IB MATH STUDIES INTERNAL ASSESMENT

What is the relationship between soccer teams experiencing better results and sacking their manager?

Candidate Number:
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Introduction:

      As a Manchester United (Man U) fan, watching the premier league the last few years has not been amazing. For years now, most fans, including myself, have been agonizing over watching our team play; seeing our team lose, draw, or play in an incredibly dull fashion. That is until Ole Gunner Solskjaer arrived. In the 2018/19 season Manchester United fired Jose Mourinho and appointed Ole Gunner Solskjaer to manage the team. Ole went on to become the first Man U manager to win his opening 6 matches, broke the record for most points won in the opening 10 matches, and broke the club record for consecutive away wins. This made me wonder, why did he do so well with the same squad as the previous manager had? What made him different? I also noticed that another team, Leicester City, seemed to always do fantastic right after firing a manager. Out of curiosity, I browsed reddit for something about it, and users seemed to come to a consensus that the "new manager bounce" is real, but no one had much evidence for it. My goal here is to investigate the basis of the myth.

Task:

      The task of this IB math studies IA is to determine if there is a relationship between a team sacking their manager and the team experiencing better results. The term sacking simply means firing in this context. The premier league frequently has teams which sack their manager in hopes of finding a manager to lead the team to a good season. As I quite enjoy watching the premier league and also play fantasy premier league (essentially fantasy football but for soccer), the topic will be interesting to investigate as it could provide me insight as to which teams may receive a boost in performance. To do this, I will be comparing the results (wins, losses, and draws) a team achieves in a period of 12 games; 6 games before a team sacks their manager, 6 games after a team sacks their manager, and 12 games where a team does not sack their manager at all.

Plan:

      The data that will be collected are the results that 50 teams experienced in a 12-game period, 6 before sacking their manager and 6 after sacking their manager, or for the control, 12 games while not sacking their manager. The teams being observed are 25 teams over the course of the last 5 seasons in the premier league who sacked their manager, and 25 teams that did not select their number which were selected by a random number generator. The experimental group were selected just because they were the most recent 25 teams to sack their managers midway through a season in the premier league. The control group were the rest of the teams in the premier league for the last 5 seasons which were assigned a number and selected by a random number generator. The results observed were attained from the official premier league website results section – "https://www.premierleague.com/results" - while the information about which teams sacked their manager midway through the season were attained from the website "https://www.thesackrace.com/managerial-casualties". This data will be organized in the form of tables showing the group its from (experimental or control), team names, wins, losses, and draws over a course of 6 games before or after a manager being sacked. The simple math processes that will be used are calculation of mean, and standard deviation. The calculation of the mean will be able to simplify the understanding of the results achieved by each group. It will show the average results for teams before sacking managers and after, and for teams who didn't sack their managers

at all. This will be used to reinforce the further math to show that there is a significant change. Standard deviation is used to see if there is a wide measurement of variability in my hypothesis. This will show how precise my information is and whether or not my theory is valid. The further math used are Chi-squared tests. Chi-squared tests are used to test how likely an observed distribution is due to chance. This will reveal how true the "new manager bounce" is or whether its just coincidence that it occurs. I believe that it will be shown that the boost in form the teams feel after sacking a manager will not be due to coincidence, that they do experience better results after firing their managers.

Raw Data:

Teams 6 Games Before Sacking Manager			
Teams	Wins	Losses	Draws
Fulham	0	6	0
Southampton	0	2	4
Manchester United	1	2	3
Huddersfield	0	5	1
Leicester City	0	5	1
Leicester City*	0	3	3
Everton	0	5	1
West Ham United	1	3	2
West Bromwich Albion	0	4	2
Swansea City	1	4	1
Stoke City	1	4	1
Watford	1	4	1
West Bromwich Albion*	0	6	0
Swansea City*	0	5	1
Crystal Palace	1	4	1
Hull City	0	4	2
Leicester City**	0	5	1
Sunderland	0	3	3
Liverpool	1	2	3
Aston Villa	0	6	0
Chelsea	1	4	1
Newcastle	1	5	0
Crystal Palace*	2	4	0
Aston Villa*	0	6	0
West Bromwich Albion	1	4	1

