., 2010), which states how fast-paced markets are less likely to see a competitive advantage being sustained for a long time. Moreover, multiple factors are shaping the industry, with *convenience and social viewing* heavily affecting the probability of people watching TV clips (Yoon et al, 2021).

2.2 Augmented Reality

The literature in recent years has focused on the future role of technologies in online and offline retailing, and how they will help customers during their purchase process (Grewal et al.,2017). Other studies focused instead on their usage in education (Proserpio & Gioia, 2007) and art (He et al., 2018).

In the context of this dissertation, the definition of AR will be the one of the Reality-virtuality continuum (Milgram et al., 1994), described as the *visualization of real-time data mixed with live images*. More specifically AR has been widely analyzed with a focus on its usage in retail stores and its effects on purchase intention. This technology was shown to have a positive impact on brick and mortar store sales, especially when uncertainty is high (Tan et al., 2021). More recent studies have shown how AR enables businesses to improve their UX (User Experience), as well as increasing customers' satisfaction and willingness to buy (Poushneh & Parraga., 2017).

Furthermore, it connects with mental imagery, which is the ability to generate mental images related to products and experiences (Pearson et al., 2015). This connection generates a positive impact on customers' Word-of-Mouth (WOM) intentions, increasing long-term retailer's reputation, as well as their revenues (Heller et al., 2019). In fact, thanks to AR empowered tools in brick and mortar stores, customers are more likely to choose a more expensive product and overall are willing to spend more (Heller et al., 2019). Moreover, object interactivity is a tool that can be used to evoke these vivid mental images, and it influences purchase intentions more than cognitive elaboration (Schlosser, 2003).

This technology has been proven to build a more intimate consumer-brand relationship, but only if marketers are able to hide the transactional aspect of AR empowered apps (Scholz & Duffy, 2018). Studies revealed that AR-based products presentations are better than classic web-based presentations for what concern media novelty and enjoyment, immersion, usefulness

and attitude toward medium; however, the benefits generated by media novelty can decay as soon as users get used to it (Yim et al., 2017).

A similar outcome has been proven in the tourism industry, with museums that offer AR features being able to generate more revenues thanks to a more engaging customers' experience (He et al., 2018).

The traditional shopping experience has changed through the addition of these AR empowered elements, which provide customers a unique omnichannel experience (Hilken et al., 2017; Hilken et al., 2018)

AR plays a role in the customers' acquisition and conversion funnel, as new technologies are a fundamental part to solve pain points in the customer journey (Lemon & Verhoef, 2016). Such technology has been demonstrated to enhance customers' experience across all stages of the purchasing journey (pre-purchase; purchase; post-purchase) (Wedel et al., 2020). This has been proven by other studies as well, where AR was shown to increase the sense of comfort in the decision-making stage (Hilken et al., 2017). Comfort is crucial for reducing post-purchase negative outcomes, indeed increasing customer retention and lifetime value (Parker et al., 2016). However, the effectiveness of this technology has been questioned. This because AR does not allow customers to have any kind of interaction with one another (Javornik, 2016).

Studies have thus focused on the concept of social AR. Social AR is the possibility to share photos of *augmented try on* with family and friends, in order to get and share purchase suggestions. Static medias like photos being combined with dynamic media (e.g. Videos of virtual try on) will make companies reap additional benefits from this technology (Hilken et al., 2019). This social aspect enhances the degree of comfort, with social AR rendering the decision-making process easier and faster. Companies do not have to adopt very similar features across their channels; before starting augmented campaigns businesses identify which emotions they want to trigger, and then deploy the technology accordingly (Becker & Jaakkola, 2020).

AR has a cognitive effect on consumers, and the more the virtual augmentation is perceived intense by people, the more customers are likely to engage with this technology, creating a positive correlation with companies offering AR empowered tools (Javornik, 2016).

Moreover, this technology makes it easier for companies to experiment with potential augmented campaigns. This effect happens especially for those with experiential offerings, like cosmetics and furniture (Hilken et al., 2017).

The tourism industry has been recently disrupted by the introduction of AR features in museums, theme parks and highly visited cities. It was shown that in theme parks visitors' satisfaction was positively impacted by AR system, content and personalized service quality,

with increased satisfaction leading to higher probabilities of visitors recommending AR applications (Jung et al., 2015), which is consistent with previous marketing research outcomes already mentioned.

More importantly, satisfaction with the AR feature leads to the creation of a positive attitude toward the cultural destination itself and to repeated visits, generating incremental revenues (Chung et al., 2017). The introduction of such technology in museums' experiences has a positive effects on visitors intention to purchase souvenirs and increase their WTP for the actual visit (He et al.,2018). The concept of Second Chance Tourism (SCT) has thus been introduced, leveraging AR applications to give a "second birth" to landmarks, sites and artifacts that are rapidly deteriorating (Bec et al., 2021). Studies have also focused on building a heritage preservation model to achieve a fully heritage digital experience (Bec et al., 2019). Specifically for museums visits, elderly people have been shown to enjoy the digital experience (Dieck et al., 2019). On the other hand, digital natives may have higher expectations with regards to the implementation of AR, and feel to have a worse experience with respect to other users; businesses have to focus on both digital and non-digital users, and provide solutions fulfilling both groups' expectations (Armingeon et al., 2019).

Other studies have proposed a framework to understand the overall visitor experience and how to integrate AR technologies in it (Han et al., 2019).

Showing too many images and information may reduce the connection with people's mental imagery (He et al., 2018). Companies need to provide customers with the minimum additional tools that are needed to maximize their experiential added value; by doing so they will avoid the opposite effect of value reduction of the overall experience. Studies have focused on 4 key areas where to focus on when implementing AR in tourism and add value to the visiting experience; these being Visitor, Organizational, Stakeholder and Economic Value (Cranmer, 2019). Another example from the tourism industry reinforces this idea of *control over the experience.* In fact, it has been shown that AR wearables should be integrated with any other kind of control (eg. voice, movement) to have customers feel in control over their augmented experience (Tussyadiah et al., 2017).

2.3 Willingness-to-Pay

There needs to be a mention of the difference between WTP and willingness to accept (WTA). The two measures are consistently different (Hanemann, 1991), especially for nonmarket goods with imperfect substitutes (Shogren et al., 1994).

Multiple methods have been developed for measuring customers' WTP. For nonmarket goods most economists have used the Contingent Valuation Method (CVM), where customers are asked to price a nonmarket good in a hypothetical situation where no transaction is needed. Its main issue is data reliability. When using this approach, surveys are conducted as realistically as possible, defining specific items to value and in a place where interviewees feel comfortable enough to give realistic product evaluation (Hanemann, 1994). However, CVM has its challenges and critics. Main criticisms are the danger of hypothetical bias and strategic behavior; the former refers to which extent answers represent an accurate representation of respondents' future behavior if presented with an actual market for the good/service; the latter refers to when respondents try to influence the provision of the good/service by under or overestimating their WTP (Mitchell & Carson, 1990). Over the years, this method has been discussed, and an updated version correcting for exaggeration biases has been developed (Park & MacLachlan, 2008). Other approaches differ based on how consumers are asked how much they are willing to pay for the product or service under analysis: whether in a direct or indirect way. Some researchers prefer the direct approach (Abrams, 1964), where customers are asked exactly the question "How much are you willing to pay for this?". This is the open-ended (OE) method. Others instead favor an indirect approach, where WTP is computed by analyzing consumers' choices between different alternatives and a "None of these" option. This is the choice-based conjoint (CBC) approach (Louviere & Woodworth, 1983).

Both these methods compute the *hypothetical WTP,* creating potential biases for companies during the price-setting process, which means these approaches should be compared with real world data of *actual WTP*.

There are direct and indirect method to compute the *actual WTP*. A direct approach to compute real WTP is to have customers purchase the product if their previously stated WTP is higher or equal to a random price drawn from a lottery. This is the BDM mechanism, named after its authors (Becker, DeGroot & Marschak, 1964). This approach creates real purchase opportunities at the point of sales, reducing customers' overestimation and underestimation biases, as consumers will actually buy the product or service at a price point that truly reflects their WTP (Wertenbroch & Skiera, 2002). BDM resolves the issue of reverse auctions, where customers are bidding a purchase price lower than their *actual WTP* in order to extract surplus from the transaction. The main disadvantage is its feasibility; it relies on realism, and if the study is not able to recreate the desired point of sale situation, results may not represent *actual consumers' WTP* (Wertenbroch & Skiera, 2002). The indirect method builds on the BDM mechanism and makes people take a purchase decision based on their revealed preferences.

This is the incentive-aligned choice-based conjoint (ICBC) analysis (Ding et al., 2005; Ding, 2007). Recent studies have compared these methods' results with real customer purchase behaviors. Incentive-aligned approaches (ICBC and BDM) were shown to be better at predicting real WTP under certain conditions (eg. prototype availability, inexpensive product and low costs of fulfilling the buying obligations) (Miller et al., 2011). In the same article, however, the authors argue that hypothetical methods (OE and CBC) can also lead to an estimation of the demand curve and pricing which does not differ significantly from the real data benchmark. Other than incentive-aligned methods, direct approaches have been shown to better predict customers' *real WTP* (Schmidt & Bijmolt, 2019), creating some disagreement with the previous literature favoring indirect methods.

More recent studies have tried to update these methods, tailoring them to more complex products, where personalization and value-added features are available. The new methods give customers the chance to upgrade a set of products' features once at the time, allowing companies to understand which alternatives are more valuable to clients (Park et al., 2008). Overall, experiments using these approaches should avoid *unrealistic situation setting* when dealing with consumers. Building an environment where people need to "*live with* their decision" is more effective in revealing their actual WTP, giving companies a good approximation of customers' actual purchase behaviors.

Another approach is the Vickrey auction (Vickrey, 1961), where the highest bidder in a sealed-bid auction gets the product for the price of the second-highest bid. Its natural extension is the GSP auction mechanism, where the highest bidder will pay the price offered by the second highest bidder, and so on (Edelman et al., 2007). Pricing policies have been shown to affect users retention rate. TPT (two-part tariff) generates significantly lower utility to users with respect to PPU (pay-per-use) pricing plans, resulting in lower retention and usage of the services, even if TPT maximize profits (Iyengar et al., 2011).

Different customers have different WTPs. Several studies have focused on market heterogeneity and methods like the latent class modeling (Kamakura & Russell, 1989). However, the extent of heterogeneity has been proven to be much greater than that measured by the pre-mentioned methods (Allenby et al., 1998). Customers heterogeneity in terms of satisfaction lead to reducing the effect of satisfaction level on future shareholder value and the contemporaneous volatility around the actual shareholder value (Grewal et al., 2010). Heterogeneity in terms of cost-per-customer has an effect on customer retention; in B2C markets customers' cost heterogeneity is relatively low, and all customers tend to be profitable, while in B2B markets, companies should "fire" high costs customers (Shin et al., 2012).

