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# Modelling the number of Animation-inspired clothing merchandise using a mixture of Poisson Distribution: An Interdisciplinary approach

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**ABSTRACT**
The increasing popularity of animation-inspired clothing through online apps has created a demand for understanding and analyzing the behavior in purchasing such products froma scientific point of view. This is an interdisciplinary workthat uses a mixture of Poisson distribution to modelthe number of purchasesthrough various online apps. This approach provides valuable insights into the nuanced patterns of consumer behavior in purchasing such products. The Poisson distribution enhances our understanding of purchasing decisions, contributing to more accurate predictions and targeted marketing strategies. The results guide clothing brands, app developers, and marketers, ultimately improving customer satisfaction and business performance. Also, the proposed mathematical theory may be extended to other relevant data sets.

**Keywords:** Animation-Inspired clothing, Interdisciplinary, Mixture Distribution, Poisson Distribution, Online Apps, Online Shopping,JEL: C60,C15, M31,M30,L81

## I. INTRODUCTION:

Clothing influenced by popular franchises like Marvel, DC, and Naruto has become quite popular in recent years. The rise of geek and pop culture has led to a surge in demand for clothing that showcases characters, logos, and references from these beloved franchises. Many clothing brands and retailers have capitalized on this trend by creating licensed merchandise featuring iconic superheroes, villains, and characters from Marvel and DC comics. You can find t-shirts, hoodies, jackets, and accessories adorned with images of characters like Spider-Man, Batman, Superman, Iron Man etc. Popular Japanese manga and anime series, have also inspired a range of clothing and merchandise. Fans can find t-shirts, hoodies, cosplay costumes, and accessories featuring characters like Goku, Vegeta, Naruto, Uzumaki, Sasuke Uchiha, and Sakura Haruno and many others.

The appeal of these clothing items lies in the opportunity for fans to express their love and connection to their favorite franchises. Wearing such clothing allows people to display their enthusiasm for superheroes or anime characters, and it has become a part of pop culture fashion. Additionally, the success of Marvel and DC movies, as well as the continued popularity of anime and manga series like Naruto and Dragon Ball Z has contributed to the mainstream acceptance of these clothing trends. They have become a way for fans to showcase their interests and connect with others who share the same passions.

The advent of online shopping and the growing popularity of animation-inspired clothing products have transformed the way consumers engage with fashion and express their fandom. As a result, the demand for animation-themed clothing has skyrocketed. This has opened up opportunities for various online apps and platforms to offer such products. Apps like Amazon, Myntra, Meesho, Beyoung, Bewakoof, The Souled Store, and many others have recognized the demand for animation-themed apparel and have included them in their product offerings.

These online apps provide a convenient way for customers to browse and purchase animation-inspired clothing from the comfort of their homes. They often collaborate with famous animation studios, franchises, or artists to create officially licensed merchandise featuring beloved

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animated characters. In fact a lot of merchandise created by these apps, specially by "The Souled Store","Beyoung"and "Bewkoof" are not available offline. This makes online buyingthe only option for customersto buy products.

This research paper is an interdisciplinary work that uses both basic and advanced statistical techniques to analyze the observed data. Our main focus is on using a mixture of Poisson distribution to model the number of animation-inspired clothing products purchased through online apps. By adopting a statistical framework, we aim to unravel the intricate dynamics and individual preferences that shape consumer choices.

Through this research, we aim to contribute by providing a robust statistical framework for modeling and understanding the purchasing patterns of animation-themed clothing products through online apps. By shedding light on the factors that drive consumer behavior in this domain, we hope to empower industry practitioners and researchers alike to make informed decisions and further explore the potential of animation in the realm of fashion.

In the subsequent sections of this paper, we will delve into the methodology employed, including the formulation of the mixture of the Poisson distribution model and the data collection process. We will then present and analyze the results, discussing the implications and providing recommendations for various stakeholders in the animation-inspired clothing industry. Also, the utility of the proposed model is not only limited to the collected data butmay very well be used for other data sets exhibiting similar statistical properties.

