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ANALYSING GENSHIN IMPACT WISH DROP RATES USING DATA-DRIVEN APPROACH

MsExcel

Sumeru Akademiya, Vahumana Darshan

Abstract

Genshin Impact uses a gacha system with drop rates officially published, but the actual distribution of rare item pulls has drawn interest from the community. While the official rates are fixed, some evidence suggests probability increases as pity counts rise. This study aims to analyse the four-star and five-star item drop rates in Genshin Impact using player-submitted wish data. We analysed a large dataset sourced from Paimon.moe website, applying empirical probability and conditional probability calculations to model drop rate behaviour. We categorized the results by banner type and pity count, analysing trends and difference from the official drop rates. Further analysis was given to variations in the high pity range and rare early pulls. Our findings confirm the presence of soft pity starting from one or two wishes before the maximum pity value for four-star items, and 16 to 17 wishes before the maximum pity value for five-star items. This study concludes that while Genshin Impact's gacha system has a more complex probability distribution compared to the official drop rates.

Key words: *Genshin Impact, gacha, pity system, drop rate analysis.*

INTRODUCTION

Genshin Impact is an action role-playing game developed by miHoYo (continued by HoYoverse), which features a gacha-based system for acquiring in-game items. The gacha system, called "Wishes," allows players to spend in-game currencies to obtain randomized rewards [4] [9]. Each wish has a chance to give players items of different rarities: three-star, four-star, and five-star items.

Figure 1 Example of Genshin Impact wish [16].

The drop rates of four-star and five-star items are important to players, as they can help players' in-game progression, team composition, and overall satisfaction [1] [5]. Understanding these drop rates helps players plan their spending and resource investment [6]. This is especially important for free-to-play (F2P) players, who rely on limited resources, in contrast with pay-to-win (P2W) players, who may bypass low odds by purchasing more wishes [2] [7] [11].

This study aims to analyse and compare the actual drop rate of four-star and five-star items in Genshin Impact's gacha system with the official drop rate notices provided by the game. By using real-world data, this study aims to determine whether the real-world outcome aligns with the stated drop rates. Furthermore, this analysis also aims to confirm the presence of the soft pity phenomenon– an increase in the likelihood of players receiving a four-star or five-star item before the maximum pity value.

This study applies two main methods to analyse drop rate behaviour: empirical probability and conditional probability. The empirical probability method analyses how often players receive high-rarity items at a specific number of wishes (pity value). On the other hand, the conditional probability method analyses the likelihood of players receiving a high-rarity item at a specific pity value.

This paper is structured into five sections, starting with the Introduction section. The Theoretical Basis section provides the theoretical background of the pity system and probability theories, followed by the Methodology section, which provides the detailed research methodology. The Results and Evaluation section provides the research results and their evaluation, followed by the Conclusion section, which summarizes the main findings and future study ideas.

THEORETICAL BASIS

According to the official notice by Genshin Impact [4], the drop rate for four-star items ranges from 5.1% to 6.0% across different banner types: Standard banner, Character event banners, Weapon event banners and Chronicled Wish. The five-star items have a lower drop rate, ranging from 0.6% to 0.7% across different banner types. The remaining three-star items are not as rare as four-star or five-star items, as they're shown in Table 1.

Table 1 Official notice drop rates of items across four different banner types [4].

Items	Standard	Character event	Weapon event	Chronicled Wish
Three-star items	94.300%	94.300%	93.300%	94.300%
Four-star items	5.100%	5.100%	6.000%	5.100%
Incl. guarantee	13.000%	13.000%	14.500%	13.000%
Five-star	0.600%	0.600%	0.700%	0.600%
Incl. guarantee	1.600%	1.600%	1.850%	1.600%

The hard pity system ensures that players are guaranteed a four-star item (or higher) every 10 wishes and a five-star item every 80 or 90 wishes, depending on banner types, if they have not received one [13]. This pity count will reset after players obtain a four-star or five-star item in the corresponding pity systems. This system prevents "bad luck" from not getting high-rarity rewards and add a randomness ceiling.

Beyond the hard pity, players have observed the likelihood increase of receiving a four-star or five-star item before the maximum pity value. The community called this phenomenon "soft pity," although the game has never officially confirmed this [10]. This likelihood appears to be one or two wishes before the maximum pity count for four-star items and about 15 wishes for five-star items.