However, other studies show that high-cost-to-serve customers are strategically relevant, and under certain conditions improve the overall company profitability; this happens because they generate positive externalities over other customers more profitable to the company (Subramanian et al., 2014). Businesses should use a customer portfolio mindset rather than analyzing each customer as a stand-alone (Subramanian et al., 2014). CLV (Customer Lifetime Value) can be substantially improved through appropriate design of marketing contacts based on customers' heterogeneity across multiple channels (Venkatesan & Kumar, 2004). Other studies have proposed models to define the right amount of CRM investments for every type of customers, suggesting that it may not always be in companies' best interests to collect more information about their customers to improve their marketing effectiveness (Musalem & Joshi, 2009). At the same time, behavior-based personalization can have pitfalls. Studies showed how by the same force that behavior-based price discrimination intensifies price wars, competitive usage of customers' purchase history in product design commoditizes products and services in the marketplace (Zhang, 2011). Another pitfall is the fact that on day 1 market leaders are more likely to offer a mainstream design, not accounting for differentiation and damaging it (Zhang, 2011). To characterize different customers, past studies have identified three main sets of variables. They refer to 1) characteristics of the product to be valued; 2) personal characteristics of the individuals being asked to make this estimation and 3) characteristics of the current macroeconomic environment (Cameron & James, 1987); they identify the characteristics of fishes (product to be valued), precipitations and temperature (macroeconomic conditions), and being resident of a particular area (personal characteristics) as affecting the WTP for going on a fishing day.

Other studies focus on specific variables tightly related to the studies' specific industries or sectors. For example, one study focuses on the WTP of visitors for natural attraction in Iceland (Reynisdottir et al., 2008).

3. METHODOLOGY

This section describes the methodology used to conduct the proposed research. It entailed scenario building, experts interviews, as well as data collection and analysis.

3.1 Research Design

This analysis involved 3 phases: (1) build scenarios that reflect how different stakeholders may influence the introduction of AR features in F1 broadcasting; (2) acquire additional information from experts to further detail the scenarios; (3) compute potential customer WTP's for different bundles of features and understand what variables affect this indicator.

(1) Scenario Building

3 different scenarios were built to understand how the industry will be in the next 5 to 10 years, using Schoemaker's (1995) methodology: Conservative, Business-as-Usual and Optimistic. Scenarios were based on the main trends in the broadcasting and F1 industries (e.g AR technology/Introduction of new technologies, regulations change), the main stakeholders and influencers affecting them and on previous industry disruptions (e.g. OTT Platforms).

(2) Expert Interviews

Scenarios were rediscussed with experts from the F1 broadcasting and AR technology industries. These discussions happened in the form of semi-structured interviews, where experts were asked to change stakeholders' behaviors or confirm the initial structure. These interviews **(Appendix 9)** also aimed at identifying the current status of AR usage in F1 broadcasting, which factors may affect its future development, potential new AR use cases, and which variables affect customers' WTP. Their insights **(Appendix 5)** have been the starting point to build the survey, and were then complemented by the literature.

(3) Survey

To compute customers' WTP the OE method paired with the CVM was used. The analysis focus on a hypothetical situation where no actual product has been developed. To obtain the data, a survey was built and sent out based on variables identified by experts **(Appendix 10)**. The aim of the survey was to compute customers' WTP for different AR features bundles and understand which factors affect it. Bundles were built through a frequency analysis **(Appendix 1)** ran after expert interviews and complemented by a market analysis on the AR features currently offered in different sports **(Appendix 7).** Bundles reflected the expected added value to customers, and were randomly assigned to respondents.

3.2 Data Collection

(1) Primary Data

Collected data were both quantitative and qualitative. They aimed at delineating the current level of AR usage in F1 broadcasting and predicting how the industry, and particularly the Italian one, will evolve in the near future. Data were retrieved from experts and consumers. 9 Experts from different industries were interviewed during the process (Table 1).

Expert	Role	Company	Range of Revenues
Carlo Vanzini	F1 commentator with 23 years' experience	Major F1 Broadcasters	15-20 Billion €
Francesco Ferrise	AR Professor with 15 years' experience	University	N/A
Piergianni Pulito	Founder of an AR company with 7 years' experience	AR and Software based Group	25-50 Million €
Monica Bordegoni	AR Professor with 20 years' experience	University	N/A
Fabiano Vandone	Former F3 Driver, F1 journalist and current CEO of an AR solutions provider for F1	AR solutions provider for F1 Broadcasters	600.000 – 1.500.000 €
Antonio Granato	F1 journalist with 8 years' experience	Radio Station	N/A
Nicolò Alpini	AR Expert for a F1 Broadcaster with 7 years' experience	Major F1 Broadcasters	15-20 Billion €
Emanuele Frontoni	AR Professor with 17 years' experience	University	N/A
Franco Tecchia	AR Professor 22 years' experience	University	N/A

Table 1: Experts Interviewed
Source: Interviews Elaboration

Survey respondents were asked questions about their demographics and to answer a set of statements related to variables affecting individuals' WTP, that were identified from literature review and experts interviews. Respondents answered the statements using a 5-point Likert scale. Consistently with the CVM Method, respondents were presented with a hypothetical market scenario where this technology is available as an add-on to their sports subscription, describing the entire bundle they are purchasing. Respondents were also shown a video about how AR is exploited by other motorsports, to make AR features as tangible as possible. Subsequently, they were asked to estimate their WTP. A "0" option has been considered, since viewers may want AR features to be already included in their package or may not be willing to purchase them. Each respondent was assigned randomly to price a single bundle out of the 3

that were built. The WTP referred to monthly figures, as respondents are used to paying their bills monthly. Data from the survey was used to test the hypothesis.

(2) Secondary Data

Academic literature supported the analysis, not only in the literature review, but complementing findings from primary data analysis. Broadcasting and AR industry reports were used as well, together with other data coming from official renowned sources (F1, economic newspapers, official websites etc.).

The methodology and data collected were used to answer these 3 Research Questions:

1. **How can new AR use cases enhance F1 Broadcasting and what factors affect their implementation?**
2. **How much are consumers willing to pay for the introduction of AR in F1 Broadcasting?**
3. **How could F1 Broadcasting look like in 5-10 years once AR has been integrated into its service?**

4. ANALYSIS AND DISCUSSION

4.1 Current AR Usage in F1 Broadcasting, future development and factors affecting it

In this section the discussion will focus on the current AR usage in F1 Broadcasting and will answer the first research question.

Current AR Usage

The analysis starts off depicting the current status of AR in F1. Experts were shown multiple AR features currently used by major F1 broadcasters (Figures 1 to 4) and asked to assign them a score from 1 ("No usage of AR) to 5 ("High level AR functionalities").

Figure 1: Drivers' POV

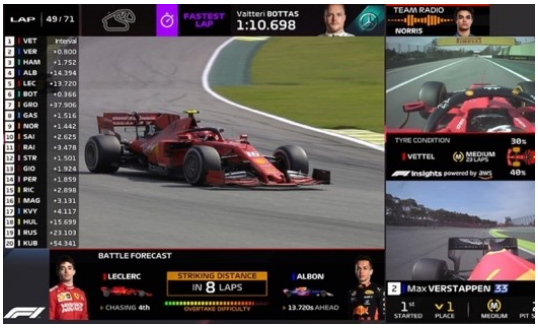

Figure 2: Multiple Features: Standing, Fast Lap, Striking Distance, POV, Rear Camera

Figure 3: Driver Performance Indicators

Figure 4: Standings and Tires Usage

Interviewees gave an average score of **2,56,** with **1,13** standard deviation. These data show how AR is poorly used by F1 broadcasters. A clear difference emerged between experts with an academic background and technical expertise, and interviewees working for major F1 broadcasters (Table 2).

Current AR Usage	Average Score	St. Deviation
Non-Tech Experts (e.g. Commentators)	4	0
Tech Experts	1,83	0,41

Table 2: Current AR Usage Scores
Source: Interviews Elaboration

Tech-experts think AR is almost not leveraged at all in the F1 industry, and many more applications can be developed. The only feature considered valuable is Figure 1, where live car's data are merged with satellite images. All tech-experts mentioned "basic" as an adjective describing these features, with 4 of them mentioning that "these are not AR features at all".

On the other hand, experts from F1 broadcasters gave very high scores. They may have been biased by the fact that they were rating their own services; moreover, they know which features work best in their industry, and additional AR features may not have been added to their offering due to their low added value. During interviews these experts often mixed graphics with AR technologies. The lack of technical background may be one of the causes, together with their higher focus on the content creation side of F1. This shows that to implement this technology in this industry, broadcasters need to be technically trained and hire AR experts to fill their technical gap.

Overall, the current usage of this technology by F1 broadcasters is very low, and its functionalities very basic, with huge room for improvement.

Focusing on how AR can enhance F1 broadcasting, 3 variables were considered. They aimed at understanding what factors will affect the implementation of this technology during live races, customers' reaction and how much AR can disrupt the industry (Table 3)

Variable	Average Score	Standard Deviation	Description
Easiness to Implement	2,56	1,42	1-Very difficult to Implement 5-Very easy to implement
Value Added to customers	4,44	0,53	1-No Value Added 5-High Value Added
Disruption	4,22	0,44	The degree to which AR can become the standard in the future of F1 broadcasting

Table 3: Variables Affecting AR Usage in F1 Broadcasting Scores
Source: Interviews Elaboration

4.1.1 Easiness To Implement

F1 broadcasters and AR tech-experts had different opinions (**Table 4**).

Easiness to Implement	Average Score
Non-Tech Experts (e.g. Commentators)	4,33
Tech Experts	1,67

Table 4: Easiness to Implement Scores
Source: Interview Elaboration

Non-tech experts considered AR as a technology that can be easily implemented during live races**.** Their major concern was the necessity to build visually appealing graphics that can be commented based on what is happening on the track. The in-house availability of AR experts, who are responsible for these graphics (e.g. software developers) may have biased respondents' answers; in fact, non-tech experts are used to receive the final product, without being involved in the development process (Interview 7). Broadcasters may indeed perceive these features to be easy to develop.

This was the focus of one of the comments by an AR experts working for a F1 broadcasters (Interview 7); he pointed out he often struggles to deliver and satisfy his colleagues because they ask him to develop features that would need additional tools not available or that the technology is not ready for. By filling this technical gap between commentators/journalists and AR experts, a co-creation process to build these features can be implemented. This would reduce the misalignment between the parties. These comments show that the first problem to solve while implementing these features during live races is the different background between commentators and in-house AR experts. This, for example, is a process already used in other industries (e.g. Medicine), where doctors and AR experts co-develop features tailored to patients and professionals necessities (Tang et al., 1998).

On the other side, all interviewees coming from the academia (Interview 2, 4, 8 and 9) mentioned the necessity to install sensors on F1 cars and tracks; these are costs that can be easily sustained by major F1 broadcasters. The most relevant challenge is creating a cross-

functional team within the F1 broadcasters to create synergies (e.g. better quality features, collaboration) between content-driven people (e.g. commentators) and AR developers. This second point was also central for one of the AR developers working for a major F1 broadcasters (Interview 7), who stated *"there is the necessity to build teams within the F1 department that are composed by software developers and content creators, that work through agile methods…by doing so we feel more involved in the process and the quality of the generated content is higher"*.

Non-tech experts as well mentioned that teams composed both by technology experts and commentators are necessary for long-term value. This is different with respect to other Media & Entertainment sectors. In the Music Industry AR features are used during live concerts at the venue and on TV **(Appendix 11).** However, these are short-term investments and projects, and in these situations homogeneous teams have been proven to perform better than heterogeneous ones (Watson et al., 1993). Moreover, F1 Broadcasting needs to leverage these features along multiple races over the season, and features need to be constantly re-elaborated. This entails additional costs throughout the year and a higher risk for technical malfunctioning. If technical malfunctions happen during the season customers may complain immediately and reduce their fidelity to the broadcaster, since they are already used to AR features. This would not happen during one-off events where AR features are only an add-on to the experience.