The structure of our paper follows a hierarchical arrangement as outlined below. In Section 2, we present the Literature review, which delves into the background and motivation that prompted our research in this particular area. Section 3 is dedicated to the methodology, where we provide a comprehensive description of the data under study (Section 3.1), followed by an explanation of the Poisson distribution (Section 3.2) and the mixture distribution (Section 3.3). Moving on to Section 4, we conduct an in-depth analysis of the collected data. In Section 5, we present the results derived from our analysis, along with the corresponding conclusions and practical implications. In this section, we highlight the key findings of our study, emphasizing their significance and relevance concerning the research objectives. Additionally, we provide valuable insights and suggestions for future research directions or potential areas of improvement.

## II. LITERATURE REVIEW:

Online shopping is an e-commerce platform that allows you to browse and purchase products from the comfort of your own home, at any time of the day or night. You can avoid crowded stores, long lines, and the hassle of physically going from one store to another. With just a few clicks, you can find and buy what you need. Scholars investigating the realm of online shopping have identified a range of advantages and disadvantages associated with this mode of commerce. Nevertheless, their overall consensus leans towards the advantages outweighing the disadvantages. Online shopping boasts benefits such as competitive pricing, time efficiency, and convenience. Moreover, it helps curb impulsive purchases, mitigating some of the drawbacks like higher delivery expenses and limited negotiation opportunities. However, for Indian consumers to fully embrace this concept, online retailers must continually innovate, ensuring that the shopping experience becomes increasingly enjoyable.According to researchers, the current proportion of online buyers in India is still minimal as compared to traditional buyers. However, this percentage is anticipated to witness significant growth with the implementation of improved technology to facilitate online purchasing. To foster this growth, companies should establish robust and efficient feedback systems, allowing consumers to reach out anytime. It is imperative not only to establish cyber laws for customer protection but also to raise awareness among customers about their rights. Online companies should introduce more flexible payment methods to enhance convenience for shoppers.For some notable literature on online shopping, one may refer to Vyas andSriniwas (2002)[1], Menon and Kahn (2002)[2], Mummalaneni (2005)[3], Park et al. (2005)[4], Gupta et al. (2013)[5],

When it comes to buying clothes people prefer popular apps such as Amazon, Flipkart, Myntra, Meesho, The Souled Store, Bewkoof, Beyoung,and Redwolf. Thesebrands have expertise in analyzing customer behavior over e-commerce platforms and bringing out products according to the demands of their customers. The success of these platforms has inspired researchers and businessmen over the years to analyze their strategies in e-commerce world. Famous players like Amazon and Flipkart have a vast customer database and their feedback system is good enough to satisfy the needs of their customers. The apps get regularly upgraded to offer new policies, cash backs, discounts, and many offers to attract a wide range of customers. Research conducted in the

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Indian domain indicates that customers have increasingly become knowledgeable and adept in utilizing technology. As a result, they are gravitating towards platforms such as Amazon. These customers exhibit a preference for online shopping, recognizing the benefits it offers in terms of convenience, extensive product range, competitive pricing, and reliable delivery services. The growing popularity of Amazon in the Indian market can be attributed to its user-friendly interface, efficient customer service, and trustworthy reputation. The research underscores the changing consumer behavior in India, indicating a shift towards embracing digital platforms like Amazon for their shopping needs. Similar responses have been observed for various other apps in the Indian market. Research indicates that customers in India have embraced the convenience and advantages offered by a range of online shopping platforms apart from Amazon. These apps, such as Flipkart, Myntra, and others, have gained popularity among tech-savvy Indian consumers. Customers appreciate the wide selection of products, competitive pricing, ease of use, and reliable services these platforms provide. Researchers have witnessed a growing trend of Indian customers exploring and utilizing multiple online shopping apps to cater to their diverse needs and preferences. Some of the notable referencesinclude Arora(2017)[6], Chandra and Chen (2019)[7], Shenbhagavadivu (2019)[8], Warrier (2021)[9], Mishra etal. (2022)[10],

