

Representation of Overs Limitation for an Individual in Rain-Affected Match

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ABSTRACT

This paper proposes a method for determining overs limitations for individual bowlers in rain-affected cricket matches by integrating analysis of bowling strike rates with the number of remaining overs, constrained by time limits. The strategy is developed in opposition to the current Duckworth-Lewis (D/L), Duckworth-Lewis-Stern (DLS), ICC, and PCB rules, which tend to stabilize the number of overs that individual bowlers can have at a fifth of the total amount of overs. As much as this rule is operationally easy, it is not always fair to competing teams. Specifically, it does not consider the contribution of the best or worst bowlers since there is no limit constructed regarding the performance related to aspects like bowling strike rate, pace, ball speed, and the average run rate of the ongoing match, particularly when there are breaks after the midpoint of the play is achieved. In addition, there may be an over as the number of overs may not be a multiple of five. In these cases, the extra over is devolved to the whims of the bowling team and is frequently distributed to the most talented of the bowlers instead of according to some objective, factor-based criterion. This discretionary allocation can bring bias and disrupt the balance of the competition. The suggested overs-limitation method solves these apprehensions by estimating “n” or “(n + R)”, i.e., how many overs each bowler is entitled to, with the help of the mean bowling strike rate of the team and the individual bowling strike rates of the team bowlers. The method will increase fairness and transparency by combining objective performance measures and practical decision-making.

INTRODUCTION

Cricket is an immensely popular sport worldwide, and One-Day International (ODI) is a particularly important form of the game, as it balances strategy, skill, and entertainment (Ghosal & Prakash, 2025). An average ODI game will have two parts, each of which will have 50 overs, and each over will have 6 legitimate deliveries. It is played on a 22-yard rectangular field, and during any international series, tournament, or league, squads of up to sixteen players may be announced; in any one game, eleven players are used. Team management that constitutes the coach and the captain is in charge of the final team selection (Ray & Roychowdhury, 2021). In the conventional circumstances of playing an ODI, 300 deliveries make up a complete innings of each team and give both teams equal chances to bat and bowl (Saikia *et al.*, 2019). Cricket, however, is an outdoor game and is thus very vulnerable to any interruption that is caused by bad weather conditions, and in this case, the most common is rain. Such disruptions can lead to temporary suspensions or the end of the play (Schall & Weatherall, 2013). In cases where play is halted and later reinstated, the cricket authorities must rebuild the conditions of the match, such as the total number of overs per team, depending on the time that the play has been discontinued and the time it has been re-enacted. Such changes are essential, since they directly affect the results of matches, the balance of competitions, and strategizing (Swartz *et al.*, 2009). Therefore, establishing reasonable and effective ways of amending targets and overs assignments in a

rain-interrupted game has been one of the long-term complications in cricket.

Besides alterations of the team objectives, interruptions cause limitations to the maximum number of overs that the individual bowlers can bowl during a reduced-overs game. Historically, this has been enforced by a certain proportional rule, according to which each bowler is not allowed to bowl more than a limited number of overs, which is one-fifth of the total number of overs apportioned to the innings. The principle is enshrined in the Duckworth-Lewis (D/L) process, Duckworth & Lewis (1998), which has been extensively used to revise the target in limited-overs cricket. Although this rule is simple and easy to use, it does not necessarily represent the relative efficiency of individual bowlers or the dynamic character of the conditions in the match. Consequently, the over restriction can unwisely tend to advantage or disadvantage some of the teams, especially in the event of the interruptions that happen after a significant percentage of the game has already been played (Preston & Thomas, 2002).

Such limitations are the subject of the method that is going to be suggested within the framework of this very research, as it would guarantee that neither side of the match will be at a disadvantage in this situation, as well as it would not be unfair to shorten a match (Shah *et al.*, 2015). The key aim is to ensure the game retains the competitive equity and still upholds its strategic integrity. The suggested strategy is meant to be simple and easy to implement with transparency that can be easily

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comprehended by match officials, players, and even the spectators. Noteworthy, the effectiveness and reliability of the method can be improved by introducing a well-defined and performance-based overs limit, which will control the critical flaws of the current D/L framework (Duckworth, 2004). The proposed method can support intervals associated with constants, and therefore, it is flexible in treating interruptions at any point of either or both innings, hence more flexible than traditional methods (Duckworth *et al.*, 2019). The current research proposes a method for determining overs limitations for individual bowlers in rain-affected cricket matches by integrating analysis of bowling strike rates with the number of remaining overs, constrained by time limits.

