



Use of Queuing Model in T20 Cricket World Cup

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Abstract:

In this chapter we assay to apply queuing model in ICC T20 world cup cricket matches. In particular T20 international cricket game in which always two batsmen open the innings . The cricket match which is going to played on a 22 yard pitch is take as single server and the number one and number two batsmen in a playing team is taken as a customer and it is also assumed that third number batsmen who will wait for their turn is considered as a waiting customer. In this paper we will obtain the utilization factor of single server after considering the batting of two batsmen o a pitch. We can drive an arrival rate and service rate from observation, we will also determine probabilities of all three possible result i.e. tie, no result, win or loss. As a result , we conclude that the result of the cricket match is either a win or tie or no result with respective probabilities.

Keywords: *Cricket, Two batsmen playing on a ground, Queuing theory , T20 intenational world cup matches, two batsmen on a ground, M/M/1 queuing model, Queue, game of cricket.*

History of T20 cricket:

Origins:when the Benson Hedges cup ended in 2002 , the ECB needed another one day competition to fill its palce. Cricketing authorities were looking to boost the game populirty with the younger generation in response to dwindling crowds and reduced sponsorship. It was intended to deliver fast paced, exicting cricket accessible to thousand of fans who were put off by the lomger versions of the game . StauratRobertson , the marketing manager of the ECB , proposed a 20 over per inning game to country chairmen in 2001 and they voted 11-7 in favour of adopting the new format.

The first official Twenty20 matches were played on 13 June 2003 between the English counties in the Twenty20 Cup. The first season of Twenty20 in England was a relative success, with the Surrey Lions defeating the Warwickshire Bears by 9 wickets in the final to claim the title.The



first Twenty20 match held at Lord's, on 15 July 2004 between Middlesex and Surrey, attracted a crowd of 27,509, the highest attendance for any county cricket game at the ground – other than a one-day final – since 1953.

Spread worldwide

Thirteen teams from different parts of the country participated in Pakistan's inaugural competition in 2004, with Faisalabad Wolves the first winners. On 12 January 2005, Australia's first Twenty20 game was played at the WACA Ground between the Western Warriors and the Victorian Bushrangers. It drew a sell-out crowd of 20,000, which was the first time in nearly 25 years the ground had been completely sold out and in Indian Premier League 2008 CSK vs KKR match played. The Attendance of the match close to 100,000 at Eden Garden stadium.

Starting 11 July 2006 19 West Indies regional teams competed in what was named the Stanford 20/20 tournament. The event was financially backed by billionaire Allen Stanford, who gave at least US\$28,000,000 funding money. It was intended that the tournament would be an annual event. Guyana won the inaugural event, defeating Trinidad and Tobago by 5 wickets, securing US\$1,000,000 in prize money.

On 5 January 2007 Queensland Bulls played the New South Wales Blues at The Gabba, Brisbane. A crowd of 11,000 was expected based on pre-match ticket sales. However, an unexpected 16,000 turned up on the day to buy tickets, causing disruption and confusion for surprised Gabba staff as they were forced to throw open gates and grant many fans free entry. Attendance reached 27,653.

For 1 February 2008 Twenty20 match between Australia and India, 85,824 people attended the match at the Melbourne Cricket Ground involving the Twenty20 World Champions against the ODI World Champions.

The Stanford Super Series was held in October 2008 between Middlesex and Trinidad and Tobago., the respective winners of the English and Caribbean Twenty20 competitions, and a Stanford Superstars team formed from West Indies domestic players; Trinidad and Tobago won the competition, securing US\$280,000 prize money. On 1 November, the Stanford Superstars played England in what was expected to be the first of five fixtures in as many years with the winner claiming a US\$20,000,000 in each match. The Stanford Superstars won the first match, however, no further fixtures were held as Allen Stanford was charged with fraud in 2009.

20–20 Internationals

On 17 February 2005 Australia defeated New Zealand in the first men's full international Twenty20 match, played at Eden Park in Auckland. The game was played in a light-hearted manner – both sides turned out in kit similar to that worn in the 1980s. the New Zealand team's a direct copy of that worn by the Beige Brigade.



