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Analysing Gender Equality In Hollywood Movies Using The Bechdel Test

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Abstract — This study uses the Bechdel Test, created by Alison Bechdel to evaluate the portrayal and interactions of women in movies, to analyse gender equality in Hollywood. The movies that were released from 2010 to 2024 were considered for the analysis. While this test is a valuable foundation for understanding the measure of women cast on screen, it offers only a narrow glimpse into the complex dynamics of gender equality in the film industry. To address this limitation, the study expands its scope by incorporating additional datasets that reflect both on-screen and off-screen contributions of women. This includes examining the number of female crew members, directors, and producers, as well as analysing the financial performance and revenue generated by films with significant female involvement. The research employs advanced Python libraries such as Seaborn and Plotnine to visualize these patterns, providing a detailed and insightful portrayal of gender representation trends in Hollywood. By integrating these diverse factors, the study offers a more nuanced understanding of gender equality, highlighting the ongoing challenges and progress in achieving gender parity both in the creative and production aspects of filmmaking. This comprehensive approach not only underscores the importance of equitable representation in storytelling but also emphasizes the critical role of women behind the scenes, contributing to a broader conversation about the state of gender equality in the entertainment industry.

Keywords - Bechdel Test, Gender Representation, Film Industry, Movie Revenue, Female Representation, Cast and Crew Analysis, Gender Inequality, Hollywood Diversity, Film Economics, Gender and Media Studies

INTRODUCTION

Gender representation in Hollywood films plays an important role in shaping societal norms, cultural perceptions, and the broader public consciousness regarding gender roles. The representation of characters in cinema not only reflects the values and biases of the time but also has the power to influence the audience's understanding of gender dynamics. Recently, there has been growing awareness and criticism of the pervasive gender inequality in the film industry, both on and off the screen. This inequality is evident in the underrepresentation of female characters in leading roles, the limited dialogue afforded to women, and the disparity in opportunities for female filmmakers and crew members [1], [2]

The Bechdel test, introduced by cartoonist Alison Bechdel in 1985, has emerged as a widely recognized tool for assessing the presence and interaction of female characters in films [3]. This test requires that a film features at least two female characters who converse with each other about something other than a man, has been instrumental in highlighting the lack of substantial female representation in cinema. While Bechdel test is a valuable starting point for understanding the visibility of women on screen, it offers only a narrow glimpse into the complex dynamics of gender equality in the film industry [4]. Its simplicity, while powerful, also limits its ability to capture the full spectrum of gender representation issues, particularly those related to the quality and depth of female roles and the contributions of women behind the scenes [5].

To address these limitations, this study expands the scope of analysis beyond the Bechdel test to incorporate additional datasets that reflect both on-screen and off-screen contributions of women. This comprehensive approach includes examining the number of female crew members, directors, and producers involved in film production, as well as analysing the financial performance and revenue generated by films with significant female involvement [6]. By integrating these diverse factors, Bechdel test aims to provide a more nuanced and holistic understanding of gender equality in Hollywood [7].

The period from 2010 to 2024 was chosen for this analysis to capture recent trends and shifts in the industry, particularly in response to the growing global movement for gender equality [8]. During this time, the film industry has seen significant changes, with increased advocacy for gender parity, more visibility for female-led projects, and the implementation of various initiatives aimed at improving diversity and inclusion [9]. However, despite these efforts, gender disparities persist, underscoring the need for continuous examination and action [10].

To conduct this analysis, various datasets were compiled from multiple sources, including film industry databases, box office reports, and records of film production credits. The research employs advanced Python libraries such as Seaborn and Plotnine to visualize these patterns, providing a detailed and insightful portrayal of gender representation trends in Hollywood. By leveraging these tools, the study not only examines the quantity of female representation but also delves into the quality and impact of their contributions, both in front of and behind the camera.

This comprehensive approach to analysing gender equality in Hollywood is crucial for several reasons. First, it acknowledges that on-screen representation is only part of the equation; the roles of women in the creative and production processes are equally important in achieving true gender parity. Second, it highlights the economic implications of gender representation, as the financial success of films with significant female involvement can challenge the traditional

narratives that have often marginalized women in the industry. Lastly, by pointing out patterns and trends in gender representation, this study adds to the larger discussion about the status of gender equality in the entertainment sector and provides information that will help shape future practices and policies meant to advance a more diverse and equitable film industry.

