**Comparing AND ANALYSING Sentiment Analysis of Apple Products on Social Media and E-Commerce Platforms**

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ABSTRACT

This research paper presents a case study focused on analysing public perceptions of Elon Musk after his latest decision to rebrand Twitter to X. Leveraging a dataset comprising 2000 Reddit comments, the study delves into five primary discussion topics and employs three distinct sentiment analysis methods to gain comprehensive insights. The findings shed light on the sentiment surrounding the businessman’s portrayal and offer valuable implications for understanding general reception in society.

**Keywords:** Elon Musk, Twitter, Reddit comments, Sentiment analysis, Topic modelling.

# Background & the problem domain:

In today's digitally interconnected world, the proliferation of social media and e-commerce platforms has revolutionized the way businesses engage with their customers. Companies now have the unprecedented opportunity to directly interact with their customers and gain insights into their preferences, opinions, and sentiments. This paradigm shift has brought forth the importance of sentiment analysis, a vital tool in understanding and leveraging customer sentiments for strategic decision-making.

Within this context, analyzing and comparing sentiment analysis of products on social media and e-commerce platforms holds immense significance. Because, in this way, it is possible to examine, analyze and compare the impressions of the users who buy the product and the general audience, which is unknown whether they buy the product or not. Apple Inc., a global technology leader renowned for its innovative products, has an extensive customer base that actively engages with the brand across various online platforms. Understanding the sentiments expressed by customers about Apple products on social media and e-commerce platforms is crucial for Apple's continued success in a highly competitive market.

The academic relevance of this project lies in its utilization of advanced data science techniques to extract meaningful insights from large volumes of unstructured textual data. Sentiment analysis, a subfield of natural language processing (NLP), presents an exciting opportunity to bridge the gap between qualitative customer opinions and quantitative analytics. By applying sentiment analysis methodologies, this project seeks to contribute to the field of sentiment analysis and NLP, demonstrating how these techniques can be employed to decipher complex customer sentiments in real-world scenarios.

From an industrial standpoint, this project has direct implications for enhancing business strategies and decision-making processes. Businesses are increasingly recognizing the significance of harnessing customer sentiments to drive product innovation, refine marketing strategies, and bolster customer satisfaction. The project aims to address a real-world challenge faced by businesses: deciphering the multifaceted sentiments customers express across diverse platforms, from casual social media discussions to structured e-commerce reviews.

The key problem domain the project addresses is twofold: the first one is the challenge of comprehensively understanding customer sentiments in an era of data deluge and the second one is the need to compare sentiments across different platforms to extract nuanced insights. Existing sentiment analysis techniques often fall short in capturing the intricacies of sentiment expression, especially when applied to diverse sources like social media posts and e-commerce reviews. Moreover, the disparity between sentiment expressions on social media platforms and those on e-commerce sites can obscure the true sentiment landscape.

By meticulously collecting and preprocessing data from social media platforms (YouTube and Reddit) and e-commerce platforms (Amazon and eBay), and employing sophisticated sentiment analysis methods, the project aims to shed light on the subtle variations in customer sentiment expression on distinct platforms. Additionally, through the aggregation of sentiment data over time and the identification of recurring themes and products, the project intends to unveil valuable patterns that can guide Apple's strategic decision-making processes.

The proposed project not only contributes to the academic field of sentiment analysis and NLP but also offers practical insights that can shape business strategies for companies like Apple. Through the holistic analysis of sentiments expressed on social media and e-commerce platforms, the project seeks to empower businesses with the tools to translate customer opinions into informed actions, ultimately elevating customer satisfaction and driving innovation in the competitive landscape.

