# A Rising Star: The Statistical Story of the 2024/25 PDC World Darts Championship

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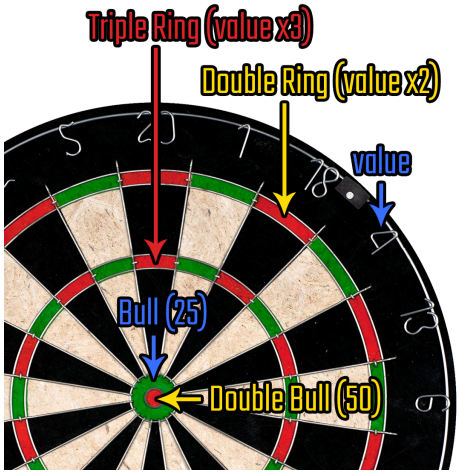
## 1. Introduction to the Data

In Darts, 2 players take turns throwing 3 darts at a time at the board. The players both start with a score of 501, with the objective being to get that score down to exactly 0. The number corresponding to the area of the board the player hits is the number of points that are removed from their score for that throw. The one catch to this format is that the dart that takes the player's score to 0 must be a double (including the double bull). A double is a dart that lands in the outer ring of the board, and takes 2x the number of that section away from their score. Similarly, there is a triple ring closer to the center of the board as well, but a player cannot end on a triple. The innermost point of the board, the double bullseye, is worth 50 points. The small ring around this point, the single bull, is worth 25 points. Since 501 is much larger than any of the point amounts on the board, players will typically aim for the highest possible number for the first several throws of the leg. This highest possible value is the treble 20 (60), which is the most commonly aimed at, and hit, part of the board by a substantial amount. When a player successfully gets from 501 to 0, they earn a leg. Winning 3 legs will earn the player a set, and winning 6 sets will win them the match. The fewest darts a player can complete a leg in is 9, and similar to a perfect game in baseball, this occurrence is very rare with only 16 ever recorded in the World Darts Championship, and exuberantly celebrated. When a player does obtain a score of 0, that turn is referred to as a checkout. The checkout is then associated with the score that the player had left when they began their turn. For example, if a player had 100 left, and then hit a treble 20, single 20, and then double 10, they would have checked out 100.




### 1.1.1 Why Darts?

Although it started as a pub game played casually in between drinks, darts has emerged in recent times, at least in Europe, as a far more legitimate sport. It now draws large rowdy crowds to its many marquee events during the season which are gaining more and more traction on social media and around the sporting world. Darts players are even becoming more popular than ever before, as seen by England's Luke Littler being recognized as a finalist for the BBC's Sports Personality of the Year (BBC Sport, 2025) award last year. Due to the casual origins of the game however, there is not a great deal of sophisticated work regarding strategy and behaviors around it. The extent of darts analysis currently is more or less just counting statistics and other basic measures such as averages, maximums, and minimums. While there is a decent sized body of assumptions on strategy, there is not much reasoning backing up the actual relationships between variables. Creating this dataset on darts would allow the start of statistical analysis in a sport

where there is currently minimal framework in place to do so. By analyzing a specific elevated match, our group hopes to visualize trends in the variables we collected to identify key patterns in both strategy and behavior that are exhibited by two high-level darts players. In the future, the metrics created will allow us to gain an understanding of what patterns of behavior lead to more successful outcomes in darts games when applied to other scenarios. Overall, we want to use the 2024/25 World Darts Championship Final to gain a better picture of Littler and Van Gerwen's trends during the match, and see how a 17-year-old Littler was able to dominantly prevail during the legs of the match that we recorded.

### 1.1.2 2024/25 World Darts Championship Final

On January 3rd, 2025, 3.1 million viewers tuned in to watch the highly anticipated final of the World Darts Championship (WDC) between the outstanding newcomer Luke Littler and the highly decorated veteran Michael Van Gerwen. The WDC is a competition that starts out with 96 participants, of which 32 participants are seeded and are given a bye to the second round (talkSport, 2025). In the 2024/25 version of the WDC, Littler and Van Gerwen were seeded 3rd and 4th respectively. Before reaching the final, Littler boasted wins over Stephen Bunting in the semifinal and Nathan Aspinall in the quarterfinal, both of which were top 10 players in the world. Van Gerwen advanced over Chris Dobey, ranked 8th in the world, in the semifinal and Callan Rydz in the quarterfinal. If a casual viewer had come across this match, they would have thought that Van Gerwen would've been the clear favorite in this match but it is quite the opposite, as Luke Littler was favored by sportsbooks and gambling sites to win the competition outright at the beginning of the WDC (Gamblingsites.com, n.d.). Despite Van Gerwen's impressive resume, which includes winning this competition three times, his form in recent years had been lacking compared to Littler with not having won a WDC since 2019 and not winning a Professional Darts Corporation sanctioned tournament since 2023 (Professional Darts Corporation, n.d.). Littler on the other hand had a hot hand coming into the competition, which included winning the Premier League, Grand Slam of Darts, and the World Series Finals, as well as finishing second in this competition in 2024 which marked his debut to professional darts (Professional Darts Corporation, n.d.). An additional benefit given to Littler in this match included the location of where the match was held which was at Alexandra Palace in London, England. Given that Littler is an Englishman and Van Gerwen is from the Netherlands, combined with his recent successes and popularity Littler likely had the majority of the support from the crowd. Another interesting aspect of the match included the age difference between Littler and Van Gerwen. Coming into the match, Littler was 17 years old compared to Van Gerwen who was 35 at the time of the match. All of these narratives combined to set the stage for what seemed to be a highly competitive match with two seemingly all time greats of professional darts.

### 1.1.3 Player Biographies

Luke Littler is an English dart player born in January of 2007. At only 18 years old he has earned the nickname of "The Nuke" for his accomplishment in the sport of Darts. He is said to have first picked up a dart at 18 months old and joined an "Elite 1 affiliated academy" (*St Helens Youth Darts Academy | Elite 1 Affiliated Academy*, n.d.) at age 8 (*Luke Littler | Professional Player | Target Darts*, n.d.). Littler was the 2024 World Youth Champion and officially joined the circuit full time at 16. He ended this most recent season with a World Championship win, becoming the youngest darts player to do so (*Luke Littler*, n.d.). He has been described as "cool, calm and collected under pressure" which is extremely valuable in the high pressure situations he often plays in. His mental approach has been praised and attributed to how he has had massive success at such a young age *(Keogh & Oxley, 2025)*. Littler's most notable achievements include: 2 World Series, 13 PDC titles in his professional career, and 5 major titles, the ninth-most in PDC history (*Luke Littler*, n.d.-b).

Michael Van Gerwen is a Dutch professional darts player. At 36 years old he is considered one of the greatest players in the history of the sport. He is a three time world championship winner and is currently ranked 3rd in the world (Michael Van Gerwen, n.d.). His darts career began at age 13 before winning the Winmau World Masters in 2006 at age 17. The mid 2010s is regarded as the peak of his career. Van Gerwen "collected numerous titles, broke records, and had the most PDC Pro Tour event wins" (Michael Van Gerwen (Darts Player), n.d.). Critics might suggest that with newer players dominating the game, Van Gerwen's career is coming to an end. However, he has managed to evolve with the changing landscape of darts and "if history has taught us anything, it's that you never count out MVG" (*Michael Van Gerwen Career | MVG's Journey to Darts Greatness*, n.d.).

