Nanotechnology Perceptions
ISSN 1660-6795
www.nano-ntp.com

Queuing Theory and Its Impact on the Indian Premier League

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In an Indian Premier League game, the innings are opened by two openers. This indicates that one down batsman or the third position batsman is waiting in a dressing room, or alternatively, we may say that the third batsman is in a queue, while one pair of batsmen is batting. Using the queuing model, we can determine the arrival rate for waiting batsmen by service node. Thus, we may apply the notion of queuing to the Indian Premier League. We draw conclusions regarding the Indian Premier League matches based on the arrival rate.
Keywords: Indian Premier League, Queuing Theory, M/M/1 Model.

1. Introduction

Eight clubs or ten clubs from different Indian cities compete in the professional Twenty20 cricket tournament known as the Indian Premier tournament (IPL). The Board of Control for Cricket in India (BCCI) established the league in 2007. Held annually, typically in March and May, it has a special place in the ICC Future Tours Programme. The world's most popular cricket league is the Indian Premier League. The Indian Premier League (IPL) had16th season, the Chennai Super Kings (CSK), who won the 2023 season, is the current IPL champions. The COVID-19 pandemic forced a site change for the 2020 season, with games taking place in the United Arab Emirates.

One of the most well-liked sports for individuals of all social classes is cricket. Cricket offers the highest degree of unpredictability, particularly in the Twenty20 format, when a single over may drastically alter the course of play. In the bat and ball game of cricket, two teams of eleven players each compete. When the Indian Premier League (IPL), a twenty-over-aside competition with eight teams named after different Indian cities/states, began in 2008, the game of cricket gained a new dimension. The players were chosen by competitive bidding from a pool of available players, and the teams were run by franchisees. The media in India gives this game more preference because of its immense popularity.

The Board of Control for Cricket in India (BCCI) established the professional Twenty20 cricket league known as the Indian Premier League (IPL) in April 2008. Vig (2008) conducted

research on the effects of India's two cricket leagues, the Indian Premier League (IPL) and the Indian Cricket League (ICL). Dey et al. (2011) evaluated the rankings of the Fast-bowlers and Spinners in the IPL (I, II, and III) based on their performances, which included metrics such as economy rate, bowling average, and bowling strike rate.

The applicability of queuing theory to ICC One Day Internationals was discovered by Patel & Bhathawala (2014), who also calculated the odds of tied ODIs, including no result (NR) and resulted ODIs. A model was created by Lamsal & Choudhary (2018) to forecast the results of its matches. Rastogi and Deodhar (2009) construct a relationship between the player traits and the final bid prices of the IPL-2008 by determining which attributes appear to be significant and what their relative worth would be. Saikia and Bhattacharjee (2011) conducted research on the strike and economy rates of every player that took part in the Indian Premier League.

Singh (2011) conducted an assessment of Indian Premier League teams' performance. After applying queuing theory to a cricket test match, Patel & Bhathawala (2013) came to the conclusion that there are two possible outcomes: a draw with equal probability or a win (by any one of the two teams). Using queuing theory as a case study, Patel and Bhathawala (2016) looked at the odds of the Indian Premier League (IPL) 2015 matches. By comparing the sizes of variations in important batting and bowling indicators between winning and losing teams, Petersen et al. (2008) examined team, batting, and bowling performances during the 2008 Indian Premier League Twenty/20 Tournament (IPL).

Parker et al. (2008) investigated the factors influencing player valuations in the Indian Premier League and looked into several theories on auction design. In their article, "ICC World Twenty20-2014 (World Cup-2014)-A Case Study," Patel & Bhathawala (2015) calculated the chance of winning a Twenty20 match by the first and second innings as well as the arrival and service rates of the pitch that serves the batsmen.

In this research, we used the queuing model to assess the arrival rate utilization of the service by service node for the waiting batsman. Thus, we may apply the notion of queuing to the Indian Premier League. We draw conclusions regarding the Indian Premier League matches based on the arrival rate. Sections two and three provided an explanation of the proposed model's fundamental assumptions. Section 4 presents a standard measure of queuing. Lastly, a discussion of the results and a numerical illustration are given.

2. Fundamental Premises of the Suggested Model:

Let us consider

i. Neither bad light nor rain is possible.

ii. In the IPL-T20, no batter is hurt, retired, absent, or impacted by COVID-19.

iii. The first two batsmen to bat are padded and are awaiting their turn.

iv. When cricket players, spectators, and staff arrive, they queue up.

v. At the end, we anticipated that the queuing system would operate in a steady state.

vi. Since only the opener batsman is serviced on the cricket pitch at any given moment, we are using the M/M/1 queuing model in this case.

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

There are finite servers (Pitches) on a cricket pitch, but only one server may be used at any given time. For this reason, we employ the M/M/1 queuing model, in which there is only one system (Pitch), arrivals (Batsman) λ are determined by the Poisson process, and service μ is exponential. Thus, let the rate of arrivals (Batsman) per unit of time be λ and the rate of service (for Batsman) per unit of time be μ.

