



Blackjack Cards Analysis – December 2024

The Directors

Entain Plc

This is to confirm that iTech Labs has examined the game logs for blackjack games for the period **December 01, 2024, to December 31, 2024**, as recorded by the respective game servers. The game logs were for blackjack games using 8 decks. iTech Labs has analysed the blackjack cards for statistical randomness. The results of the analysis are given below.

For details on the gaming sites serviced by the Entain Plc game servers and used in this audit refer to the [List](#).

1. Blackjack hand value

Blackjack hand value analysis involved creating subsets of data and conducting Chi-square tests on each subset. Opening hands are the value of the first two cards dealt. Final hand value is the hand value at the end of the game. Dealer final hand value is based on the fixed rules of the game. Player final hand value is dependent on player strategy choice, so has no theoretical basis for comparison.

The null hypothesis for the chi-square test is that the observed frequencies of each type of hand matches the theoretical values for a deck that has been shuffled using a perfect random number generator. The p-values observed in these multiple tests are expected to follow a uniform distribution for the range 0.0 to 1.0.

The analysis performs a KS Test (Kolmogorov-Smirnov test) for uniform distribution on the observed p-values, and the combined p-value result of this test is taken as the final result of the blackjack opening hand value statistics tests.

1.1 Player's opening score (from first two cards):

Test No.	DOF	ChiSqr	P-Value
1	17	8.41	0.95708
2	17	11.08	0.85262
3	17	11.58	0.82475
4	17	9.35	0.92859
5	17	19.81	0.28415
6	17	15.81	0.53719
7	17	28.60	0.03844
8	17	17.18	0.44204
9	17	20.35	0.25649
10	17	19.53	0.29905
11	17	12.21	0.78725
12	17	9.60	0.91939
13	17	10.77	0.86807
14	17	23.24	0.14158
15	17	28.17	0.04304
16	17	17.45	0.42461
17	17	23.56	0.13179
18	17	13.68	0.68969
19	17	15.98	0.52490
20	17	15.54	0.55675
21	17	9.50	0.92341
22	17	33.64	0.00934

23	17	9.45	0.92499
24	17	20.67	0.24124
25	17	19.20	0.31734
26	17	15.32	0.57276
27	17	23.67	0.12877
28	17	14.18	0.65461
29	17	23.84	0.12376
30	17	8.75	0.94767
31	17	27.11	0.05653
32	17	20.07	0.27080
33	17	10.51	0.88108
34	17	19.29	0.31202
35	17	17.28	0.43531
36	17	12.49	0.76989
37	17	15.27	0.57581
38	17	21.34	0.21139
39	17	19.79	0.28490
40	17	14.88	0.60441
41	17	4.37	0.99907
42	17	23.33	0.13878
43	17	26.25	0.06998
44	17	10.05	0.90171
45	17	12.24	0.78508
46	17	15.78	0.53978
47	17	18.20	0.37613
48	17	30.28	0.02437
49	17	7.66	0.97323
50	17	12.45	0.77197
51	17	14.88	0.60413
52	17	18.86	0.33683
53	17	8.43	0.95637
54	17	18.72	0.34505
55	17	15.97	0.52595
56	17	22.69	0.15973
57	17	14.68	0.61819
58	17	14.10	0.65971
59	17	6.61	0.98803
60	17	22.14	0.17946
61	17	15.22	0.57971
62	17	16.47	0.49075
63	17	23.15	0.14448
64	17	16.67	0.47662
65	17	8.79	0.94658
66	17	10.89	0.86239
67	17	16.22	0.50830
68	17	17.89	0.39603
69	17	21.45	0.20685
70	17	7.88	0.96905
71	17	16.09	0.51776

72	17	22.17	0.17823
73	17	21.72	0.19563
74	17	26.71	0.06251
75	17	18.63	0.35017
76	17	13.87	0.67640
77	17	13.90	0.67399
78	17	26.99	0.05816
79	17	18.83	0.33861
80	17	11.33	0.83906
81	17	17.58	0.41597
82	17	15.29	0.57484
83	17	21.23	0.21600
84	17	11.31	0.84020
85	17	13.78	0.68227
86	17	12.51	0.76851
87	17	18.70	0.34579
88	17	11.96	0.80232
89	17	13.60	0.69498
90	17	8.59	0.95233
91	17	19.23	0.31556
92	17	15.79	0.53870
93	17	22.79	0.15611
94	17	9.26	0.93169
95	17	10.45	0.88366
96	17	23.13	0.14501
97	17	12.53	0.76687
98	17	12.08	0.79498
99	17	18.29	0.37060
100	17	18.98	0.32961
Combined P-value for all tests (Using KS method)			0.57906

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there is sufficient data.

