An Application of Queuing Theory to Indian Premier League Based on M/M/1 Queuing Model

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Abstract:

The Indian Premier League (IPL) is a domestic Twenty20 cricket league in India. In IPL match, two opener batsmen open the innings. That means, at a time two batsmen use to bat on ground and the third position batsman is waiting in the dressing room or we can say third batsman is in queue. We can find out the rate of arrivals the execution by service nodes for waiting batsman using the queuing model. On the basis of arrival rate we conclude about the matches of IPL.

Keywords: IPL, Queuing Theory, M/M/1 Model, Arrival Rate, Services.

1. Introduction:

The Indian Premier League (IPLT-20) in competent alliance tournament of cricket, in contested by eight bunches of players, named on particular cities of our country. This format was founded by the Board of Control for Cricket in India (BCCI) in 2007. This T-20 is generally completed in the month of March, April and May in every year and has an exclusive window in the International Cricket Council (ICC) future tours Programme. In the IPL there are maximum crowd in the ground and maximum seen in the country. Thirteen acclimatized of the IPL tournament has been done. Mumbai Indians is current IPL championship holder who won the 2020 season. The venue for the 2020 season was replaced to United Arab Emirates (UAE) due to the COVID-19 pandemic. Now a day, cricket becomes very famous and engrossing game for all categories like children, youth and old age persons. T-20 is highly unexpected game where a single over can change completely the outcomes of the game. As we everyone knows that Cricket is bat-ball game and played between two bunches of eleven players in each sides. Through IPL the cricket got a new shape and dimensions where a competition, completes by twenty over of each inning of T–20 within 3 hours that is 90 minutes followed by intervals of 15 minutes. The teams have driven by franchisee and the players were selected through competitive bidding. Due to the tremendous amount of popular among the citizen, media also gives more and more important among all other games in India.

Vig (2008) observed about the implications of two cricket leagues in India that is Indian Cricket League (ICL) and IPL. Dey et al. (2011) measured the on the base of their economy rate, fast bowler and spinners performance of IPL and also considered the evaluation of the average of bowling, strike rate and other different area of match to assets performance. Patel and Bhathawala (2014) studied about the probabilities of tied One day International (ODIs) tournament. Lamsal and Choudhary (2018) formulate a model for prediction of outcomes of matches. Rastogi and Deodhar (2009) learnt and understood the importance particular attributes and what could be their relative valuations. They established a relation between IPL-2008 final bid prices and the player attributes. Saikia and Bhattacharjee (2011) studied on all-rounder performers, who participated in IPL based on their economy rate and strike rate. Singh (2011) measured the performance of teams and player in the Indian Premier League. Patel and Bhathawala (2013)

analyzed about the result of the cricket test match is either a win, loss or a draw with respective probabilities. Patel and Bhathawala (2016) examined with help of the probabilities in the IPL 2015 matches use the application of waiting line theory. Petersen et al. (2008) analyzed about team, batting and bowling performances of players at the 2008 IPL competition by comparing the magnitudes of differences in key batting and bowling indicators, between losers and winners. Parker et al. (2008) observed about players valuation in the Indian Premier League and explored the determinants of valuations and investigate a number of hypotheses related to the design of the auction. Patel and Bhathawala (2015) studied about ICC World cup T-20 played in 2014. They found the service rate and the arrival rate of the pitch which serves to batsmen finally they determined the probability about winner of first innings and second innings in T-20 match.

In this paper, we analyzed the arrival rate use the service by service node for waiting batsman using the queuing model. So we can use the queuing theory to an Indian Premier League. On the basis of arrival rate we conclude about the matches of Indian Premier League. Section two and three explained about the basic assumptions and M/M/1 queuing model. In the fourth section, some common measures of queuing theory have been derived. Finally, numerical illustration and discussion of the results has been presented.

2. Basic Assumptions of the Proposed Model:

Let us consider
(i) There is no chance for rain or bad light.
(ii) No batsmen are injured, retired hurt, absent or covid-19 affected in IPL-T20
(iii) First two opener batsman are padded and waiting for his turn.
(iv) Arrival of cricketer's, crowed and staff follows the queuing system.
(v) finally we assumed that queuing system is to be steady state.
In this we use waiting line model M/M/1 because first time Cricket pitch serves only opener batsmen.

3. IPL Based on M/M/1 Queuing Model:

In a cricket ground there are finite servers (Pitches) but only one server can use at rule of cricket match therefore we use M/M/1 queuing model in which system have a single (Pitch) and arrivals λ (Batsman) are determined by Poisson process and service μ is exponential. So let arrivals rate (for the batsman)is λ and service rate (for the batsman)is μ.