Some of the players also sported moustaches/beards and hair styles popular in the 1980s taking part in a competition amongst themselves for a *best retro look*, at the request of the Beige Brigade. Australia won the game comprehensively, and as the result became obvious towards the end of the NZ innings. The players and umpires took things less seriously – Glenn McGrath jokingly replayed the Trevor Chappell underarm incident from a 1981 ODI between the two sides, and Billy Bowden showed him a mock red card (red cards are not normally used in cricket) in response.

The first Twenty20 international in England was played between England and Australia at the Rose Bowl in Hampshire on 13 June 2005. Which England won by a margin of 100 runs, a record victory which lasted until 2007.

On 9 January 2006 Australia and South Africa met in the first international Twenty20 game in Australia. In a first, each player's nickname appeared on the back of his uniform, rather than his surname. The international match drew a crowd of 38,894 people at The Gabba. Australia convincingly won the match with the man of the match Damien Martyn scoring 96 runs.

On 16 February 2006 New Zealand defeated West Indies in a tie-breaking bowl-out 3–0; 126 runs were scored apiece in the game proper. The game was the last international match played by Chris Cairns – NZC handed out life-size cardboard masks of his face to patrons as they entered the ground.

History of ICC world cup Twenty 20

ICC WT20

Every two years an ICC World Twenty20 tournament is to take place, except in the event of an ICC Cricket World Cup being scheduled in the same year, in which case it will be held the year before. The first tournament was in 2007 in South Africa where India defeated Pakistan in the final. Two Associate teams had played in the first tournament, selected through the 2007 ICC World Cricket League Division One, a 50-over competition.

In December 2007 it was decided to hold a qualifying tournament with a 20-over format to better prepare the teams. With six participants, two would qualify for the 2009 World Twenty20 and would each receive \$250,000 in prize money. The second tournament was won by Pakistan who beat Sri Lanka by 8 wickets in England on 21 June 2009. The 2010 ICC World Twenty20 tournament was held in West Indies in May 2010, where England defeated Australia by 7 wickets. The 2012 ICC World Twenty20 was won by the West-Indies, by defeating Sri Lanka at the finals.

It was the first time in Cricket history when a T20 World Cup tournament took place in an Asian country. The 2014 ICC World Twenty20 was won by Sri Lanka, by defeating India at the finals,



where the tournament was held in Bangladesh. The 2016 ICC World Twenty20 was won by West Indies, by defeating England at the finals, where the tournament was held in India.

Major Twenty20 Domestic Leagues:

With this rich history of Twenty20, most of the cricketing nations set their own leagues. Which Includes:

- Bangladesh Premier League
- Natwetst T20 Blast
- Indian Premier League
- SuperSmash T20 (NZ)
- Pakistan Super League
- Global T20 League (SA)
- Super 4's T20 Cup (SL)
- Caribbean Premier League (WI)
- National T20 Cup (ZIM)
- Shpageeza Cricket League (AFG)
- Inter-Provincial Twenty20 Trophy (IRE)
- Hong Kong T20 Blitz (HK)
- Everest Premier League (Nepal)
- Women's BigBash League (AUS)
- Women's Cricket Super League (ENG)

Here is list of ICC T20 cricket world cup winners(2017-2021)

winner	Runner up	Year /host
India	Pakistan	2007/ South Africa
Pakistan	Sri Lanka	2009/England
England	Australia	2010/West Indies
West Indies	Sri Lanka	2012/ Sri Lanka
Sri Lanka	India	2014/Bangladesh
West indies	England	2016/India
Postponed due to covidpendamic	Postponed due to covid pandemic	2020/ Austrlia
Austrlia	New Zealand	2021/ UAE and OMAN
TBD	TBD	2022/ Austrlia



Assumptions:

While starting the 1st inning, the waiting customer has already padded up.

Each team has exactly 11 number of player

Each batsman complete his innings i.e. no retired hurt in inning takes place.

There is no obstructing like bad light, raining in the match.

The queuing system is assumed to be in a steady state.

M/M/1 T20 Model:

As in the single server Queuing model which has a limited number of customers in system, an T20 model can be considered as single server model which has maximum 20 number of customers given by N in both innings which are served by single server i.e. pitch of ground.

The arrival rate of the customers is denoted by λ and the service rate is given by μ .

When arrival of customers reaches its maximum limit i.e. N=20, no extra arrival of customers is allowed in the system.