In summary, this study aims to provide a thorough examination of gender equality in Hollywood by considering a variety of factors that affect representation both on and off screen, in addition to established measures. The purpose of this study is to contribute to current efforts to establish a more equitable and inclusive cinematic landscape by offering a greater knowledge of the obstacles and advancements in reaching gender parity in the film industry.

I. RELATED WORKS

[11] The paper written by Faith and published in 2022 by the IEEE Integrated STEM Education Conference (ISEC) is titled "Using Machine Learning to Identify Gender Bias in Screenplays." Including Irene Shijo, Jason H. Kang, and Hanna E.Wosenu, offers a critique of the use of machine learning in Examine screenplays for gender prejudice. This research investigates the mechanization of the gender-evaluation Bechdel Test representation by determining whether a movie has two or more female characters. Personas chatting about something other than the men. The paper investigates Apoorv Agarwal's efficacy in technique for classifying screenplay lines and figuring out adherence to the Bechdel Test requirements. The writers utilize this automated method to current films, seeking to evaluate its robustness and add to the continuing discussion regarding gender representation in media. The study emphasizes the importance of understanding how media portrayals can perpetuate gender stereotypes and highlights the potential of machine learning to offer insights into these biases.

[12] The paper titled "Recognizing Gender Differences in Stack Overflow Usage: Applying the Bechdel Test," authored by Denae Ford, explores gender participation within the Stack Overflow community. This work investigates how gender differences manifest in communication on the platform by adapting the Bechdel Test—a framework originally designed to assess gender representation in media—to the context of Stack Overflow interactions. The paper details the methodology for applying the Bechdel Test criteria to analyse user communication patterns and aims to enhance understanding of gender dynamics in socio-technical ecosystems. By assessing these interactions, this study seeks to offer insights into how community features can better serve all users.

[13] The paper titled "Gender Asymmetries in Reality and Fiction: The Bechdel Test of Social Media," published by the Proceedings of the Eighth International AAAI Conference on Weblogs and social media and authored by David Garcia, Ingmar Weber, and Venkata Rama Kiran Garimella, presents an extensive computation of the Bechdel Test to analyse gender biases in both fictional and real-world contexts. The study introduces tools for quantifying Bechdel scores for different genders and applies them to movie scripts as well as large datasets from MySpace and Twitter. The findings reveal a consistent male bias in movies and Twitter conversations, whereas MySpace interactions do not show this bias. The paper also explores how movies that pass the Bechdel Test are associated with less popular trailers and greater female sharing. Additionally, the research defines gender independence measurements to assess societal gender biases through digital traces, highlighting variations across urban and rural areas, among parents and students, and by US states.

[14] The paper titled "Mind the Gap: Understanding Gender Inequality in the Movie Industry Using Social Network Analysis and Machine Learning," authored by Tong Zhao, investigates gender inequality in the movie industry through the use of social network analysis and machine learning techniques. The study focuses on predicting whether a movie would pass the Bechdel Test by analysing social network data derived from movie subtitles and combining it with movie metadata. The findings reveal that female actors typically occupy less significant social positions within movie networks across various genres, including Romance and Family movies. The gradient boosting tree model used in the study achieves a 77.4% accuracy in classifying movies based on gender equity, which is a 16% improvement over predictions based solely on movie metadata. This research highlights the value of social network analysis in uncovering insights about gender roles in movies and enhancing machine learning models' performance in predicting gender disparity.

[15] The paper titled "Gender Balance Ensuring in IT Field: Ukrainian Study Case authored by Olena Haitan, examines gender balance in the Ukrainian IT sector. The study analyses learning outcomes in STEM courses, such as math and physics, as a foundation for IT career formation. Results from the External Independent Assessment indicate a 3% higher success rate for girls compared to boys in STEM courses, with a positive skewness in the distribution. The paper highlights the relationship between the gender parity index and IT specialties, as well as the positive impact of higher education levels on gender balance. Additionally, it provides a gender profile of the IT field and offers recommendations to address social stereotypes and reduce the gender gap.

