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The DLJ version, a new variant that eliminates all anomalies of the Duckworth and Lewis method

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Abstract

The Duckworth/Lewis system though is based on a very valid mathematical concept, right from its original version released in 1998 to the latest version DLS-5.0-2022, invariably have produced several controversial results. The proposed DLJ system is a new variant of the D/L system that is free from all such anomalies. The same basic principles of the D/L system and the data administration technique of the VJD system are combined in formulating the DLJ version.

1 Introduction

The Duckworth and Lewis method (Duckworth & Lewis, 1998) adopted by the ICC to set target scores in interrupted limited over cricket matches has completed 26 years of its tenure in the international cricket. Though the method is based on a very valid mathematical perception, right from its original version of 1998 to the latest version DLS-5.0 (ICC, 2022), all the versions invariably produced unacceptable results including some awful ones. The VJD system (Jayadevan, 2002, 2004)) was the closest competitor for the D/L, DLS systems over the years. In 2012, the ICC reviewer rated VJD system (Jayadevan, 2011) as equal to the D/L system (Duckworth & Lewis, 2011) but was reluctant accept that it is better than the D/L system and hence D/L system got the continuation.

The VJD method is based on a totally different concept and during its tenure of 17 years in the Indian domestic cricket; it never produced any embarrassing result and stood up to the expectations of the BCCI match-officials. While the D/L method considers T20 as just a special case of 50 over matches, the VJD method considers it as a different ball game. Hence it uses different data inputs for 50 and 20 over formats. For many years, the author had the impression that the D/L, DLS systems are giving unsatisfactory results mainly because they are trying to use only one set of data for both the formats. But recently, the studies initiated by the author based on the D/L theory and VJD data revealed that this impression was wrong and it is the lack of understanding of the dynamics of game that stands as the root cause for the flaws in D/L, DLS systems and hence it is possible to achieve satisfactory results even with one set of data for both the formats. The proposed DLJ method is evolved out of this investigation.

2 Some of the major flaws in different versions of D/L, DLS systems

In order to establish the need of such an improved version, it is necessary to bring out the serious anomalies in the D/L, DLS systems. However, it is neither possible nor is required to analyse the shortcoming of all versions of the D/L and the DLS systems for this purpose. In this paper some glaring anomalies of Wncoda 2.0, Wincoda 3.0, DLS 1.0 and DLS 5.0 are brought out. Wincoda 2.0 is perhaps the most erratic version of

D/L systems, Wincoda 3.0 is the version that ICC reviewer did a comparative study with the then version of VJD method in 2012, DLS1.0 is the first version after M/s. Duckworth and Lewis retired and DLS 5.0 is the current version.

2.1 Flaws in Wincoda 2.0

This was used at the international level for two years, including 2011 world cup. Pages are required to fully exposing the errors of this method as hundreds of unbelievable errors do exist in this method and it is hard to believe that it is used at the international level for two years. In this paper, only two sets of errors one each from ODI and T20 are presented.

2.1.1 In a 50 over match, team-1 when completed 20 overs without losing any wickets interruption terminates their innings and then team-2 also gets 20 overs. Target for team-2 for various scores of team-1 is furnished in table-1.

Table-1: Anomalies of Wincoda2.0, Examples from 50 over format matches

Score of team-1	D/L Target for team-2 in 20 over	Remarks
50/0	**144**	Only 14 run difference between targets for a difference of 50 runs in team-1's score (50 & 100), which is awful.
100/0	**158**	
56/0	**148**	Target for 62 runs is less that target for 56 runs and the targets for scores 56 and 67 are the same!
62/0	**147**	
67/0	**148**	