**Michael Van Gerwen vs Luke Littler Timeline**

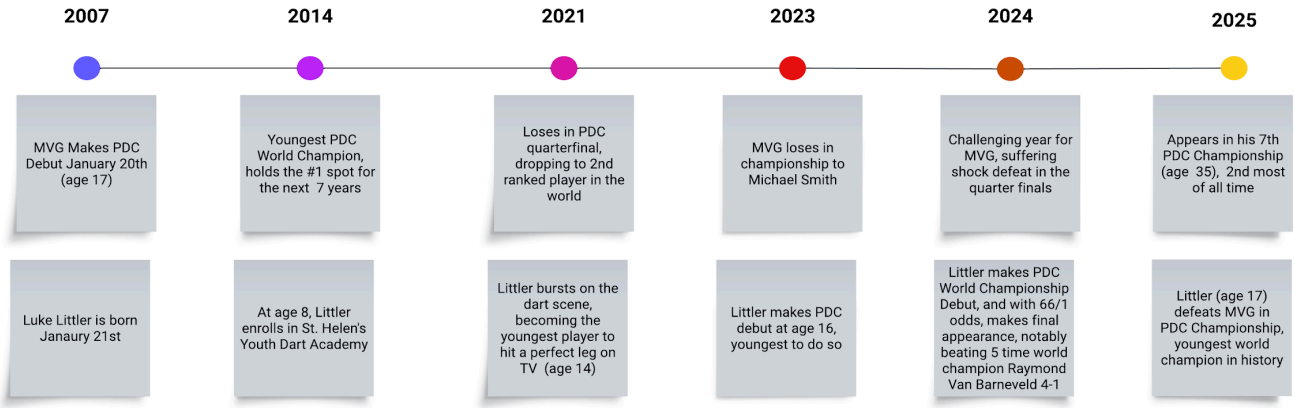


Table 1 below summarizes the averages, number of 180's (max possible score in one turn, from hitting 3 treble 20s) and leg win percentage of Luke Littler and Michael Van Gerwen in the last 12 months. At just a quick glance, Littler appears to be the better player in the 12 months preceding the Championship, which could allow for a rough hypothesis as to who would win.

*Table 1: Individual Player Statistics From The Past 12 Months*

| | ***Averages*** | ***180's*** | ***Leg Win %*** |
|---|---|---|---|
| ***Luke Littler*** | 100.3 | 953 | 60.39% |
| ***Michael Van Gerwen*** | 97.34 | 439 | 54.69% |

*Note: all data sourced from Darts Orake*

Table 2 presents the averages, number of 180's, and leg win percentage for the five most recent head to head matches between Michael Van Gerwen (MVG) and Luke Littler (LL). The table shows that Van Gerwen and Littler had faced off five times in the span of eight months before this match, with Van Gerwen having defeated Littler three out of the past five matches, but Littler winning the last two. Given the dominance in the last two matches in Leg Win %, it supports why Littler was favored to win the match.

*Table 2: Head to Head Match Statistics (April-October 2024)*

| | ***Averages*** | | ***180s*** | | ***Leg Win %*** | |
|---|---|---|---|---|---|---|
| ***Match*** | ***MVG*** | ***LL*** | ***MVG*** | ***LL*** | ***MVG*** | ***LL*** |
| ***1*** | 90.38 | 88.12 | 3 | 1 | 66.66% | 33.33% |
| ***2*** | 92.89 | 86.89 | 4 | 2 | 85.71% | 14.29% |
| ***3*** | 101.93 | 100.83 | 5 | 7 | 62.5% | 37.5% |
| ***4*** | 99.20 | 107.95 | 4 | 8 | 26.67% | 73.33% |
| ***5*** | 112.19 | 110.57 | 5 | 6 | 14.29% | 85.71% |

*Note: all data sourced from FlashScoreUSA for matches occurring on April 11 2024, May 9 2024, July 15 2024, September 15 2024, October 20 2024*

**1.2 Preview of our Data**

To begin exploring patterns within a high-level darts match, we compiled a dataset based on individual dart throws from a single recorded event. Specifically, we watched the final of the 2024/25 World Darts Championship - "Littler v van Gerwen FINAL 2025 World Darts Championship", which was available to watch on YouTube. Each group member manually recorded data from 2-3 legs of the match, beginning from the start of the match. This meant that only the first 3 sets from the match were recorded in our dataset. This hands-on approach involved documenting throws in a spreadsheet and occasionally replaying sequences to ensure accuracy. Our goal was not to generalize the broader game of darts, but instead to collect a detailed snapshot from one particular match that could offer insights into gameplay at the top level and understand player behavior within that isolated context. Moreover, we wanted to uncover the progression of the match from a statistical lens to discover what led to such a dominant victory from Littler. Since our data was sourced from such a limited base, we are not in a position to draw any broader conclusions than ones specifically about this match.

Each row in our dataset represented a single dart throw with close to 400 total observations across 17 variables. While some of the features were directly observed, others were calculated afterward to capture more details from the throws. Below is a preview of the dataset, split into two sections.

*Table 3: Preview of Dataset (Columns 1-9)*

| ***Name*** | ***Throw*** | ***Turn*** | ***Leg*** | ***Score*** | ***Target*** | ***Expected - Actual Points*** | ***Score Left*** | ***Leg Win (Bin)*** |
|---|---|---|---|---|---|---|---|---|
| Van Gerwen | 1 | 1 | 1 | 20 | 60 | 40 | 481 | 0 |
| Van Gerwen | 2 | 1 | 1 | 60 | 60 | 0 | 421 | 0 |
| Van Gerwen | 3 | 1 | 1 | 20 | 60 | 40 | 401 | 0 |
| Littler | 1 | 1 | 1 | 20 | 60 | 40 | 481 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Littler | 2 | 1 | 1 | 19 | 57 | 38 | 462 | 0 |

*Table 4: Preview of Dataset (Columns 9-17)*

| ***Double (Bin)*** | ***Triple (Bin)*** | ***Checkout Chance (Next 3 Throws)*** | ***Win Chance Change*** | ***Time Between Throws (sec)*** | ***Miss Distance From Target (mm)*** | ***Celebrated? (Bin)*** | ***60-Rate*** |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | N/A | 6.4 | 0 | 0 |
| 0 | 1 | 0 | 0 | 2.25 | 0 | 0 | 0.5 |
| 0 | 0 | 0 | 0 | 1.71 | 1.3 | 0 | .33 |
| 0 | 0 | 0 | 0 | 7.07 | 6.7 | 1 | 0 |
| 0 | 0 | 0 | 0 | 1.2 | 5.1 | 1 | -1 |

Many of the variables in Table 3 are straightforward. Name refers to the player who made the throw, while throw indicates the dart number within a turn (1st, 2nd, or 3rd). Turn and Leg are terms often used in darts, and these mark the sequence of play. A Leg refers to a single game played within a match, in which players try to get from 501 to 0. Again, you must end up with exactly 0 left, and your last throw must be a double. A player needs 3 legs to win a set, and 6 sets to win the match. A Turn is the period when a player has the opportunity to throw darts in that specific Leg. This is why above you will see the first five rows only have 1's filled in for Turn and Leg, because for each player, it is their first turn during the first leg. Score is the number of points scored on that particular dart throw, and Target is the area of the board the player was aiming for based on the idea of trying to get from 501 to 0 in the least amount of throws.

Expected - Actual Points shows the difference between the expected value given the Target and the actual result, and Score Left reflects how many points the player had remaining after that specific throw. Leg Win is a binary variable that denotes whether the player won the leg on that throw (1 = yes and 0 = no). This is why you will see in the dataset that this variable is only listed as 1 at the end of each leg.

Table 4 includes two more binary indicators in Double and Triple, which show whether the dart thrown landed in a double or triple scoring area. The double area is the thin ring around the outside of the board, and the triple area is the thin ring around the middle of the board. The remaining six variables were variables specifically created for this project. Each individual in our group created one variable and the following are these variables explained in more detail and why we decided to track these specific metrics.

### 1.2.1 Chance of Checking Out in Next 3 Throws

Although this variable was not collected directly from observation, it will become crucial to analysis later on, and is worth describing. This variable was created using the checkout percentage of elite darts players in conjunction with the Score Left column. Checkout percentages were derived from the Darts Orakel Checkout Almanac, which keeps track of number of attempts and successes of each checkout from players on the Pro Tour, which is the same competition that Luke Littler and Michael van Gerwen are a part of. The Almanac has recorded every checkout attempt from the Pro Tour since 2017, so it consists of an enormous sample size for checkout success. It displays the tour average for each number, and that is the value that was used for this variable. For each value in the Score Left column, the value of checking out that score in the next 3 throws was taken from the Almanac and thus the new variable was created.