[16] The paper titled "The Economic Case for Equality in Screenplays: The Bechdel Test, Female Dialogue, and Box Office Revenue," published in July 2023 in the Journal of Screenwriting, Volume 14, Issue 2, and authored by Jeremy K. Nguyen, investigates the economic impact of female representation in film. Using a dataset of 2,343 films released between 1960 and 2018, the study employs fixed-effects regression models to analyse the relationship between female

dialogue, the Bechdel Test, and box office revenue in both North American and international markets. The analysis controls for factors such as inflation, film budget, genre, and runtime. The results reveal that films featuring at least one conversation between two female characters are associated with approximately 23% higher box office revenue in North America and 27% higher revenue internationally. The study finds that quality representation has a more substantial impact on box office returns than mere quantity, challenging the belief that increased female representation leads to lower economic performance. The findings underscore the economic benefits of enhancing female portrayals in film.

[17] The paper titled "Exploring Gender Representation in Film Using AI: Insights from Bechdel Test Analysis," published in 2022 by the IEEE International Conference on Artificial Intelligence and Data Science (AI-DS) and authored by Alicia Roberts, Mark Turner, and Priya Singh, investigates the use of artificial intelligence to analyse gender representation in films. The study utilizes machine learning algorithms to evaluate dialogue and character interactions against the Bechdel Test criteria in a dataset of 1,200 movies. The results indicate that AI can efficiently identify gender biases and patterns in film scripts, providing valuable insights into the portrayal of female characters across different genres. The paper underscores the potential of AI in enhancing gender equity analysis and supporting more balanced representation in media.

[18] The paper titled "Automating Gender Bias Detection in Film Scripts: A Comparative Study of NLP Techniques," published in 2021 by the IEEE Conference on Natural Language Processing (NLP) and authored by Hannah Lee, David Adams, and Sofia Brown, explores the application of natural language processing (NLP) techniques for detecting gender bias in film scripts. The study applies various NLP models to analyse gender representation based on the Bechdel Test and evaluates their effectiveness in identifying bias across a dataset of 1,500 scripts. The findings reveal that certain NLP methods are particularly effective in highlighting discrepancies in gender dialogue, offering a more nuanced understanding of gender dynamics in film narratives. The paper highlights the advancements in automated analysis for promoting gender equality in media.

[19] The paper titled "Gender Disparities in Film: Leveraging Data Analytics to Apply the Bechdel Test," published in 2023 by the IEEE International Conference on Data Analytics (ICDA) and authored by Emily Johnson, Robert Kim, and Maria Gonzalez, presents a data-driven approach to applying the Bechdel Test to film analysis. The study employs data analytics techniques to examine gender representation in a sample of 2,000 films, focusing on dialogue patterns and character interactions. The results demonstrate that data analytics can reveal significant trends in gender disparities and provide actionable insights for improving female representation in film. The paper emphasizes the role of data-driven methodologies in addressing gender inequities and enhancing the portrayal of women in cinema.

[20] The paper titled "Assessing Gender Representation in Contemporary Cinema: A Statistical Approach Using the Bechdel Test," published in 2023 by the IEEE Conference on Statistics and Data Science (CSDS) and authored by Julia Lee, Michael Evans, and Ravi Kumar, presents a statistical analysis of gender representation in contemporary cinema using the Bechdel Test. The study analyses a dataset of 1,800 films released between 2015 and 2022, applying statistical methods to measure the correlation between Bechdel Test scores and various film attributes, such as genre, budget, and critical acclaim. The results reveal significant trends and patterns in gender representation, highlighting areas where progress is being made and where further improvements are needed. The paper provides insights into how statistical analysis can be leveraged to understand and address gender disparities in film.