Overall, the hardest challenges in developing these features are not related to hardware components like sensors and cameras, but to the need to build an agile team formed by complementary members.

4.1.1.1 Major Investments and Operational Costs

Related to the easiness to implement, experts were asked to identify the most relevant investments and operational costs to sustain before and during the F1 season:

Initial Investments: In addition to cameras, sensors and all the technical requirements for deploying AR, experts working for AR companies (Interview 1, 3, 5 and 7) mentioned **data.** F1 Broadcasters need plenty of information to create valuable features, and this data is available only to the FOM (FormulaOne Management), F1 Teams and race stewards (organizers).

In addition, building an in-house UX (User Experience) team is core to the business (Interview 2, 5 and 7); to quote Interview 2, *"showing too much information on the screen can be overwhelming to consumers…it reduces the value added to the race"*. This shows how crucial the interface, visuals and technology design is relevant to the success of AR in F1 racing. The

necessity to build a good user interface is confirmed by reports, which show performance differences between companies developing good and bad UX.

A recent McKinsey report from 2018 shows a correlation between high MDI (McKinsey Design Index) scores and superior business performance, translating into higher revenue growth and returns to shareholders. From a cost perspective, good **initial** design can save financial resources. It was estimated that up to 50% of development time is spent reworking projects with avoidable faults (Charette, 2005).

Other than UX, broadcasters have to deal with other initial costs. The word "compatibility" was cited by 6 interviewees when asked this question. This is a concept specific to the Media Industry.

In the Retailing sector, AR is leveraged through kiosks positioned inside the stores **(Appendix 11)**. This allows companies to work with a single operating system, and there is no need to adapt the software. F1 Broadcasters instead needs to deal with different technical requirements from different devices (Besen & Johnson, 1986); this needs additional investments, as some features may not be sustained by different devices. In order to maximize revenues broadcasters should develop AR features compatible with the majority of devices.

In addition to it, 4 Interviewees (all tech-experts) mentioned the words "predictive models".

Similarly to the Healthcare sector, data available to broadcasters are used to develop predictive models. In the medical sector this technology is more often applied during treatment scenarios(Eckert et al., 2019), while in the F1 industry AR can anticipate the results of the Qualifying and race. This shows that AR can be leveraged for different purposes.

Overall, as mentioned before, hardware costs are the least relevant costs to sustain. Developing a valuable and technically viable product accessible to everyone is essential, with the pre-launch phase being the most relevant moment.

Operational Costs reflect the day-to-day activities and resources necessary to F1 broadcasters to show these features on-air. All interviewees mentioned **Maintenance and Updating**. Software and Predictive models are at the base of AR, and they need to be updated every week before the race with new data. This is crucial for their relevance to the viewing experience, and the most relevant updating cost to sustain. One of the experts stated *"imagine having a predictive model*[1] *that is not even close to reality…the features leveraging it would add no value and have a negative spillovers on the other AR products"* (Interview 3). Data and their usage are indeed two of the most important sources/activities to be deployed by F1 Broadcasters.

[1] Software based on historic data used to predict ideal race trajectory, qualifying outcome etc.

Updating refers to the continuous input of new data from drivers, cars, tracks and the creation of new features created according to consumers' preferences.

Maintenance costs are closely related to updating ones. They refer to all the costs sustained to avoid technical failures during live races.

All these costs do not differ from other industries (e.g. Retail, Healthcare etc.), where data updating and software maintenance are necessary as well. Overall, there is no evidence that F1 AR features follow a different implementation process with respect to different sectors, even if with different purposes. The only additional cost would be to develop AR features compatible with multiple devices.

Overall, after the initial investments, costs to be sustained along the F1 season were not considered substantial.

4.1.2 Value Added to Customers

All experts agreed that this technology can add a lot of value to viewers. Experts with different backgrounds had different perspectives on which type of information should be displayed in the features. Interviewees with an engineering background (Interviews 2 and 6) think that these features can add more value to consumers if they showcase engineering information. To quote Interview 6, *"I would go crazy if F1 broadcasters will show information like the toe effect, sling effect and car's lift".*

Experts working for F1 broadcasters (Interview 1, 5 and 7) think that this technology can benefit customers and simplify broadcasters' job during live races.

From a customer perspective, AR can create visuals displaying information not easily accessible and that are easy to interpret (e.g. car's lift, sling effect etc.).

From a broadcaster perspective, this technology can simplify some processes happening during live races. One example that was cited during interviews was this one:

Team Pits information: during live races, cars may reduce their performances all of a sudden. The reason of why that is happening is retrieved by F1 broadcasters in the paddock area. However, there may be delays in the collection of this information (e.g. microphone not working). This problem can be easily solved by AR through the development of ad-hoc graphics enabled by sensors in F1 cars. This solution reduces the timeframe necessary to retrieve information and convey it to viewers.

3 interviewees (non-tech experts) mentioned the words "immediate updates" (previous example), while 4 tech-experts mentioned the words "predictions" when asked about AR

advantages. This shows how both broadcasters and AR experts are sure about the reliability of this technology, and are willing to launch it at a higher scale. This shows that the benefits of this technology overcome the risks; moreover, AR predictive models improve their accuracy over time, providing viewers with information/outcomes close to what is actually going to happen in the race.

These advantages reflect to higher revenues as well. Adjusting the Penetration Rate to 20% , which is the most probable outcome from scenario analysis **(Appendix 3),** and using the Average WTP from the survey, we have incremental revenues for more than 7 Million € **(Appendix 4).**

4.1.2.1 Co- Creation & Interactivity

Customers' co-creation and interactivity emerged while interviewees were talking about Value Added to viewers. In this context Interactivity means the possibility for consumers to build their personalized F1 dashboard with customized AR features. As an industry standard, viewers are used to watch contents in the way they are proposed by broadcasters. There is no interaction between the offer and the demand, and no possibility to follow the desired drivers.

One interviewee (Interview 7) described **Co-creation** as the evolution of open innovation. Company-wise, especially in the tech sector, open innovation has been used to reduce costs in the innovation phase. Co-Creation uses customers' knowledge to develop new products (in this case AR features) appealing to them. Using this process can help broadcasters to build a connection with consumers (Morreale, 2016) and increase their level of satisfaction (Vega-Vazquez et al., 2013).

Broadcasters can leverage their customer base to add value to their features with respect to other sectors. In fact, in other Media Sectors (e.g. live concerts) and industries (e.g. Healthcare), customers do not interact with companies to co-develop tailored AR features; this happens because of the little time available before a concert (Forbes), and because of the lack of medical methods and tools allowing for patients' involvement (Elg et al., 2012). Broadcasters instead have the possibility to leverage their long-term customer relationship and the length of the F1 season to constantly update and develop new features appealing to customers.

Many interviewees (Interview 1, 2, 3, 5 and 6) mentioned the concept of **Interactivity**. These experts come from the broadcasting industry or had some experience counseling for companies working in the media sector. Worth to mention is that AR together with Interaction commands generate **Mixed Reality**, an extension of AR (Interview 3). Experts with a technical background did not mention this possibility. This shows how content-driven professionals are more likely

to foresee new ways in which new technologies can be used to have incremental revenues. Current solutions like the "Interactivity Board" **(Figure 5)** for a major F1 Italian broadcaster have tried to add value to the customers' racing experience. This interface allows viewers to select drivers' POV (decided by broadcasters), watch drivers' split times or focus only on the race. However, this functionality has been used for years and little progresses have been made. This due to the lack of a complementary technology enhancing the user experience.

Figure 5: Interactivity Board
Source: Sky Italia

Related to complementary technologies is the fact that the greatest challenge for Interactivity is to reduce the time gap between the satellite signal and the visuals selected by consumers. Live graphics are pre-built by the F1 Broadcasters, and viewers are provided with information from previous laps (Interview 1). Interactivity requires the data to be timely updated (e.g. almost live); something that is not yet supported by technology in the broadcasting industry. However, in the Healthcare industry doctors have the possibility to leverage real-time data during surgeries or other types of treatments (Eckert et ., 2019). This shows that AR by itself can be used during live events, but needs an external complementary technology to support real-time functionalities. Over time, as delay between live events and satellite signal close to 0, AR added value can be fully leveraged.

A temporary alternative to interactivity features are **partnerships**. Broadcasters can leverage information from external applications to offer a better service. One example is the partnership between SKY Italy and Fantacalcio.it (Fantacalcio.it, 2020). This partnership allows consumers to see fantasy football scores for each player during live games on their screens. The same concept can be used by F1 broadcasters and leverage the information of the F1 app. This solution is technologically feasible and adds value to the current viewing experience, providing customers with new information (e.g. live telemetry, tire usage history). It would prepare consumers to the new interactive AR features, avoiding the creation of a technological gap between broadcasters and customers. Overall, there seems to be the necessity to incrementally

introduce AR features in the market; this to educate customers and wait for **live interaction** to be technologically feasible.

Moving toward this direction, broadcasters and FOM are investing in new technologies (e.g. AR, Omnichannel Experience) to deliver content in the most effective way (Interview 5). In the near feature viewers will be able to create their own AR visuals and select which drivers, cars and teams' performance to focus on. Similarly to other industries (e.g. Retail) the objective of these features is to personalize consumers' experience, and collect incremental revenues (Papagiannis, 2020).

This shows that technologies are shaping companies' behaviors. 4 non-tech experts mentioned the words "evolution" and "direct to consumers" when talking about the FOM and the AR technology. The FOM is improving its direct offering to consumers to increase revenues and have more control on their products; a similar business-model has been adopted in other industries (e.g. Retail). For example, Nike has started to focus more on their direct channel to consumers rather than selling through their partners. Financial outcomes confirmed that this strategy increase revenues (Nike, 2021). This shows that broadcasters should follow along by investing in AR interactive features if they want to maintain and improve their competitive positioning. This shows how in the next years the FOM and the FIA could be the one shaping the viewing experience.

In fact, F1 broadcasters are able to build graphics only on top of the mandatory images provided them by the FOM (Interview 5). However, not all available cars/drivers' information are used by the FOM in their graphics. Broadcasters need to be able to fill the gap between the available space they have to build their graphics, and the FOM's unused information. This will allow them to add value to the current customer experience and introduce a diversification element in their offering; by doing so they are able to maintain their competitivity in the F1 industry.

4.1.3 Disruption

In this dissertation this variable has a slightly different meaning with respect to how the adjective *Disruptive* is used in a business environment. In fact, Disruption in this context means the extent to which AR features are becoming a standard in the F1 broadcasting industry, and not the action of completely changing the traditional way that an industry or market operates by using new methods or a new technology. From this perspective, Interview 5 was the most insightful. The interviewee often mentioned that his agency offering AR services is constantly being contacted by F1 broadcasters wanting to implement this technology in their offering.

F1TV, which is the official streaming service for F1, is heavily investing in its digital platform and it is likely to introduce new AR features in the coming seasons (Interview 1 and 5).

Looking at another technology that changed the F1 broadcasting industry, the F1 Global Fan Survey anticipated the disruption of F1 streaming platforms, with 25% of young F1 fans declaring to prefer watching races via streaming, laptop or mobile. This is confirmed by 7 interviewees who mentioned the words "streaming/OTT platform" when asked about tools to boost AR features' adoption rate..