The reason for using tour average instead of individual players' averages was that many of the sample sizes were too small for the individuals. Especially for Luke Littler, who was 17 years old at the time of the 2024/25 PDC World Championship, there simply wasn't enough data on his personal feats to have significant averages. Additionally, van Gerwen and Littler both had no prior data at all on several checkouts (such as 131), so the tour average would have been needed to get an accurate estimate for these values anyway. Because of these reasons and for consistency sake, we thought it was best to use the tour average for all the values.

### 1.2.2 Win Chance Change

The Change in Win Chance was simply created by taking the difference of the current chance of checking out from the present throw and the previous one, to see how much the win chance increased from the throw on that row.

### 1.2.3 Time Between Throws

In professional darts, legs unfold quickly, but subtle shifts in rhythm and timing can impact a player's performance. One often overlooked factor within the game is the duration between a player's turns. These seconds may seem trivial, but in darts, the time between throws can reflect a player's confidence, focus level, or even tactical hesitation. To capture this, we created the "Time Between Throws" variable, which measures the number of seconds elapsed between turns for each throw.

This data was collected manually by using a stopwatch to record the time between each player's turns. The first throw of a leg naturally has no "previous" turn, so its Time Between Throws was left undefined. This makes sense, as the metric is intended to measure how long a player takes to prepare and throw once already engaged in the rhythm of the game. For every subsequent turn, however, this variable serves as a proxy for pacing, with quicker turns likely reflecting confidence, while longer intervals could signal hesitation or nerves. It is important to understand that unless the players were switching turns, often the difference in time was milliseconds. The overall goal of including this variable was to explore whether pacing plays a meaningful role in player performance, as the rhythm of play in many sports can often reveal deeper underlying dynamics.

### 1.2.4 Target and Points From Target Points (pts)

The Target variable captures the intended location of a throw, offering valuable insight into a player's strategic intent. This is a crucial factor because it reflects decisions actively made by players and coaches, providing a rare point of control in an otherwise reactive sport. Identifying the target enables us to classify throws not just by outcome, but by intention, distinguishing accurate shots from misses in a more meaningful way. This approach assumes that professional players generally don't miss by much (so their intended target was obvious), and that early in a leg, their targets are often triple segments to maximize scoring potential. The second variable, Points from Target Points, measures the actual value obtained relative to the intended target, helping quantify the quality of a miss. For example, a small deviation from treble 20 might still yield a decent score (if the dart landed in the single 20), while a larger miss could drastically change the leg's trajectory.

### 1.2.5 Distance from Target (mm)

The Distance from Target data was collected by manually plotting each throw and measuring the shortest distance from the throw to the intended target area. To accurately measure this variable, an image of the official Winmau dartboard was overlaid onto an x-y plot and scaled so the diameter matched the official 451mm. Measurements for the triple ring, double ring, and

bullseye were also verified. If a player's dart throw hit the intended target, the distance was recorded as 0. Otherwise, the location of the throw was plotted, and the distance was calculated as the shortest line from that point to the intended target area.

### 1.2.6 Celebration (bin)

Audience reaction is often an indicator of how successful a player's turn was. Therefore, through observation, a binary variable was created recording whether the audience appeared to celebrate a player's throw or not. Even without a nuanced understanding of darts, this variable provides a simplistic way to roughly identify the best moments of a player's performance. In addition, it could be interesting to observe patterns in audience celebration. For example, are there certain types of throws or times during a leg that the audience cheers more for?

### 1.2.7 60-Rate

This variable was created by observing Van Gerwen and Littler's accuracy hitting the treble 20 sector when it was clear they were aiming for it on the dartboard and when it made strategic sense during the leg. Given that this sector on the dartboard is the maximum score that a player can get during a turn, and is by far the most targeted area of the board, we thought that this was something worth observing given that both players were playing in a championship match and would be influenced to perform to the best of their abilities and throw the least darts possible. 60-Rate was calculated as a cumulative average success of hitting the 60 for each leg. We denote a player's 60-Rate when they were not aiming for the treble 20 sector or when it did not make strategic sense with a negative one in the designated row. We defined not aiming for the treble 20 sector being when the player threw a dart that landed in sectors that are not the 5 sector, 20 sector, or 1 sector on the dartboard. We define strategic sense in that a player has a score remaining of 62 or greater, given that the leg can only end on a throw from a player that hits the double ring of a sector that completely reduces the player's score remaining to zero.

## 2. Summary of the Data

### 2.1 Summary Statistics of Continuous Variables

*Table 5: Summary Statistics of Continuous Variables*

| | ***Expected-Actual Points*** | | ***Checkout Change (Next 3 Throws)*** | | ***Win Chance Change*** | |
|---|---|---|---|---|---|---|
| | ***MVG*** | ***LL*** | ***MVG*** | ***LL*** | ***MVG*** | ***LL*** |
| ***Min*** | -16 | 0 | 0 | 0 | -12.8 | -10.26 |
| ***Max*** | 60 | 59 | 77.39 | 75.03 | 76.4 | 75.03 |
| ***Mean*** | 22.77 | 20.62 | 14.28 | 15.54 | 6.04 | 8.44 |
| ***SD*** | 20.69 | 20.58 | 24.91 | 25.94 | 13.97 | 18.37 |
| ***95% CI*** | (19.61, 25.69) | (17.36, 23.28) | (12.15, 20.33) | (12.92, 21.07) | (12.15, 20.33) | (12.92, 21.07) |

*Table 6: Summary Statistics of Continuous Variables*

| | ***Time Between Throws (sec)*** | | ***Miss Distance From Target (mm)*** | | ***60-Rate*** | |
|---|---|---|---|---|---|---|
| | ***MVG*** | ***LL*** | ***MVG*** | ***LL*** | ***MVG*** | ***LL*** |
| ***Min*** | 1.01 | 1.15 | 0 | 0 | 0 | 0 |
| ***Max*** | 9.88 | 8.78 | 18 | 26.7 | 1 | 1 |
| ***Mean*** | 3.32 | 3.37 | 3.45 | 3.34 | 0.39 | 0.42 |

| | *Time Between Throws (sec)* | | *Miss Distance From Target (mm)* | | *60-Rate* | |
|---|---|---|---|---|---|---|
| | ***MVG*** | ***LL*** | ***MVG*** | ***LL*** | ***MVG*** | ***LL*** |
| ***SD*** | 1.93 | 2.04 | 4.2 | 4.83 | 0.29 | 0.25 |
| ***95% CI*** | (3.05, 3.62) | (3.06, 3.65) | (2.85, 4.10) | (2.56, 3.95) | (0.32, 0.43) | (0.38 0.47) |

Tables 5 and 6 contain the summary statistics (minimum, maximum, mean, and standard deviation) for the 6 continuous variables in which such information would be helpful. For example, including the "score left" variable provides no actual insights and therefore was omitted. To optimize functionality in data analysis, statistics were collected individually for Van Gerwen (MVG) and Littler (LL). It is worth noting that the statistics for 60-Rate were computed only using rows where the variable was non-negative. The row "95% CI" represents the 95% confidence interval for the true population average difference for each variable, separately for Van Gerwen and Littler.