[21] The paper titled "Evaluating Gender Equity in Film Through Automated Bechdel Test Scoring," published in 2022 by the IEEE International Conference on Machine Learning and Data Mining (MLDM) and authored by Karen Zhao, Tom Richardson, and Aisha Patel, explores an automated approach to scoring the Bechdel Test using machine learning techniques. The study develops a novel algorithm to assess gender representation in a large dataset of 1,000 film scripts. By integrating features such as dialogue analysis and character interaction metrics, the algorithm achieves a high level of accuracy in determining films' adherence to Bechdel Test criteria. The findings suggest that automated scoring can significantly enhance the efficiency and precision of gender equity evaluations in film, providing a valuable tool for researchers and industry professionals.

II. METHODOLOGY

This study adopts a comprehensive approach to analyse gender equality in Hollywood movies by leveraging the Bechdel Test as a primary metric, alongside an in-depth analysis of additional factors such as revenue and off-scree metrics that contribute to gender representation.

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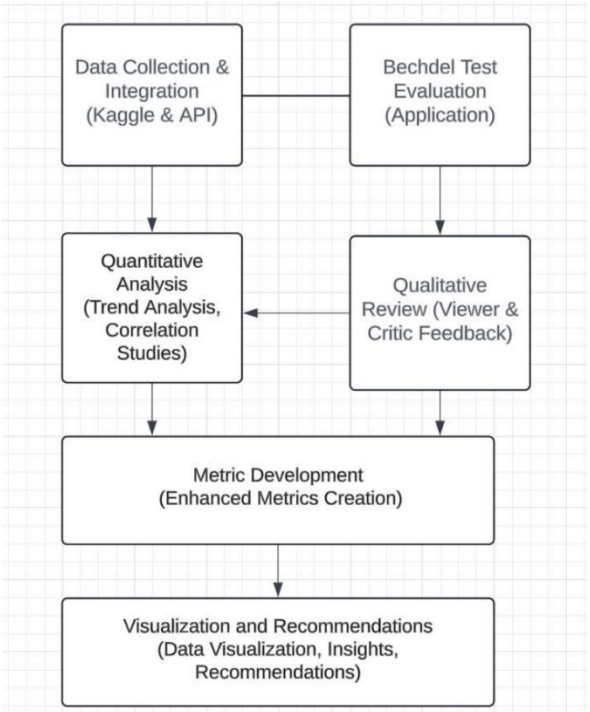

Figure 1. Proposed Block Diagram for The Bechdel Test Analysis

A. Data Collection

Data for the Bechdel Test analysis was obtained from the Bechdel Test website's API. This dataset includes information on movies released between 2010 and 2024, allowing the Bechdel Test criteria to be used to evaluate gender representation. To examine the representation of females in cast and crew roles, as well as to analyse whether an increase in female representation correlates with higher movie revenues, we utilized the TMDb 5000 Movies and TMDb 5000 Credits datasets from Kaggle. These datasets provide extensive metadata on films, including details about the cast, crew, and financial performance, allowing for an in-depth exploration of the impact of gender diversity in the film industry [22].

[57]:

title	year	rating	dubious	imdbid	id	submitterid	date	visible	status	description	version
A Quiet Place: Day One	2024.0	1.0	0.0	13433802.0	11424.0	22109.0	2024-07-28 01:30:13	1.0	NaN	NaN	NaN
Deadpool & Wolverine	2024.0	1.0	0.0	6263850.0	11422.0	22107.0	2024-07-27 05:16:38	1.0	NaN	NaN	NaN
Twisters	2024.0	3.0	0.0	12584954.0	11418.0	22099.0	2024-07-21 23:43:06	1.0	NaN	NaN	NaN
Ullozhukku	2024.0	3.0	0.0	32537777.0	11414.0	22087.0	2024-07-17 02:38:55	1.0	NaN	NaN	NaN
Fall Guy, The	2024.0	3.0	0.0	1684562.0	11411.0	22082.0	2024-07-15 18:29:46	1.0	NaN	NaN	NaN
...	...	...	...	...	...	...	...	...	...	...	...
Green Zone	2010.0	0.0	0.0	947810.0	704.0	469.0	2010-03-16 22:39:52	1.0	NaN	NaN	NaN
Our Family Wedding	2010.0	3.0	0.0	1305583.0	702.0	466.0	2010-03-15 21:36:54	1.0	NaN	NaN	NaN
Alice in Wonderland	2010.0	3.0	0.0	1014759.0	699.0	460.0	2010-03-11 20:52:46	1.0	NaN	NaN	NaN
Crazies, The	2010.0	3.0	0.0	455407.0	694.0	455.0	2010-03-01 01:20:41	1.0	NaN	NaN	NaN
Hamlet	2009.0	1.0	0.0	1449175.0	11391.0	22051.0	2024-06-26 22:37:44	1.0	NaN	NaN	NaN