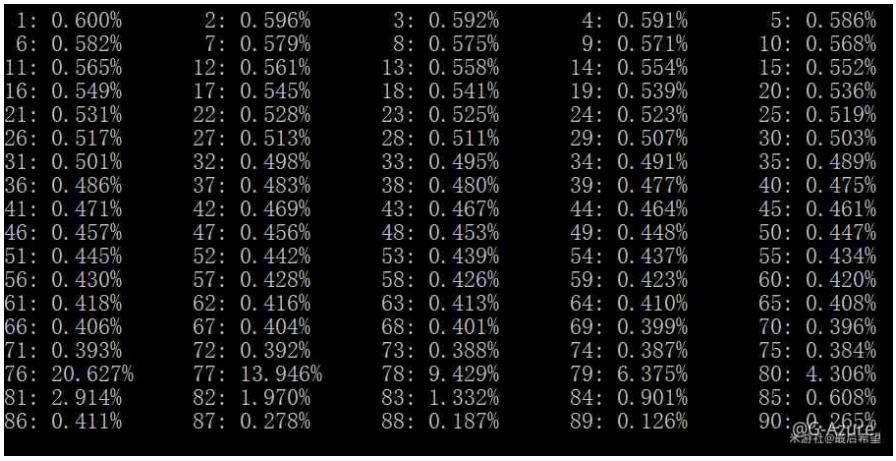

Figure 2 An earlier analysis of Genshin Impact's soft pity phenomenon using empirical probability to represent the true probability of each roll by username G-Azure [15].

Under a uniform probability model without soft pity, the likelihood of receiving a four-star or five-star item should remain constant per wish until hard pity is reached. This would result in a relatively flat distribution of four-star and five-star item drops across the early pity range, with a sudden jump at the maximum pity count. Any consistent rise in probability before hard pity would suggest a change from the uniform probability model, which supports the existence of the soft pity phenomenon.

Empirical probability, also known as experimental probability, is calculated by dividing the number of times an event occurs by the total number of trials [12]. It reflects observed outcomes rather than theoretical expectations and is useful for analysing real-world data. This approach is often used when the underlying probability distribution is unknown.

If the frequency of event E occurs is f and the total frequency is N, the empirical probability of event E, $\mathrm{P}(E)$ can be written as:

$$\mathrm{P}(E) = f \div N \quad (1)$$

In our case, event E is a four-star or five-star item obtained at a specific pity count, f is the number of times players obtained a four-star or five-star item at a specific pity count and N is the total number of wishes. If the pity count is k, we can rewrite the equation as:

$$\mathrm{P}(E_k) = f_k \div N \quad (2)$$

In contrast, conditional probability is the probability that an event occurs given that another event has already occurred. This probability is important in analysing systems where the occurrence of an event influences the chances of another. This approach is often used to understand how the probability of an outcome changes when additional information is known.

If the probability of event A and B occurs is $\mathrm{P}(A \cap B)$, the conditional probability of event A happening given event B has occurred, $\mathrm{P}(A|B)$ can be written as:

$$\mathrm{P}(A|B) = \mathrm{P}(A \cap B) \div \mathrm{P}(B) \quad (3)$$

In our case, event A is a four-star or five-star item obtained at a specific pity count and event B is the event where no four-star or five-star item is obtained before the pity count. If the pity count is k, we can rewrite the equation as:

$$\mathrm{P}(A_k|B_k) = f_k \div \left(N - \sum_{i=1}^{k-1} f_i\right) \quad (4)$$

METHODOLOGY

Paimon.moe is a community-based website that offers various Genshin Impact-related tools, such as the Wish tracker, which allows players to track their wish history. This study's data was collected from Paimon.moe API, which is documented on their GitHub repository (https://github.com/MadeBaruna/paimon-moe-api). The data was taken from four available banners: Standard banner, Character event banners, Weapon event banners, and Chronicled Wish, as they're shown in Table 3.

Table 3 More details of the dataset across four banners.

Banner type	Total banners*	Total wish	Total users
Standard banner	1	3,109,174	381,978,137
Character event banners	75	1,373,517,857	28,388,661
Weapon event banners	75	341,774,957	10,823,566
Chronicled Wish	2	253,872	12,449,143
Total	153	1,718,655,860	433,639,507

*Different banners with the same type on the same banner phases is calculated as one banner.

Before processing, the dataset was pre-processed to remove unnecessary entries. The entries taken were banner ID, banner type, four-star item pity counts, and five-star item pity counts. For replication purposes, we have included the pre-processed data in our GitHub repository (see Appendix section below).

Two primary methods were applied to analyse the data: empirical probability and conditional probability. For empirical probability, the total number of four-star and five-star drops at each pity (pity 1 to pity 80 or pity 90) was calculated (eq. (1)). For conditional probability, the likelihood of receiving a four-star or five-star item at a given pity count, assuming no four-star or five-star item obtained previously, was calculated by dividing the drops at that pity count by the number of players who reached the said pity count (eq. (4)).