LITERATURE REVIEW

In the last few decades, various alternative techniques of revising targets and allocations of overs in the interrupted matches have been suggested by researchers. Most of these works have compared their suggested methods to those of the D/L system on the basis of large datasets that have been provided by domestic leagues and international competitions. Other researchers have also concentrated on direct comparisons to the original D/L technique, and others have studied its scaled version as applied in the Twenty20 format (Stern, 2009). With these efforts, most of the available methods mainly focus on the team level of resources, including the wickets left and overs to play, whereas they put less consideration on the performance characteristics of individual players.

To date, there has been no systematic investigation of interruption-adjustment strategies that incorporate both individual and team bowling strike rates as key determinants of over-allocation (Stern, 2016). This constitutes a huge literature gap, especially considering the fact that bowlers have a central part to play when determining the outcomes of matches. Bowling in the field of cricket is a very sophisticated exercise that can best be described as a combination of art and science (Sargent & Bedford, 2012). A bowler also works within biomechanics but takes advantage of aerodynamic forces that act on the ball, as well as the contact between the pitch surface and the ball, to mislead the batter and manipulate the possibility of scoring. These contribute to differences in strike rate, pace, and effectiveness that cannot be appropriately described by equal restrictions to overs (Duckworth, 2008).

In commenting on the use of a sport as a medium of explicating numerical and statistical concepts, Clarke (1998) noted that cricket was one of the first sports to undergo this. Nevertheless, academic sources in the field of professional cricket are still rather limited, and little literature has been carried out to answer similar questions in a systematic way. Earlier studies have tried to normalize the performance of the batters by correcting the number of runs scored based on the comparison of a rate of strike rate of an individual batter with the rate of strike rate of the matches. These have been adjusted measures

that have come up with more reasonable evaluations of batting averages in different conditions of play (Lemmer, 2011; Lemmer, 2002).

Cohen tested bowling strike rate as a means of estimating the likelihood of dismissal of the opposing batters in ODI cricket in the context of bowling performance, and he assigns the likelihood of dismissal to the individual bowlers (Cohen, 1999). Empirical research, which is dependent on the one-way ANOVA, shows that faster bowlers are more likely to show high performance in terms of bowling average and strike rate, but no statistically significant differences were calculated in terms of economy rate and CBR (Malhotra & Krishna, 2018). These findings indicate that strike rate is a useful measure of bowling performance.

More recent work has used a wide spectrum of related issues, such as the optimization of the batting order, the portfolio of the individual player performance, and the prediction of the outcome of a match by normal statistical and computational methods (Swartz *et al.*, 2006; Swartz *et al.*, 2009; Bhattacharya *et al.*, 2011; Carter & Guthrie, 2004; Singh *et al.*, 2015). Simultaneously, the use of genetic algorithms and other machine-learning systems in team selection and performance prediction has been implemented in a team-related context in cricket and other sports (Tsakonas *et al.*, 2002; Omkar & Verma, 2003). Based on these bases, the current paper would contribute to existing literature by suggesting a performance-based overs limit system that incorporates the personal and team bowling rates of strikes to promote impartiality and objectivity in rain-interrupted limited-overs cricket.

Before the 1960s, the number of overs that could be bowled was inexhaustible. At times, the play would continue the following day until either team lost all ten wickets. Although play might continue the following day, the time in which play was to take place might run out, and either a match was considered a draw or a no result (McHale & Asif, 2013). This is what prompted the development of a response condition of limited overs that was announced later on in order to counter this challenge (Abbas & Haider, 2019). Various rescheduling techniques and strategies have been considered important as they have already been implemented on both regional (e.g., in multiple leagues) and international scales (e.g., at the One-Day International Cricket World Cup). They include Most Productive Overs (MPO), Dynamic Most Productive Overs (DMPO), Average Run Rate (ARR), CLARK CURVE, Johnston ETAL, and the Venn-Jayasuriya Duckworth method (VJD) (De Silva *et al.*, 2001).