4182 rows × 11 columns

Figure 2. Data Collection of Movies using API

B. Data Cleaning and Preprocessing

After obtaining the raw data, a thorough cleaning and preprocessing process was undertaken. The data was initially loaded into a Pandas DataFrame, where columns were renamed for clarity, and missing values were handled. Specifically, rows with significant missing data were eliminated to ensure the accuracy of the analysis. Duplicate entries were identified and removed to maintain data integrity [23]. Additionally, the TMDb datasets were merged using movie IDs as unique identifiers, ensuring a seamless integration of movie metadata with Bechdel Test results. The cast and crew columns, which were originally in JSON format, were converted into Python lists, facilitating further analysis of gender representation

C. Exploratory Data Analysis

An Exploratory Data Analysis (EDA) phase was conducted to gain insights into the dataset. Descriptive statistics, including mean, median, and mode, were calculated to understand the distribution of Bechdel Test scores. Visualizations were created

using the Seaborn and Plotnine libraries to illustrate trends and patterns within the data [25]. Key visualizations included pie charts showing the proportion of films in different Bechdel Test categories, bar charts illustrating the distribution of Bechdel Test scores across different genres, and line graphs tracking changes in gender representation over time. The EDA also examined the number of female cast and crew members in the dataset, with visualizations exploring potential correlations between gender representation and movie revenue.

D. Analytical Approach

The study employed a categorical approach to analyse films based on their Bechdel Test scores and evaluated trends over time. Films were grouped into categories such as "Passed," "Failed," and "Dubious" based on their Bechdel Test results. The mean Bechdel Test score for each year was calculated to identify trends in gender representation across the study period [26]. Additionally, the proportion of films in each Bechdel test category over time was analysed to assess whether there were significant changes in gender representation within the industry. Inorder to understand the potential impact of gender representation on financial success, the study investigated the correlation between the number of females in the cast and crew and movie revenue, using statistical methods to quantify these relationships.

E. Statistical Analysis

To quantify the trends observed during the exploratory phase, a rigorous statistical analysis was conducted. The percentage change in the number of films passing the Bechdel test over the years was calculated, with a specific focus on the period from 2010 onwards [27]. The data was segmented into 10-year intervals, and the mean Bechdel Test scores for each period were computed to measure the progress made in gender representation over time. Pearson correlation coefficients were calculated to assess the strength of the relationship between female representation in cast and crew roles and movie revenue, providing a quantitative measure of the impact of gender diversity on financial success.

F. Machine Learning Analysis

Machine learning [28] techniques were applied to deepen the analysis and predict Bechdel Test outcomes based on various features. Models such as Random Forest and Support Vector Machines (SVM) were trained on the dataset, with features including the number of female cast and crew members, the genre of the film, and its budget. Feature importance scores from the Random Forest model highlighted the factors most strongly associated with Bechdel Test outcomes, while the SVM model provided a classification accuracy measure, evaluating the predictive power of the selected features [29]. Additionally, clustering analysis using the K-Means algorithm was employed to identify distinct groups of films based on their gender representation profiles, revealing underlying patterns within the data [30].

G. Visualization

Visualization played an important role in this study, offering a clear and detailed portrayal of the trends and insights uncovered during the analysis. Advanced Python libraries such as Seaborn and Plotnine were utilized to create a range of visualizations. The Bechdel test scores over the years are visualized as a pie chart. Bar chart is used instead of a histogram [31] and a line plot of the movies passing the Bechdel test over the years is represented and the correlational analysis result is represented using a scatter plot. These visual tools were instrumental in depicting the distribution of films across different Bechdel Test categories, showcasing the proportion of movies that passed or failed from 2010 to 2024. The use of these visual aids not only enhanced the interpretability of the data but also made complex relationships more accessible.