**2.2 Summary Statistics of Binary Variables**

*Table 7: Summary Statistics of Binary Variables*

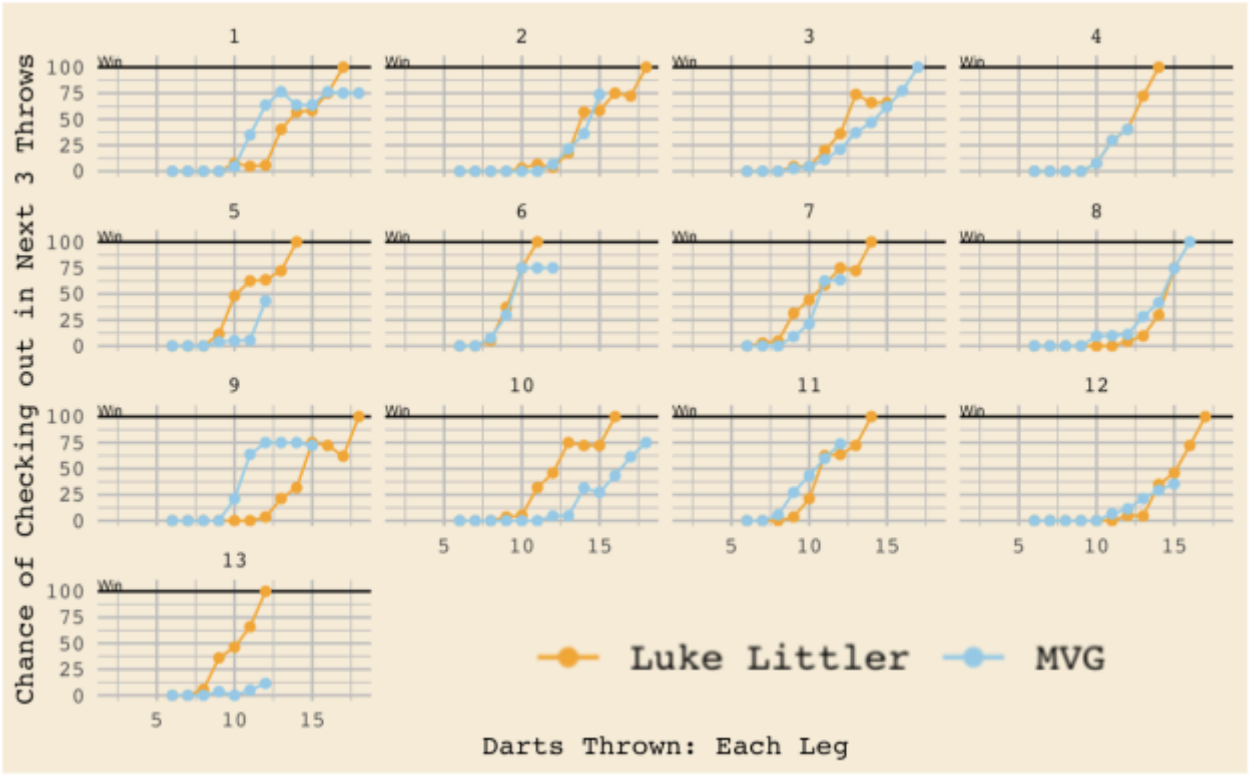
| | *Leg Win (bin)* | | *Double (bin)* | | *Triple (bin)* | | *Celebration (bin)* | |
|---|---|---|---|---|---|---|---|---|
| | ***MVG*** | ***LL*** | ***MVG*** | ***LL*** | ***MVG*** | ***LL*** | ***MVG*** | ***LL*** |
| ***Count - 0*** | 11 | 2 | 179 | 186 | 117 | 121 | 118 | 122 |
| ***Count - 1*** | 2 | 11 | 7 | 10 | 69 | 75 | 68 | 73 |
| ***Relative Frequency - 0*** | 84.6% | 3.4% | 96.24% | 94.9% | 40.9% | 40.88% | 63.44% | 62.56% |
| ***Relative Frequency - 1*** | 3.4% | 84.6% | 3.76% | 5.1% | 59.1% | 59.12% | 36.56% | 37.44% |

Table 7 contains the summary statistics for the 4 binary variables in the dataset. The frequency and relative frequency of every variable for each player (MVG, Van Gerwen and LL, Littler) has been calculated. For the leg win variable, the 0s recorded during gameplay were omitted from the final calculations. Therefore, the summary is an accurate reflection of how many legs each player won rather than being skewed by the values recorded before each leg was over when neither player could technically win.

### 2.3 Figure 1

For our first figure, we plot the win chance (Chance of Checking Out in the Next 3 Throws) over the number of throws in each leg. This figure shows the chance for both Van Gerwen and Littler to checkout in the next 3 throws as the leg continues. Essentially this figure describes what percentage each participant has at winning the leg on their next turn at each point in the legs that we collected data for. The Chance of Checking Out in the Next 3 Throws is plotted on the y-axis and the number of throws is plotted on the x-axis. Van Gerwen is represented by the blue points whereas Littler is represented by the orange points. A line was drawn through the points of Van Gerwen and Littler to better showcase the relationship between the two variables.

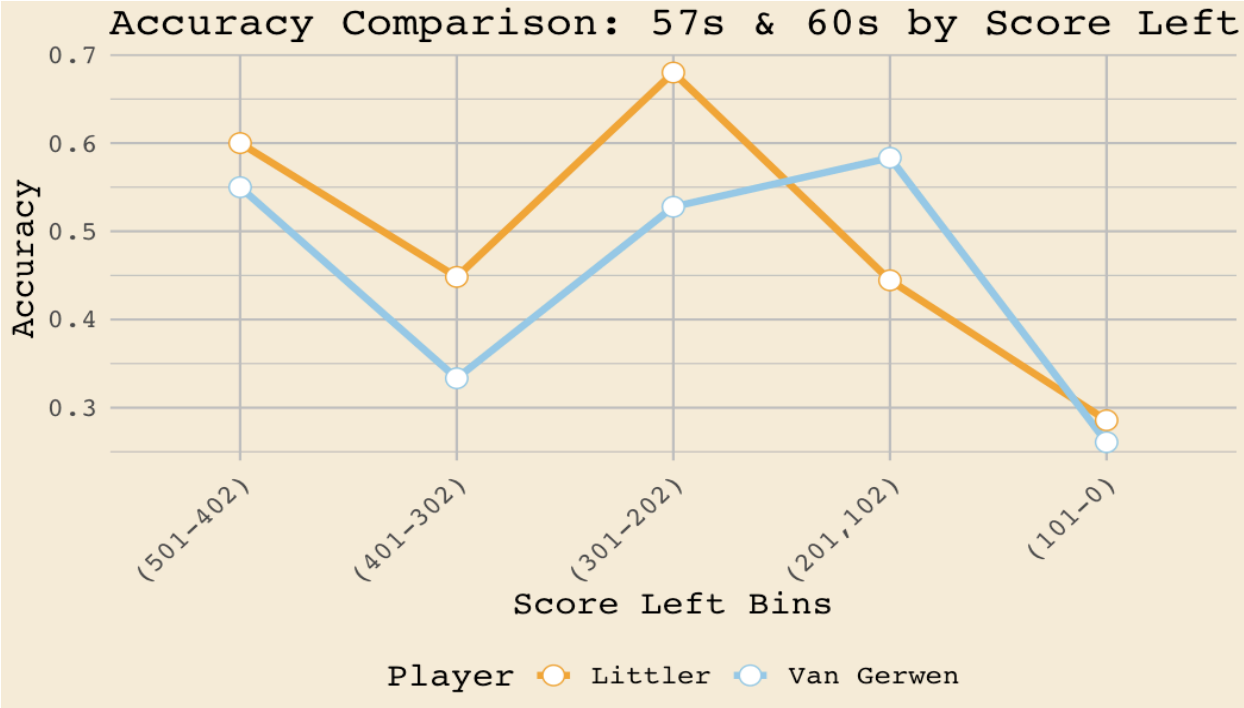
*Figure 1 - Win Chance by Leg*



### 2.4 Figure 2

For our second figure, we plot the success rate of hitting 60s and 57s against the score left during each leg. The accuracy variable is plotted on the y-axis with a range of 0.2-0.7, while the score left variable is plotted on the x-axis and split up into 5 bins. Each bin represents a range of 100 points based off of the score left variable. The first bin takes in values of score left from 501 to 402, and the final bin takes in values from 101-0. This figure shows how accurate both Van Gerwen and Littler were at hitting these key targets based on how far they were from finishing the leg. This provides insight into how each player performed during the procedural part of the match, in which they were just trying to knock as much off their score as possible (not aiming for specific, calculated numbers). Some early findings showed a similar trend in accuracy from 501-202 points among the two players, and that Littler was dominant in that same point range. Littler is represented by the orange color and Van Gerwen by the blue color.

*Figure 2 - Accuracy Comparison by Score Left*




### 3. Insights from the Data

Before we begin the insights, it's important to note something about the nature of darts as a whole: the difference between above or below 170 score remaining. While the score remaining is above 170, darts players will simply aim for the highest possible score on each throw. This is because 170 is the highest possible number you can mathematically checkout in three throws.