Teams 6 Games After Sacking Manager			
Team	Wins	Losses	Draws

Fulham	1	3	2
Southampton	2	4	0
Manchester United	6	0	0
Huddersfield	1	5	0
Leicester city	5	1	0
Leicester City*	3	1	2
Everton	3	2	1
West Ham United	1	3	2
West Bromwich Albion	1	1	4
Swansea City	1	3	2
Stoke City	1	2	3
Watford	3	2	1
West Bromwich Albion*	3	1	2
Swansea City*	1	3	2
Cystal Palace	0	5	1
Hull City	2	2	2
Leicester City**	5	1	0
Sunderland	2	3	1
Liverpool	2	2	2
Aston Villa	0	4	2
Chelsea	2	0	4
Newcastle	1	3	2
Crystal Palace*	2	3	1
Aston Villa*	0	5	1
West Bromwich Albion	2	1	3

Teams 6 games while they did not sack their manager			
Team	Wins	Losses	Draws
Wolverhampton Wanderers	4	1	1
Watford	2	3	1
Everton	1	5	0
Burnley	3	0	3
Brighton	1	4	1
Arsenal	2	3	1
Newcastle United	1	4	1
Chelsea	3	2	1
Tottenham Spurs	5	1	0

Bournemouth	3	1	2
Bournemouth*	1	4	1
Liverpool	4	1	1
Southampton	1	3	2
Stoke	2	2	2
Watford	2	2	2
Manchester City	3	0	3
Everton	3	3	0
Leicester City	1	4	1
West Bromwich Albion	2	1	3
Tottenham Spurs*	4	2	0
Chelsea*	4	1	1
Southampton	2	3	1
West Ham	2	2	2
Stoke City	4	1	1
Hull City	0	4	2

Teams 6 games further while not sacking their manager			
Teams	Wins	Losses	Draws
Wolverhampton Wanderers	3	2	1
Watford	1	1	4
Everton	0	5	1
Burnley	2	4	0
Brighton	0	3	3
Arsenal	4	2	0
Newcastle United	2	2	2
Chelsea	3	2	1
Tottenham Spurs	5	1	0
Bournemouth	1	2	3
Bournemouth*	2	3	1
Liverpool	5	1	0
Southampton	2	3	1
Stoke	1	4	1
Watford	3	3	0
Manchester City	1	4	1
Everton	0	3	3
Leicester City	3	3	0
West Bromwich Albion	2	3	1
Tottenham Spurs*	4	0	2
Chelsea*	3	2	1

Southampton*	3	2	1
West Ham	1	5	0
Stoke City	2	3	1
Hull City	1	5	0

Simple Math:

The calculation of the mean will be able to simplify the understanding of the results achieved by each group. It will show the average results for teams before sacking managers and after, and for teams who didn't sack their managers at all.

Calculating the mean:

Teams 6 games before sacking-

Wins:

$$\frac{0+0+1+0+0+0+0+1+0+1+1+1+0+0+1+0+0+0+1+0+1+1+2+0+1}{25} = .48$$

Losses:

$$\frac{6+2+2+5+5+3+5+3+4+4+4+4+6+5+4+4+5+3+2+6+4+5+4+6+4}{25} = 4.2$$

Draws:

$$\frac{0+4+3+1+1+3+1+2+2+1+1+1+0+1+1+2+1+3+3+0+1+0+0+0+1}{25} = 1.32$$

Teams 6 games after sacking-

Wins:

$$\frac{1+2+6+1+5+3+3+1+1+1+1+3+3+1+0+2+5+2+2+0+2+1+2+0+2}{25} = 2$$

Losses:

$$\frac{3+4+0+5+1+1+2+3+1+3+2+2+1+3+5+2+1+3+2+4+0+3+3+5+1}{25} = 2.4$$

Draws:

$$\frac{2+0+0+0+0+2+1+2+4+2+3+1+2+2+1+2+0+1+2+2+4+2+1+1+3}{25} = 1.6$$

Teams 6 games not sacking-

Wins:

$$\frac{4+2+1+3+1+2+1+3+5+3+1+4+1+2+2+3+3+1+2+4+4+2+2+4+0}{25} = 2.4$$

Losses:

$$\frac{1+3+5+0+4+3+4+2+1+1+4+1+3+2+2+0+3+4+1+2+1+3+2+1+4}{25} = .28$$

Draws:

$$\frac{1+1+0+3+1+1+1+1+0+2+1+1+2+2+2+3+0+1+3+0+1+1+2+1+2}{25} = 1.32$$

Teams 6 games further not sacking-

Wins:

$$\frac{3+1+0+2+0+4+2+3+5+1+2+5+2+1+3+1+0+3+2+4+3+3+1+2+1}{25} = 2.16$$

Losses:

$$\frac{2+1+5+4+3+2+2+2+1+2+3+1+3+4+3+4+3+3+3+0+2+2+5+3+5}{25} = 2.72$$

Draws:

$$\frac{1+4+1+0+3+0+2+1+0+3+1+0+1+1+0+1+3+0+1+2+1+1+0+1+0}{25} = 1.12$$

Teams	Wins	Losses	Draws
Teams 6 games before sacking their manager	.48	4.2	1.32
Teams 6 games after sacking their manager	2	2.4	1.6
Teams 6 games while not sacking manager	2.4	2.28	1.32

Teams 6 games further while not sacking manager	2.16	2.72	1.12

Standard Deviation:

The calculation of standard deviation will show the difference of number of wins, losses, and draws before and after sacking their manager, or while they did not sack their managers at all.

Sacking Manager

Standard Deviation, σ: **28.746014216467**

Count, N: 6
Sum, Σx: 300
Mean, μ: 50
Variance, σ²: 826.33333333333

Steps

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}.$$

$$\sigma^2 = \frac{\Sigma(x_i - \mu)^2}{N}$$

$$= \frac{(12 - 50)^2 + ... + (105 - 50)^2}{6}$$

$$= \frac{4958}{6}$$

$$= 826.33333333333$$

$$\sigma = \sqrt{826.33333333333}$$

$$= 28.746014216467$$

Not Sacking manager

Standard Deviation, σ: **14.502873278538**

Count, N: 6
Sum, Σx: 300
Mean, μ: 50
Variance, σ²: 210.33333333333

Steps

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2}.$$

$$\sigma^2 = \frac{\Sigma(x_i - \mu)^2}{N}$$

$$= \frac{(60 - 50)^2 + ... + (28 - 50)^2}{6}$$

$$= \frac{1262}{6}$$

$$= 210.33333333333$$

$$\sigma = \sqrt{210.33333333333}$$

$$= 14.502873278538$$

Chi Squared:

To find whether or not there is a relationship between sacking a manager and experiencing better results, a chi squared test will be used. The chi-squared test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories. A chi-squared test can be used to attempt rejection of the null hypothesis that the results of a team is independent of sacking of a manager.

$$x^2 calc = \frac{\Sigma(o - e)^2}{e}$$

Results of Game	Teams 6 Games Before Sacking Manager	Teams 6 Games After Sacking Manager	Total
Wins	12	50	62
Losses	105	60	165
Draws	33	40	73
Total	150	150	300

Degrees of Freedom: df = (r-1) (c-1) df = (3-1)(2-1) = 2
Significance level: .05
$x^2 critical: 5.99$
Null Hypothesis (H_o): Teams 6 games before or after sacking manager and result of the games are independent
Alternative Hypothesis (H_1): Teams 6 games before or after sacking manager and result of the games are not independent

Expected Value: The expected number value of Teams 6 games after sacking the manager resulting in total number of wins, losses, or draws

Formula: ev = row total × column total / grand total

Expected Value Table:

Results of Game	Teams 6 Games Before Sacking Manager	Teams 6 Games After Sacking Manager
Wins	31	31
Losses	82.5	82.5
Draws	36.5	36.5

o	e	o - e	$\dfrac{\sum(o-e)^2}{e}$
12	31	-19	11.64
50	31	19	11.64
105	82.5	22.5	6.136
60	82.5	-22.5	6.136
33	36.5	-3.5	0.335
40	36.5	3.5	0.335
			Total: 36.222

p-value: 0.000000001354

$x^2 calc$: 36.222

Degrees of freedom: 2

Conclusion: Since $x^2 calc$ (36.222) is > then $x^2 critical$ (5.99), there is statistical significance. We reject the null hypothesis. Teams 6 games before or after sacking manager and result of the games are not independent.

 Chi Squared Controls:

      To find whether or not there is a relationship between results of games while not sacking a manger a chi-squared test will be used. The chi-squared test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories. A chi-squared test can be used to attempt rejection of the null hypothesis that the results of a team is independent of not sacking their manager.

$$x^2 calc = \frac{\sum(o-e)^2}{e}$$

Results of Game	Teams 6 games while they didn't sack their manager	Teams 6 games further while not sacking their manager	Total
Wins	60	54	114
Losses	57	68	125

Draws	33	28	61
Total	150	150	300

Degrees of Freedom: df = (r-1) (c-1) df = (4-1)(2-1) = 3

Significance level: .05

$x^2 critical: 5.99$

Null Hypothesis (H_o): Teams 6 games while or further while not sacking manager and result of the games are independent

Alternative Hypothesis (H_1): Teams 6 games while or further while not sacking manager and result of the games are not independent

Expected Value: The expected number value of Teams 6 games further while not sacking the manager resulting in total wins, losses, or draws

Formula: ev = row total × column total / grand total

Expected Value Table:

Results of Game	Teams 6 Games While Did Not Sack their Manager	Teams 6 Games Further While Sacking Their Manager
Wins	57	57
Losses	62.5	62.5
Draws	30.5	30.5

x^2 calc:

o	e	o - e	$\dfrac{\sum(o-e)^2}{e}$
60	58.94	1.06	0.01906
54	60.36	-6.36	0.67013
57	64.63	-7.63	0.90077
68	55.051	12.94	3.04584
33	31.54	1.46	0.67584
28	29.45	-1.45	0.07139
			Total: 5.38303

p-value: 0.428779

$x^2 calc$: 5.38303

Degrees of freedom: 2

Conclusion: Since x^2 calc (5.38) < x^2 critical (5.99) there is no statistical significance. We failed to reject the null hypothesis, there is insufficient evidence. Teams 6 games while or further while not sacking manager and result of games are independent.

Conclusion:

The final calculations showed that there is a relationship between a team sacking their manager and experiencing better results. The data was able to provide the information used to show the mean as well as allowing for the chi-square tests to be done. The chi-square test showed that there is a relationship between a team sacking their manager and results of wins, losses, and draws. This essentially revealed and supported my previous hypothesis that they are not independent. I was able to follow my plan without straying, and I was able to carry out the project smoothly. The limitations of not choosing a large sample size can be fixed by incorporating teams from all over the world and not just the premier league. Also, to better factor in other variables, the data can be more specific such as goals scored and assists made. Focusing more on individual player performance could have shown how a manager really affects his team, and could have showed different values of each team during these periods.

Validity:

Although for the most part the project was fine without any problems, there were a couple of limitations. Instead of using more leagues than just the premier league, I stuck to one domestic league. It may be possible that any answer found here is only applicable to the Premier league. The sample size was relatively small to what it could have been, so it may not apply to all populations. In order to make it apply more to soccer in general, I could have used teams from all over the world. The other limitation is that numbers can only provide so much insight as to what is really occurring. Often times team will play beautiful soccer and do well but get unlucky, so the numbers don't match their performance. To improve the preciseness of investigating whether or not teams truly do experience an increase in performance, more data can be looked at such as more specific statistics like passes made or shots blocked. Although the project takes into account a decent sample size for the premier league, it should not be considered wholly valid for soccer in general, instead it should only be considered valid for the premier league.

Sources:

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