In 1988, Clark proposed a process by which wickets in hand are a prerequisite to calculate optimal scoring in a match to maximise the performance expectations in the first innings and minimise the likelihood of victory in the second innings. Some of the common approaches employed in ODI cricket before the Duckworth-Lewis (D/L) system are briefly described, and their shortcomings and ineffectiveness are readily shown by the biased results

on various teams, also known as the favoritism scale. It was shown that the Duckworth-Lewis process, which had been proposed in 1992 and implemented in international cricket between 1996-1997, was formally ratified by the International Cricket Council (ICC) in 1999 to be used in ODI matches (Duckworth *et al.*, 2019). Since that time, different criticisms and changes in the approach have been proposed. Sargent & Bedford (2012) worked on the probabilistic techniques of sustaining the winning prospects in the rain interruptions, but Carter & Guthrie (2004) found that the D/L approach could not achieve the probability fairness interruption-wise. Additional research by McHale & Asif (2013) opined that the D/L framework might be further advanced to incorporate findings that would improve the accuracy of pinpointing the target.

MATERIALS AND METHODS

This paper uses the case study method to analyse rain interrupted international limited-overs matches in cricket and assess the weaknesses of current target revising protocols and allocation of overs. Historical match information was taken in the form of publicly accessible databases on cricket, such as ESPN Cricinfo and the statistical archives of the International Cricket Council (ICC). These are sources that have detailed match scorecards and player statistics, such as team totals, overs played, bowling records, and bowling strike rates, along with which are necessary to evaluate the overs allocation and match fairness following interruptions. As case studies, a group of representative international games between the teams of England, New Zealand, Pakistan, Zimbabwe, India and the United Arab Emirates was chosen. These games were selected due to rain, which interrupted the games, and these games were solved by the available target-adjustment methods, especially, Duckworth–Lewis–Stern (DLS) method. The matches chosen permit an empirical analysis of the distribution of overs to each bowler in the conditions of reduced matches and the factors whether these distributions corresponded to the principles of the fairness and proportional utilization of the resources. The analysis of the case study is based on three aspects. First, it re-examines the use of current rain-adjustment procedures that are applied to modify match targets. Second, it looks at the weaknesses of the existing systems in terms of how much overs can be given by individual bowlers following breaks. Third, it is used to apply the proposed overs-limitation model to the chosen matches to illustrate how in reduced-over scenarios bowling overs might be more fairly allocated.

Most Productive Overs (MPO)

The MPO method calculates the target by including cumulative runs scored by the first batting team from the {G}th top-scoring overs. If T2{over} is the resource overs of the second team, then the revised target Trgt. {MPO} is provided by the following expression:

$$\text{Trgt. \{MPO\}} = \{\Sigma(T2\{\text{over}\}) M\{G\}\} + 1$$

Where M{G} is the runs scored from the {G}th highest-scoring overs in the first team’s innings. Allan Border, an Australian cricket captain, was the first to apply this method. However, no strict constraints were imposed on overs in interrupted segments.

Clark Curves

The ninth revision/correction of the Projected Average Run Rate (PARR) system under three stops per squad per inning is the Clark curves (Clarke, 1998). It was the first time in the history of the cricket game that wickets had been targeted in revision after any kind of suspension of the game. In case there is a target set, this curve can be used to determine the par score in the remaining part of the innings. When the amount of overs is known before the commencement of the innings, a second curve is employed to draw targets, as seen in Figure 1.

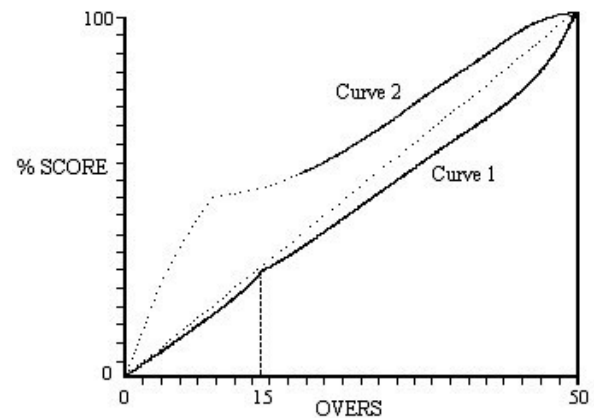


Figure 1: Clarke Curve

As rain may occur at various times of a match, the consequences of the inconvenience are determined not only by its duration but also by the time when it takes place. Different interventions are used whereby the interruption is considered in relation to the match.