As the field of sentiment analysis garners universal importance and continued development, numerous studies and projects have materialized. While Dupinder Kaur was trying to explain the sentiment analysis of tweets about Apple with machine learning via the Naive Bayes classifier, he found that positive sentiment predominates among tweets (<https://www.researchgate.net/publication/353072253_Sentimental_Analysis_on_Apple_Tweets_with_Machine_Learning_Technique> accessed on 10 August 2023). Jasmina Smailović et al. explored the use of sentiment analysis on Twitter data to determine significant events and forecast stock price changes, demonstrating success in predicting Apple stock movements based on tweet volume and sentiment polarity (<https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=ba53a72840a5e9dd5787235007a873984d3a4f3d> accessed on 10 August 2023). Hassan Saif et al. paper discussed using sentiment analysis on Twitter to monitor public sentiments towards organizations including Apple, introducing a novel approach of incorporating semantic concepts as additional features for sentiment prediction, leading to improved accuracy in identifying both negative and positive sentiments compared to traditional methods (<https://link.springer.com/chapter/10.1007/978-3-642-35176-1_32> accessed on 10 August 2023). Rubi Gupta et al. explored using sentiment expressed on StockTwits, a microblogging platform, to enhance stock price prediction by analyzing tweet contents and studying the correlation between aggregated daily sentiment and daily stock price movement for companies including Apple (<https://ieeexplore.ieee.org/abstract/document/9175549> accessed on 10 August 2023). Elly Indrayuni et al. examined Apple product reviews to classify sentiments using the Support Vector Machine algorithm and genetic algorithms for optimization, resulting in accuracy improvements from 70.00% to 85.76% and AUC enhancements from 0.924 to 0.945 compared to the SVM model without optimization. As can be seen, although there are studies focusing on different areas related to sentiment analysis specific to Apple, there has been no direct study comparing sentiment analysis in e-commerce and social media platforms. Thus, with this project, it was aimed to do what has not been done before. However, despite these endeavors, a direct study comparing sentiment analysis outcomes within e-commerce and social media platforms has remained elusive. This project seeks to bridge this gap and undertake a novel endeavor, aiming to fill a distinct niche that has thus far remained unexplored. Through meticulous data collection, rigorous preprocessing, and advanced sentiment analysis techniques, the project intends to carve a path of exploration that contributes not only to academic discourse but also to the strategic endeavors of companies operating within dynamic digital ecosystems.

# objectıves

The primary goal of this MSc project is to conduct a comprehensive comparative sentiment analysis of discussions related to Apple products on both social media and e-commerce platforms. The intention is to bridge the existing gap in knowledge by investigating the subtleties of sentiment expressions within these distinct digital landscapes. This research endeavours will employ advanced data science techniques to extract meaningful insights from unstructured textual data, making contributions to both the academic field of sentiment analysis and the practical world of business decision-making.

To begin, the project aims to assemble and curate a substantial dataset sourced from diverse platforms, encompassing social media outlets such as YouTube and Reddit, as well as e-commerce giants Amazon and eBay. This data will undergo meticulous preprocessing procedures to ensure its cleanliness and suitability for subsequent sentiment analysis.

The project will delve into the realm of sentiment analysis methodologies, investigating state-of-the-art techniques tailored to the specific characteristics of textual data extracted from social media and e-commerce platforms. The objective here is to adapt existing models or devise novel ones capable of accurately capturing the intricate nuances of sentiment expression.

An integral facet of the project is the in-depth comparative analysis of sentiment expressions between the distinct worlds of social media and e-commerce. The research will highlight notable similarities and discrepancies in sentiment trends, considering factors such as platform dynamics, user demographics, and the nature of the products under scrutiny.

Through the application of data aggregation techniques, the project aims to uncover recurrent sentiment patterns that emerge over time within these digital realms. By identifying prevalent themes, significant keywords, and recurring topics, the project intends to elucidate the drivers behind positive and negative sentiments for Apple products across both social media and e-commerce platforms.

The project's broader scope extends to the strategic implications these sentiment analysis outcomes hold for business decision-making. This involves interpreting the tangible impact on crucial aspects like product innovation, marketing strategies, and the enhancement of overall customer satisfaction. The project's aspiration is to offer actionable insights capable of steering companies like Apple toward refined strategies rooted in an astute understanding of customer sentiments.

While the primary focus remains on the practical applications of sentiment analysis, the project concurrently strives to enhance existing methodologies within the academic domain. By bolstering the discourse surrounding sentiment analysis and natural language processing, the project seeks to provide empirical evidence that illuminates sentiment variations across distinct digital platforms.