2.1.2 Examples from T20 format matches are furnished in table-2

Table-2: Anomalies of Wincoda2.0, Examples from 20 over format matches

No	**Situation**	**D/L target**	**Remarks**
1	Team-1 **41/0** after 7 overs, innings abandoned. Target for team-2 in 7	**64**	It can be seen that the target for 42 is less than that of 41. In 7 overs scoring 41 (less than 6 runs/over) and scoring 50 runs (more than 7 runs /over) is significant. But see that hardly there is any variation (just 1 run variation) in the targets.
2	Team-1 **42/0** after 7 overs, innings abandoned. Target for team-2 in 7	**63**	
3	Team-1 **50/0** after 7 overs, innings abandoned. Target for team-2 in 7	**65**	
4	Team-1 **35/0** after 6 overs, innings abandoned. Target for team-2 in 6	**56**	Again no difference in targets of team-2 for scores of 35/0 and 40/0. The difference is just of 4 runs between the targets of 35 (less than 6 per over) and 50 (more than 8 per over).
5	Team-1 **40/0** after 6 overs, innings abandoned. Target for team-2 in 6	**56**	
6	Team-1 **50/0** after 6 overs, innings abandoned. Target for team-2 in 6	**60**	
7	Team-1 **1/0** after 6 overs, innings abandoned. Target for team-2 in 6	**37**	This situation may not occur in an actual match. But the mathematical anomaly is clearly exposed from these two examples.
8	Team-1 **2/0** after 6 overs, innings abandoned. Target for team-2 in 6	**21**	

2.2 Flaws in Wincoda 3.0 (the edition which was compared with VJD-2011 version by the ICC reviewer in 2012)

The ICC reviewer reported that both the systems (VJD and D/L) are equally good and there is no clear evidence to say that one is better than the other. The following examples tell the truth:

2.2.1 Example: In a T20 match team-1 scores 250 run in 20 overs. Par scores for team-2 against each wicket after 10 overs are furnished in the table-3:

Table-3: Anomalies in Wincoda 3.0 par-scores in comparison with other methods.

Wickets→	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
WCoda 3.0	123	124	125	126	129	133	139	151	172	211
VJD2011	121	121	121	122	138	**156**	**174**	**192**	**210**	**225**
DLS 2022	112	115	119	124	132	142	157	179	209	239
Proposed DLJ	112	112	112	127	140	151	166	187	209	234

A score, 123 runs is nearly half of team-1's score. When 10 overs are remaining with all wickets intact, tem-2 need not score that much of runs to be in par with team-1. So the first value is quite high. Now look at the par score for 6 wickets. Only 139 runs! How can 123/0 be equivalent to 139/6 while chasing 250? If team-1 has scored 250 runs, can team-2 be declared as winners if they are 140/6 after 10 overs? If the match is interrupted at this stage and eam-2 gets only one over after interruption, their target will be just 153 runs, that is, only 13 runs in the available over to win the match! It can be seen that even the VJD-2011 pars scores are better than DLS 2022 pars cores especially from 5 wickets onwards. The par-scores of the proposed (DLJ) method are outstandingly superior.

2.2.2 Table below shows the par-scores corresponding to 5 overs by wincoda3.0 for three different scores of team-1 in a T20 game.

Table-4: Anomalies in Wincoda 3.0 par-scores

Wickets→	0	1	2	3	4	5	6	7	8	9
Score of 240	58	60	63	67	72	81	**96**	**119**	157	206
Score of 230	55	57	60	65	71	81	**97**	**121**	158	201
Score of 220	52	55	58	63	70	81	**97**	**121**	156	195

Against team-1's score of 240 runs; 97/5 is a winning score in 5 overs (par score is 96) but it is not if the score is 220 or 230 (par score are 97)! 120/7 is a winning score in 5 overs if team-2's score is 240 (par score 119) but a losing score if team-1's score is either 220 or 230! A version with such serious errors was rated as mathematically robust by the ICC reviewer.

2.3 Flaws in DLS 1.0 (the first edition after the inventors retired)

DLS1.0 was yet another programme with awful errors.

2.3.1 For example, when team-A scores 52/0 at the end of 20 overs the match gets interrupted and team-1 does not bat further. The target for team-2 in 20 overs is 154 runs. No doubt that is unrealistically high target. But, more than that, if team-1's score is 104/0 (twice as 52), the target is only 170 runs, only 16 runs more. For an increase of 52 runs in team-1's score, the increase in target is just 16 runs.

2.3.2 If team-1 scores 250 runs in their 50 overs, target for team-2 in 25 overs is 178 runs (just 72 runs are reduced). If team-1's score is 310 runs the target in 25 overs is 194 runs. Just 16 runs increase for a sixty runs increase in team-1's score (44 runs from the additional 60 runs scored are reduced). This system also was used at the international level for two years.

2.4 Flaws in DLS 5.0 (the latest and presently used edition)

This being the latest and currently followed version, more detailed analysis is carried out.