To evaluate the results, the probability curves were compared against the official drop rates provided by the game. Analysis was also made to assess whether the probability increased before hard pity, which would support the existence of the soft pity phenomenon. Additionally, results were compared across different banners to check for consistency and analyse any variations between banners.

RESULTS AND EVALUATION

Figure 3 displays the probability distribution for four-star items across four banner types: Standard banner, Character event banners, Weapon event banners, and Chronicled Wish. For the Standard banner, Character event banners, and Chronicled Wish, the four-star item empirical probability remained consistent from pity 1 to pity 8, ranging from 3.571% to 5.829%. The probability spiked at pity 9, ranging from 35.220% to 36.862%, before ending at pity 10, ranging from 26.934% to 28.490%.

The Weapon event banners showed a different trend in their empirical probability distribution, where the four-star item empirical probability remained consistent from pity 1 to pity 7, ranging from 3.571% to 5.181%. The probability spiked at pity 8 at 41.921% before declining to pity 9 at 21.268% and pity 10 at 0.251%. This shows that very few players reached the hard pity for four-star items in Weapon event banners.

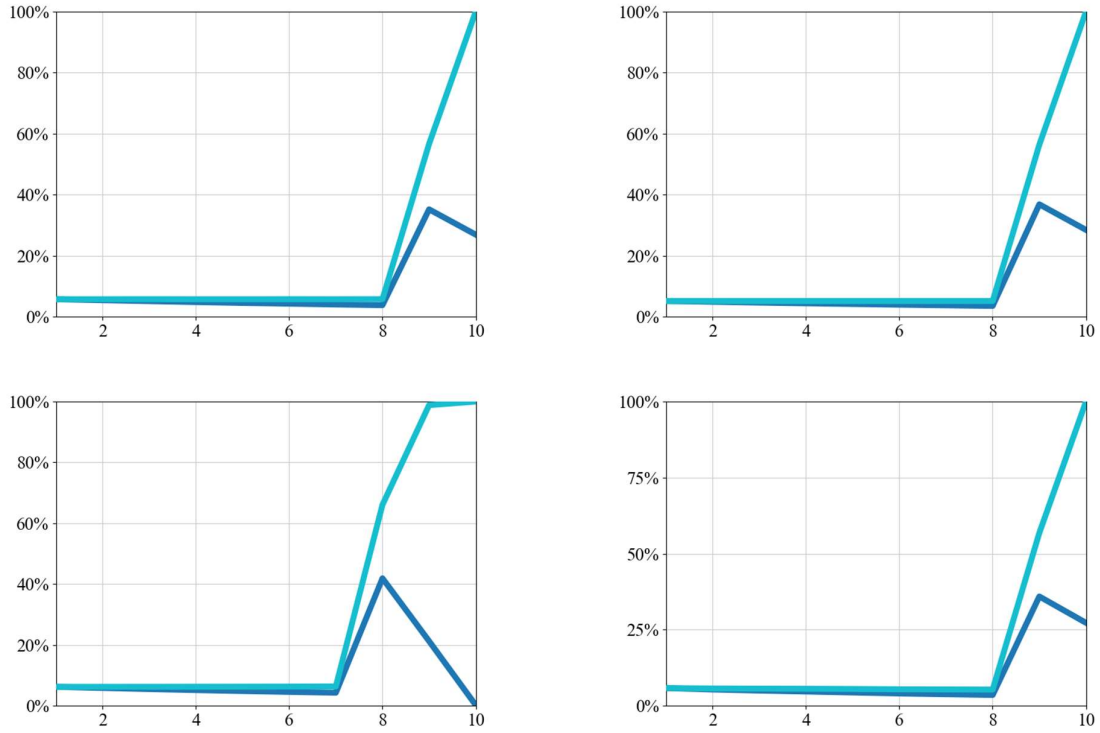

Figure 3 Probability distribution across four banner types: Standard banner (top left), Character event banners (top right), Weapon event banners (bottom left) and Chronicled Wish (bottom right) for four-star items. Empirical probability is marked with dark blue and conditional probability is marked with light blue.

The conditional probability analysis further confirmed these patterns. For the Standard banner, Character event banners, and Chronicled Wish, conditional probabilities remained steady from pity 1 to pity 8, ranging from 5.175% to 5.829%. The probability spiked at pity 9, ranging from 56.405% to 56.840%, before ending at pity 10 with 100.0% (hard pity).

For Weapon event banners, the conditional probability remained steady from pity 1 to pity 7, ranging from 6.252% to 6.371%. The probability spiked at pity 8 at 66.080%, continued by pity 9 at 98.835% before ending at pity 10 with 100.0% (hard pity). This shows that almost all players got a four-star item at pity 9.