Average Run Rate (ARR)

The ARR technique determines an adjusted target for the team that is batting second in a limited-overs match after any break. Assuming that (scr)T1 is the score of the first team, (over)T1 and (over)T2 are the resource overs of the first and second teams, respectively, then the newly adjusted target Trgt. {ARR} can be obtained as:

$$\text{Trgt. \{A.R.R\}} = ((\text{scr})T1 \times (\text{over})T2) / ((\text{over})T1) + 1$$

Nevertheless, ARR does not give any evident prohibitions on individual bowlers following an interruption. Key issues include: ARR and MPO are more favorable to T2 and T1, respectively; there is no calculation of lost or further wickets in hand in the updated target environment, and there is no adequate restriction on the amount of personal overs that should be bowled in the remaining overs.

V. Jayadevan(VJD) Method

The VJD method proposed by Jayadevan (2002) was a

more substitute D/L strategy. The purpose of this method is to ensure a better chance of success when compared to the Duckworth-Lewis process. Although issues of fairness are still debatable, the VJD method has been identified as a legitimate alternative (Jayadevan, 2002).

The VJD methodology comprises two curves (Figure 2): A Curve of the Normal Score, which indicates the changes in the performance of a batting team, and a Curve of Target Score of the remaining portion of the runs to be scored. The BCCI had thought of utilizing VJD in the IPL in 2010, but eventually D/L method was used.



Normal curve gave the number of scored runs and other one for required speed up pattern.

Figure 2: VJD Method

Duckworth Lewis Method

Clark, Duckworth, and Lewis (Duckworth & Lewis, 1998; Duckworth, 2004; Stern, 2009; Stern, 2009; Duckworth & Lewis, 1999) added the wickets lost and the overs remaining in their calculations. The D/L method, in contrast to Clark, alters targets upon two-factor correlation of overs left and wickets in hand:

$$Z(u^{\cdot}) = Z(\text{wick}) \times [1 - \exp(-b(\text{wick})u^{\cdot})]$$

This has also been adjusted in 2003 to the professional D/L model, which is used to compensate teams that have suffered from interruption, taking into consideration the wickets lost, overs remaining, and time factor. This new structure was first announced in 2009 (Stern, 2009). Lewis (2005) aimed to make the teams fairer to their efficiency. In a game where there is a delay or derailment of a match, a bowler cannot bowl more than a fifth of the total overs unless it is stipulated by the ICC (PCB, 2025). Clause 12.6 stipulates as follows: “Each bowler is not permitted to bowl over ten overs in an innings. Should the new number of overs not be in fives, the number of overs per bowler shall be increased to include one extra over to check allocation.

Over Limitation for an Individual in Rain-Affected Match

The D/L method has been in use since 1997, when it was used in rescheduling overs and updating targets following interruptions. Nevertheless, it failed to specify appropriate limits on the maximum number of overs that one bowler can deliver. The suggested approach adds

a limit to the number of overs that will be allowed to an individual, on a decrease in the overall length of the match to that of a regular 50-over game.

The proposed method introduces another constraint that enables the officials to restrict an individual for limited-overs according to the reduction margin with respect to the 50-overs pattern. For this bowling strike rate of an individual player is a key factor, and the total revised/limited-overs for batting too.

To get the maximum new limited overs for a player to bowl in an interrupted match, the bowling strike rate is needed. Which is available on Cricinfo or other international cricket coverage platforms easily, also, ICC has those records categorically. Proposed formation for a maximum over limitation is given by,

$$(O.L)Max = \sum_{n=11}^{i=1} \frac{\ln(S.R)pi [11 \times e \ln(A.SR)team]}{11} + IRC$$

Where, IRC = 1, 2, 3, . . . , 6 for every interval of 5 overs after a 20-overs game.