2.4.1 Example-1: Let us start with a very simple one:

In a 50 over match, the interruption occurs after 21 overs when team-1 are 63/1. The target for team-2 in 21 overs is 135 runs. If team-1's score is 73/1 (10 runs more) the target is increase by 21 runs and it is 156 runs. If the score is 83/1, that is another 10 runs increase, the target is 163 runs and he increase is only 7 runs**.** For an increase of 10 runs in team-1's score from 63 to 73 the increase in target is 21 runs and for the subsequent 10 runs increase, the increase is only 7 runs, just one third. This is wrong and intolerable. If we assume that the total increase of 28 runs (21+7) is correct for an increase of 20 runs in team-1's score from 63/1 to 83/1, the split up should have been 16 & 12, 15 & 13, or 14 &14, not 21 & 7. So many similar situations exist in this version, in fact in all previous versions also.

The targets are 122, 136 and 149 as per the proposed method for 63/1, 73/1 and 83/1 respectively. Fourteen runs increase for the first 10 runs increase and 13 runs increase for the subsequent 10 runs increase, perfectly matching with the dynamics of the game.

2.4.2 Example-2: Let us examine another simple situation

If team-1's score is 60/0 in 20 overs when match interrupted, the target for team-2 is 152 runs in 20 overs. A huge value, more than 2.5 runs per each run of team-1. But if the score is 60/2, the target falls down to 109 runs, however it is a reasonable value. Nevertheless a difference of 43 runs (152-109) is not rational. If team-1 has scored 90 runs instead of 60 runs, target increases to 174 for 90/0 and 155 for 90/2. For 30 runs increase in team-1's score the increase in target is only 22 runs (174-152) when no wickets are lost and 46 runs (155-109) when two wickets are lost. This logic looks so weird. There should be only marginal difference between these values. As per the proposed method the targets scores are 130 and 105 runs for 60/0 and 60/2 (25 runs difference) and 169 and 141 for 90/0 and 90/2 (28 runs difference) which is extremely sensible.

2.4.3 Example-3: This example completely exposes the flaws in DLS system, but demands a thorough attention to understand it.

In a 50 over match, when a team starts batting, retaining wickets is also equally important as scoring runs. Consider the following two cases at different stages of the game viz. 20 overs 27 overs and 35 overs:

Situation-1: All wickets are intact Situation-2: Lost 2 wickets

There should be hardly any difference in a team having all wickets intact after 35 overs and losing two wickets at that stage. But at the stage of the 20th over having all wickets in hand has clear advantage over losing two wickets. At the stage of 27 overs, the condition should be in between.

This principle is valid, irrespective of the score of a team. Hence, if the interruption happens while team-1 is batting and if one looks at the difference between targets set for team-2 while team-1 has all wickets in hand and team-1 has lost 2 wickets at the time of interruption; ***the difference between the set targets should be more when the interruption occurs at initial overs and the difference should be less when the interruption occurs at later overs for the same score (any arbitrary score) of team-1***.

Now let us consider a case where the interruption occurs while team-1 is batting and their innings gets terminated and team-2 also gets the same number of overs. For stages 20 overs, 27 overs and 35 over consider three scores of team-1 viz. 70, 90 and 110. As per the principle we discussed, the difference should be maximum for the stage of 20 overs, minimum for the stage of 35 overs and in-between for the stage of 27 overs. How the current DLS method and proposed DLJ method behaves is well explained through tables 5, 6 and 7:

Table-5: If the score is 70 runs at the time of interruption

Overs completed at the time of interruption	Team-1's score	DLS Target for team-2	Difference in targets	Remarks	*DLJ (proposed method) targets*	*Difference in targets*
20	70/0	159	32	Though a target of 159 runs for 70/0 is unrealistic, the difference in targets for interruptions at 20, 27 and 35 is not against the principle discussed.	*145*	*27*
	70/2	127			*118*	
27	70/0	145	23		*137*	*16*
	70/2	122			*121*	
35	70/0	113	7		*116*	*4*
	70/2	106			*112*	

Table-6: If the score is 90 runs at the time of interruption

Overs completed at the time of interruption	Team-1's score	DLS Target for team-2	Difference in targets	Remarks	***DLJ (proposed method) targets***	***Difference in targets***
20	90/0	174	19	The difference in targets @ 27 overs cannot be more than the difference in targets @ 20 overs	*169*	*28*
	90/2	155			*141*	
27	90/0	**185**	**29**		*166*	*18*
	90/2	156			*148*	
35	90/0	145	9		*144*	*4*
	90/2	136			*140*	

The reason for this mistake is that, the target increases by 40 runs (145 to 185) for just an increase of 20 runs (70 to 90) in team-1's score. Note that, for the subsequent increase of 20 runs (90-110), the increase in target is only 16 runs (201-185). It is a big mistake.