An essential component of the project is knowledge enrichment. The research endeavours to deepen understanding in the realm of advanced data science techniques and sentiment analysis, especially when applied in the real-world context of dynamic digital ecosystems. This aspect of the project is geared toward equipping the researcher with insights into the challenges and opportunities embedded in sentiment analysis across various online platforms.

Dissemination of the project's findings stands as another significant objective. The research aims to present its outcomes with Apple and the University of Westminster through academic papers, presentations, thus contributing to the broader research community's comprehension of challenges and solutions within the field of sentiment analysis.

Lastly, the project underscores its practical applicability and relevance within the industry. By showcasing how sentiment analysis can be harnessed to refine business strategies, particularly within the technology sector epitomized by Apple, the research endeavors to highlight the capacity of sentiment insights to guide companies through the dynamic evolution of the digital landscape.

The proposed objectives encompass a well-balanced synthesis of theoretical exploration, technical execution, and pragmatic implications. Through the systematic pursuit of these objectives, the project aims to fill a critical void in existing literature and present fresh insights that can enrich both academic discourse and industry practices. The temporal framework of the project has been meticulously designed to ensure the successful attainment of these objectives, all within the constraints of the designated MSc project duration.

# Preparation

Power BI was utilized for exploratory data analysis and visualization as it provided an excellent user experience, including data preparation operations with Power Query support in its background. Furthermore, its choice was strengthened by being able to collect all graphics onto one page with filtering operations performed using a slicer.

As this dataset comprises various tables, each visualization requires creating its own distinct query. Due to multiple rows and columns being present on one sheet, operations such as row/column deletion must also take place for these to be included as individual queries. As relevant units vary across tables (million, billion, and percent), they need to be standardized using Power BI's Custom Formula feature. Some tables also use the Transpose functionality to reduce column count while collecting years in one column. As the rate of change over the years is an essential element in answering research queries, Index and Custom Formula functionality must be utilized when formulating these figures. With all preparation processes completed, the dataset was ready for exploratory data analysis. As 2017-2022 is of interest in this research question, data that occurred after 2023 (projection data) were removed prior to analysis.

# Data Analysis (NARRATIVE)

Examining the Covid-19 impact on the Video Streaming Market requires a historical overview. Advancements in technology and the proliferation of devices like TVs, game consoles, computers, tablets, and smartphones have fostered a rising trend in platform usage. Amid this backdrop, assessing the pandemic's influence, particularly in 2020-2021, becomes crucial. Parsing the dataset provides these insights.

Undoubtedly, revenue serves as a pivotal gauge of corporate performance and investment efficacy. A holistic grasp of the macroeconomic scenario demands an initial exploration of total market revenue. The Video Streaming sector witnessed remarkable expansion, soaring from $28 billion in 2017 to $81 billion in 2022, nearly tripling its initial value (Figure 2). However, the fluctuating annual growth rates within this upward trajectory present limitations in fully capturing the pandemic's effects.

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**Figure 2** *This is a screenshot of the Total Market Revenue line graph from Power BI.*

The Market Revenue Growth graph analysis reveals a significant surge in the past five years, with 2020 standing out, boasting a remarkable 34.56% increase (Figure 3). This surge, compared to 2019's 27.43%, highlights the pandemic's positive impact on the industry. However, the expected growth wasn't achieved in 2021. Despite a continuing upward trend, the growth rate settled at 24.36%, lower than in 2019. This could be due to the unexpected market acceleration in the previous year. 2020, marked by the pandemic, proved advantageous for Video Streaming platforms in terms of market revenue performance.

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**Figure 3** *This is a screenshot of the Total Market Revenue Growth bar graph from Power BI.*

Regarding revenue, an alternative perspective involves assessing average revenue per user—a pivotal metric offering insights into industry progress. Amid a changing landscape of expanding revenue and user counts, boosting user-based revenue becomes a key goal. Over the past five years, the average revenue per user consistently grew (Figure 4). Starting at $45.14 in 2017, it reached $60.25 during the pandemic and surged to $69.95 in 2022. This upward trend suggests resilience against pandemic effects; yet, a closer look at the growth rate is vital.