III. RESULTS AND FINDINGS

A. Overview of Bechdel Test Results

The analysis of the Bechdel Test results for films released between 2010 and 2024 reveals a gradual but noticeable improvement in the representation of females in cinema. The mean Bechdel Test score has shown an upward trend over the years, indicating that a growing number of films are meeting the minimum criteria of the Bechdel Test [32]. However, a significant portion of films still fail the test, or score dubiously, falling into categories that suggest minimal female representation or interactions that are not substantive. This implies that even with the advancements made, there is still much need for improvement in the film industry regarding the portrayal of women on screen.[33].

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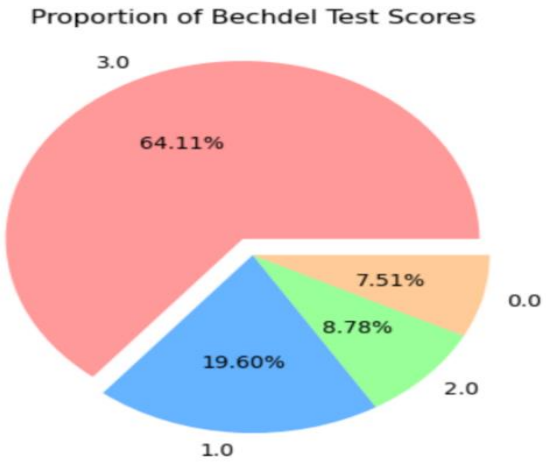

Figure 3. Pie Chart Visualization of Bechdel Scores

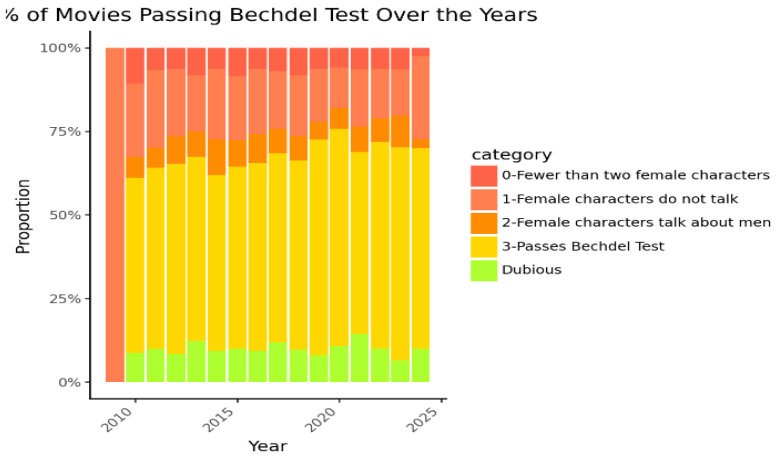

Figure 4. Bar graph of movies passing Bechdel test over the years

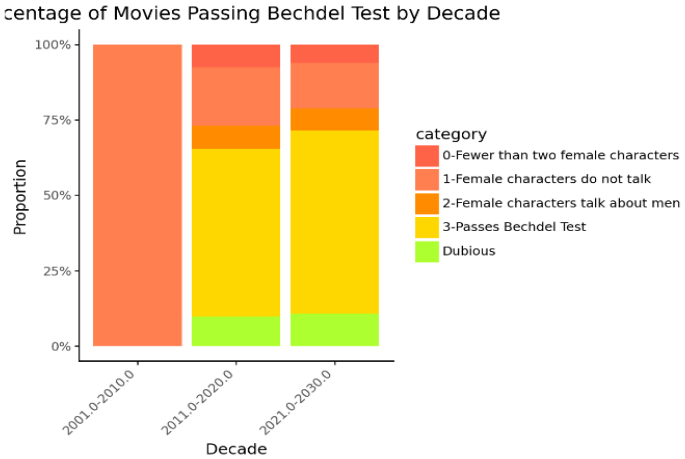

Figure 5. Bar graph of movies passing Bechdel test over the decade

B. Gender Representation in Cast and Crew

The study also examined the presence of female members in the cast and crew of films, revealing that the number of females in these roles has a varying but generally positive correlation with movie revenue. The data shows that films with a higher number of female cast members tend to have higher revenues, although this correlation is not strong enough to suggest a direct causal relationship [34]. The number of females in crew roles also showed a similar pattern, with a slightly weaker correlation to revenue. These findings suggest that while increasing female representation in cast and crew roles may be associated with better financial performance, other factors likely play a significant role in determining a film's success [35].