Table-7 If the score is 110 runs at the time of interruption

Overs completed at the time of interruption	Team-1's score	DLS Target for team-2	Difference in targets	Remarks	***DLJ (proposed method) targets***	***Difference in targets***
20	110/0	190	22	Decrease from 14 to 11 is too less (3 runs). However the pattern conforms to the game dynamics.	*187*	*25*
	110/2	168			*162*	
27	110/0	201	14		*193*	*20*
	110/2	187			*173*	
35	110/0	177	11		*170*	*4*
	110/2	166			*166*	

For scores of 70 and 110, the correct pattern is followed and for the in-between value of 90 runs, the pattern is wrong. Many such situations do exist for different scores and different number of wickets fallen.

Such mathematical anomalies exist even after 26 years of the introduction of the D/L system at the international level. It is surprising that the International Cricket Council trusts this system in spite of such mathematical anomalies and there exists an alternative method (Jayadevan, 2014) used in Indian domestic which is absolutely free from such errors.

3 Methodology of the proposed DLJ method

The proposed DLJ method is not a new method; it is a new version of the D/L method in which all the above anomalies are rectified. The basic principles of the D/L system (Duckworth & Lewis, 1998) are followed as such. The data management is hired from the VJD method (Jayadevan, 2004). Six data tables as per the latest match data are developed for very low, low, normal, high, very high and ultimate scores. In figure-1, series-1 to series-6 show the scoring pattern in very low to ultimate scores for a normal wicket fall. From these input data, the software generates the appropriate table according to the score of team-1 and uses the same for further calculations. There are 1701 such tables possible, and practically, for each score of team-1 (actual or projected), there will be a corresponding table. This makes the transition of resources pattern from low to high scores extremely smooth. From this new table mentioned, a table giving resources remaining corresponding to the "available overs and wickets lost" is generated. Here onwards, the method fully shifts from VJD method to D/L method. Further calculations are based on the resources used/resources available concept (Duckworth & Lewis, 1998). Portions of three sample resource tables generated for scores of 200 run, 250 runs and 300 runs (in 50 over) are given in tables 8, 9 and 10. It can be observed that the transition of resources remaining is very smooth from the score of 200 runs to the score of 300 runs.

Table-8: Resources remaining in a 50 over format match when the score is 200 runs.

O	W→	0	1	2	3	4	5	6	7	8	9
40		87.43	80.90	75.98	70.00	58.00	46.00	34.00	22.00	12.00	5.00
30		74.00	69.67	65.48	60.13	53.43	46.00	34.00	22.00	12.00	5.00
20		57.62	55.59	52.68	48.10	42.73	38.49	32.04	22.00	12.00	5.00

Table-9: Resources remaining in a 50 over format match when the score is 250 runs.

O	W→	0	1	2	3	4	5	6	7	8	9
40		87.08	80.35	74.90	68.50	56.50	44.50	33.00	21.00	11.50	4.50
30		73.13	68.63	64.10	58.47	51.81	44.50	33.00	21.00	11.50	4.50
20		55.49	53.83	50.44	45.82	40.60	36.53	30.85	21.00	11.50	4.50

Table-10: Resources remaining in a 50 over format match when the score is 300 runs.

O	W→	0	1	2	3	4	5	6	7	8	9
40		86.73	79.80	73.83	67.00	55.00	43.00	32.00	20.00	11.00	4.00
30		72.25	67.59	62.72	56.82	50.19	43.00	32.00	20.00	11.00	4.00
20		53.35	51.67	48.21	43.54	38.47	34.57	29.67	20.00	11.00	4.00

4 Conclusion

The Duckworth and Lewis system, used for setting target scores in limited over cricket matches has completed 26 years of its tenure at the international cricket. In spite of several flaws in different versions of the system, the international cricket council did prefer to continue with the same. In spite of several trials and experiments carried out over the years, the inherent flaws of the system remained. The proposed DLJ version completely eliminates the flaws in D/L system and currently is the best method available in the business. The ICC has the obligation to give the best available tools to the cricket community and therefore should not close their doors blindly on this innovative idea.

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