AR and streaming platforms were considered complementary, with the former depending more on the latter rather than the opposite, since their adoption rate depends on how many individuals have access to it.

Overall, in addition to waiting for satellite images to be fully live, it seems that in the near future broadcasters may have to invest heavily on OTT services to increase the adoption rate of AR features.

In addition to it, one quote from Interview 5 was particularly interesting with regards to the future of F1 broadcasting and live racing: *"The FOM, FIA and F1 as an organization are rethinking the race experience…they have understood that broadcasting is a major market…and revenues from live races tickets will be used to cover races' organizational costs".*

As soon as F1TV is offering AR features (exclusively for their subscribers), F1 broadcasters will invest in this new technology to avoid losing market share.

AR and complementary technologies are disrupting the sport broadcasting sector. This has been confirmed by multiple reports. A recent one from IBM confirms that sports viewers as enthusiasts about AR technology. People are becoming used to seeing digitally overlaid trajectories, strikes zone (baseball), 3D ball rotation (basketball) and line calls (tennis), and are willing to receive more of this information and graphics.

In a recent IBV study, it was shown that AR combined with AI (Artificial Intelligence) will become an industry standard, since 57% of respondents indicated that they would like to receive personalized highlights of their favorite teams and players in AR form.

This is an incredible preliminary outcome for a feature that consumers have not experienced yet together with the non-presence of a Minimum Viable Product (MVP).

The predictions of future AR demand confirm the high possibilities of disruption. By 2025 the AR industry will reach $100 Billion in Revenues, almost doubling from 2021 levels, with Video Entertainment and Live Events being respectively the 3rd and the 2nd highest revenues creative industries behind Video Games (McKinsey, 2017).

This interest is also confirmed by data from the survey. When people were asked how much they were willing to pay for these new features, a score of 0 (*"I am not willing to buy these features"*) was not predominant. More than 65% of respondents were willing to purchase them. 6 Interviewees mentioned the words "tailored to consumers" when asked the question related to disruption. This shows that in order to become an industry standard, technologies need to satisfy different customers' needs; crucial is to understand who are your consumers. For example, AR in the HC sector would focus on doctors, in the movie sector on both filmmakers and consumers (MacIntyre et al., 2001). In the F1 the focus is mainly on viewers.

Overall, AR has potential to disrupt the industry.

An alternative to this technology is VR (Virtual Reality) (Interview 5). However, this technology is not feasible in the short-term. The majority of viewers is not used to VR, and hardware investments are much higher; broadcasters offering VR may need to ask their customers to buy specific hardware to sustain this technology, with the lowest AR hardware costing about 250$ (Statista). With AR the majority of costs are covered by broadcasters, and viewers can focus on the enhanced racing experienced, rather than being stressed about learning to use a *completely* new technology. Moreover, the financial barriers to adopt AR are much lower with respect to VR, especially for the fact that VR headsets may be used for very few broadcasters' events due their current low penetration rate (Statista). Over time, as hardware costs decrease, VR can become a valid alternative to AR.

Overall, to answer the first research question, AR can enhance F1 broadcasting by providing customers with a more personalized and interactive racing experience. The main factors to consider while implementing these features are initial investments for planning and development, and the need to refine complementary technologies enabling live AR features (e.g. satellite, OTT platforms, AI).

4.2 WTP ESTIMATION AND FACTORS AFFECTING IT

This section provides the answer to the second research question and insights about which factors affect consumers' WTP.

4.2.1 Hypothesis

Interviews and literature review were the starting point to build the survey estimating consumers' expected WTP for AR features. The OE method together with the CVM were used, since customers have been presented a hypothetical situation were no actual product has been developed. The survey was directed to a population below 30 years of age and sent out through

social media thanks to the collaboration of multiple F1 related pages. This because during multiple interviews (Interview 1, 5 and 6) it was mentioned that young people are the ones being interested the most about F1. This is confirmed by a recent F1 report (Nielsen) that shows how the fanbase growth is driven by the younger population.

Income

As previous research (Cameron & James, 1987), interviewees identified household's income as a variable influencing consumers' WTP. This factor influences expenditures, and experts highlighted that paying an additional fee to the subscription may not appeal individuals with a lower income.

H1: Individuals with a higher household income have a higher WTP for AR F1 features

Engineering Background

Experts defined F1 as a highly technical sport. Most fans are passionate about the engineering and the technical work behind the creation of high-performing cars (Interview 6).

H2: Individuals with an engineering academic background have a higher WTP for AR F1 features

AR Familiarity

People who do not know anything about AR may not adopt this new technology. This because they are not familiar with the value this technology adds to the viewing experience (Interview 9). Individuals with past experiences with this technology, through mobile devices, physical experiences or any other kind of AR application know what the technology can add to F1, and may be willing to pay more to have these features.

H3: Individuals who are familiar with AR have a higher WTP for AR F1 features

Technology Enthusiasm

Experts highlighted that to adopt this technology you do not necessarily need to be a F1 Fan, and that people who are enthusiastic about new technologies may be willing to purchase these features at a higher price to be early adopters.

H4: People who are always keen on trying new technologies have a higher WTP for AR F1 features

F1 Fan

All experts mentioned how passionate F1 fan may be the first ones to adopt these additional features. This relates to their passion for F1, making them pay a substantial amount of money in addition to their current subscription.

H5: Passionate F1 fan have a higher WTP for AR F1 features

Interactivity

Experts highlighted how features characteristics may affect customers' WTP. They mentioned how easy and ready to use technologies have covered a substantial role in the technological developments of mobile devices, TVs etc.

Experts working in the Broadcasting industry added that consumers are very interested in the introduction of interactive features allowing them to choose what to see. Interactivity may affect individual's WTP, especially for those used to this kind of technology.

H6: People who prefer to use Interactive technologies have a higher WTP for AR F1 features

Features Bundles

Bundles proposed to consumers **(Appendix 2)** were built based on a frequency analysis on experts-generated features and complemented by a market analysis focused on what features are already offered in different sports **(Appendix 1 & 8).** The ones that were less cited were grouped in the *Low Added Value Bundle (Bundle 1).* In this bundle none of the features is already offered in any other sport even if they are technologically feasible. It means that they would add no or little value to the current racing experience. The ones that were cited by half of the experts were grouped into the *Average Added Value Bundle (Bundle 2)*. In this bundle the only feature already offered in different sports (e.g. Football, Cycling) are the Augmented Studios (**Appendix 6**). This last feature has been proven to be valued by consumers, and over the years it has been adopted by an increasing number of broadcasters. The most cited features were grouped into the *High Added Value Bundle (Bundle 3);* they leverage predictive models and sensors on game courts/tracks, and are widely spread in F1 and in other sports (e.g. Football, Basketball, Tennis, Volleyball) **(Appendix 7 & 8).**

H7: People will have a higher WTP for Average Added Value and High Added Value Bundles versus the Low Added Value Bundle

4.2.2 RESULTS

The survey had **430** ***complete*** responses, with **301** males and **129** females. Respondents came from 8 different countries where F1 is broadcasted on live TV. Results were obtained through STATA and show how consumers' WTP is affected by the considered variables. For the *Income* variable, the differentiation between High Income and Low Income was based on the average OECD Income of almost 30,000€ (OECD). To test the hypothesis related to those questions using a 5-Point Likert Scale (H1, 3, 4, 5 & 6), survey respondents were divided in 2 groups (High & Low). 3 was considered the first value of the *High* group. This dissertation considered meaningful those results with a p-value lower or equal to 0,05.

H1 is NOT accepted. There is no evidence that viewers with a higher income are willing to pay more than the average consumer for the same features (Table 5).

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
High Inc	368	5.117663	.3097101	5.941269	4.508634	5.726692
Low Inco	62	4.387097	.7266022	5.721271	2.934166	5.840028
Combined	430	5.012326	.2849626	5.90911	4.452229	5.572422
diff		.7305663	.8113952		-.8642489	2.325381

diff = mean(High Inc) - mean(Low Inco) t = 0.9004
H0: diff = 0 Degrees of freedom = 428

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.8158 Pr(|T| > |t|) = 0.3684 Pr(T > t) = 0.1842

Table 5: Income Hypothesis Test
Source: Survey Data Elaboration

Income does not affect the amount of money they are willing to spend to improve their racing experience. These results contrast with expert interviews. All experts cited income as an important factor affecting WTP. However, reports show that customers are willing to pay a 9% price premium (in the TV Industry) for technologies improving their experience, without any difference between high income and lower income people in absolute terms.

H2 is NOT accepted. There is no significant evidence that viewers with an engineering background have a higher WTP (Table 6).

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
Engineer	54	4.546111	.7366836	5.413497	3.068511	6.023711
Others	376	5.079282	.3084278	5.980637	4.472817	5.685747
Combined	430	5.012326	.2849626	5.90911	4.452229	5.572422
diff		-.5331708	.860553		-2.224607	1.158265

diff = mean(Engineer) - mean(Others) t = -0.6196
H0: diff = 0 Degrees of freedom = 428

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.2679 Pr(|T| > |t|) = 0.5359 Pr(T > t) = 0.7321

Table 6: Engineering Background Hypothesis Test
Source: Survey Data Elaboration

Engineering students are overall more exposed to the F1 world during their studies, as many universities have their own racing teams. However, F1 has recently started a worldwide project called F1 in schools. Students compete regionally and nationally, and the challenge aims at introducing young students to the world of F1, while developing their skills in physics, aerodynamics, software development and strategy.

What may happen is that participants are attracted by different F1 aspects (e.g. business, strategy), and decide to apply for universities focusing on them.

H3 is accepted. Viewers who are familiar with AR are willing to pay **2,69€/month** more than the average consumer for the same features (Table 7).

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
High_AR_	274	5.987117	.3735946	6.184091	5.251624	6.722609
Low_AR_F	156	3.300192	.3975551	4.965462	2.514867	4.085518
Combined	430	5.012326	.2849626	5.90911	4.452229	5.572422
diff		2.686924	.5789816		1.548923	3.824926

diff = mean(High_AR_) - mean(Low_AR_F) t = 4.6408
H0: diff = 0 Degrees of freedom = 428

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 1.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 0.0000

Table 7: AR Familiarity Hypothesis Test
Source: Survey Data Elaboration

This finding is confirmed by literature, as the accuracy of knowledge for a good (in this case AR), dramatically affects customers' valuation for it. In fact, well-informed individuals show a higher WTP for the good (LaRiviere et al., 2014). This finding shows that AR is considered valuable by its users. Those who have already used AR applications enjoyed its added value, and are willing to increase their expenditures to benefit from it in the F1 setting. Overall, the number of consumers that will become more familiar with AR will increase over time at a very fast pace (GrandViewResearch), and F1 Broadcasters can benefit from it.

H4 is accepted. People who are more keen on trying new technologies are willing to pay **2,46€/month** more than the average consumer for the same features (Table 8).

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
High_Tec	348	5.482213	.330503	6.165454	4.832171	6.132254
Low_Tech	82	3.018171	.4568514	4.136965	2.10918	3.927162
Combined	430	5.012326	.2849626	5.90911	4.452229	5.572422
diff		2.464042	.7163838		1.055974	3.87211

diff = mean(High_Tec) - mean(Low_Tech) t = 3.4396
H0: diff = 0 Degrees of freedom = 428

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.9997 Pr(|T| > |t|) = 0.0006 Pr(T > t) = 0.0003

Table 8: Technology Enthusiast Hypothesis Test
Source: Survey Data Elaboration

This finding is interesting for those broadcasters introducing new products or services in their offering. For example, SKY Italy can look at the adoption rate of their new service SKY Q and adjust it for the number of people having a F1 subscription to have an estimation of the potential initial target market. Moreover, broadcasters can piggyback on their current offering, speeding up the customers' adoption process.