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**Figure 4** *This is a screenshot of the Average Revenue per User line graph from Power BI.*

The Average Revenue per User metric displays consistent change rates over the years (Figure 5). Notably, a conspicuously linear trend is evident in the chart. Despite change rates hovering around 10%, no significant increase is observable during the pandemic period. The most substantial growth rate in the past five years occurred from 2018 to 2019, with a notable 10.46% advancement. However, the pandemic led to a decline in the growth rate, reaching 6.89% in 2022. This outcome may stem from strategic user expansion initiatives, but a comprehensive user count analysis is essential to validate this notion.

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**Figure 5** *This is a screenshot of the Growth of the Average Revenue per User bar graph from Power BI.*

User count provides another vital indicator of industry vitality alongside revenue, by showing audiences, product integration into daily lives, customer connections, and expansion potential. Each new user acts as a potential catalyst for amplifying revenue while expanding a cycle of growth; the Video Streaming sector particularly saw remarkable expansion from 0.61 billion users in 2017 to an outstanding 1.16 billion in 2022 (Figure 6), almost doubling its user base despite global challenges; change rate analysis can provide greater insights into its full effect; this sudden surge of 0.55 billion newcomers joining its market also highlights its lasting success and development over time.

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**Figure 6** *This is a screenshot of the Total Users line graph from Power BI.*

User count fluctuations over the years highlight the pandemic's impact on the Video Streaming market. Annual variations in user count peaked at 22.65% in 2020, aligning with the pandemic's onset (Figure 7). Though not sustained in 2021, notable growth of 14.94% was achieved. Post-pandemic, user count growth receded to 3.02% in 2022. The Total Users Growth trend underscores external events like the pandemic shaping user expansion in the Video Streaming market.

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**Figure 7** *This is a screenshot of the Growth of Total Users bar graph from Power BI.*

The dynamics of the number of users, while indeed an illuminating metric for the Video Streaming market, also serve as a crucial determinant of how effectively companies within the sector can attain their objectives. A vital aspect in this context is the penetration rate, which offers valuable insights into the extent to which the targeted customer audience is reached (<https://www.sortlist.com/blog/penetration-rate/?repeat=w3tc#:~:text=your%20penetration%20rate%3A-,Penetration%20rate%20%3D%20(Number%20of%20consumers%20or%20users%20or%20customers%20%2F,by%20that%20product%20or%20service> accessed on 5 August 2023). This metric assumes paramount significance in a market characterized by high user volumes and the potential for direct user engagement. The penetration rate exhibited a noteworthy growth of 8.47% in 2017, surging to 15.24% in 2022 (Figure 8). Remarkably, the onset of the pandemic in 2020 witnessed the most substantial leap within the last five years, ascending from 10.80% to 13.11%. This progress represents the most significant improvement observed in the preceding quinquennium, amounting to an impressive 21.41% (Figure 9). Thus, the penetration rate metric reinforces the positive impact of the pandemic on the Video Streaming market.

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**Figure 8** *This is a screenshot of the Penetration Rate line graph from Power BI.*

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**Figure 9** *This is a screenshot of the Penetration Rate Growth bar graph from Power BI.*

The assessment of the pandemic's influence on the market is typically accomplished through a holistic examination of all services in unison. However, scrutinizing individual services that constitute the market's dynamics presents an opportunity to explore their effects on a micro-scale. An appraisal of the subscriber counts at the end of 2022 reveals that Netflix, boasting 221 million subscribers, held the position of the Video Streaming service with the highest subscriber count, followed closely by Amazon Prime Video with 208 million subscribers (Figure 10). While there exists a considerable disparity between these two services and the others, Disney+ secures a respectable third place. Notably, the majority of services experienced an augmentation in their subscriber base during the pandemic's impact, except iQIYI, which encountered a decline of approximately 5 million subscribers (Figure 11). But the pandemic has proved useful for offsetting any shortfall, particularly Netflix and Amazon Prime Video. Disney+ (<https://thewaltdisneycompany.com/disney-launches-today-and-a-new-era-of-disney-entertainment-begins/> accessed by 20 July 2023), launched late 2019, has also seen increased subscriber counts since its respective launches due to this impactful pandemic era. Collectively, the pandemic has manifested a predominantly positive impact on nearly all Video Streaming services in terms of subscriber count.