1.2 Dealer's opening score (from first two cards):

Test No.	DOF	ChiSqr	P-Value
1	17	15.40	0.56679
2	17	12.60	0.76224
3	17	6.34	0.99062
4	17	14.75	0.61369
5	17	13.95	0.67033
6	17	16.05	0.52003
7	17	16.63	0.47976
8	17	16.32	0.50105
9	17	22.79	0.15633
10	17	14.88	0.60380
11	17	17.11	0.44717
12	17	12.53	0.76731
13	17	9.58	0.92033

14	17	22.16	0.17868
15	17	16.39	0.49626
16	17	27.25	0.05455
17	17	15.00	0.59552
18	17	17.93	0.39303
19	17	17.57	0.41658
20	17	10.74	0.86984
21	17	9.97	0.90467
22	17	18.24	0.37371
23	17	33.92	0.00860
24	17	5.02	0.99771
25	17	11.06	0.85325
26	17	24.19	0.11441
27	17	17.61	0.41387
28	17	14.38	0.63970
29	17	12.84	0.74686
30	17	20.41	0.25369
31	17	23.18	0.14333
32	17	11.83	0.81041
33	17	18.48	0.35891
34	17	22.50	0.16639
35	17	5.87	0.99402
36	17	20.82	0.23429
37	17	13.36	0.71150
38	17	29.49	0.03024
39	17	18.04	0.38611
40	17	13.61	0.69457
41	17	22.65	0.16112
42	17	21.27	0.21455
43	17	10.86	0.86385
44	17	12.53	0.76712
45	17	21.19	0.21802
46	17	18.43	0.36224
47	17	21.25	0.21518
48	17	8.88	0.94391
49	17	19.39	0.30674
50	17	39.27	0.00164
51	17	16.89	0.46204
52	17	21.48	0.20553
53	17	15.45	0.56316
54	17	21.61	0.20022
55	17	18.69	0.34688
56	17	12.36	0.77759
57	17	22.55	0.16452
58	17	23.23	0.14180
59	17	25.47	0.08465
60	17	19.18	0.31827
61	17	21.62	0.19995
62	17	8.44	0.95624

63	17	11.98	0.80114
64	17	15.62	0.55078
65	17	13.16	0.72561
66	17	16.70	0.47513
67	17	8.44	0.95610
68	17	23.11	0.14576
69	17	22.66	0.16062
70	17	18.73	0.34419
71	17	22.08	0.18181
72	17	10.50	0.88157
73	17	23.52	0.13302
74	17	14.10	0.66001
75	17	14.10	0.65972
76	17	11.82	0.81079
77	17	23.25	0.14130
78	17	20.09	0.26961
79	17	12.22	0.78665
80	17	21.06	0.22358
81	17	18.84	0.33791
82	17	15.51	0.55906
83	17	29.15	0.03319
84	17	19.06	0.32522
85	17	19.29	0.31214
86	17	29.48	0.03032
87	17	19.08	0.32424
88	17	15.61	0.55166
89	17	6.01	0.99313
90	17	12.70	0.75585
91	17	15.95	0.52705
92	17	14.47	0.63361
93	17	18.80	0.34020
94	17	18.03	0.38726
95	17	13.21	0.72201
96	17	10.85	0.86440
97	17	21.24	0.21594
98	17	25.55	0.08306
99	17	21.40	0.20890
100	17	20.40	0.25409
Combined P-value for all tests (Using KS method)			0.41938

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there is sufficient data.