H5 is accepted. Passionate F1 Fans are willing to pay **2,19€/month** more than the average consumer for the same features (Table 9).

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
Die-Hard	396	5.185101	.301746	6.004669	4.591872	5.77833
Not F1 F	34	3	.7239228	4.221159	1.527168	4.472832
Combined	430	5.012326	.2849626	5.90911	4.452229	5.572422
diff		2.185101	1.051957		.1174565	4.252746

diff = mean(Die-Hard) - mean(Not F1 F) t = 2.0772
H0: diff = 0 Degrees of freedom = 428

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.9808 Pr(|T| > |t|) = 0.0384 Pr(T > t) = 0.0192

Table 9: F1 Fan Hypothesis Test
Source: Survey Data Elaboration

There is little to add to this finding. F1 Fans are willing to spend more money to have a better live racing experience. This because F1 Fans are some of the most loyal ones, and are not influenced by price or advertising when it comes to following their favorite sport (Interviews 1 and 5).

H6 is accepted. People who prefer to use interactive technologies are willing to pay **2,21€/month** more than the average consumer for the same features (Table 10).

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
High_Int	365	5.346027	.3159778	6.036748	4.724656	5.967399
Low_Inte	65	3.138462	.5895227	4.752884	1.960755	4.316168
Combined	430	5.012326	.2849626	5.90911	4.452229	5.572422
diff		2.207566	.7892722		.656234	3.758898

diff = mean(High_Int) - mean(Low_Inte) t = 2.7970
H0: diff = 0 Degrees of freedom = 428

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.9973 Pr(|T| > |t|) = 0.0054 Pr(T > t) = 0.0027

Table 10: Interactive Technologies Familiarity Hypothesis Test
Source: Survey Data Elaboration

This confirms findings from expert interviews and technology reports, where Interactivity is considered to be one of the main drivers for future developments (Deloitte). Broadcasters should leverage their interactive platforms together with AR features to provide an immersive racing experience to consumers.

H7 is accepted. Offering the High Value Added bundle (Bundle 2) and the Average Added Value Bundle (Bundle 3) increase customers' WTP respectively by **3,89€/month (Table 11),** and **1,19€/month (Table 12)**.

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
Bundle_1	134	3.283582	.3433665	3.974755	2.604416	3.962748
Bundle_3	145	7.171103	.6387429	7.691483	5.90858	8.433627
Combined	279	5.303978	.3879351	6.479794	4.540315	6.067642
diff		-3.887521	.7419767		-5.348151	-2.426892

diff = mean(Bundle_1) - mean(Bundle_3) t = -5.2394
H0: diff = 0 Degrees of freedom = 277

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000

Table 11: Bundle 1 vs Bundle 3 Hypothesis Test

Group	Obs	Mean	Std. err.	Std. dev.	[95% conf.	interval]
Bundle_1	134	3.283582	.3433665	3.974755	2.604416	3.962748
Bundle_2	151	4.473444	.378184	4.647202	3.726188	5.220699
Combined	285	3.914	.2592783	4.377122	3.403649	4.424351
diff		-1.189862	.5155696		-2.2047	-.1750237

diff = mean(Bundle_1) - mean(Bundle_2) t = -2.3079
H0: diff = 0 Degrees of freedom = 283

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.0109 Pr(|T| > |t|) = 0.0217 Pr(T > t) = 0.9891

Table 12: Bundle 1 vs Bundle 2 Hypothesis Test
Source: Survey Data Elaboration

The features available in Bundle 3 were consistently cited during experts interviews, and are already used in other sports. The amount of necessary information would not go beyond the information available to broadcasters; this would speed up the implementation process and allow broadcasters to gain incremental revenues in the short-term.

This is of particular interest for the next years. At the beginning a single bundle targeted to F1 Fan may be offered to maximize broadcasters revenues; presumably Bundle 3. Over time, different AR features levels (Bundle 1 & 2) may be added to the offering to have those consumers who did not buy these features at the beginning subscribe to the add-on. The possibility to have different levels of AR features was cited by one Interviewee (Interview 5). This pricing strategy would resemble the one used by different subscription platforms in the SaaS industry, which offer different packages for different prices. However, it has not been adopted yet by broadcasters.

Overall, to answer the second research question, customers are willing to pay an additional amount of money to their subscription to have F1 related AR features (e.g. on average 7,50€/month). Consumers' characteristics affecting their WTP are being enthusiast about new technologies, familiarity with AR, being a F1 Fan, and the Bundles offered to them.

4.3 The future of F1 Broadcasting

This section answers the third research question and defines the most likeable scenario to happen in the next 5 to 10 years, with a focus on primary, secondary stakeholders and influencers.

4.3.1 Scenario Analysis

Experts were provided 3 different scenarios **(Appendix 3)** to comment and confront. Each expert gave a percentage to every scenario to define their likelihood to happen. The average percentage was then considered for each scenario.

Scenarios are consistent with previous disruptions in the broadcasting industry. Previous disruptions were driven by technological developments that helped companies to develop valuable new products, services and business models (BCG, 2016). Moreover, in the most recent industry disruption (e.g. streaming platform) consumers' preferences and need for personalization played a major role (BCG, 2016). Consumers together with companies (e.g. broadcasters) are indeed the **primary stakeholders**. Since AR is not easily accessible to all broadcasters (Interview 1), technology providers will influence its usage; this especially at the

beginning, as not all broadcasters may have in-house AR experts. Other stakeholders like the FOM, FIA and F1 Teams should be considered, as the value added to consumers depend on the information provided by them to F1 broadcasters. These are **secondary stakeholders**. Regulators have affected previous disruptors in different countries (e.g. Netflix in Asia), and broadcasters operating in different countries need to consider that to tailor their local offerings. Social Media instead did not play a major role in past disruptions, as they were not yet available to consumers or because they were not leveraged by disruptors (e.g. OTT platforms) . However, it is a tool that can influence the adoption of his technology, as it has been proven to influence the adoption of new products and services (Tekic et al., 2013). These are the two main **Influencers**.

4.3.2 Experts comments on Scenarios

Conservative Scenario

In this scenario all stakeholders have low interest toward the introduction of AR features in F1 broadcasting. Experts agreed that some AR features will be offered as a premium service, while some basic ones will be displayed in the standard product. This is a common trait to all scenarios. Overall, this scenario was considered too conservative, and none of the experts added something to the a-priori version. In fact, experts have given this scenario a **15%** probability to happen. This result shows how the F1 and broadcasters ecosystems are positive toward the future implementation of this technology during live races.

Business-as-Usual Scenario

This scenario was given a **50%** probability to happen. In this scenario experts focused on the behaviors of the FOM, FIA, F1 Teams and AR providers. The behaviors of these stakeholder described in this paragraph are the most probable to happen in the next 5 to 10 years.

The **FOM, FIA** and **F1 Teams** are considered crucial for this technology. Every year teams participate in the so called “World Meeting”, which is coordinated by the FIA (Interview 6). They decide which information every team has to disclose to broadcasters. This happens through a voting system, and acceptance happens through unanimity. This system saves competition between teams (Interview 6). On the other side, this means that F1 broadcasters may not receive the necessary information to display in the developed AR features. What companies should do is to wait for this meeting to happen and then start the process of co-creation. However, experts are confident about the disclosure of more information over time. This is confirmed by the trend of these past years, where F1 Teams have started collaborating

more with broadcasters (Interview 1). The evolution of F1 technical regulations is pushing for further information disclosure. From 2022 the FIA will reduce the maximum amount of investments per team and some components will be standard; this will reduce the technical gap between F1 teams (F1 Press Conference). With the new rules teams will have less sensitive information to not disclose, as cars and their performances will be very similar to one another. This allows the FOM and the FIA have more control over the information. The "World Meeting" will still be held, but F1 Teams will have less contractual power. This allows F1 broadcasters to directly negotiate with the FIA to display more information on their AR features. **AR Providers** will work closely with F1 TV, which is the official streaming service of F1 managed by the FOM. F1 broadcasting experts defined it the platform to look at for *"new features during live races"* (Interview 5). In fact, during the past years the platform has introduced many new features, and it is likely that AR features will be introduced first by F1 TV. Broadcasters can benefit from this competition, as AR providers will sustain investments to improve their offering and win the exclusive deal with F1 TV. Even if technology providers do not collaborate with the FOM, they will work with other F1 broadcasters, and improve the quality of the live racing offering.

Optimistic Scenario

The last scenario was given on average a 35% probability to happen by experts. In this scenario experts focused on the behaviors of Customers and Broadcasters. The behaviors of these stakeholder described in this paragraph are the most probable to happen in the next 5 to 10 years.

Customers will be excited by these new features (Interviews 1, 5, 6 and 7). They will consider this technology as something changing their viewing experience, and will suggest their friends and family to purchase the new features. On the other side, Broadcasters will invest on AR (Interviews 1 and 5) and focus on the customized viewers experience to introduce new features. They will invest heavily to make AR features interactive. To do so, broadcasters will hire additional AR experts, and leverage external AR providers as consultant, in order to build in-house expertise and get external extensive AR market knowledge (Interviews 1 and 5).

This is the hardest challenge they will face and it will allow consumers to personalize their live racing dashboard. The necessity to invest in Interactivity is confirmed by technology reports, where Interactivity is considered to be one of the main drivers for future technological developments, leading toward Real-environment experience (Deloitte). This is an extremely interesting finding for the FOM: the organization can have millions of spectators purchasing

these real-environment experiences at the same price point of live races tickets. This would generate millions of incremental revenues. However, this experience will be available only in 10+ years, and does not allow the FOM to organize its introduction in their offering in the short-term.

4.3.3 Additional Comments on Scenarios

Before interviews there was the expectation that academics may be more positive toward AR usage in the near future; however, F1 broadcasters and providers showed more interest and had trust in the success of the technology. This shows how AR is now ready to be fully launched on the market. Interview 2 highlighted that 10 to 15 years ago "AR developers were considered as crazy people…the ones playing with videogames". In the meanwhile, broadcasters and consumers have understood that AR can enhance respectively their products and viewing experience. Social Media and Regulators were considered as residual influencers in the ecosystem. None of the experts made any comment. This is interesting, as social media are used by the majority of companies to launch their products, and studies show that they have a positive impact on new products or services (Tekic et al., 2013). Overall, social media seems to be more influential for physical products and for services in other industries; broadcasters cannot exploit the advantages of these platforms to launch new products for F1. Moreover, regulators play a less relevant role in this context, as F1 rights are managed by a single organization worldwide (e.g. the FOM). Thanks to this, broadcasters can standardize their AR features in different markets to reduce costs. Interviewees mentioned the necessity to integrate cloud technologies in the creation and development phases. This service is necessary if advanced features are introduced (Interview 7). This technology has already been used by broadcasters for other services they offer (Interview 7); indeed, integrating it in the F1 offering is an easy process, and its usage should happen both in the Business-as-Usual and Optimistic Scenarios. The few features available in the Conservative scenario would not require additional investments related to the technology. Cloud technologies allow broadcasters to better manage their content, and deliver it to the right audience (e.g. for worldwide broadcasters, direct to consumers) in an automatized manner (Amagi). All experts shared the same idea about the Penetration Rate. The a-priori analysis focused on OTT platforms as a disruptor, suggested a maximum rate of 15/20% in 5 to 10 years (Statista). However, all experts suggested that this percentage should be almost doubled, and be close to the 35% of the Optimistic scenario. This is confirmed by data from the AR industry which suggest a faster adoption and higher growth rates for this technology (GrandViewResearch); this because AR has been on the market for more years than streaming

platforms, and it is now ready to be fully leveraged. Data from the survey confirms it, as 65% are likely to buy these features if offered. Related to Customers' WTP, all experts mentioned that it would increase on average by 40%. This was confirmed by data from the survey, as the average WTP is close to 7,50€, with an average subscription for F1 in Italy costing about 16€/month (Sky Italy).