(S.R)pi = bowling strike rate of a player, and (A.SR) team is the average bowling strike rate of the team.

Algorithm with Application

1. Find the player's bowling strike rate (S.R.) Pi, who is playing in the match.
 2. Calculate the average bowling strike rate of the team.
 3. Further go to bowling proportional coefficient “(P.C)” of an individual through, $[11 \times \ln(S.R) pi e \ln(A.SR) team]$
 4. To attain “(P.C) team”, take the summation of “(P.C)” of each player except those who have exactly 11.
 5. After that, divide it by 11.
 6. At the end, just add an interval relative constant according to the given rescheduled number of overs.
- Table 1 expresses the overs limitation for individuals according to the remaining overs interval-wise.

Table 1: Overs Limitation

Total Remaining Overs	An Individual Can
Bowl 20-25	(O.L)Max + 1
21-30	(O.L)Max + 2
(31-35)	(O.L)Max + 3
36-40	(O.L)Max + 4
41-45	(O.L)Max + 5
46-50	(O.L)Max + 6

RESULTS AND DISCUSSION

Results

In this section, some of the interrupted matches are discussed in reference to the overs limitation for an individual, which describes the flaw of overs limits ignorance.

Case Study 1

It was the match between England and New Zealand. There was a limit of 10 overs in a match of 50 overs for bowling. In the same ratio, let us go to the above matches discussed in the portion of the special case. According to

that match and the proposed tool, the bowling strike rate of an individual is needed, which is shown in Table 2.

Table 2: England's Squad

Player (Pi)	(S.R) Pi	(P.C)i
James Anderson	35.6	4.150
Stuart Broad	34.3	3.905
Kevin Peterson	57.1	3.751
Andrew Flintoff	33.2	11.000
Samit Patel	49.4	3.896
Grame Swann	36.6	3.903
Owais Shah	27.5	3.638
Ian Bell	14.6	3.875
Ravi Bhopara	46.5	4.156
Paul Collingwood	46.7	4.270
Matt Prior	Nil	4.131

Further, (P.C) team = 3.605 and IRC according to limited overs is 1. So the maximum over that any player can bowl is $4.605 \approx 5$ overs. This implies that in this match, bowlers can bowl a maximum of five overs. This implies that in this match bowler can bowl a maximum of five overs. Now the question is how many bowlers can bowl 5 overs, which is cope through, for this, by the ceiling rule, pick the upper bound, which is 5, and only two bowlers can bowl five overs; the rest of them should bowl fewer than five 5-overs in a 22-over game.

$$22/50 \times 10 = 4.4$$

$$22 \pmod{5} = 2$$

Revised target by D/L 198, while according to the proposed method is 188. In this match, the overs bowled by Stuart Broad were six, one more than the limitation. Probably, it varies the winging probability of the match somehow.

Case Study 2

Pakistan came against Zimbabwe in the 17th match of the World Cup on 21st March 2007 and scored 349/5 in an inning of 50 overs. There was a delay in the 2nd inning due to rain intrusion, and 30 overs were lost by the second

Table 3: Pakistan's Squad

Player (Pi)	(S.R) Pi	(P.C)i
Kamran Akmal	Nil	11.00
Imran Nazir	49.0	3.58
Shoaib Malik	50.3	3.55
Inzamam-ul-Haq	19.3	4.68
Muhammad Yousaf	02.0	9.00
Younis Khan	94.6	2.96
Shahid Afridi	44.7	3.68
Mohammad Sami	35.4	3.93
Ifthkhar Anjum	38.4	3.84
Umar Gul	33.8	3.99
Danish Kaneria	56.9	3.42

team (Zimbabwe), and according to D/L, Zimbabwe has to 193 runs in 20 overs to win the match. As Pakistan enjoys its complete innings and any Zimbabwean player can bowl a maximum of ten overs, on the other hand in Pakistani bowlers should bowl the maximum number of overs accordingly, but it wasn't in that match. Also, their revised overs by D/L were not properly associated with overs left. The Pak's squad with individuals' Bowling strike rate and (P.C) I is given in Table 3 below.