Since it's not possible to checkout from above 170, there is no reason to try for specific smaller numbers that leave you with a particular score remaining. You simply want to take as much score off the board as possible. To do this, players will almost always aim for treble 20. This is the highest possible score you can obtain from one throw (60) and so it's the preferred choice for throws when the score remaining is above 170. Sometimes players will choose to aim for treble 19 (57) in this situation instead. This is almost always in the second two throws of the turn, and happens because a previous dart from the turn will be physically blocking the player from hitting treble 20. This happens when they throw a dart at the treble 20 and hit it or somewhere close to it, but the dart goes into the board at an angle and is physically covering that area of the board from the player's perspective. Due to these facts, there is a fundamental difference between aiming for 60/57, and all other numbers. There is almost always a specific need for every other number, while those two are typically aimed at to take as many points off the board as possible. Finally, the difference between aiming at 60/57 vs not aiming at them splits the leg into a beginning and an end phase.

### 3.1 - Logistic Regression Analysis of 57/60 Target Success

Based on our data collected and the outcome of the match, we had hypothesized that Littler had a major advantage in hitting the higher numbers in the early parts of each leg. To explore this, we engineered several new variables to better capture player performance during the early stages of each leg.

One of the first issues we addressed was the "Time Between Throws" variable. During data collection, this variable was recorded with a stopwatch, and we noticed that the first throw of each turn (Turn 1) consistently had longer times than the subsequent throws. This was due to the natural player movement and repositioning that occurs between turns. To correct for this systematic difference, we standardized the time data. Specifically, we computed the mean "Time Between Throws" for Turn 1 throws and the mean for Turns 2 and 3. We then adjusted the Turn 1 times by subtracting the mean of Turns 2 and 3 from the mean of Turn 1. This allowed us to account for the physical repositioning at the beginning of a turn and create a "Standardized Time" variable that provided a fairer comparison across throws.

After we created other variables, we felt it could be interesting to understand Littler's advantage. Variables like "Target Type", a categorical variable, were made to categorize throws. We created a categorical variable, "hit_or_miss," to create a binary classification for accuracy. Then, to identify whether the player had a checkout opportunity, we created a "Below_170" variable, a binary variable to indicate if the score was below 170. Additionally, with the goal of trying to capture short-term performance trends such as momentum or fatigue, we calculated a rolling average of the standardized time over the previous three throws for each player. Our reasoning behind choosing three throws goes back to the concept of a turn being three total

throws. By doing this, we aligned the rolling average with the natural rhythm of the game, allowing us to capture performance fluctuations. After these transformations, we cleaned the dataset to retain only the most relevant rows, throws aimed at 57 and 60, which are among the highest possible scores with a single dart and most critical for gaining an early lead.

With these variables in place, we decided to build a generalized linear model (logistic regression) to predict hit or miss outcomes. The goal was to understand which factors most strongly influenced throwing accuracy at the key targets (57 and 60). Predictor variables in the model included each player's name, throw number, turn number, leg number, score left, celebration (from the throw before), standardized time, whether the score was below 170, and rolling average time over the last three throws. We purposefully excluded certain variables to avoid redundancy and overfitting. For instance, "Double (Bin)", "Triple (Bin)" and "Target Type" were omitted because both 57 and 60 are triple targets, "Distance From Target" was excluded as it is too closely related to hit/miss, and "Time Between Throws" was standardized so that was used instead of the raw variable. Other metrics like "Leg Win" and "Chance of Checking Out" were also excluded, as neither directly influenced throws aimed at 57 or 60 early in legs. The generalized linear model used can be seen underneath.

$$\text{logit}(\text{Hit or Miss}) = \beta_0 + \beta_1(\text{Player Name}) + \beta_2(\text{Throw Number}) + \beta_3(\text{Turn Number}) + \beta_4(\text{Leg Number}) + \beta_5(\text{Score Left}) + \beta_6(\text{Celebration (Lead)}) + \beta_7(\text{Standardized Time}) + \beta_8(\text{Below 170}) + \beta_9(\text{Average Time of Last 3 Throws})$$

Additionally, the results of the logistic regression are summarized below in Table 8:

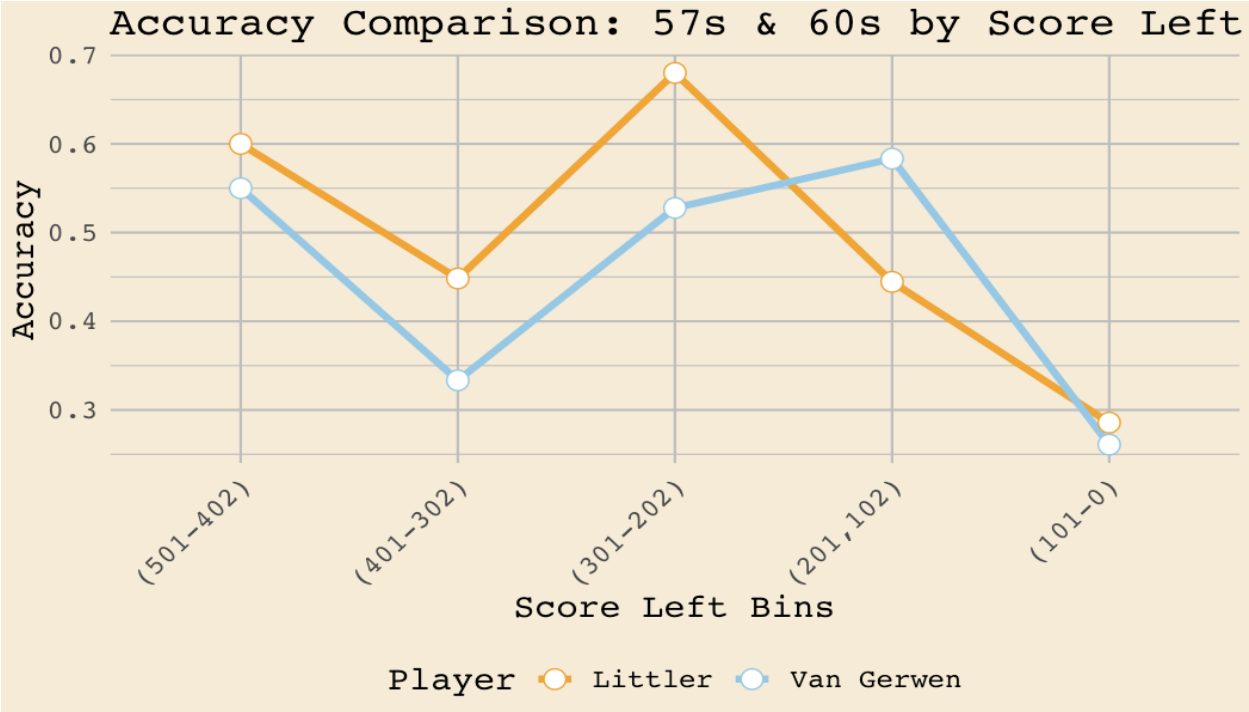
*Table 8: Significant Logistic Regression Results Predicting Hit or Miss*

| ***Predictor*** | ***Estimate*** | ***Std. Error*** | ***Z-Value*** | ***P-Value*** | ***Significance*** |
|---|---|---|---|---|---|
| ***(Intercept)*** | -20.86 | 3.67 | -5.68 | 1.33e-08 | *** |
| ***factor(Throw)3*** | 2.51 | 0.72 | 3.49 | 0.00048 | *** |
| ***factor(Turn)2*** | 3.64 | 0.83 | 4.38 | 1.21e-05 | *** |
| ***factor(Turn)3*** | 8.75 | 1.54 | 5.69 | 1.29e-08 | *** |
| ***factor(Turn)4*** | 13.18 | 2.13 | 6.19 | 6.00e-10 | *** |
| ***factor(Turn)5*** | 16.29 | 2.62 | 6.21 | 5.25e-10 | *** |
| ***factor(Leg)13*** | 2.60 | 0.95 | 2.75 | 0.0059 | ** |

| *Predictor* | *Estimate* | *Std. Error* | *Z-Value* | *P-Value* | *Significance* |
|---|---|---|---|---|---|
| ***factor(Leg)3*** | 2.55 | 0.83 | 3.05 | 0.0023 | ** |
| ***factor(Leg)4*** | 2.13 | 0.84 | 2.55 | 0.0108 | * |
| ***factor(Leg)7*** | 2.31 | 0.99 | 2.32 | 0.0203 | * |
| ***Score Left*** | 0.0465 | 0.0071 | 6.44 | 5.93e-11 | *** |