Over the years, animation has inspired fashion in society, people express their love by wearing the brands that represent their favorite characters. The popularity and appeal of wearing Captain America T-shirts have been witnessed in recent years. Research suggests that Captain America is a beloved superhero from the Marvel Comics universe and is a symbol of heroism, known for his bravery, leadership, and commitment to justice. Wearing a Captain America T-shirt allows fans to express their admiration for these heroic qualities and align themselves with the character's values.A similar attraction for Wonder Woman, a female superhero from DC Universe has been observed amongst teenage girls. By wearing Wonder Woman T-shirts, girls admire a powerful female character who stands for justice and equality. It serves as a symbol of empowerment and representation, inspiring girls to embrace their own strength and capabilities.Talking about Goku, the iconic protagonist of the Dragon Ball series, has inspired people in several ways. Goku's unwavering determination and never-give-up attitude have resonated with many individuals. His relentless pursuit of becoming more assertive and overcoming challenges has inspired people to adopt a similar mindset in their own lives. Goku's willingness to push past his limits and keep striving for improvement encourages others to persevere through difficulties and pursue their goals relentlessly.Wearing clothing merchandise inspired by Goku makes people feel confident and assertive. Although people have different choices regarding their favorite animation, still franchises such as Marvel, DC, Naruto, and Dragon Ball Z, stand ahead of others. To have more understanding of these facts one may refer to the following.https://www.vogue.in/content/fashion-designers-inspired-by-comic-books-superheroes[11], https://www.themarysue.com/comic-inspired-fashion/ [12], Apparel – Dragon Ball Z[13], How 'Dragon Ball Z' Took Fashion to a New Power Level[14], https://comicsalliance.com/superhero-fashion-week-jeremy-scott/ [15], Brown (1997)[16],Gunelius (2008)[17], Geraffo(2019)[18], Groppel. (2018 )[19], Rochman( 2022 ),https://www.sportskeeda.com/pop-culture/new-naruto-merch-where-get-price-release-date-explored[21],

There are number of online apps that provide Animation based clothing ( https://www.thesouledstore.com/men[21], https://www.beyoung.in/catalogsearch/result?q=marvel[22],https://www.bewakoof.com,https://www.amazon.in/s?k=marvel+T+shirts&crid=2ZJL0VB2ZXAQ6&sprefix=marvel+t+shirts%2Caps%2C265&ref=nb_sb_noss_1[23],https://www.myntra.com/dc-tshirts?rawQuery=DC%20Tshirts[24],https://www.redwolf.in/?gclid=CjwKCAjwpuajBhBpEiwA_Ztfhcf V-IsSduLB16MS5gW5-ptCHgerjQ6hKY8BVCZFlkraT_AT7ekMKBoCqycQAvD_BwE[25], https://www.meesho.com/search?q=Naruto&searchType=manual&searchIdentifier=text_search[26]). We are pioneers in this groundbreaking research, exploring a unique domain of animations-inspired clothing that is yet to be explored by any other researchers. As a result, there is a scarcity of existing literature on the specific topic we are investigating.In our endeavor, we find ourselves at the forefront of an unprecedented research undertaking. The realm of animations-inspired clothing remains uncharted territory, with no prior investigations delving into this innovative domain. As trailblazers in this field, we are venturing into unexplored avenues.

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## III. METHODOLOGY

3.1 The Data under study

The dataset utilized for this research was exclusively collected from a range of popular online shopping platforms, specifically The Souled Store, Bewkoof, Amazon, Myntra, Beyoung, Redwolf, Flipkart, and Meesho. The data collection process encompassed various districts within Delhi, extending from July 2020 to June 2023. The primary focus of the study revolved around examining the monthly quantity of animation-inspired clothing items purchased. The dataset included various franchises, including Marvel, DC, Naruto, Dragon Ball Z, Garfield, Looney Tunes, Peanuts, Winnie the Pooh, Popeye, and more. However, it is worth noting that Marvel, DC, Naruto, and Dragon Ball Z emerged as the favored choices, representing the majority of observations.