So, we have
$$\lambda_n = \begin{pmatrix} \lambda, n=0,1,2,3,\dots,N-1 \\ 0, n=N,N+1,\dots \end{pmatrix}$$

$$\mu_n = \mu, n = 0,1,2, \dots \dots$$

The probability of n customers in the system given by
$$P_n = \begin{cases} \left(\frac{\lambda}{\mu}\right)^n P_0, n \leq N \\ 0, n > N \end{cases}$$

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Where P_0 denote the probability of no customers in the system and it is given by properties of probability of happening of any event is equal to one

So,
$$\sum_{n=0}^N P_n = 1$$

$$P_0 + P_1 + P_2 + \dots \dots + P_N = 1$$



$$P_0 + \left(\frac{\lambda}{\mu}\right)P_0 + \left(\frac{\lambda}{\mu}\right)^2P_0 + \dots \dots \dots \left(\frac{\lambda}{\mu}\right)^N P_0 = 1$$

$$P_0 \left[1 + \frac{\lambda}{\mu} + \left(\frac{\lambda}{\mu}\right)^2 + \dots \dots \dots \left(\frac{\lambda}{\mu}\right)^N \right] = 1$$

$$P_0 \left[\frac{1 - \left(\frac{\lambda}{\mu}\right)^{N+1}}{1 - \frac{\lambda}{\mu}} \right] = 1$$

$$P_0 = \frac{1 - \frac{\lambda}{\mu}}{1 - \left(\frac{\lambda}{\mu}\right)^{N+1}}$$

$$\text{So, } P_0 = \begin{cases} \frac{1 - \frac{\lambda}{\mu}}{\left(1 - \frac{\lambda}{\mu}\right)^{N+1}} & \text{if } \frac{\lambda}{\mu} \neq 1 \\ \frac{1}{N+1}, & \frac{\lambda}{\mu} = 1 \end{cases}$$

Hence, the probability of n customer in the system (P_n) is given by

$$P_n = \begin{cases} \frac{\left(1 - \frac{\lambda}{\mu}\right) \left(\frac{\lambda}{\mu}\right)^n}{1 - \left(\frac{\lambda}{\mu}\right)^{N+1}}, & \frac{\lambda}{\mu} \neq 1 \\ \frac{1}{N+1}, & \frac{\lambda}{\mu} = 1 \end{cases}$$

In M/M/1 ODI model, we considered that arrival rate is same as service rate so, ratio of arrival and service rate i.e. $\frac{\lambda}{\mu}$ is equal to 1

The expected number of customer in the system is given by $L_s = \sum_{n=0}^N nP_n$

$$P_0 + P_1 + 2P_2 + \dots \dots \dots NP_N$$

$$P_0 + \left(\frac{\lambda}{\mu}\right)P_0 + 2\left(\frac{\lambda}{\mu}\right)^2P_0 + \dots \dots \dots + N\left(\frac{\lambda}{\mu}\right)^N P_0$$

$$P_0 \left[1 + \frac{\lambda}{\mu} + 2\left(\frac{\lambda}{\mu}\right)^2 + \dots \dots \dots + N\left(\frac{\lambda}{\mu}\right)^N \right]$$



As, $\frac{\lambda}{\mu} = 1$ so,

$$L_s = \frac{1}{N+1} \{1 + 2 + 3 + \dots + N\}$$

$$\frac{1}{N+1} \left[\frac{N(N+1)}{2} \right] = \frac{N}{2}$$

So, as in T20 maximum number of customer is N=20 so, the expected number of customer in system is $L_s = \frac{20}{2} = 10$ which gives that 10 wickets is falling in both innings.

Here, we applied queuing model to ICC world cup match. The real record of the world cup 2019 is as under:

Match number	No of wickets in first inning	No of wickets in 2 nd inning
1	4	5
2	7	0
3	4	0
4	8	2
5	8	5
6	9	2
7	8	6
8	6	3
9	7	5
10	6	5
11	10	6
12	10	2
13	5	9
14	7	2
15	4	10
16	10	4
17	2	5
18	5	5
19	2	7
20	10	2
21	3	8
22	4	7
23	10	2
24	7	2
25	2	8
26	8	2
27	4	6



28	8	1
29	4	5
30	4	5

From this table we observe that , total number of wickets in both innings are 313 and if we find average of wickets in both innings in a particular match of a cricket T20 world cup then it comes

$313/30 = 10.4$ which is nearer to 10 that is same as from the calculation with the help of queuing model.