Based on the results above from our model, we were able to validate that "Score Left" had a significant relationship with hit or miss rates, specifically at the key targets of 60 and 57. This confirmed that the remaining score is a meaningful predictor of success at these targets and could be used confidently as a control variable. With a positive relationship, the model indicated that higher remaining scores were associated with greater success on early high-value targets. To compare players more fairly, we binned scores into five intervals and evaluated the 60/57 success rate within each bin rather than overall, accounting for different stages of "Score Left". By examining success rates within each bin, we were able to account for the fact that as players get closer to finishing a leg, their targets and strategies change.

*Figure 2 - Accuracy Comparison by Score Left*

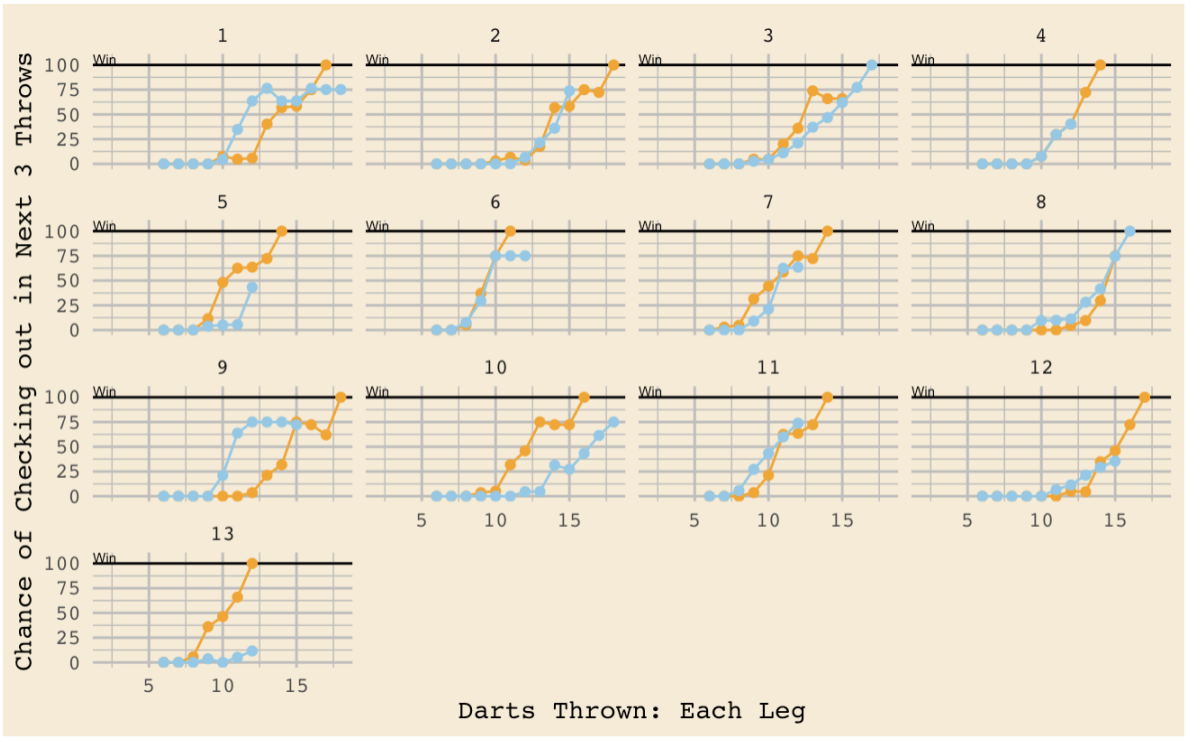


Our findings above show Littler outperforming Van Gerwen in four of the five score bins — (501 - 402), (401 - 302), (301 - 202), and (101 - 0) — also seen in Figure 2. This indicates he was more consistently effective regardless of remaining score. In particular, his dominance in the first three bins (501–202) is critical, as these are the stages where high scores are the most important. Early in a leg, players aim to maximize scores by repeatedly hitting trebles, particularly treble 20 (60) and treble 19 (57). Hitting these consistently allows players to set up favorable finishes later. Conversely, once the score dips below 170, the focus shifts to precision and finishing combinations rather than maximizing individual scores. Littler's superiority earlier in the legs, when the higher scores matter most, played a key role in his success in the match.

Ultimately, this analysis suggests that Luke Littler was better at hitting key targets during the early and final stages of the legs. This was crucial for establishing scoring dominance and winning the 2024/25 PDC World Darts Championship. By controlling for score left and isolating success rates within contextual bins, we demonstrated that Littler's performance advantage is not merely about having easier opportunities but reflects an advantage in the execution of the highest scored targets. The fact that Littler was so much more accurate in the first three bins is telling, given that those times are objectively the most important times to be good at 60s and 57s. Once your score starts dipping below 170, precision in smaller numbers becomes much more of a factor, and there is more strategy involved than simply hitting the largest number.

### 3.2 - A New Metric for Determining "Clutchness", or the Ability to Set Up Key Checkouts

*Figure 1*



Our second insight refers back to Figure 1 which displays how the Chance of Checking Out in the Next 3 Throws variable changed after each throw from the match. This graph provides an interesting summary of the match as it essentially demonstrates the quality of checkouts that each player was leaving themself with. With the knowledge that this match was a Luke Littler blowout in mind, this graph raises a couple questions:

1. How was Michael Van Gerwen losing so many legs in which his chance of winning was close to 70% (see legs 1, 2, 6, 9, 10, 11)?
2. The relationship between win chance and throw is obviously not linear, so which throws are leading to the steepest increases in win chance?

To answer the first of these questions, we created a new metric that doesn't currently exist within the sport of darts: Expected Win Points. This variable was created by taking the Chance of Checking out in the Next 3 Throws variable and applying to each *checkout* that the players attempted, rather than seeing how it changed after each thrown dart, as the data currently displays. To do this, we took the score remaining from the last throw of the previous turn and applied it to the 3 throws from the current turn. Now we can see which overall number the player was trying to take down with that turn.

*A note on this: The data currently has the score remaining after each throw, and while this is valuable, it doesn't tell us directly about the player's intentions. For example, say you have 120 remaining and then hit a 60 on throw 1 of your turn, a 20 on throw 2, and a 40 on throw 3 to complete the leg. While the chance of winning does change after hitting the first 60, we want to focus on analyzing whether or not you were successful given that you started your turn at 120, since that number determined your intended targets for the next 3 throws initially.*

The next step in creating the Expected Win Points variable was determining if the player was successful at the checkout objective they started their turn with. If they were, they earned 1-*Chance of Checking Out in Next 3 Throws*, to award them with a number of points equivalent to the percentage of the time you wouldn't expect them to checkout that number. If they were unsuccessful, they got (-) *Chance of Checking Out in Next 3 Throws* points. These positive and negative point values would then be summed for each checkout the player attempted within the leg. There was one adjustment we had to make during this process however, in the fact that we had to account for dependent checkouts in the same leg. If you face multiple checkouts (indicating you were unsuccessful on at least one checkout), then the Expected Win Points needs to account for the fact that you can't checkout multiple times. To get around this, we simply used the union formula, and subtracted the product of the win points, if there were multiple checkout attempts, for each leg. This also ensured that the Expected Win Points for a leg could never go above 100. Finally, we converted the Expected Win Points to a proportion.