4.3.4 Next 5 to 10 years

To answer the third research question, the future of F1 broadcasting industry will look like the **Business-as-Usual Scenario**. Previous disruptions in the broadcasting industry (e.g. streaming platforms) leveraged new technologies and the improvement of existing ones (e.g. expanded bandwith), leading to a change in companies' business model. In this case, AR will add a new stream of revenues to the current offering, not redefining the entire broadcasters' business model. The FOM, FIA and F1 Teams' decisions are shaping the industry in the near future. Since their past behaviors moved toward a democratization of information, the F1 ecosystem (commentators, tech-experts etc.) is positive about the possibility to have more information displayed during live races. Also, there is the expectation that new regulations favoring data disclosure will be approved in the next years.

Customers will play an important role during the first phases of the adoption process; overall, their behaviors will be similar to the ones in recent disruptions, where personalization and companies' focus on their preferences drove adoption. During the first 2 to 3 years broadcasters will collaborate with external AR providers; after, they will invest on Interactive AR features. Meanwhile, broadcasters will hire more AR experts and have technical trainings to fill the gap between content creators (e.g. commentators) and tech-experts. This will allow them to benefit from external AR experts knowledge, while developing in-house competences. Broadcasters will offer only the High Added Value Bundle, and it is not likely that different levels of AR features will be offered, as suggested by the Optimistic Scenario. Regulators will not limit broadcasters' AR features development, and social media will be useful for marketing campaigns and consumers' interactions. However, they will not play a pivotal role in the process.

5. LIMITATIONS AND FURTHER RESEARCH

This dissertation studies the current status, implementation and future of AR in F1 broadcasting. It focuses mainly on the Italian market, as all experts are from Italy. Additional research should study factors affecting the introduction of AR in other countries and account for cultural differences in computing customers' WTP.

This exploratory dissertation identifies customers' WTP for AR features. However, no actual MVP has been developed, and individuals were not put in a real-life purchase situation. This may have created biases and pushed upward the actual WTP estimations. Moreover, the survey was sent to individuals who do not necessarily pay their sports subscription and may have a reference price higher than the actual price for a F1 monthly subscription. Additional research in collaboration with F1 broadcasters should develop a MVP and create a real purchase situation where participants are the ones paying for their F1 subscription. By doing so, the *real WTP* is expressed by individuals (Wertenbroch & Skiera, 2002). Moreover, further analysis should focus on which are the features customers value the most; this dissertation analyzes how features add value as a group, but a conjoint analysis is more useful to understand the most valuable features.

Another limitation refers to the fact that all interviewees came from Italy. Their perspectives may have been too narrow, not fully representing the worldwide F1 Broadcasting Industry.

This dissertation focuses on how broadcasters can implement AR technologies during F1 races. Further studies should focus on the introduction of this technology in additional sports events like basketball (Euroleague and European leagues) and Ski, which can leverage the high amount of data generated to enrich the broadcasting content. Moreover, one of the experts (interview 2) mentioned that AR can be leveraged to blend videogames and live racing, but was unsure about its short-term feasibility; further research should focus on its technological feasibility, develop a business model to make it financially feasible and study customers' preferences to create the most effective launch strategy. Focusing on the competition side of F1, AR can be implemented by F1 teams to improve their performances. Further research should focus on new AR use cases that can generate a competitive advantage for F1 teams in terms of cars and drivers' performances.

6. CONCLUSION

This dissertation analyzed how AR can enhance F1 broadcasting, how consumers will react to the technology and identified the most likeable scenario to happen in the next 5 to 10 years. It combined both qualitative and quantitative data to provide a perspective both from F1 broadcasters/AR providers and customers.

Qualitative data answered the research question related to the main variables affecting the implementation of AR during live events/racing and how the technology can enhance live races. They highlighted that the technology is mature to be used by broadcasters at a higher scale, but need to wait for the refinement of complementary technologies (e.g. satellite). The high added value offered to customers will make this technology a standard in the broadcasting industry in the next years; this will happen if broadcasters develop a team able to integrate customers' insights in the software development process.

The scenario analysis gave an overlook of the next 5 to 10 years and how different stakeholders will affect the industry. Experts identified the FOM, FIA and F1 Teams as the main influencers, with Broadcasters being able to leverage in the AR features the information these stakeholders provide.

Quantitative data answered the research questions related to the viewers' WTP for this product, and identified the characteristics of the individuals willing to spend more for these features. The persona broadcasters look for to maximize their revenues is an early technology adopter, passionate about F1, with familiarity with AR and Interactive Technologies.

This study revealed that F1 Broadcasters have the technical and financial capabilities to implement this technology, which data show to be highly valued by customers. Major investments have already been done by the F1 itself, and broadcasters should closely follow to not lose a source of sustainable competitive advantage. In the next 5 to 10 years AR will redefine the live racing experience, with viewers covering a central role in it.

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APPENDIX

APPENDIX 1: Frequency Analysis AR Features

AR FEATURE	Times Mentioned
Ideal trajectory during Qualifying and Races through a "ghost car" on the track	**8**
After-incident cars' analysis and real-time analysis of why drivers are slowing down	**7**
Drivers' POV with complementary information (e.g. G-Force, Steering Wheel movements/buttons)	**7**
Every Team's Pit-Walls and boxes visualization (e.g. Team Radio, Potential Strategies, Pit-Stop analysis)	**6**
Tires Usage and Management (displayed on tires)	**5**
Pit-Stop strategy and how it varies according to external condition (e.g. rivals' pit-stop, rain coming);	**4**
Augmented Studios	**4**
Distance in meters between cars, between cars and walls (e.g. Monte Carlo)	**3**
Toe Effect (Incremental Speed on straight);	**3**
Augmented Sector-Time Detection Point;	**3**
Drivers' Reaction Time at the start of the race	**2**
Augmented Drivers' Sectors comparison/ Championship Standings/ GP History	**2**

APPENDIX 2: 3 Bundles

Low Added Value	*Average Added Value*	*High Added Value*
1.Toe Effect (Incremental Speed on straight); ***2.Augmented Sector-Time Detection Point;*** ***3.Drivers' Reaction Time at the start of the race;*** ***4.Augmented Drivers' Sectors comparison/ Championship Standings/ GP History***	***1.Tires Usage and Management (displayed on tires);*** ***2.Pit-Stop strategy and how it varies according to external condition (e.g. rivals' pit-stop, rain coming);*** ***3.Augmented Studios*** ***4.Distance in meters between cars, between cars and walls (e.g. Monte Carlo)***	***1.Ideal trajectory during Qualifying and Races through a "ghost car" on the track;*** ***2.After-incident cars' analysis and real-time analysis of why drivers are slowing down;*** ***3.Drivers' POV with complementary information (e.g. G-Force, Steering Wheel movements/buttons);*** ***4.Every Team's Pit-Walls and boxes visualization (e.g. Team Radio, Potential Strategies, Pit-Stop analysis)***

Source: Interviews Elaboration

APPENDIX 3: Scenario Analysis

	Stakeholders	Conservative Scenario (5-15% penetration)	"Business as usual" Scenario (15-25% penetration)	Optimistic Scenario (25-35% penetration)
	Service Level	Basic AR features displayed in standard offering + additional basic features through additional fee	Basic AR features embodied in the standard product + additional premium features available through additional fee	Basic AR features embodied in the standard product + different levels of premium features offered through additional fees
PRIMARY	**Customers**	Few customers will be interested by the new functionalities. The	The most passionate F1 fans will be enthusiastic about this new offering. They will combine the	Not only F1 fans, but also commercial avenues (e.g.

		majority will not see them as a true value added to the broadcaster offering. Customers will look for other products/services completing their watching experience, relying more on social media and services already offered by broadcasters themselves (eg. Simple On-board cameras).	AR watching experience with social media posts; they will talk about the new AR functionalities in blogs, radio talks etc.. Customers will suggest other motorsport fans to buy these functionalities, increasing the penetration rate over time. However, they will still like to have some non-AR functionalities in the experience, preferring not to be immersed in a fully digital race.	restaurants, bars) will adopt new technology. It will give AR more visibility and will help building larger customer base. Customers will ask for additional functionalities to be added to the current offerings, as they want the overall experience to converge toward a fully digital live race. They will interact with the AR technology during the race trough gamified features, allowing them to watch what they really want.
	Broadcasters	Few competitive broadcasters will outsource the development of basic AR functionalities in selected historical circuits. Before launching them, they will air "educational programs" related to these new features, to make customers more familiar with them. More importantly, they will test the correct pricing of these services, making AB testing to understand the most profitable price-point, sorting out if the investment and project can be sustained in the long run. Over time they may extend them to all circuits, but features will likely remain basic ones for some time before new features are added.	Very competitive broadcasters will start investing in this new technology. They will develop many functionalities at the beginning of the season, and introduce them gradually in the watching experience. AB testing will be done in order to understand which are the customers' preferred features and improve the product. Other broadcasters will instead wait to introduce this new technology. For some time they will observe the results of more competitive broadcasters, and decide to invest in AR only if financial results make sense to them. These investments relate to in-house AR capabilities development, as one AR expert can focus on many functions, and outsourcing a source of competitive advantage can be dangerous. The aim is to hire experts to get to a more integrated and automatized system.	All broadcasters will have an initial investment in this new technology. They will hire new people related to UX and software development. The most competitive ones will lead the pack, offering many additional functionalities. They will introduce gamified elements leveraging AR. Others will offer the most common features to which customers are more familiar with. Broadcasters will continuously introduce new features, not necessarily built at the beginning of the season, by asking customers what they want to see on the screen, and make AR as interactive as possible.
SECONDARY	**F1 (FOM and FIA)**	F1 will be part of the pioneers of this new technology. It will introduce these AR features in its broadcasting service F1	F1 TV will have the AR features integrated in their offering, with some premium ones offered as an add-on. However, F1 will allow broadcasters to benefit	F1 will offer AR features in F1 TV without requiring customers to pay an add-on subscription. The same features will