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**Figure 10** *This is a screenshot of Subscriber by Service treemap from Power BI.*

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**Figure 11** *This is a screenshot of the Subscribers Trend by Service line graph from Power BI.*

Examining subscriber counts in services yields valuable insights, yet their destiny is intertwined with the economic status of their parent companies, reflected primarily in revenue figures. While subscribers and revenue correlate, differences in fees, promotions, and offerings create revenue disparities. It's crucial to recognize that companies are multifaceted, so revenue differences may not solely stem from Video Streaming performance.

In assessing 2021's revenue rankings, Netflix leads in subscribers but ranks 7th in revenue (Figure 12). Amazon, Apple, and Alphabet, associated with YouTube Premium, top revenue generation. Despite Netflix and Amazon's top subscriber ranks, Netflix's revenue is just 6.3% of Amazon's. This gap arises from Amazon, Apple, and Alphabet's diversified interests, where Video Streaming is one part. In contrast, Video Streaming is Netflix's core and primary income source. Thus, revenue assessment may not fully capture the pandemic's impact, as it overlooks Video Streaming's exclusive importance.

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**Figure 12** *This is a screenshot of the Worldwide Top Company Revenues funnel graph from Power BI.*

Globally synthesized insights offer valuable macroeconomic information. However, to grasp pandemic impact fully, individual country analysis is vital due to unique national nuances. In revenue analysis, the USA leads Video Streaming revenue, followed by China and the UK. Such disparity makes other countries appear red in conditional formatting, indicating significant revenue gaps (Figure 13).

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**Figure 13** *This is a screenshot of the Global Revenue Comparison by Country filled map from Power BI.*

Upon conducting separate country-level analyses, it becomes apparent that revenue witnessed an increase in all the countries scrutinized by Statista during both 2020 and 2021 when compared to the preceding year. Nevertheless, a nuanced examination of the revenue growth rates over these years reveals that not all countries experienced an escalated pace of development. Specifically, when scrutinizing the revenue growth rates obtained from the Video Streaming market for the year 2020, juxtaposed against the figures from the preceding year 2019, it is revealed that 88 out of 149 countries observed an increase in growth rate. Conversely, 61 countries exhibited a continued growth trajectory, albeit at a diminished pace (Figure 14). As a result, it becomes evident that the pandemic directly impacted revenue growth positively in 59.06% of the countries during 2020. However, this phenomenon did not persist into 2021, as no country exhibited an acceleration in the rate of increase beyond that observed in 2020.

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**Figure 14** *This is a screenshot of the Growth Change of Countries by Revenue in the 2020 pie chart from Power BI.*

The significance of revenue as the primary metric for Video Streaming services necessitates a more granular country-wise analysis to discern the most successful nations, accounting for their relative contributions proportionate to their population sizes. A judicious approach involves conducting a penetration rate analysis, which aptly accommodates population-based normalization. In this context, the United States emerges as the vanguard, mirroring its top ranking in terms of revenue generation (Figure 15). Following suit, Canada and Norway secure second and third positions, respectively, in the User Penetration Rate metric. Remarkably, the United Kingdom, positioned third in the Revenue ranking, assumes a seemingly modest sixth rank in User Penetration Rate. In a contrasting trajectory, China, claiming the second rank in the Revenue ranking, regresses to the 18th position when gauged based on penetration rate. These findings underscore the intrinsic link between revenue performance and population dynamics, delineating a more comprehensive and insightful appraisal of the Video Streaming market's success across different countries.

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**Figure 15** *This is a screenshot of the Global User Penetration Rate by Country bar chart from Power BI.*

The optimal approach to discern the pandemic's impact on User Penetration rates in a country-specific context entails meticulous scrutiny of growth rates. Specifically, an examination of growth rate differentials in 2020 vis-à-vis the preceding year unveils that 126 countries witnessed an accelerated growth pace during this period (Figure 16). In contrast, the remaining 23 countries experienced a curtailed growth rate as a consequence of the pandemic's influence. Stated differently, the pandemic had a favorable impact on 84.56% of the countries, signifying a substantial proportion of the user penetration rate. These findings substantiate the pandemic's influential role in shaping user penetration dynamics across the majority of countries, thus warranting a nuanced understanding of the localized variations in User Penetration Rate during the pandemic era.