*Expected Win Points Formula*

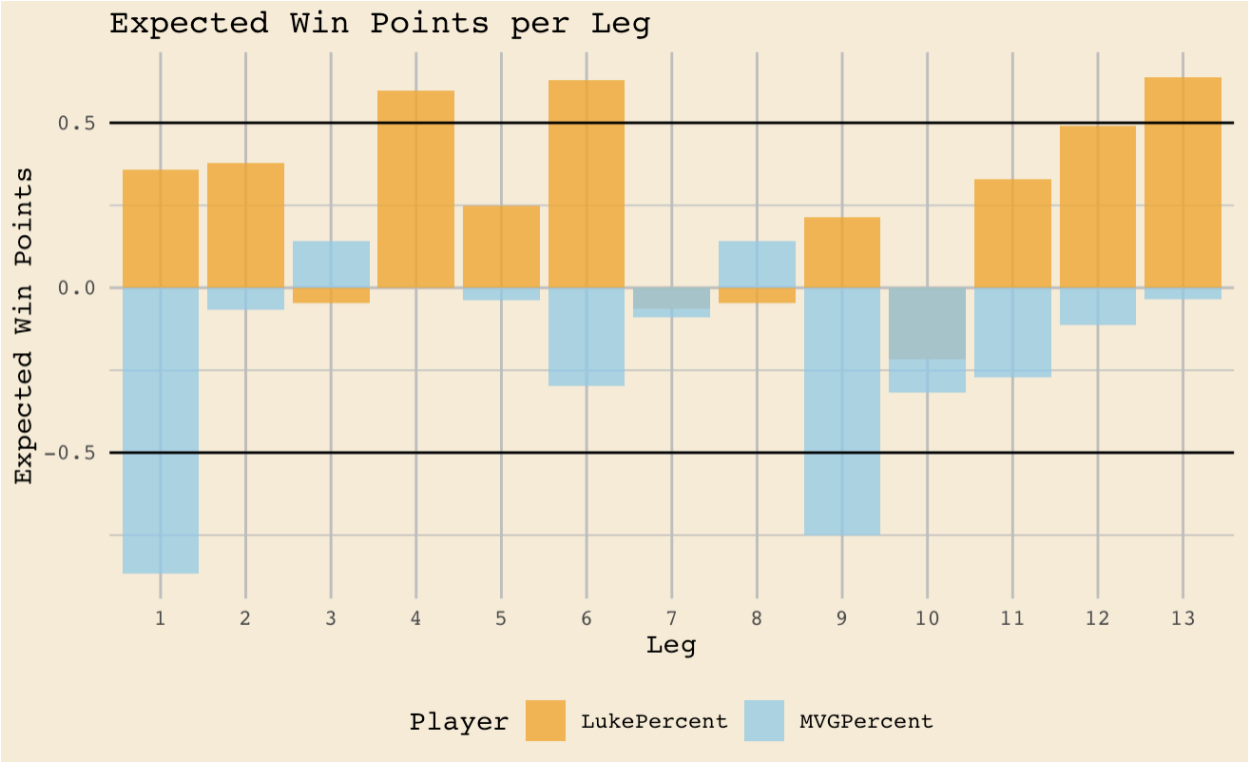
$$xWP = \sum (1 - (\%\ 3\ throws, success)) - (\%\ 3\ throws, fail) - [(\%\ 3\ throws, success) * (\%\ 3\ throws, fail)]$$

*Union Formula*

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

What this essentially leaves us with is whether or not the outcome of each leg was expected, based on the checkouts they attempted. If a player accumulates more than 50 Expected Win Points in a leg, then they had greater than a 50% of winning given the opportunities they had, and subsequently would have been expected to win that leg.

*Figure 3*




It's important to note that a player can only accumulate positive Expected Win Points if they win the whole leg, so the interpretation of the graph should be geared more toward viewing the top half as things you were not expected to do but did, and the bottom as things you were expected to do but didn't. In other words, the higher above 0, the more impressive your performance was, and the lower below 0 it was, the more disappointing your performance was. Looking at the graph through this lens elicits a couple immediate reactions:

1. Littler won two legs (7 and 10) with negative Expected Win Points, indicating that we would have expected it to be easier for him to finish one of the checkouts he was unsuccessful at than the one he actually did
2. Van Gerwen had an absolute nightmare on the first leg
3. Most of Van Gerwen's bars are very small

Not much further analysis is needed for the first two points, as they simply point toward individual legs with notable progressions. The third one however, reveals a lot about how the match developed. While Figure 1 seemed to demonstrate that Van Gerwen's win chance was relatively high in many of the legs, this figure seems to suggest otherwise. The key reason for this is that this graph only accounts for checkouts that were actually *attempted*, while the previous one includes the effect that all darts thrown would've had on the next three, even if the opponent finished on their subsequent turn and those next three darts were never realized. Since this graph only includes the Expected Win Points generated from checkouts that were actually attempted, we can make a key conclusion that explains the lack of success that Van Gerwen saw: he wasn't giving himself easy enough checkouts. It would be easy just to point to the graph and suggest that he choked the match away if all his legs looked like 1 and 9, but instead many of the bars simply have very little length at all. These short negative bars are of course obtained from failing very difficult checkouts, or ones that have a very small expected success rate. Failing difficult checkouts over and over again suggests that there is something wrong prior to attempting the checkout, rather than with the last three darts themselves. The higher values toward the end of Van Gerwen's lines in Figure 1 do suggest that eventually he was setting himself up with easy checkouts, but the small bars in Figure 3 imply that he was doing this too late most of the time, with Littler being able to capitalize and end the leg before he was even able to attempt to clear the score he left himself with.

To take it one step further and maximize the tactical value gained from this insight, we take a look at the specific "set up darts" that Van Gerwen struggled with. It was clear from Figure 1 that the relationship between Win Chance and throw is nonlinear, and that some darts are worth much more in terms of guiding a player toward winning the leg. To find these, we needed to group the throws by the intended target (per throw, not the overall checkout), and then use the Change in Win Chance variable. Averaging the Change in Win Chance for each target shows us, on average, how much a player tended to increase their Win Chance depending on what they were aiming at. In other words, this explains what they were aiming at when their Win Chance increased/decreased the most. The reasons for choosing the Target over the actual Score were that:

1. Target is something the player has complete control over, which makes potential conclusions more valuable from a coaching standpoint, since there are physical actions that can be altered

2. Due to the nature of the game, some targets can be more helpful than others even when they're not hit directly (since, for example, missing the treble of a number will still result in you getting the single of that number, if you miss in the right place)

After obtaining these values for each dart thrown for each player, we were able to plot the results, with green being the most helpful and red being the least helpful targets. Since almost all these targets only come into play in late-leg situations, we're referring to these values as the Clutchness of each target, as it corresponds to how helpful each of them was when it mattered the most. One important note is that, actual leg winning darts were left out, since we're trying to understand the effectiveness of these throws at *setting up* key finishes, not actually clearing the board themselves. This leaves Clutchness to be determined by the average change in win percent chance per target, on non leg-ending throws.