(P.C) Team = 3.87 and zero retunes in the head of IRC according to a limited match of 20 overs. So any player can bowl four overs maximum in this match, but the overs bowled by Mohammad Sami and Umar Gul were ten, five 5-overs each instead of four.

Case Study 3

In the 22nd match of 2019's World Cup. Pakistan won the toss and decided to field instead of batting first. India enjoyed a full inning of 50 overs and scored 336/5. But the rain delayed the 2nd inning, and the 10-over game skipped from the 2nd inning. The revised target by D/L was 302 in 40 overs.

Table 4: Indian's Squad

Player (Pi)	(S.R) Pi	(P.C)i
KL Rahul	Nil	11.00
RG Sharma	74.1	3.56
V. Kohli	160.2	2.91
HH Pandya	Nil	11.00
MS Dhoni	36.0	4.30
V Shankar	58.2	3.80
KM Jadhav	43.9	4.09
B Kumar	41.2	4.15
Kuldeep Yadav	29.8	4.52
YS Chahal	31.2	4.47
IJ Bumrah	29.2	4.55

Further, from Table 4, the (P.C) team = 3.308 and IRC according to limited overs is four. So the maximum over that any player can bowl is $7.308 \approx 8$ overs (upper limit). This implies that in this match, bowlers can bowl a maximum of seven or eight overs, but not more than eight at any cost. In that match, Kuldeep Yadav bowled nine overs. From the complete scorecard/data on crick-info in this match, Kuldeep was the second most dangerous bowler with an economy rate of 3.55 only, which was unfair to the team, which was in batting turn. [V Jayadevan, a new method for the computation of target scored in interrupted, limited over cricket].

Case Study 4

The eighth Super Sixes match in the 2018 World Cup qualification was contested on March 22. Zimbabwe won the toss and chose to bat first. When the play was called off due to rain, they were on 235/7 from 47.5 overs.

From 40 overs, the new aim was 230. According to the DLS system, Zimbabwe put up a valiant fight but fell short by just three runs.

Table 5: UAE's Squad

Player (Pi)	(S.R) Pi	(P.C)i
Rohan Mustafa	47.1	3.49
Ashraf Ahmed	55.7	3.32
Ghulam Shabber	Nil	11.00
Rameez Shahzad	Nil	11.00
Shaiman Anwar	29.2	4.03
M. Usman	Nil	11.00
Adnan Mufti	Nil	11.00
Ahmed Raza	43.6	3.57
M. Naveed	36.5	3.77
Qadeer Ahmed	64.5	3.18
Amir Hayat	40.8	3.64

Further, from the above Table 5, the (P.C) team = 2.27 and IRC according to limited overs is five. So maximum over that any player can bowl is 7.2, ≈ 7 overs." Bowler" is a term used by selectors and fans to describe a player who is chosen mostly or completely for their bowling ability. While a team may only have four of those, plus a real all-rounder batting at 5th,6th, or 7th who contributes with the ball, any player can be" the bowler" according to the Laws. There are usually two or three batsmen in a team who can bowl part-time off-spin or medium speed, so there's no excuse. If their captain instructs them to bowl an over, because almost any player in international cricket can bowl a legal delivery, even if they aren't particularly competent, and hence get smacked. In this type of situation, the umpires would insist that about the"6th bowler" from the remaining players of the team. The rotation or selection of the under-debate 6th bowler is up to the captain if his bowlers stay under the over the limit. The captain should allow the player whose bowling is good compared to the rest of the list.

As five bowlers bowl eight overs each in this match, but according to their bowling strike rate, the above study allows a maximum of seven overs to any individual. More precisely, the remaining five overs should be bowled by someone other than those who have already bowled their maximum overs.

Allocation of (n + R) th Overs

As ICC's rules under section 4.1, the extra overs after assigning equal overs to a bowler, any of them can bowl, and never fix it through any formal criteria, which causes the existence of unfairness. Unfairness in such a way, if that extra over is bowled by the most dangerous bowler, then it is not fair to the batting team; if bowled by an average/moderate bowler, then it comes with the bowling/fielding team. To cope with this bowling strike rate and their average bowling strike rate is meaningful. If the number of total overs at resumption of play is

not completely divisible by five, then what should be the way of allocation of remaining overs such that the winning probability and fairness of the game are not get in any disturbance. First of all, arrange the difference of an individual's bowling strike rate with the average strike rate of that bowler in ascending or descending order. After that, allow "n" equal numbers of over to each. At the end, assign the extra over to that player/bowler who comes closer to the mean of their difference (of the individual's bowling strike rate with the average strike rate of that bowler) very much accordingly. Here," R" moves defiantly from 1 to 4.