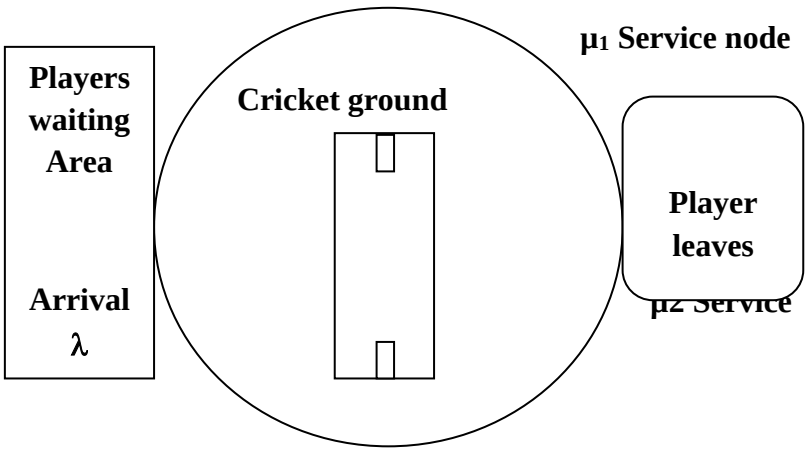

Figure 3.1 M/M/1 Queuing Model in IPL T-20 Match

In each IPL-T20 matches, two innings will happen and in each innings **$1 < \lambda \leq 11$** batsmen can use service node μ_1 andμ_2 according to T-20 rule. So let maximum number of batsmen be n=11. Let $\rho = \lambda/\mu$. The probability P(n) of having n batsman in the system.

$$P_n = \rho^n P_0 \quad where\ 1 \leq n \leq 11 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

When zero batsman is in cricket pitch that means first inning is over. So we find P_0 using equation (1) and taking summation from 1 to 11.

$$P_0 = \frac{1-\rho}{\rho(1-\rho^n)} \quad where\ 1 \leq n \leq 11 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

4. Some Common Queuing Measures:

In a queuing situation most commonly used measures are
Number of batsman in the system = L_S
Number of batsman in queue = L_q
Waiting time for the next batsman in the system = W_S
Expected waiting time for next batsman in the queue = W_q
And use the little formula we can find out the relation between Ls and Ws (also Lq and Wq). So
Ls = λWs
Lq = λWq
It shows that in the system with the increment of weighting time, batsmen's numbers also increase and vice versa with the decreasing of waiting time batsmen's numbers also decrease in system.

5. Numerical Illustration and Discussion of the Results:

In our model $1 \leq n \leq 11$ that means maximum number of batsman is 11 and number of over is limited for batsman in each innings IPL T-20 match will have a result if n=22 batsman are served or we can say if 22 wickets are down, IPL T-20 match have a result.

Now let us scrutinize the probability of wining of both the teams of T-20,who is batting first and who balling first.

Probability of arrival rate for first innings when less than or equal to 11 batsman are in the system $P_0 = \sum_1^{11} \frac{1-\rho}{\rho(1-\rho^n)}$ where $\rho = 5.5$

After calculation we get P_0 = 0.2158 (Decimal four place approx)

Remaining probability i.e. more than 11 batsmen in system in each innings

$$= 1 - \sum_1^{11} \frac{1-\rho}{\rho(1-\rho^n)}$$

$$= 0.7842$$

In other words, we can say 21.58% is probability of arrival rate when all batsmen use the service by service node and 78.42% is arrival rate when less than 11 batsman use the service by service node. We observed that in IPL T-20 sometimes in the match no wicket or one wicket or two wickets etc. had fallen in IPL T-20 match and match had resulted (win or loss) in maximum time. We have already found out our calculation using our model so in this case arrival rate are varied or nearer thus commonly we can say that the arrival rate of our IPL T-20 match is 21.58% when all batsmen use the service by service node and 78.42% is arrival rate when less than 11 batsmen use the service by service node. This arrival rate can be verified from the actual IPL T-20 record (As on 02 May 2021).

Table -1 IPL T-20 record

Team	**Matches**	**Won**	**Loss**	**Win%**	**Loss%**
RCB	203	94	102	46.30	50.24
MI	209	121	84	57.9	40.20
DD	202	89	107	44.05	52.90
KKR	199	100	95	50.3	47.73
CSK	186	111	73	59.6	39.24
RR	171	84	82	49.12	47.90
SRH	131	66	61	50.3	46.50
KXIP	198	88	106	44.45	53.53
TOTAL	1499	753	710	50.23	47.36

excluding no result, tied & won, tied & loss.

From this table 1, we observe that winning percent & loss percent lies in 21.58% to 78.42%. That means we can say average arrival rate or (wicket fallen) in each inning of IPL T-20 batsmen is near to 5 to 6 wickets use the service by service node.

6. **Conclusion:**

It has been observed from the above calculation that in the IPL T-20 match arrival rate is 21.58% when all batsmen use the service by service node and 78.47% is arrival rate when less than 11 batsmen use the service by service node . Hence the waiting line theory can be used in an IPL T-20 match to calculate the arrival rate. This proposed development would be useful for IPL players, franchisees owners, and sports literature analysis.

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