*Clutchness Formula*

$$C = (\sum (\Delta W\%)) / n$$

*Figure 4*

**MVG Clutchness: Setting Up Checkouts in Crunch Time**

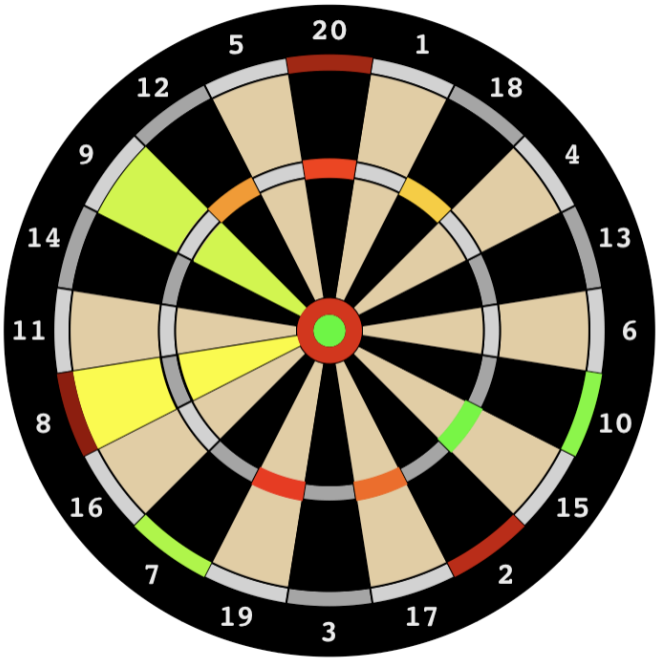
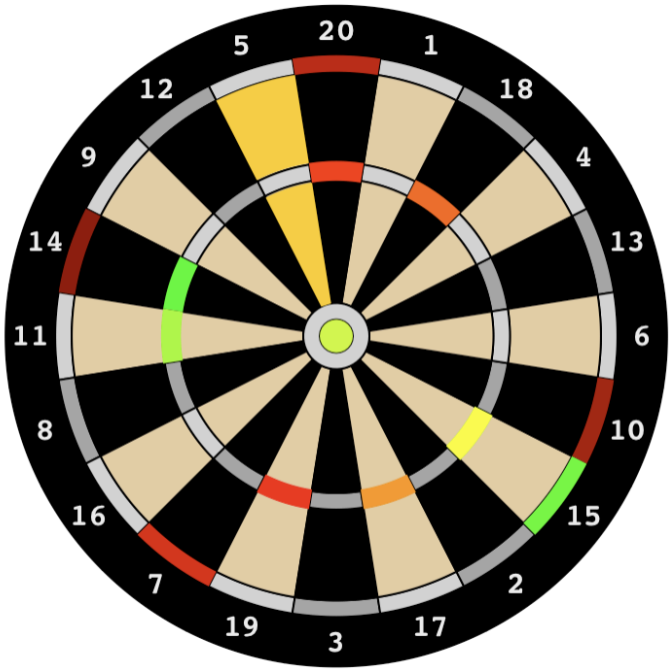


*Figure 5*

**Littler Clutchness: Setting Up Checkouts in Crunch Time**




From here, we can see that Van Gerwen struggled especially in setting up checkouts that required him to aim at the top of the board. Specifically, double 20, known colloquially in the sport as "tops", was a key weakness. The lack of ability to hit tops in clutch time likely did not do any favors for either player. Additionally, Van Gerwen has dark red in a few other key areas, including double 8, double 2, and the single bull. These are outstanding targets for a couple of reasons:

1. These are especially low numbers which suggest that they were targeting them for very specific reasons, such as setting up a particular checkout
2. These are numbers that are commonly aimed at in succession
    a. This is because missing a double 8 is likely to result in a single 8. Assuming that you were trying to get 16 via the double 8, you'd be left with 8. From there, you would have to try double 4. If you missed the double 4 and hit a single 4, you'd then be on double 2. There are many common scenarios such as this that are played out very often in darts

The first point indicates that Van Gerwen simply lacked clutchness. There were small numbers he aimed at late in the leg for specific reasons and was unsuccessful, which ultimately hindered him from setting up the easy checkout he wanted. The second point suggests that he

was also taking a long time to arrive at his checkouts, which is also supported by the differences in Figures 1 and 3 as previously discussed. Van Gerwen was simply taking too long to get to easier checkouts, and this was likely due to his lack of clutchness.

The final piece of evidence that Van Gerwen's lack of success in the match was the result of taking too long to put himself into scoring position comes from a simple summary statistic. Table 9 shows the average Clutchness of every target not including 60 and 57. This gives us the amount of benefit each player was deriving from late game throws. From this, we can see that, in general throughout the match, Van Gerwen was simply not as good at hitting specific targets when it mattered the most. This is an inherent fact related to Clutchness, because hitting your intended target will result in the biggest increase in Win Chance. This means that lower Clutchness of a target is related to missing that target, as that's one way the Win Chance will be harmed by aiming at it. Missing key targets was a primary reason that it was taking so long for Van Gerwen to set up easy checkouts.

*Table 9: Clutchness on Non 60s and 57s*

| ***Player*** | ***Non 60/57 Clutchness*** |
|---|---|
| ***Littler*** | 9.870769 |
| ***Van Gerwen*** | 7.782051 |

As we wrap up this insight, it's again important to note that the results of this study are not generalizable to the game of darts, or even professional darts players. This was merely a case study on the 2024/25 World Darts Championship between two of the most talented and influential darts players of all time, in two vastly different stages of their careers. We attempted to explain key elements of the match that lead to the eventual outcome from a statistical lens, while also providing small details into what things the players were successful or unsuccessful at, in this scenario of the most possible pressure. Additionally, through Figures 4 and 5, we learned which targets specifically were most and least helpful on the day. Going forward, these results, and those figures in particular, may not necessarily play a pivotal role in darts analysis, but could be impactful for the psychology of the players. Perhaps learning which targets were most reliable for them under the ultimate pressure with the highest of stakes could lead them to feel more confident in aiming at those targets moving forward. From a psychological lens, it never hurts to obtain feedback and know what worked and what didn't work for you in the past.

Furthermore, this study contains the framework for studying setup throws in darts, which is something that is not currently studied. There is ample data out there, such as that which is contained in the Darts Orakel Checkout Almanac, which describes the effectiveness of certain

checkouts. Completing your favorite checkouts is all well and good, but if you can't ever get to these checkouts, then that's not important. We created two new metrics that were used to measure effectiveness of set up shots (Expected Win Points and Clutchness) in the 2024/25 World Championship. We believe that, with better data, these metrics we created could be used to find real insights about the sport as a whole, especially considering the lack of current knowledge in the phases of the game that we studied.

### 3.3 - What We Would Change

If we were to do this study again, the most significant change we would make would be to modify the sample the data came from. A lack of forethought on behalf of the group led to data only being collected from the beginning of one match in order to meet the minimum size requirement for the dataset. If we were serious about really trying to study the sport of darts, we would've taken a random sample from many matches with different players so our results could actually be generalized to the sport. If we could do it again, we would gather all the legs from the 2024/25 Pro Tour season and then take a random sample of them to get the data for our project. This would leave us with a sample that contained many different players and matches, as well as different points in the season, and different points within the matches themselves. This would ensure that our results would truly reflect the nature and trends of professional darts.

Another thing that could've been improved upon was the fact that the first insight didn't offer any additional visuals to the one (Figure 2) that was included in the summary section. It might have been helpful to cite another graph or so that went on to further explain the relationship between the variables that this insight talked about.

A small critique from the second insight is that there is a slight mathematical error in how the union formula was implemented for the Expected Win Chance variable. Technically, for situations in which one player attempted 3 or more checkouts in one leg, there are small alterations needed to how their xWC was calculated. This is due to overcounting the overlap in success chance between multiple checkouts. This was accounted for in cases where there were exactly 0, 1, or 2 checkouts attempted (by subtracting the intersection of the 2 if there were 2, or doing nothing if there were 1 or 0), but this formula doesn't quite hold for 3 or more checkouts. For 3, the intersection of each possible pair needed to be subtracted and then the intersection of all 3 needed to be added back again. The formula for 4+ follows this pattern as well. The difference in the resulting value on the back of not doing this was likely extremely marginal, but it's still a mathematical error in the paper.

Another thing that might have benefitted the paper is tracking more behavioral variables, because these are things that can be directly controlled by the player. Identifying more of these would have led to more nuanced insights that referenced specific actionable things that players

could address in regard to their performance. This includes things such as body language, responses to the crowd, and other specific actions.

Something else we could've done differently was reference more previous works. We stated that there is minimal statistical work surrounding darts right now, and that is true. However, there is probably a body of small niche case studies out there however, and it might've been interesting to compare our work to those ones. It would have also been a good way for us to start our project, giving us ideas of new metrics and a better base to start off from.

Despite these limitations, we firmly believe our paper does well to analyze the 2024/2025 World Darts Championship Final between Litter and Van Gerwen. It captures a very important moment in the history of darts, where an upcoming prodigy took down one of the greatest dart players in the history of the game. This singular event could mark a turning point in darts, where a new great takes his place among the sport's legends and potentially ushers in a new era of dominance.

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