Based on the data above, soft pity for four-star items has been confirmed, particularly in pity 8 or pity 9. For standard banners, character event banners, and Chronicled Wish, the increase begins at pity 9, where the probability increases to around 56%. On the other hand, Weapon event banners have an even earlier soft pity count at pity 8, where the probability increased to 66%, followed by pity 9 at 98%.

Figure 4 displays the probability distribution for five-star items. For Standard banners, Character event banners, and Chronicled Wish, the five-star item empirical probability remained consistent from pity 1 to pity 73, ranging from 0.372% to 1.428%. The probability increased slightly at pity 74, ranging from 2.747% to 4.017%, and continued to pity 78, ranging from 5.531% to 9.090%.

However, the empirical probability of pity 79 to pity 90 shows a declining trend. Pity 79, which ranges from 4.551% to 6.673%, continues to decline to pity 90, which ranges from 0.006% to even as low as 0.002%. This shows that almost no player got a five-star item at hard pity.

The Weapon event banners showed a different trend in their empirical probability distribution. The four-star item empirical probability remained consistent from pity 1 to pity 62, ranging from 0.672% to 0.893%. The probability spiked at pity 63 with 4.515%, continuing to pity 66 with

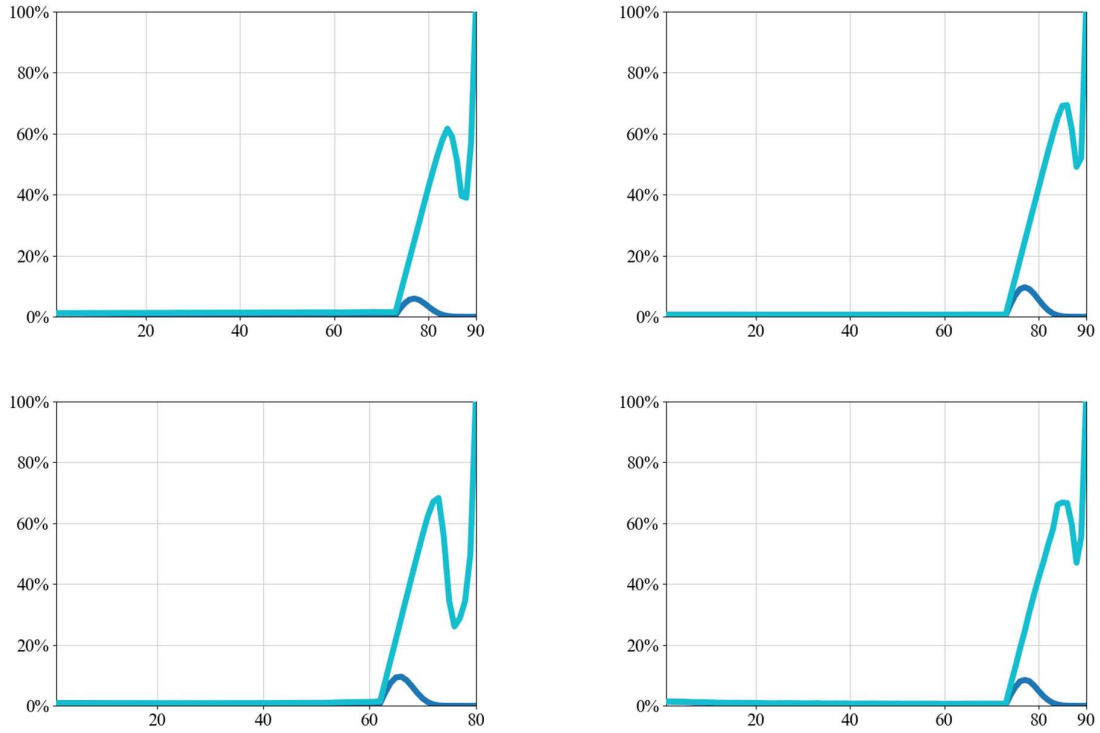

Figure 4 Probability distribution across four banner types: Standard banner (top left), Character event banners (top right), Weapon event banners (bottom left) and Chronicled Wish (bottom right) for five-star items. Empirical probability is marked with dark blue and conditional probability is marked with light blue.

9.585%. Just like with the case of other banners, the probability will then decline to pity 80, going as low as 0.004%.