Discussion

The main objective of this research project is to deal with the inflexibility of the current rules of ICC and PCB on the issue of bowler over allocations in a match affected by bad weather. Assuming that all the bowlers have equal contributions to the potential of a team, the one-fifth rule has been used as a blanket rule. However, when looking at case studies of the international fixtures in England, Pakistan, India, and the UAE, this standardized approach cannot explain the difference in the impact of elite bowlers (Ghosal & Prakash, 2025). The existing system is based on an entirely mathematical breakdown of the total overs, without reference to qualitative aspects like having a high-impact or a dangerous bowler (Ray & Roychowdhury, 2021). When total overs cannot be divided by five, the captain is free to allocate the same at his own pleasure, which unwillingly introduces an unbalanced playing field. This paper suggests that this kind of discretionary allocation would give preference to the strategic preferences of the captain since he or she would be able to pick the most effective bowler and, therefore, offer the fielding side an unfair edge (Carter & Guthrie, 2004). In comparison, the batting side suffers in such a case, which is that letting a high-impact bowler pass beyond a nominal quota is a possible way of changing the course of a game. When played on tight margins, a single over can be the difference between a loss and a win. In order to solve this problem, our proposed model will use Bowling Proportional Coefficient (P.C.) and Interval Relative Constant (IRC) to establish performance-based distribution of overs to eliminate subjective captain decision making with a model based on player statistics and past performance (De Silva *et al.*, 2001).

The basis of our model is the individual strike rate of a given bowler and the average strike rate of a team, which allows a fairer allocation than the DLS method, which mostly looks at the resources wasted, which include wickets and left-over overs (Duckworth *et al.*, 2019). As an example, the study of the English team shows that the current policies allow bowlers to play more than our model would suggest. Stuart Broad is a high-impact bowler and can be allowed to bowl six overs in a shortened game, but we have calculated five (Kimber, 1993). When this is the case, the equilibrium of competition is destroyed. Using a logarithmic scale, the model provides that overlimits are

not based on a mathematical fraction of the remaining overs only, but also on additional information on past performances and performance on match-days (Olivier *et al.*, 2019). In this way, the best bowlers are distributed in disproportional numbers with respect to the shortened length of matches, and too much dependency on the elite talent is avoided, putting the batting side into the care of the bowlers.

The addition of extra overs, or the $(n + R)$ element, may be considered to be one of the most powerful causes of unfairness in contemporary international cricket. Section 4.1 of the regulations of the ICC does not give any formal guidelines on how these overs are distributed. In cases where these overs are allocated to the most influential bowler, the batting side will be placed in an unequal task in meeting the new target (Lemmer, 2011). On the contrary, when they force an ordinary bowler to bowl these extra overs because they have no tactical maneuverability, then it is tantamount to punishing the fielding team (Cohen, 1999). The mean-difference approach is proposed in our solution. Through the comparison of the personal bowling rate against the average team rate, we can determine the bowler whose performance is the average performance of the team. The R overs would then be vested in this player to preserve the ethos of fair play, as they would not have to bear an extra workload to an elite performer. This removes subjective tactics bias and maintains the desired win/loss potential of a normal game.

Our model is especially effective in Case Study 3, which takes the 2019 World Cup match between India and Pakistan. Based on the rules, Kuldeep Yadav was allowed to bowl nine overs. Our model, however, showed that a fair amount of overs would only be eight, as he was the second most influential bowler and had an economy rate of 3.55. Allowing a ninth over gave a significant advantage to the fielding team it was not in proportionately justified in the 40-over innings (Swartz *et al.*, 2006). Failure to consider important variables like the ball speed, pace, and the existing economy rate causes a biased competitive nature. As illustrated in our tabulated examples, in almost every match in rainy conditions, the existing DLS system has seen at least one high-impact bowler bowl over his or her fair share, which would not have been permitted by a standard 50-over match (Duckworth & Lewis, 1999). This is to show that the DLS and ICC over-limit rules are not just mathematically incomplete but structurally biased, always in favor of the bowling side by overusing strike bowlers (Shah *et al.*, 2015).