1.3 Dealer's final score (total of all cards for hands with 3 or more cards):

Test No.	DOF	ChiSqr	P-Value
1	50	45.21	0.66547
2	50	46.62	0.60990
3	50	49.60	0.48931
4	50	60.80	0.14091

5	50	94.01	0.00017
6	50	63.15	0.10022
7	50	36.85	0.91669
8	50	45.11	0.66937
9	50	50.79	0.44226
10	50	40.79	0.82030
11	50	38.28	0.88690
12	50	59.68	0.16417
13	50	54.65	0.30245
14	50	47.82	0.56121
15	50	44.12	0.70736
16	50	62.72	0.10692
17	50	35.49	0.93973
18	50	37.44	0.90523
19	50	71.76	0.02345
20	50	42.69	0.75890
21	50	37.57	0.90254
22	50	45.16	0.66757
23	50	57.72	0.21147
24	50	46.59	0.61095
25	50	65.73	0.06709
26	50	32.71	0.97215
27	50	49.51	0.49307
28	50	37.16	0.91085
29	50	46.28	0.62346
30	50	43.76	0.72041
31	50	37.62	0.90143
32	50	34.80	0.94950
33	50	42.00	0.78210
34	50	35.33	0.94216
35	50	56.06	0.25805
36	50	49.55	0.49143
37	50	42.15	0.77714
38	50	45.93	0.63728
39	50	61.43	0.12893
40	50	34.32	0.95562
41	50	49.76	0.48311
42	50	45.86	0.64019
43	50	67.25	0.05217
44	50	30.66	0.98584
45	50	49.27	0.50279
46	50	67.47	0.05029
47	50	62.24	0.11475
48	50	59.46	0.16910
49	50	49.27	0.50260
50	50	61.82	0.12184
51	50	47.61	0.56963
52	50	35.35	0.94188
53	50	57.84	0.20841

54	50	48.56	0.53132
55	50	55.43	0.27739
56	50	35.37	0.94158
57	50	46.20	0.62676
58	50	53.99	0.32437
59	50	50.67	0.44698
60	50	72.67	0.01980
61	50	37.07	0.91253
62	50	51.30	0.42243
63	50	52.56	0.37522
64	50	63.67	0.09264
65	50	52.58	0.37426
66	50	59.62	0.16559
67	50	30.06	0.98856
68	50	36.90	0.91585
69	50	36.33	0.92614
70	50	55.45	0.27668
71	50	50.31	0.46128
72	50	36.80	0.91775
73	50	44.21	0.70390
74	50	52.31	0.38428
75	50	52.48	0.37818
76	50	42.65	0.76026
77	50	59.50	0.16818
78	50	44.55	0.69114
79	50	59.17	0.17564
80	50	63.85	0.09009
81	50	45.86	0.64024
82	50	38.27	0.88726
83	50	49.52	0.49271
84	50	65.85	0.06579
85	50	45.21	0.66567
86	50	50.11	0.46913
87	50	43.21	0.74033
88	50	50.29	0.46173
89	50	48.60	0.52952
90	50	42.52	0.76465
91	50	48.60	0.52972
92	50	45.07	0.67111
93	50	45.07	0.67095
94	50	49.92	0.47650
95	50	39.26	0.86313
96	50	48.44	0.53612
97	50	48.95	0.51545
98	50	41.14	0.80953
99	50	43.88	0.71634
100	50	62.19	0.11557
Combined P-value for all tests			0.15045

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there is sufficient data.

2. Blackjack rank statistics

The blackjack rank analysis aims to establish that the rank of the cards to player and dealer was equally distributed in one of the 13 possible ranks (2, 3, 4, 5, 6, 7, 8, 9, 10, J, Q, K, A).

The blackjack rank analysis involved creating subsets of data and conducting Chi-square tests on each subset. The analysis performs a KS Test (Kolmogorov-Smirnov test) for uniform distribution on the observed p-values, and the combined p-value result of this test is taken as the final result of the Ranks statistics tests.