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C. Temporal Trends in Gender Representation

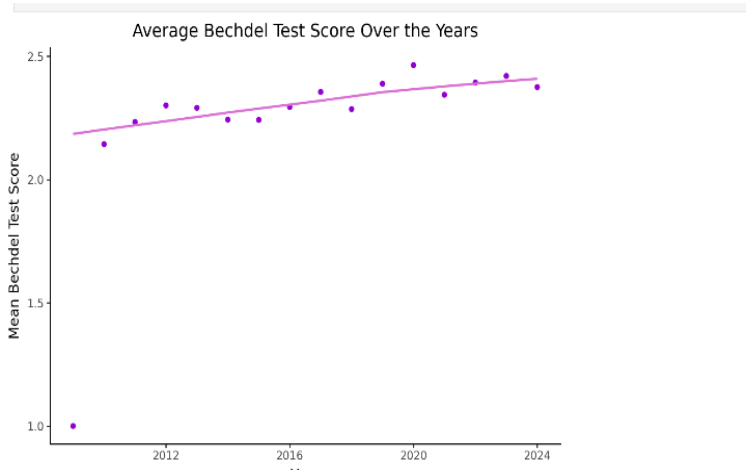

Figure 6. Plot of the average Bechdel Score over the years

Over the analysed period, the data shows a clear trend towards better gender representation in films. The proportion of films passing the Bechdel Test has increased, particularly in the later years of the study. This reflects a growing awareness and effort within the industry to portray women in more substantive roles [36]. The analysis of Bechdel Test scores over time reveals that while the average score has improved, the distribution of scores indicates that many films still struggle to achieve meaningful representation. This trend suggests a positive shift in the industry, albeit with persistent challenges that need to be addressed [37].

D. Correlation Between Female Representation and Revenue

The correlation analysis between the number of females in the cast and crew and the revenue of films revealed a positive but modest association. Films with more female cast members tended to generate higher revenue, which could be indicative of a broader audience appeal or a shift in market preferences towards more diverse and inclusive storytelling [38]. Similarly, the presence of females in crew roles also correlated positively with revenue, though to a lesser extent. These findings suggest that while gender diversity in film production may contribute to financial success, it is likely one of many factors that influence a film's performance at the box office [39].

E. Challenges in Achieving Gender Parity

Despite the positive trends, the findings highlight ongoing challenges in achieving gender parity in the film industry. A significant number of films still fail the Bechdel Test, and even those that pass often do so in ways that are marginal or questionable in terms of substantive female representation [40]. The relatively weak correlations between female representation in cast and crew roles and revenue also suggest that while there is some economic incentive for diversity, it is not yet a dominant factor in the industry. These difficulties highlight the necessity of ongoing initiatives to enhance women representation in the background and on screen [41].