The conditional probability analyses further confirmed these patterns. For the Standard banner, Character event banners, and Chronicled Wish, conditional probabilities remained steady from pity 1 to pity 73, ranging from 0.641% to 1.575%. The probability starts spiking at pity 74, ranging from 6.746% to 7.460%, and keeps increasing.For Weapon event banners, the conditional probability remained steady from pity 1 to pity 62, ranging from 0.889% to 1.457%. The probability spiked at pity 63 at 8.285% and keeps increasing. This spike is slightly higher than the probability spike in Standard banner, Character event banners and Chronicled Wish.

The results also showed that the conditional probability slightly declines about three to six wishes before the hard pity. This decline is likely due to a sample size artefact since very few players reach such high pity without obtaining a five-star item. As a result, even a small number of cases can lower the conditional probability, creating a slight dip just before the hard pity.

Like the result for four-star items, soft pity for five-star items has been confirmed, particularly in range of 16 to 17 wishes before hard pity. For Standard banners, Character event banners, and Chronicled Wish, the increase begins at pity 74 (16 wishes before hard pity), where the probability increased to around 6% to 7%. On the other hand, Weapon event banners have an even earlier soft pity count at 63 (17 wishes before hard pity), where the probability increased to 6%.

Figure 5 displays the comparison of the game's official notice's drop rate and conditional probability. The official drop rate appears as a uniform probability distribution only spiking once at hard pity. In contrast, the conditional probability begins to rise significantly at soft pity, confirming the probability of obtaining a four-star or five-star item increases with each pull, before peaking at hard pity.

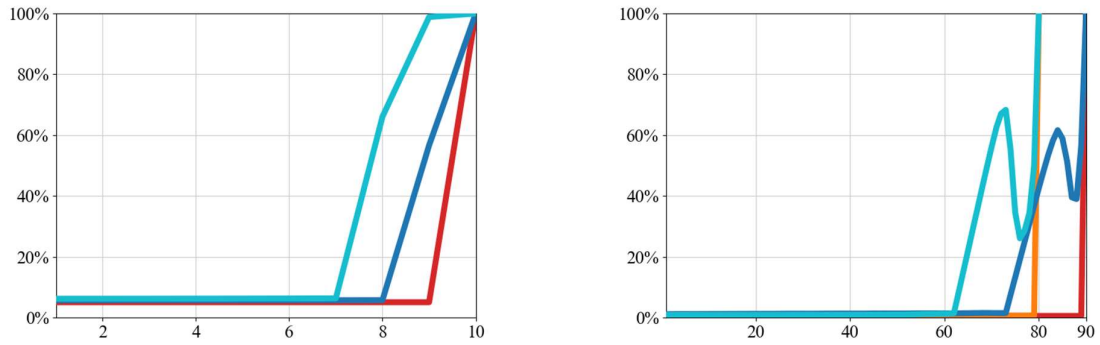

Figure 5 The comparison of Standard banner conditional probability (dark blue), Weapon event banners conditional probability (light blue), the game's official drop rates for Standard banner (red) and the game's official drop rates for Weapon event banners (orange). The left side displays the four-star item pity and the right side displays the five-star item pity.

CONCLUSION

This study reveals that the actual drop rates for four-star and five-star items in Genshin Impact differ from the flat drop rates stated in the game's official notices. Empirical and conditional probability data show that drop rates start relatively low but gradually increase as pity progresses. These findings confirm that the game employs a non-uniform probability distribution influenced by the pity system.

The data clearly support the existence of the soft pity phenomenon. In the case of four-star items, conditional probabilities begin to rise around one or two wishes before hard pity, which gives players a probability of 56% to 66%. On the other hand, for five-star items, conditional probabilities begin to rise around 16 to 17 wishes before hard pity, which gives players a probability of 6% to 8%, and they keep increasing.

It is important to note that the data used in this study comes from user-submitted logs in Paimon.moe website. Because of this, there is a potential for inaccuracies due to incomplete or selectively submitted data or inconsistencies in logging. While the sample size is large enough to establish reliable trends, the data is not fully representative of all players' experiences.

There are also edge cases that slightly alter the analysis. An example would be the rare cases where players obtain a five-star item without first receiving a four-star within the guaranteed ten wishes. These outliers, although statistically minimal, can distort the calculated probabilities.

For future research, expanding the dataset would allow for more accurate probability calculations. Collecting more detailed logs, such as whether a pull was part of a ten-pull or a single-pull, could also improve accuracy and give more insights. Additionally, to handle the example rare case mentioned above, future analyses might separate these outliers, either excluding them or analysing them separately to understand their impact on the overall trend better.

APPENDIX

The author would like to thank Noelle, the Maid of Favonius, who has greatly inspired the author and become a figure the author can admire. This study's source code is documented our GitHub repository: https://github.com/MsExcel85/genshin-drop-rate.

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