2.1 Blackjack rank statistics for all player cards:

Test No.	DOF	ChiSqr	P-Value
1	12	12.30	0.42220
2	12	15.85	0.19829
3	12	16.74	0.15982
4	12	12.27	0.42446
5	12	8.33	0.75900
6	12	14.46	0.27209
7	12	4.78	0.96486
8	12	8.85	0.71529
9	12	10.61	0.56227
10	12	5.27	0.94841
11	12	12.14	0.43450
12	12	10.19	0.59953
13	12	4.04	0.98265
14	12	12.80	0.38349
15	12	18.56	0.09984
16	12	9.11	0.69368
17	12	19.55	0.07610
18	12	7.04	0.85524
19	12	2.88	0.99632
20	12	14.66	0.26066
21	12	6.24	0.90325
22	12	15.20	0.23052
23	12	3.85	0.98604
24	12	9.15	0.69011
25	12	5.14	0.95298
26	12	7.76	0.80339
27	12	19.35	0.08051
28	12	10.98	0.53087
29	12	8.33	0.75895
30	12	9.42	0.66698
31	12	10.55	0.56742
32	12	9.49	0.66092
33	12	3.91	0.98496
34	12	9.39	0.66896
35	12	5.15	0.95262
36	12	8.88	0.71290
37	12	5.08	0.95513

38	12	7.45	0.82621
39	12	13.51	0.33302
40	12	8.66	0.73168
41	12	8.66	0.73163
42	12	16.75	0.15943
43	12	17.63	0.12726
44	12	9.83	0.63122
45	12	9.42	0.66681
46	12	6.13	0.90935
47	12	17.85	0.12024
48	12	15.68	0.20616
49	12	7.10	0.85098
50	12	9.76	0.63701
51	12	9.78	0.63521
52	12	8.72	0.72696
53	12	18.51	0.10099
54	12	19.41	0.07917
55	12	10.14	0.60404
56	12	9.29	0.67781
57	12	10.44	0.57716
58	12	9.96	0.61925
59	12	8.12	0.77557
60	12	11.18	0.51377
61	12	3.56	0.99013
62	12	3.61	0.98949
63	12	21.00	0.05037
64	12	6.85	0.86753
65	12	15.62	0.20949
66	12	16.38	0.17448
67	12	15.00	0.24152
68	12	11.06	0.52383
69	12	11.80	0.46149
70	12	8.18	0.77113
71	12	7.59	0.81625
72	12	27.31	0.00698
73	12	11.91	0.45286
74	12	16.67	0.16259
75	12	13.04	0.36620
76	12	28.05	0.00543
77	12	5.73	0.92888
78	12	11.71	0.46965
79	12	9.92	0.62267
80	12	9.13	0.69137
81	12	18.84	0.09234
82	12	19.28	0.08192
83	12	10.86	0.54067
84	12	7.97	0.78728
85	12	9.03	0.70029
86	12	11.29	0.50405

87	12	17.48	0.13248
88	12	18.32	0.10635
89	12	9.28	0.67852
90	12	15.27	0.22696
91	12	11.89	0.45457
92	12	6.48	0.89016
93	12	16.52	0.16843
94	12	12.98	0.37060
95	12	11.51	0.48547
96	12	9.25	0.68175
97	12	11.87	0.45606
98	12	11.35	0.49957
99	12	12.97	0.37159
100	12	16.44	0.17196
Combined P-value for all tests (Using KS method)			0.33895

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there is sufficient data.

2.2 Blackjack rank statistics for all dealer cards:

Test No.	DOF	ChiSqr	P-Value
1	12	8.31	0.76051
2	12	8.71	0.72745
3	12	13.42	0.33940
4	12	12.67	0.39366
5	12	8.15	0.77345
6	12	11.17	0.51441
7	12	10.01	0.61470
8	12	12.81	0.38320
9	12	10.37	0.58376
10	12	12.61	0.39838
11	12	10.46	0.57543
12	12	11.81	0.46138
13	12	8.81	0.71924
14	12	19.92	0.06866
15	12	12.62	0.39737
16	12	15.21	0.23035
17	12	12.55	0.40225
18	12	8.05	0.78153
19	12	3.91	0.98493
20	12	9.80	0.63370
21	12	13.56	0.32951
22	12	10.54	0.56848
23	12	15.07	0.23770
24	12	14.10	0.29430
25	12	12.78	0.38491
26	12	9.87	0.62767
27	12	11.80	0.46166
28	12	14.42	0.27477
29	12	13.10	0.36154
30	12	17.97	0.11649
31	12	14.63	0.26238
32	12	5.89	0.92177