To facilitate analysis, the collected data was organized into five distinct categories: Marvel, DC, Naruto, Dragon Ball Z (abbreviated as DBZ), and others. It is important to emphasize that throughout the entirety of this study, the term "item(s)" explicitly refers to the total count of animation-inspired clothing merchandise purchased by users.

The research aimed to gain insights into the online shopping behaviors and preferences of users, specifically regarding their choices in animation-inspired clothing. By examining the monthly purchase patterns within different districts of Delhi, the study sought to identify any significant trends or variations across the selected platforms. The extensive data collection timeframe spanning nearly three years allowed for a comprehensive analysis of consumer behavior over an extended period.

3.2 The Poisson distribution

The Poisson distribution is an important discrete distribution that represents the number of events that occur in a fixed interval of time or space, given a known average rate of occurrence and assuming that the events happen independently and at a constant average rate. Such as the number of phone calls received at a call center in a given hour, the number of accidents in a day, the number of emails received per day, the number of online products ordered per month, the number of online products returned per month, etc. For details on Poisson distribution, one may refer to Zhao et al. (2020)[27]. If X is a random variable following Poisson distribution. The Probability Mass Function is given by

$$P(X=x) = e^{-\lambda}\frac{\lambda^x}{x!}, x = 0, 1, \ldots$$

Where $\lambda$ is a constant and represents the average rate. So, in our case, if Xrepresents the number of items bought in a month, then $\lambda$ representsthe average number of items bought per month.

3.3 The Mixture distribution:

A mixture distribution is a probability distribution that arises from combining multiple component distributions together. In a mixture distribution, each component contributes to the overall distribution with a certain weight or mixing proportion. Mixture distributions are employed when the data, instead of arising from a single distribution, arise from a combination of several distributions. The empirical density plot of the data gives us an idea of whether we should go for a mixture distribution or not. When the empirical density plot is multimodal it is beneficial to use a suitable mixture distribution. For details on mixture distribution, one may refer to Chandra(1977)[28], and Dempster (1977)[29].

Let $X_1\ X_2 \ldots X_n$bean independent and identically distributed random sample from a K-component finite mixture of probability distributions. This mixture distribution is represented as

$$f(x; \boldsymbol{\Theta}) = ;\sum_{k=1}^{K}\pi_k f_k(x;\ \theta_K)\ , \qquad (1)$$

subject to $\sum_{k=1}^{K}\pi_k = 1$

where $\boldsymbol{\Theta} = (\boldsymbol{\pi}', \boldsymbol{\theta}') = (\pi_1\ , \pi_2, \ldots, \pi_{k-1}\ , \theta_1\ , \theta_2\ , \ldots\ \theta_k\ )$ is the vector of unknown parameters and $0 < \pi_i \leq 1$ . These K distributions may or may not be from the same family. In this paper, we assume that for the mixture density given in (1) the component densities$f_k(.)$ are from the same family(Poisson family). Further, we implement EM Algorithm for parameter estimation [see Dempster (1977)[29]]

## IV. DATA ANALYSIS

The data analysis is carried out using R software. Figure1 shows the Bar plot of the observed data and Figure 2 shows the Pie chart.