The concept of the introduction of the so-called sixth bowler further emphasizes the need for tactical diversity. Bowling is legal in international cricket, and any player may do so, whether he is a specialist in it or not. By introducing such part-time bowlers into the model, with more stringent limits put on n or $(n + R)$ overs, one is guaranteed that the fielding team is working with the resources it has based on a standard 50-over match (Preston & Thomas, 2002). The team lost by only three

runs in the case of the Zimbabwe qualification match. The application of the over-limitation model would have optimized the distribution of overs, redistributing some of the burden on less productive bowlers without being unfair (Carter & Guthrie, 2004). This shows that our model is more balanced and provides an interesting experience to both parties.

Despite the fact that the Duckworth-Lewis method is a decisive step in the management of interrupted matches, it has certain drawbacks in not viewing the effectiveness of bowlers as a resource with constraints (Duckworth & Lewis, 1999). This weakness is overcome in our model because it allows the suspensions not to enable teams to evade the inherent limits associated with bowling depth. Combining quantitative and qualitative variables (historical strike rates, performance on the match-day, and average result of the teams), the model introduces a more relevant competition in the rain-affected matches with a fair system. It can give equal weight to the needs of the batting and fielding teams, reduce subjective captain decisions, and maintain the statistical integrity of limited-overs cricket (Schall & Weatherall, 2013).

In addition, the model can allow variations of the match days by including the Interval Relative Constant (IRC). This will make sure that the distribution of overs is still maintained at the same rates in the various periods, even when there is an extreme reduction of the innings (Duckworth, 2008). Representation The Bowling Proportional Coefficient is logarithmic, which means that outlier performances cannot have a disproportionate impact on the distribution of resources, and that the proportionality of high-impact bowlers is reflected. Such a consideration of both past and present performance results in dynamism and flexibility of over-limitation and greater fairness of the match (Abbas & Haider, 2019).

The strategic planning can be implied by the suggested model, too. The information of the calculated overs limits can be used by captains and coaches to make good decisions regarding field positions, rotations of bowlers, and what to avoid on the field. Teams can achieve over-reliance on single talent and allocate bowling load effectively by preemptively knowing who can deliver overs when a match is affected by rainfall (Jayadevan, 2002). This is in line with the higher goal of the model, which is to uphold the desired competitive equilibrium, avoid interpersonal bias, and make sure that rain breaks do not favor one team over another.

Lastly, the applicability of this approach applies to any limited-overs game, such as Twenty20 and ODI cricket. The model is flexible to changes in the length of the match, format, and the level of skills of the players by looking at the individual strike rate and the average of a team. This offers an objective, consistent, and clear way of controlling overallocation by the cricket authorities to minimize controversies of fairness and maintenance of the sport of cricket's competitive integrity in tournaments and international matches.

CONCLUSION

It has been able to prove through this research that the existing one-fifth rule of bowler over allocation in interrupted matches is not adequate to support the element of competitive equity. The current DLS and ICC system permits a tactical imbalance that unjustifiably favors the fielding team by disregarding both individual performance measures (a bowling strike rate and the Interval Relative Constant (IRC)). Our model proposes a dynamic allocation system (n) that involves an allocation system (n + R), which is governed by objective data, namely Bowling Proportional Coefficient, to calculate over limits. In the analysis of four different case studies, we have demonstrated that high-impact bowlers are often over their fair quota of overs with existing rules, having a direct influence on the likelihood of winning the match. To sum it up, the incorporation of personal strike rates into over-limitation equations offers a more transparent and data-driven approach to cricket analytics. We suggest that governments such as ICC and PCB should look at abandoning the fixed fractional allocations in favor of such a performance-based measure. This will help to keep the rain-affected matches a skill contest between the two teams as opposed to the game that was won by the excessive use of fine bowling resources.

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Data Availability Statement

All the required data are already included in the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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