	TV. F1 only allows broadcasters to build graphics on top of FIA images, and this will not change. This gives F1 TV more room to develop their own functionalities and slow down the development of these new technologies. AR features in F1 TV will be paid as an add-on to the subscription, and broadcasters will not be able to use them in their offering.	from these functionalities in their product. Moreover, F1 will give broadcasters more room to develop their own AR functionalities, not acting as a monopolist.	be given to broadcasters; they will be given more free room to develop their own graphics during live races, increasing the quality and the competition between service providers.
F1 Teams	Since all teams are required to provide the same information, they will agree on not providing additional ones, making broadcasters work on adapting the current graphics into the new AR functionalities. Indeed, the value added will be very little to customers, that will benefit only from a more digitalized viewing experience.	Regulations change will allow the FOM and the FIA to have more control on the information to give to broadcasters. During the World Meeting F1 teams will discuss which additional information to give out to broadcasters. The FOM and the FIA will create a common base to which to start, and will include information that were not mandatory. F1 teams will respond positively to the new technology, providing more technical information.	Regulations change will allow the FOM and the FIA to have **full** control on the information to give broadcasters. They will collaborate with F1 Teams to choose which are the information to provide to not disclose sources of technical competitive advantage. F1 Teams will collaborate with broadcasters, and provide them with additional information during the race week-ends.
Technology Providers	Broadcasters will look for the most suitable technology providers. Tech providers will offer their service at a discount to enter the market first. Overall, few providers will work with F1 broadcasters. There will be few generalists, offering basic AR services. They will have medium contractual power with broadcasters, as few other providers will focus on F1 since it is a small market (in terms of AR). This will lead to lower quality and lower added value to customers.	Tech providers will fight over getting an exclusive deal with F1 TV. However, they will offer their products to other broadcasters as well. The wider usage of AR in F1 will make the technology needed for multiple purposes which need more technical expertise (eg. Educational, studios). Tech providers may specialize in hardware and software related to specific functionalities. Overall, there will be both generalist (big groups) and specialized companies. Mid-level value will be offered to broadcasters and users. Incremental business will be created as well for CLOUD Services (eg. AWS), since broadcasters are moving toward	Tech providers will fight over the exclusive deal with F1 TV. AR will be much more spread in F1 broadcasters, giving them contractual power over technology providers. The popularity of AR features will make technology providers develop top notch hardware and software to sustain high level functionalities. Most companies will specialize in specific value propositions. CLOUD services will be used as main tool for

			a cloud system to develop software for AR graphics, reducing investments for hardware.	software and graphics development, reducing production costs.
INFLUENCERS	**Social Media**	Social media channels will not be very enthusiastic about this new technology. F1 official pages will still prefer to post about teams radios or amazing overcomes, not focusing on such AR features. F1 related pages will do the same, with AR features used only in futuristic videos related to the future of F1, and making this technology feel like 10 years ahead.	F1 official pages will mix posts related to new AR functionalities with the most common posts related to team radios and on-boards. However, posts will not make AR feel like a futuristic feature, with F1 trying to build awareness in their social medias to increase their F1 TV revenues. F1 related pages will follow along, and post funny memes/pictures related to AR functionalities	The most common posts by F1 official pages and F1 related pages will be related to AR. Also broadcasters page will try to build awareness about these new functionalities; this through the use of ads and educational videos.
	Regulators	Regulators will try to reduce as possible the amount of information shared by the F1 teams. They will do so by imposing a limit to those teams believing in the success of this technology. Moreover, they will control for the price-premium offered to consumers, making it difficult for F1 TV itself to sustain its investment.	Regulators will act mostly as a moderator for prices. Information will be free to flow between the parties, with limits imposed by F1 and F1 teams themselves; even if regulators may still impose some limits, but very low ones. Indeed, regulators will focus on customers' well-being.	Regulators will only have a residual role in price setting. They will not have any kind of role in information sharing between the parties. Focus will still be on broadcasters' price setting, but very residual.

Notes*

- With **Penetration** here we mean the % of people adopting AR technologies in F1 broadcasters having an additional fee to watch sports events like F1.

APPENDIX 4: Incremental Revenues

Number of Subscribers 4,8 Million

Penetration Rate 20% → 960.000 Adopters

Average WTP = 7,50€/month (Data from the survey)

Total Incremental Revenues per month = 7,2 Million€

APPENDIX 5: Interviews Insights

Interview 1

Carlo Vanzini			
Variable	***Points Given***	***Insights***	
Current AR Usage	**4**		
Easiness To Implement	**4**	F1 Broadcasters have used this technology for other sports, and it would be easy for them to adapt it to F1; Match satellite signals with the visuals is the biggest challenge, but can be overcome	
Added Value	**5**	AR would improve viewers' experience, as they will have access to more data in a more accessible way; Interactivity and Personalization through AR will elevate the product to another level	
Disruption	**5**	The process to make it a standard may take less than 5 years	
Adoption Rate	**25%**	**WTP Increase**	**33%**
Conservative Scenario **	**Business-as-usual Scenario**		**Optimistic Scenario**
Additional Insights	The FOM and the FIA have invested a lot of money to standardize the product → Broadcasters need to use new technologies to differentiate themselves; From 2022 F1 will give provide F1 Teams with the same car. This allows the FOM and the FIA to have more control on the data generated		

Interview 2

Francesco Ferrise			
Variable	***Points Given***	***Insights***	
Current AR Usage	**1**		
Easiness To Implement	**1**	Major Investments and Operational Costs to sustain are not an issue for broadcasters. The major challenge is to develop the graphics/software and get the information to show	
Added Value	**4**	F1 Fans focus on technicalities, and AR can provide them the information they want in an enjoyable manner	
Disruption	**4**	The process will take some years, but as soon as broadcasters will introduce these features, customers will adopt the technology at a relatively fast pace	
Adoption Rate	**40%**	**WTP Increase**	**10%**
Conservative Scenario **	**Business-as-usual Scenario**		**Optimistic Scenario**
Additional Insights	The imitability for this technology depends on the amount and type of information F1 broadcasters have available. The AR technology is more rare in Europe, where F1 is a more popular sport, with respect to the US		

Interview 3

Piergianni Pulito			
Variable	***Points Given***	***Insights***	
Current AR Usage	**2**		
Easiness To Implement	**2**	**N/A***	
Added Value	**4**	**N/A***	
Disruption	**4**	AR together with interaction creates Mixed Reality. Broadcasters should make it the standard for future live sports broadcasting	
Adoption Rate	**50%**	**WTP Increase**	**20%**
Conservative Scenario	**Business-as-usual Scenario**		**Optimistic Scenario**
10%	**60%**		**30%**
Additional Insights	The AR technology has been used by other motorsports like NASCAR, but by only 1 broadcaster (FOX Sports). By then, its market share has increased, as consumers perceive AR to improve their experience		

Interview 4

Monica Bordegoni			
Variable	***Points Given***	***Insights***	
Current AR Usage	**2**		
Easiness To Implement	**1**	The major difficulty is related to the pre-software development. Broadcasters need to understand what truly adds value to customers and develop their offering from there. The positioning of sensors on tracks and cars is crucial for the software development phase; negotiations are involved in the process. Missing out some variables during pre-implementation may lead to a failure	
Added Value	**4**	**N/A***	
Disruption	**5**	**N/A***	
Adoption Rate	**20%**	**WTP Increase**	**40%**
Conservative Scenario	**Business-as-usual Scenario**		**Optimistic Scenario**
10%	**50%**		**40%**
Additional Insights	The technology per se is NOT rare. What makes this technology rare is the amount of information available to be displayed in the features		

Interview 5

Fabiano Vandone			
Variable	***Points Given***	***Insights***	
Current AR Usage	**2**		
Easiness To Implement	**4**	Hardware's costs will decrease over time. F1 Broadcasters must understand which hardware they need before starting the software development and implementation processes	
Added Value	**5**	F1 Broadcasters in the past could not leverage AR. Through it they can customize the commenting, images and extra-content provided to customers, increasing the product's value	
Disruption	**4**	Many F1 Broadcasters are working with the expert's AR company. The number is growing each year, leading to more market penetration	
Adoption Rate	**35%**	**WTP Increase**	**40%**

Conservative Scenario	Business-as-usual Scenario	Optimistic Scenario
5%	**55%**	**40%**
Additional Insights	The FOM and the FIA are the organizations controlling the images provided to broadcasters all over the world. They define which images to show, and F1 broadcasters can only build on top of them. F1 TV is hugely investing in new features to show viewers during live races. Broadcasters need to speed up their innovation process and fill the empty gaps left by the FOM before them to acquire more customers. If they are not able to do so, F1 may be aired only by F1 TV in a 15 years span; Race tickets will be functional to cover organizational costs. F1 is investing on developing high quality streaming content to appeal its market outside the races geographical areas; F1 has started to partner up with gamers in the motorsport industry to attract new customers and target the younger population	

Interview 6

Antonio Granato			
Variable	***Points Given***	***Insights***	
Current AR Usage	**4**		
Easiness To Implement	**5**	The technology is not a problem. Information to show during the race may be more difficult to obtain	
Added Value	**5**	F1 Fans focus on technicalities, and AR can provide them the information they want in an enjoyable manner	
Disruption	**4**	**N//A***	
Adoption Rate	**20%**	**WTP Increase**	**30%**
Conservative Scenario	**Business-as-usual Scenario**		**Optimistic Scenario**
15%	**40%**		**45%**
Additional Insights	F1 Teams decide which information to provide broadcasters during the "World Meeting". It takes place once a year before the start of the season, and decisions are made through unanimity; Changes of regulations are pushing toward standardization; this allows for more information control by the FOM and the FIA, making the negotiation process to acquire them easier for broadcasters, as not all teams are involved		

Interview 7

Nicolò Alpini		
Variable	***Points Given***	***Insights***
Current AR Usage	**4**	
Easiness To Implement	**2**	The software and graphics to be developed are time consuming and require financial investments. A major difficulty is to build the right cross-functional team to build AR features that add true value to customers
Added Value	**4**	Broadcasters have already experimented AR in other formats. It added value to the viewing experience. The same effect would happen for F1 spectators
Disruption	**4**	Not all broadcasters have introduced this technology in their offering. In the Italian market

		only SKY Italy has done so, but very little in F1. In the near future (5 years) there is a high probability that AR will be predominant in all F1 broadcasters	
Adoption Rate	**30%**	**WTP Increase**	**20%**
Conservative Scenario	**Business-as-usual Scenario**		**Optimistic Scenario**
20%	**70%**		**10%**
Additional Insights	F1 broadcasters provide their software developers with the graphics to be developed. There is no co-creation process within the organization, and consumers are not involved at all. To create the best possible product broadcasters should involve customers in the development process, and AR features should be iterated through a process involving multiple stakeholders within the organization; Cloud computing will be required to develop these features in the 2nd and 3rd scenario		

Interview 8

Emanuele Frontoni			
Variable	***Points Given***	***Insights***	
Current AR Usage	**2**		
Easiness To Implement	**2**	**N/A***	
Added Value	**5**	**N/A***	
Disruption	**4**	AR can be complemented by AI to provide viewers with a more personalized experience. AR will become a standard first, but as soon as AI is available to implemented by broadcasters, its full potential will be reached	
Adoption Rate	**35%**	**WTP Increase**	**40%**
Conservative Scenario	**Business-as-usual Scenario**		**Optimistic Scenario**
10%	**50%**		**40%**
Additional Insights	**N/A***		

Interview 9

Franco Tecchia			
Variable	***Points Given***	***Insights***	
Current AR Usage	**2**		
Easiness To Implement	**2**	**N/A***	
Added Value	**4**	**N/A***	
Disruption	**4**	**N/A***	
Adoption Rate	**20%**	**WTP Increase**	**40%**
Conservative Scenario	**Business-as-usual Scenario**		**Optimistic Scenario**
25%	**25%**		**50%**
Additional Insights	In the scenario analysis, the expert identified commercial activities as those driving the adoption of these features, because of their huge reach and influencing power		