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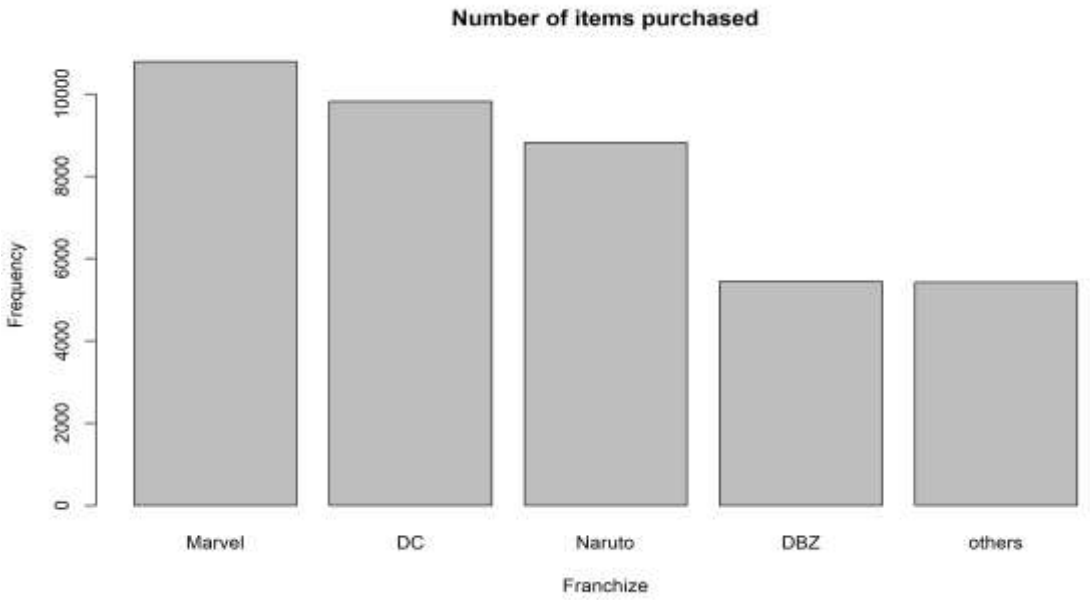


**Figure1 : Bar plot showing the Number of Items purchased per month under different franchisees.**


**Figure2 : Pie chart showing the Number of Items purchased per month under different franchisees.**

Through visual presentation we can clearly see that Marvel DC and Naruto are more preferred than others.The highest number of items are purchased from Marvel (26.78%) followed by DC (24.36%) , Naruto(21.89%), DBZ(13.50%) and Others(13.46%).

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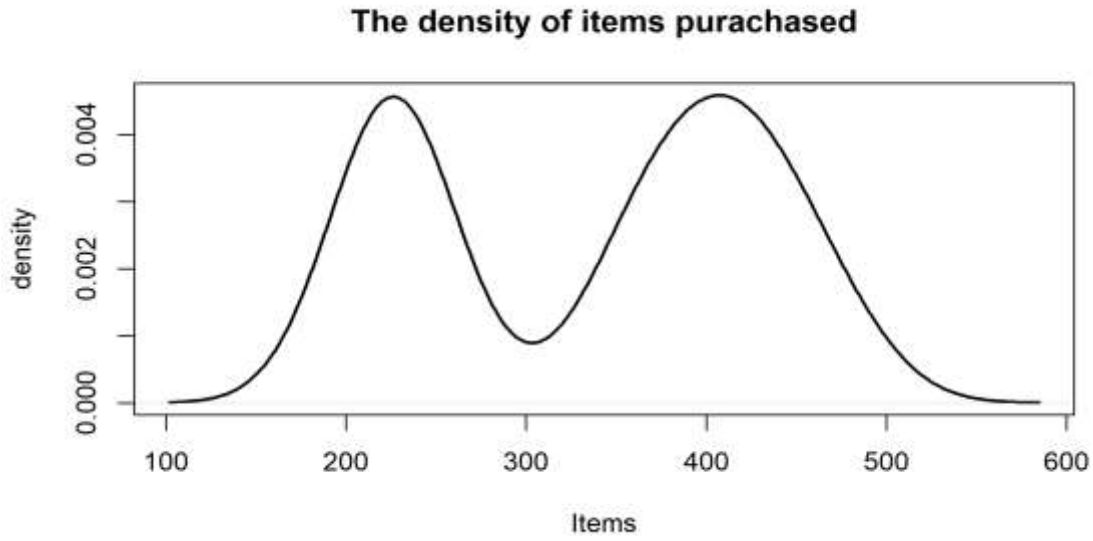