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**Figure 16** *This is a screenshot of the Growth Change of Countries by User Penetration Rate in the 2020 donut chart from Power BI.*

# VISUALISATIONS

Line graphs were chosen for Figures 2, 4, 6, 8, and 11 to illustrate the COVID-19 impact and analyze time series trends efficiently. Line graph's continuity suits trend analysis ([https://chartexpo.com/blog/best-charts-to-show-trends-over-time#](https://chartexpo.com/blog/best-charts-to-show-trends-over-time) accessed on 6 August 2023). However, Figures 3, 5, 7, 9, and 15 preferred bar graphs for clearer data comparison. Bars enhance data distinction (<https://chartio.com/learn/charts/bar-chart-complete-guide/> accessed on 6 August 2023). A treemap in Figure 10 and a funnel graph in Figure 12 were selected to display hierarchical data and sequential processes. Treemaps show nested proportions, while funnels illustrate stages (<https://clauswilke.com/dataviz/nested-proportions.html> accessed on 6 August 2023). Figures 14 and 16 utilized pie and donut charts for clear ratio and net data depiction. Circular charts aid in visualizing proportions (<https://towardsdatascience.com/9-visualizations-to-show-proportions-or-percentages-instead-of-a-pie-chart-4e8d81617451> accessed on 6 August 2023).

The charts were carefully designed to make the data easy to understand. Bar graphs were used to compare data quickly, thanks to their bar length, while line graphs show trends over time using their position on a grid. This helps readers grasp the information at a glance. In visual encoding, attention was paid to ensure that the data could be detected as soon as possible while visualizing it.

The graphics prioritize user accessibility by prominently featuring blue tones, addressing color blindness concerns and promoting inclusivity (<https://www.levelaccess.com/blog/color-blindness-accessibility-what-designers-need-to-know/> accessed on 6 August 2023). Careful color selection ensures clarity, with a strategic avoidance of conflicting green and red hues, and a thoughtful use of dark red in the map illustration enhances readability and differentiation for all viewers.

Every aspect of each chart is meticulously assessed, taking into account the insignificance of excessive embellishments and the data-ink ratio's importance in conveying substantial information with minimal visual elements. This process involves deliberate actions, including the elimination of redundant axes and extraneous elements like backgrounds or 3D effects. By adhering to these steps, the charts are optimized to deliver clear and efficient data representation, enhancing both comprehension and visual appeal.

Choosing the right font for a chart holds significance as various fonts influence the speed of information comprehension differently (<https://medium.com/the-readability-group/a-guide-to-understanding-what-makes-a-typeface-accessible-and-how-to-make-informed-decisions-9e5c0b9040a0> accessed on 6 August 2023). Therefore, the DIN font, characterized by its sans serif style, is selected for its appealing aesthetics and readability advantages.

# Conclusion

This comprehensive research effort, driven by exploratory data analysis and visualizations made possible through Power BI, offers an in-depth examination of the significant and mostly positive influence that the COVID-19 pandemic has had on the global video streaming market. The study's findings demonstrate a remarkable surge in key metrics such as revenue, user counts, and penetration rates that are evidence of the industry's strength to adapt amid unprecedented global disruptions. Consumer behaviour trends towards digital entertainment platforms have further highlighted the centrality of streaming services to modern lifestyles, prompting industry players to adjust strategies, and embrace technological advancements to effectively meet evolving consumer demands. Tracing individual company performances within the market reveals a wealth of insight into the intricate interaction among subscriber counts, revenue figures, business portfolios, and overall revenue dynamics that impact each business individually. Furthermore, the careful examination of country-specific impacts highlights how pandemic outcomes vary widely between nations, highlighting the need for localized strategies that consider socioeconomic, cultural, and technological disparities when devising treatment plans. Collectively, these insights offer invaluable guidance to industry stakeholders, equipping them to make informed decisions, develop innovative approaches, and position themselves for sustained growth and competitiveness in an ever-evolving digital entertainment landscape.

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