33	12	11.42	0.49310
34	12	14.66	0.26074
35	12	20.99	0.05053
36	12	12.25	0.42551
37	12	11.03	0.52594
38	12	30.47	0.00237
39	12	14.36	0.27825
40	12	9.64	0.64741
41	12	11.14	0.51682
42	12	18.17	0.11058
43	12	16.01	0.19091
44	12	4.83	0.96328
45	12	11.83	0.45973
46	12	14.43	0.27380
47	12	9.08	0.69632
48	12	4.59	0.97029
49	12	7.32	0.83571
50	12	20.09	0.06532
51	12	14.45	0.27262
52	12	9.48	0.66143
53	12	9.01	0.70191
54	12	23.64	0.02279
55	12	19.38	0.07972
56	12	15.38	0.22130
57	12	11.09	0.52155
58	12	19.74	0.07223
59	12	5.53	0.93794
60	12	12.77	0.38586
61	12	13.81	0.31279
62	12	5.46	0.94074
63	12	17.73	0.12399
64	12	11.23	0.50946
65	12	14.40	0.27591
66	12	13.42	0.33932
67	12	10.79	0.54662
68	12	13.24	0.35163
69	12	14.24	0.28588
70	12	10.12	0.60512
71	12	11.18	0.51348
72	12	12.34	0.41891
73	12	9.99	0.61703
74	12	15.52	0.21410
75	12	6.50	0.88862
76	12	6.83	0.86840
77	12	15.55	0.21269
78	12	9.78	0.63537
79	12	9.73	0.63927
80	12	9.85	0.62929
81	12	18.27	0.10766
82	12	12.55	0.40276
83	12	9.46	0.66279
84	12	26.03	0.01062
85	12	9.12	0.69249
86	12	12.15	0.43360
87	12	19.74	0.07222
88	12	9.85	0.62913

89	12	12.93	0.37384
90	12	4.90	0.96118
91	12	11.81	0.46096
92	12	11.44	0.49156
93	12	16.68	0.16211
94	12	6.85	0.86724
95	12	5.03	0.95700
96	12	7.43	0.82797
97	12	19.47	0.07777
98	12	7.27	0.83922
99	12	14.66	0.26054
100	12	22.06	0.03685
Combined P-value for all tests (Using KS method)			0.18880

Notes:

- 1) The P-values are observed probabilities from the Chi-Square tests. The last row shows the result of the KS Test performed on the p-values for all Chi-Square tests, where there is sufficient data.

4. Summary of the analysis of blackjack tests

The Blackjack cards analysis is completed by combining the result of the KS Test performed in the two types of analysis (Hand Values and Ranks) for using the Holm's method and producing a single Combined P -value.

The combined p-value produced using the Holm's method is used as an indication for statistical randomness.

Combination of p-values using Holm's Method		
Test	P-Value	P-Adjusted
Opening Score (Player)	0.57906	1.00000
Opening Score (Dealer)	0.41938	1.00000
Dealer's Final Score	0.15045	0.75224
Player Cards Rank	0.33895	1.00000
Dealer Cards Rank	0.18880	0.75519
Combined P-Value using Holm's Method		0.75224

Notes:

- 1) The combined p-value of all statistical tests using Holm's Method conducted for blackjack is greater than the minimum value of 0.05 which indicates that the randomness of the observed data falls within 95% confidence limits.

The final outcome of the analysis of blackjack indicates that the RNG is working correctly.

5. Conclusion

Analysis of actual data from game logs for 'player opening score', 'dealer opening score', 'dealer final score', 'player card rank' and 'dealer card rank' indicated statistical randomness. The results were satisfactory for 8 decks blackjack.

We conclude that the Random Number Generator (RNG) is working correctly.

iTech Labs has done limited sanity checks to verify the integrity of the game logs. iTech Labs also maintains a copy of the game logs for verification purposes. There were a large enough number of game records to give the calculations sufficient statistical power.

The scope of the review did not include reviews of financial controls or casino operations. We believe that the probabilities were calculated correctly from the game logs.

Please click [here](#) to see the [Original](#) report.

Signed:



Divya Bhargava
Project Manager
iTech Labs Australia
Date: 04 February 2025

Signed:



Alvin Rizaldi
Chief Executive Officer
iTech Labs Australia
Date: 04 February 2025

Disclaimer.

While it is not possible to test all possible scenarios in a laboratory environment, iTech Labs has conducted a level of testing appropriate for a component test of this type.