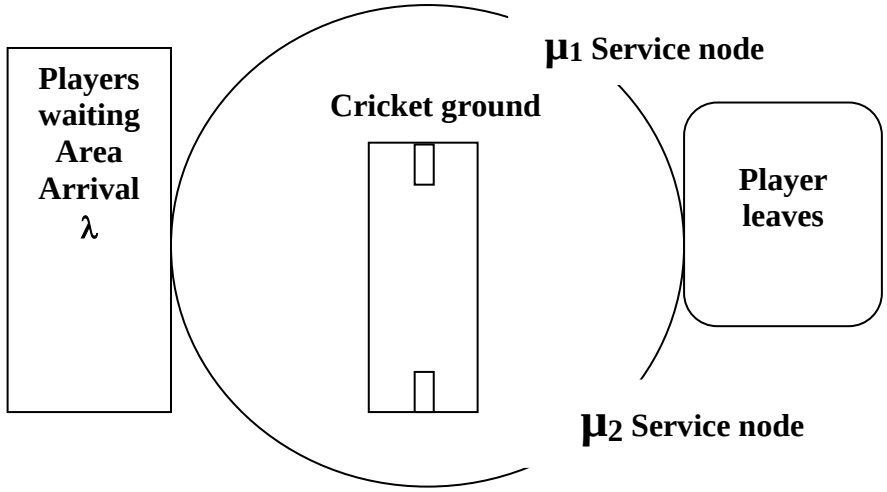

Figure 3.1 Model of M/M/1 Queuing for IPL T-20 Match

In each IPL-T20 matches, two innings will happen and in each innings $1 \leq \lambda \leq 11$batsman can use service node μ_1 andμ_2 according to T-20 rule.

Thus, let n=11 as the maximum number of batsmen. Let $\rho = \lambda/\mu$. The probability P(n) of having n batsman in the system.

$$P_n = \rho^n P_0 \text{where } 1 \leq n \leq 11 \qquad \dots\dots\dots\dots\dots\dots\dots (1)$$

A cricket match's first inning concludes when there are no more batsmen available.

So we find P_0 using equation (1) and taking summation from 1 to 11.

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

4. Several Standard Queuing Techniques:

When there is a line, the most widely employed strategies are

Ls = Expected number of batsman in the system.

Lq = Expected number of batsman in queue.

Ws = Expected waiting time for next batsman in the system.

Wq = Expected waiting time for next batsman in the queue.

And use the little formula we can find out the relation between Ls and Ws (also Lq and Wq).
$Ls = \lambda Ws$

$Lq = \lambda\ Wq$

It demonstrates that as system waiting times rise, so does the expected number of batsmen, and that as system waiting times fall, so does the expected number of batsmen. Similarly, an increase in queue waiting time should result in a corresponding rise in the number of batsmen in queue. The number of batsmen in queue should decrease if the waiting period is shortened, and vice versa.

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 there is a cap on the number of over's a batsman can play in each innings. If n = 22 batsmen are served, or if 22 wickets are lost, the IPL T-20 match is declared a winner.

In a T-20 encounter, we aim to determine the likelihood that the team batting first will prevail and the likelihood that the team batting second will do so.

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

$$= 1 - \sum_{1}^{11} \frac{1-\rho}{\rho(1-\rho^n)} = 0.7842$$

Stated otherwise, the likelihood of an arrival when every batsman uses a service by a service node is 21.58%, whereas the likelihood of an arrival when less than 11 batsmen use a service by a service node is 78.42%.

We noticed that in IPL T-20 matches, there have occasionally been no wickets falling, one wicket falling, two wickets falling, etc., and the match has concluded (win or defeat) in the shortest amount of time. In general, 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% when fewer than 11 batsmen use the service by service node. We have already determined our calculation using our model, so in this case the arrival rate is varied or nearer. The actual IPL T-20 record can be used to confirm this arrival rate (As of 30 May 2023).

Table -1

Team	Matches	Won	Loss	Win%	Loss%
RCB	241	114	120	48.73	51.27
MI	247	138	105	56.68	43.32
DD	238	105	127	45.33	54.67
KKR	237	119	114	51.05	48.95
CSK	225	131	91	58.96	41.04
RR	206	101	100	50.24	49.76
SRH	166	78	84	48.19	51.81
KXIP	232	104	124	45.68	54.32
TOTAL	1792	890	865	50.6	49.39

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

This table shows that the winning and losing percentages range from 21.58% to78.47%. This indicates that the average arrival rate, or wicket fell, for IPL T-20 batsmen in an inning is close to five to six wickets per service node. Regarding the real IPL T-20 record (As of 30 May 2023).

6. Conclusion:

As a result of this research paper, we can conclude 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 only when less than 11 batsmen use the service by service node thus queuing theory can be applied to a IPL T-20 match to calculate the arrival rate. The proposed development would be useful for IPL players, franchisees owners, and sports literature analysis.

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