**Figure 3 : The density plot of the Number of Items purchased.**

**Table1 : Descriptive Statistics**

| Min | Q1(First Quartile) | Median | Q3(Third Quartile) | Mean | Max |
|---|---|---|---|---|---|
| 200 | 229 | 366 | 414.2 | 335.7 | 487 |

Table1 presents the descriptive statistics of the collected data. The median being 336 shows that around 50% of the times more than 336 items were purchased in a month. Figure3 three holds an important realm from the model-building perspective. This figure shows the empirical density plot of the data. Wecan clearly see that the density is bimodal. This implies that a mixture of two distributions would be a better choice to fit the observed data than a single distribution. The descriptive and empirical analysis of our data suggests using a mixture of two Poisson distributions rather than single Poisson distribution.

Introducing the notion of mixture distribution underthe Poisson familywe see analogues to the density in (1). The probability mass function comprising a mixture of two Poisson Distributions would be represented as

$P(X=x) = \pi_1(e^{-\lambda_1}\frac{\lambda_1{}^x}{x!}) + (1-\pi_1)(e^{-\lambda_2}\frac{\lambda_2{}^x}{x!})$ , x= 0 ,1, 2 . . . (2)

With the average as $,\lambda = \pi_1(\lambda_1) + (1-\pi 1)(\lambda_2)$(3)

Using EM Algorithm we estimate parameters$\lambda_1$ , $\lambda_2$ , $\pi_1$ . as given in Table 2

**Table 2: Estimates of the parameters**

| $\lambda_1$ = 408.611 | $\lambda_2$ = 226.271 | $\pi_1$= .60 |
|---|---|---|

Using these parameter estimates from Table 2 and putting in (3) we get $\lambda$ = 335.675

## V. RESULTS AND CONCLUSION

From our perspective, we are the pioneers in conducting this particular study, as no similar research has been previously undertaken. Our work offers a distinctive and unparalleled contribution to the field by providing a comprehensive understanding of the market dynamics surrounding animation-based clothing. This research paper adopts an interdisciplinary approach, employing both fundamental and advanced statistical techniques to analyze the collected data.

Based on the descriptive study and parameter estimates derived from a mixture of Poisson distribution, we can conclude that, on average, 357.373 ($\lambda$) animation-based clothing merchandise is purchased per month in Delhi. A significant proportion, approximately 72% ($\pi_1$), of these purchases comes from the Marvel, DC, and Naruto franchises. The average monthly number of items bought from these three franchises is 408.611 ($\lambda_1$). Conversely, approximately 28.1% of items are purchased from the DBZ and other franchises, with an average monthly purchase of 226.271 ($\lambda_2$) items.

Furthermore, if an individual makes a purchase, there is a high likelihood that the item belongs to the Marvel, DC, or Naruto franchise. Therefore, when considering the trend of animation-based clothing, the market dominated by Marvel, DC, and Naruto appears robust compared to others. We have identified several key suggestions for various stakeholders:

1. Clothing brands: It would benefit them to collaborate with popular franchises like Marvel, DC, Naruto, and DBZ, as they constitute the most sought-after group.
2. App developers: Following the example of "The Souled Store," there is a market for developing more apps that deliver fashion content based on animation.
3. Furthermore, as statisticians, we propose the application of a finite mixture of Poisson distribution, leveraging both Poisson and Mixture distribution techniques, not only for the dataset analyzed in this paper but also for other datasets sharing similar statistical properties. We believe that our study stands among the first to explore such a market. To gain a more comprehensive perspective, a future study could be conducted by collecting a larger sample from various states across India, instead of limiting the analysis to Rajasthan alone. This approach would provide a better depiction of the overall scenario.

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