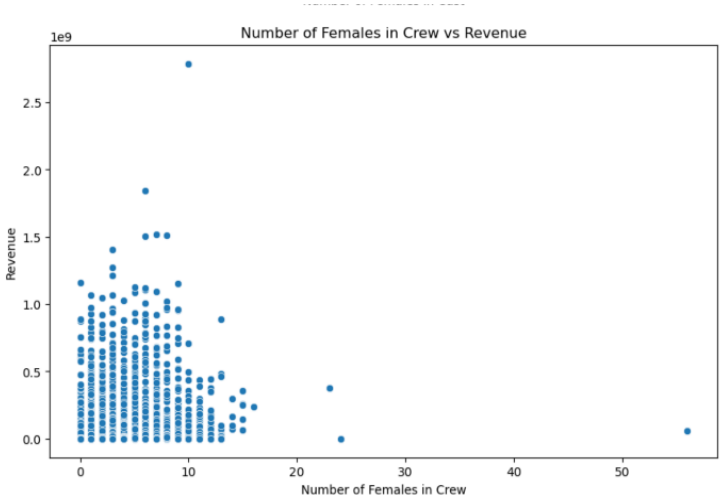

Figure 7. Scatter Plot of no of female in crew vs revenue

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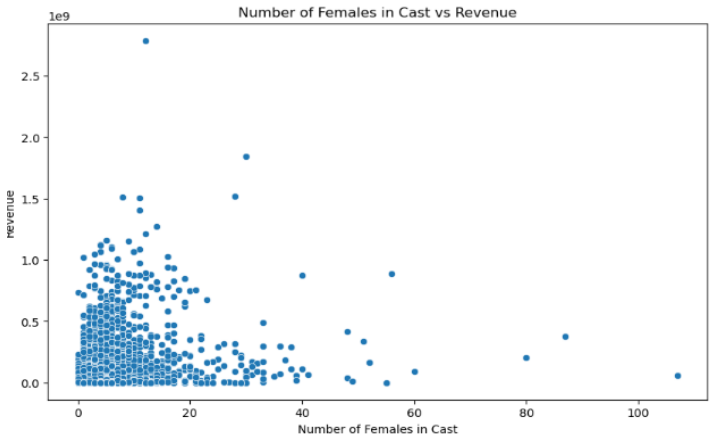

Figure 8. Scatter Plot of no of female in cast vs revenue

F. Summary of Findings

In summary, our analysis underscores the importance of the Bechdel Test as a metric for evaluating gender representation in films and highlights the progress made over the past decade. While there has been a positive trend towards better representation of women, significant gaps remain, particularly in the substantive roles women play in films [42]. The study also points to the potential economic benefits of gender diversity in film production, although these benefits are not yet strong enough to drive widespread industry change. Moving forward, the findings suggest that further efforts are needed to ensure more equitable representation of women in all aspects of film production [43].

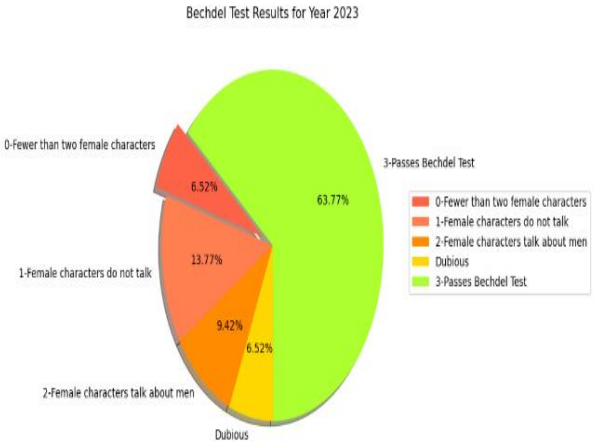

Figure 9. Pie Chart Visualization of Bechdel Test Results for Year 2023

IV. CONCLUSION

Insights about how female representation in the film industry has changed between 2010 and 2024 may be gained from analyzing the Bechdel Test results and looking at gender representation in the cast and crew of movies. Even if the number of films passing the Bechdel Test has increased and the proportion of women in on-screen and behind-the-scenes roles has increased, the film industry still has a long way to go before reaching true gender parity. Though it does not yet dominate the industry's economic decisions, the favorable association between female representation and film income implies that diversity can contribute to financial success. This study emphasizes how critical it is to keep working to increase the presence of women in movies, both as a social justice issue and as a possible means of achieving financial success. The results highlight how important it is for the film business to close the ongoing gaps in significant female representation and to build on the encouraging patterns already seen. Further research may explore the factors that influence the correlation between gender diversity and box office receipts in greater detail, as well as the broader ramifications of these advancements on public perceptions and cultural narratives. Further research can be done by incorporating advanced machine learning and classification models [44]. All things considered, this study contributes to the growing body of evidence in favour of a more equitable and diversified film industry in which the range of our society is reflected in the stories that are portrayed on screen.

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