Now, we present a one more table of ICC T20 world cup for showing resemblance of calculated and actual expectation of number of wickets in both the innings

Number of match	Wickets in first innings	Wickets in 2 nd inning
1	7	0
2	5	6
3	6	4
4	7	4
5	8	9
6	4	8
7	5	4
8	5	10
9	9	3
10	5	7
11	5	5
12	7	9
13	7	9
14	4	8
15	8	7



16	8	10
17	4	8
18	7	8
19	6	4
20	10	2
21	8	3
22	2	3
23	9	6

Calculations of probability:

A coin is tossed to decide the team who will bat first

Let A_1 be the event that the team bat in 1st innings and A_2 be the event that the team bat in 2nd innings.

$$P(A_1) = P(A_2) = \frac{1}{2}$$

Let B_1 be event that team having 1st innings win and B_2 be the event team having 2nd innings win.

$$\text{So, } P(B_2) = P(A_2)P(n \leq 8 \text{ in } 2\text{nd innings}) = \frac{1}{2} \left(\frac{1}{11} + \frac{1}{11} + \dots + \frac{1}{11} \right) 9 \text{ times}$$

$$= \frac{1}{2} \left(\frac{9}{11} \right) = \frac{9}{22}$$

The probability of team having 1st innings win is

$$P(B_1) = P(A_1) + P(A_2)P(n = 10 \text{ in the } 2\text{nd innings}) = \frac{1}{2} + \frac{1}{22} = \frac{12}{22}$$

Probability of winning an ODI match by any one of the team is

$$P(B_1) + P(B_2) = \frac{12}{22} + \frac{9}{22} = \frac{21}{22} = 0.954$$



From the law of probability, total probability is equal to one so, probability of tied matches is

$$1-0.954=0.046$$

Probability of winning of team who will bat first or bat second is given by

$$\sum_{i=1}^n x_i p(x_i) = \frac{1}{2} \left(\frac{12}{22} \right) + \frac{1}{2} \left(\frac{9}{22} \right) = \frac{12}{44} + \frac{9}{44} = \frac{21}{44} = 0.47$$

Here, winning percentage of different team over the years is given the table:

Team	Matches	won	Lost	Tied	NR	Prob. of winning
Australia	153	79	69	2	3	0.5
Bangladesh	123	43	78	0	2	0.4
England	148	77	64	2	5	0.5
India	153	95	51	3	4	0.6
New Zealand	160	78	70	8	4	0.4
Pakistan	189	117	64	3	5	0.6
South Africa	147	85	60	1	1	0.5



Sri Lanka	148	67	77	2	2	0.5
West Indies	157	66	79	3	9	0.4

It shows that winning probabilities of each team in T20 matches is equal to 0.5 which is nearer to calculated probabilities 0.47.

Now , we will showing this result of winning or loosing the matches in T20 world cup 2021

Team	Matches	Won	Loss
England	5	4	1
Australia	5	4	1
South Africa	5	4	1
Sri Lanka	5	2	3
West Indies	5	1	4
Bangladesh	5	0	5
Pakistan	5	5	0
New Zealand	5	4	1
Indonesia	5	3	2
Afganistan	5	2	3
Namebia	5	1	4
Scotland	5	0	5

Here. Total number of matches are 60 and number of matches which are win or loss by any team is equal to 30 . Probability of winning of the T20 matches in this world is also 0.5 which match with calculated probabilities.



Moreover , in this type of T20 , we neglect the tied t20 matches because in case of tied matches in T20 the rule of ball over in earlier stage and rule of super over in later stage comes to find the result of the matches.

The table given below shows the tied matches with result obtained in super over

Match date	Country	versus	Result
16/02/2006	New Zealand	West Indies	New Zealand won in bowl out
14/09/2007	India	Pakistan	India won in bowl out
26/12/2008	New Zealand	West Indies	West indies won in super over
28/02/2010	New Zealand	Australia	New Zealand won in super over
07/09/2012	Pakistan	Australia	Pakistan won in super over
27/09/2012	Sri Lanka	New Zealand	Sri Lanka won in super over
01/10/2012	New Zealand	West Indies	West indies won in super over
30/11/2015	Pakistan	England	England won in super over
19/03/2019	South Africa	Sri Lanka	South Africa won in super over

Conclusion:

As a result, we conclude that the expected percentage of team winning batting first or second is 47.

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