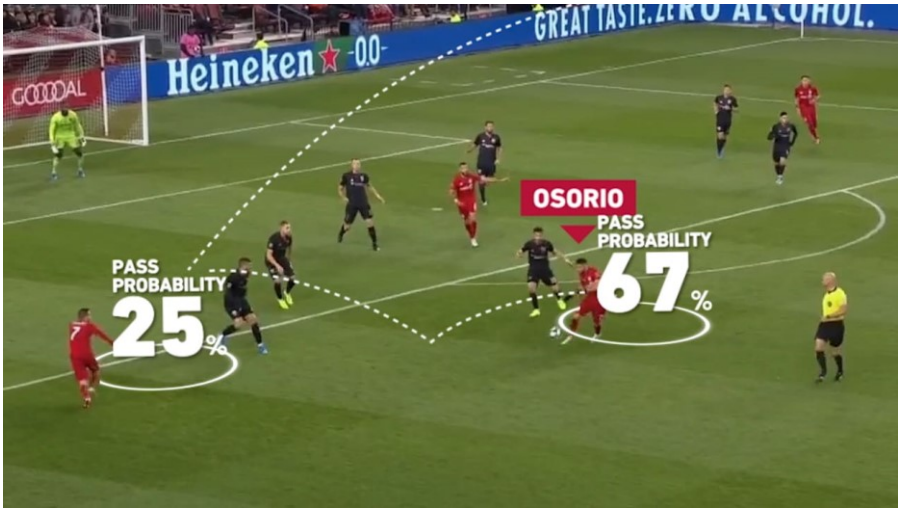
N/A* means that the expert has not provided any relevant additional insight with respect to what have been said by her/his previous colleagues
**** This question was not asked to the expert**

APPENDIX 6: AR Studios

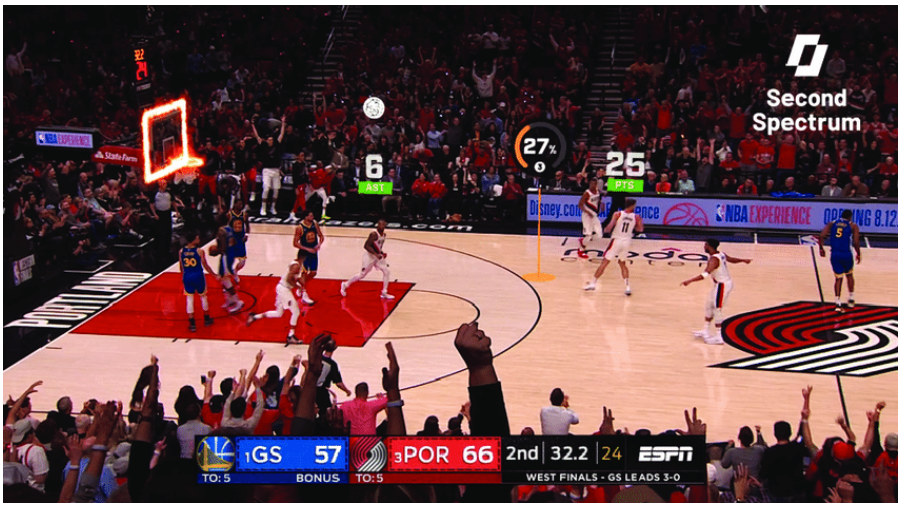
Source: Sky Italia

APPENDIX 7: Multiple Sports AR Predictive Models

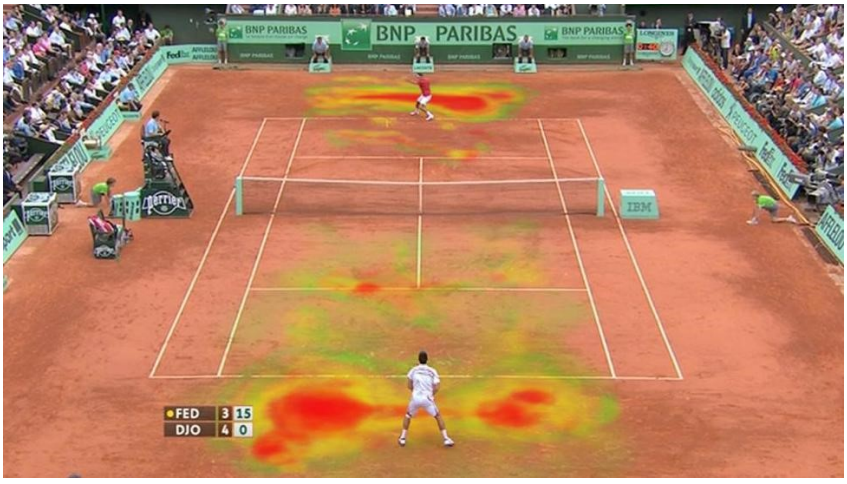
Volleyball
Source: Sky Italia



Football
Source: Sky Italia



Basketball
Source: Second Spectrum



Tennis
Source: Sky Italia

APPENDIX 8: F1 AR Usage

Drivers' POV & Teams' Pit Wall
Source: Sky Italia

APPENDIX 9: Expert Interviews Structure

1) Do you think AR is exploited enough by F1 broadcasters (after having shown current usage during races) through their current functionalities? How? Could you quantify it from 1 to 5?

   PICTURES OF CURRENT FUNCTIONALITIES (In Section 3)

   With:
   - 1 Not at all exploited
   - 2 Very few and basic functionalities
   - 3 Average functionalities
   - 4 Above average functionalities
   - 5 Top of the chart functionalities

2) How do you think AR can disrupt the services offered to customers? And to which customer segments would it be more applicable (Ex. During races, Educational content, Live races from home in PS5 etc.)? Could you quantify from 1 to 5?
   - 1 Not at all disruptive
   - 2 Very few disruption
   - 3 Average Disruption
   - 4 Above Average disruption
   - 5 Absolutely disruptive
   -

   With **Disruption** here we mean the extent to which over time broadcasters will need to adopt this technology in order to remain competitive in the market. E.g. The extent to which AR will become a standard in the future

3) How easy would it be to implement AR technologies in F1 broadcasting?
   - 1 Very difficult to implement
   - 2 Difficult to implement
   - 3 Average difficulty to implement
   - 4 Easy to implement
   - 5 Very easy to implement

4) Which could be possible **additional use cases** for AR in F1 broadcasting?

5) How much value would these new technology add to customers?
   1- No Value Added
   2- Little value
   3- Average Value
   4- Above Average Value
   5- High Value Added

6) How will this technology be adopted by customers? All at once-normal adoption curve- or how spread in time? Do you think customers **WTP** will increase (in %) through adding these functionalities? Which will be the **Penetration rate** of such technology for customers?

7) What are factors influencing the WTP of such technology by consumers?

8) What are main costs to be sustained during the implementation of such functionalities and its operational costs? Indeed investments pre-implementation + post implementation recurring costs

9) **Looking at these 3 different scenarios, which is the likelihood of each of these to happen? Comment**

APPENDIX 10: Survey

INTRODUCTION: This survey is part of a study conducted by me to complete my Master Thesis at Católica Lisbon School of Business and Economics and Bocconi University. Questions will focus on Formula1 and Augmented Reality (AR). The survey will last about 2-3 minutes, and your answers will remain anonymous.

First Page

1) Is your household subscribed to any kind of sports related streaming or broadcasting service (Examples: SKY, DAZN, Eurosport)?
   Yes No (If no End the survey)

Second Page

2) Gender
   Male FemaleOther Prefer not to say

3) Age Range
   18-23 24-29 30-35 36-41 42-47 48-53 54+

4) What is your household's annual income?
   <10.000 10.000-20.000 20.000-30.000 30.000-40.000 40.000-50.000 50.000-60.000 60.000+

5) What is your current level of Education?
   Middle School High School Bachelor of Science Master of Science PhD Other

Page only for "High School" or above

6) What is your Academic Background?
   Engineering Business Medicine Architecture History
   Other

Third Page

Please answer to the following statements

7) **I am very familiar with Augmented Reality (AR) and I have already used some applications that use it**

   1 Strongly Disagree 2 Disagree 3 Neither Agree nor Disagree 4 Agree 5 Strongly Agree

8) **When I find out new technologies are available, I am keen on trying them**
   1 Strongly Disagree 2 Disagree 3 Neither Agree nor Disagree 4 Agree 5 Strongly Agree

9) **I am a die-hard Formula1 Fan**

   1 Strongly Disagree 2 Disagree 3 Neither Agree nor Disagree 4 Agree 5 Strongly Agree

10) **I prefer to use interactive technologies (e.g. technologies that allow me to choose what to do and see)**
   1 Strongly Disagree 2 Disagree 3 Neither Agree nor Disagree 4 Agree 5 Strongly Agree

Fourth Page

Augmented Reality (AR) has been used in multiple sports broadcasting events (Ex. Basketball, NASCAR, Football etc.) and these are some of its functionalities

VIDEO

Fifth Page

Other questions to be randomly assigned for computing WTP for different bundles of features (selected based on the frequency analysis from experts interviews)

11) Imagine you can add these features to your current subscription to watch F1 (Low Value Added):

- Tow Effect → Display the incremental Speed gained during the straight
- Augmented Sector Time Detection Point (e.g. digital line defining the end of one sector during Qualifying)
- Drivers' Reaction Time at the start of the race (for whatever driver the viewer want)

- Augmented Drivers' Sectors Comparison/Drivers' Championship Standings/GP History etc. (For this last feature imagine to visualize everything like in the picture below)

How much would you be willing to pay **PER MONTH IN ADDITION TO YOUR CURRENT SUBSCRIPTION** (Please type 0 if you are not willing to buy them)?

12) Imagine you can add these features to your current subscription to watch F1 (High Value Added):

- Ideal Trajectory during Qualifying and races (for overtaking) through a "ghost car" appearing in the track

- After-Incident analysis of the cars (what has been damaged) and real-time analysis of why drivers are slowing down or going faster than rivals
- Drivers' POV (On-board) selected by viewers (**for every driver**) with complementary information always selected by viewers (steering wheel movements, steering wheel buttons, G-Force, Wind Perception, Qualifying Time etc.)
- Every Team pit-walls and boxes visualization (selected by viewers') → Team-Radio, Potential Strategies, Pit-Stop (why it was good or what went wrong)

How much would you be willing to pay **PER MONTH IN ADDITION TO YOUR CURRENT SUBSCRIPTION** (Please type 0 if you are not willing to buy them)?

13) Imagine you can add these features to your current subscription to watch F1 (Middle Value Added):

- Tires usage and management (displayed directly on tires)
- Pit-Stop Strategy and how it varies according to external condition (e.g. the rival makes a pit-stop, rain coming, alternatives → displayed on screen instead of being explained by commentators)

- Augmented Studios (Ex. 3D cars, Pilots interviews) (Ex. In the picture below the player is NOT in the studio)

- Distance in meters between cars

How much would you be willing to pay **PER MONTH IN ADDITION TO YOUR CURRENT SUBSCRIPTION** (Please type 0 if you are not willing to buy them)?

APPENDIX 11: AR indifferent Industries

Music Industry
Source: Grammy Live

Retail Industry
Source: Timberland