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NFL 4th DOWN DECISIONS ANALYSIS REPORT

EXECUTIVE SUMMARY

This study analyzes NFL 4th down decision patterns using 2024 play-by-play data. Teams punt nearly 50% of the time and attempt field goals on 25% of 4th downs, demonstrating a predominantly conservative approach across the league. Our logistic regression model achieves 87.7% accuracy in predicting "go_for_it" in 4th down decisions based on five key variables: game quarter, time remaining, yards needed, field position, and score differential.

Key findings reveal teams double their aggression in the second half compared to the first half, with 4th quarter go-for-it rates reaching 32.5% versus just 13-17% in earlier quarters. Teams prove significantly more likely to attempt conversions when trailing and when positioned closer to their opponent's end zone. Statistical testing confirms a moderate but significant relationship between game quarter and decision type (Cramer's $V = 0.193$, $p < 0.0001$).

1. INTRODUCTION

In American football, 4th-down decisions can make or break games. Teams face a critical choice: risk going for it to maintain possession or opt for kicking strategies through punts or field goals. This study analyzes 2024 NFL play-by-play data to identify key factors influencing these high-stakes decisions and develops a predictive model using logistic regression to understand coaching patterns.

2. BACKGROUND OF STUDY

Previous research in football analytics has increasingly focused on the value of data-driven decision-making, particularly around 4th down plays. Studies by academic institutions and sports analysts, such as those by Brian Burke (formerly of Advanced NFL Stats), have shown that teams often make overly conservative choices that reduce their chances of winning. Burke's models suggested that teams should go for it more frequently, especially in short-yardage situations or when trailing late in games.

In a related analysis, Romer (2006) used historical NFL data and found that the expected value of going for it on 4th down frequently exceeds that of punting or attempting a field goal, especially in opponent territory. However, despite growing analytical support, real-world adoption has been slow due to traditional coaching norms, fear of failure, media scrutiny, and career risk.

With more franchises now employing analytics departments and consultants, the NFL is gradually seeing a shift toward more aggressive 4th down strategies. This report contributes to that growing body of research by quantifying recent trends using 2024 data and building a predictive model that captures the evolving decision-making landscape.

3. DATA PREPARATION

The dataset was imported from a CSV file containing 2024 NFL play-by-play data. I filtered the data to include only 4th down plays using SAS programming software. For this analysis, the predictor variables included: quarter (qtr), game_seconds_remaining, ydstogo (yards to go), yardline_100 and score_differential. A new binary variable "go_for_it" was also created as the response variable to indicate the decision made:

- **1** if the team ran or passed (go for it),
- **0** if the team punted or attempted a field goal(kick)

However, plays that did not fall into these categories were excluded from further analysis.

4. EXPLORATORY DATA ANALYSIS

A. **4th Down Decision Patterns and Tendencies**: Most 4th down decisions were punts 49.66%, which indicates that nearly half the time, teams choose to give up possessions to avoid the risk of failing to convert. Additionally, field goals were also 24.91*%,* which indicates that teams opt to attempt a field goal, with the aim of at least securing three (3) points rather than risk coming away with nothing. Notably, 18.73% of 4th down situations resulted in a "go for it" attempt, which shows that aggressive plays to retain possession are relatively rare. However, the remaining 6.7% fall under "other" scenarios, which likely include end-of-half or game clock management, penalties that change possession or down situation, kneel-downs, or other unclassified outcomes. Overall, the statistics confirm that most teams and coaches take a risk-averse approach on the 4th down, in other words,

coaches prefer to prioritize minimizing potential loss over maximizing gain, often punting or settling for field goals rather than extending drives. This conservative pattern reflects long-standing norms, fear of criticism from failed 4th down attempts, or situational factors like field position and game clock. Nonetheless, as analytics continue to influence coaching decisions, we may see a gradual shift in these tendencies in the seasons ahead.

The FREQ Procedure

play_type	Frequency	Percent	Cumulative Frequency	Cumulative Percent
field_goal	1063	24.91	1063	24.91
no_play	268	6.28	1331	31.19
pass	488	11.44	1819	42.63
punt	2119	49.66	3938	92.29
qb_kneel	1	0.02	3939	92.31
run	328	7.69	4267	100.00
Frequency Missing = 12				

qtr	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	917	21.43	917	21.43
2	1187	27.74	2104	49.17
3	913	21.34	3017	70.51
4	1246	29.12	4263	99.63
5	16	0.37	4279	100.00

go_for_it	Frequency	Percent	Cumulative Frequency	Cumulative Percent
0	3182	79.59	3182	79.59
1	816	20.41	3998	100.00
Frequency Missing = 281				

Figure 1: Frequency distribution of 4th down play types

B. **Cross Tabulation Analysis of Go-for-It Rate by Quarter**: The data revealed that teams became increasingly aggressive as the game progressed, with a noticeable spike in the fourth quarter (Q4). The fourth quarter recorded the highest go-for-it rate at 32.5%, more than the rates seen in the earlier quarters. Notably, quarters 1 to 3 showed more moderate actions, with go-for-it rates within the range of 13.3% to 17.1%. The fifth quarter (Q5), which may represent overtime or special scenarios, still had a moderate go-for-it rate of 20%. To enhance clarity, I performed a two-way cross-tabulation between game quarter and the binary decision variable "go_for_it." This binary outcome was labeled as “Go-for-it” (1) and “Kick” (0), with “Kick” representing both punts and field goals. While previous

discussion highlighted go-for-it percentages, this cross-tabulation offers a more complete view by presenting both decision outcomes. For instance, in Q4, 32.5% of plays were go-for-it decisions, while the remaining 67.5% were kicks. In contrast, Q1 showed only 13.3% go-for-it plays, with 86.7% resulting in kicks. This clearer labeling and dual-percentage display underscore how teams shift toward riskier strategies later in the game.

The FREQ Procedure

Frequency
Percent
Row Pct
Col Pct

Table of qtr by go_for_it

qtr	go_for_it 0	go_for_it 1	Total
1	754 18.86 86.67 23.70	116 2.90 13.33 14.22	870 21.76
2	932 23.31 83.96 29.29	178 4.45 16.04 21.81	1110 27.76
3	715 17.88 82.85 22.47	148 3.70 17.15 18.14	863 21.59
4	769 19.23 67.46 24.17	371 9.28 32.54 45.47	1140 28.51
5	12 0.30 80.00 0.38	3 0.08 20.00 0.37	15 0.38
Total	3182 79.59	816 20.41	3998 100.00

Frequency Missing = 281

Figure 2: Cross tabulation Go-for-it Rate by Quarter

C. **Relationship Between Game Quarter and 4th Down Decision Type**: A Chi-square test of independence revealed a statistically significant association between the game quarter and the type of 4th down decision made, with a p-value less than 0.0001($p<.0001$). This result suggests that teams' decision-making strategies vary meaningfully depending on the quarter in which the 4th down occurs. Cramer's V, with a value of 0.193, was used to assess the strength of this association, indicating a moderate relationship between quarter and play choice. This supports the notion that as the game progresses, especially into later quarters, teams become more inclined toward aggressive strategies such as going for it, likely influenced by increased game pressure and time constraints.

Statistics for Table of qtr by go_for_it

Statistic	DF	Value	Prob
Chi-Square	4	148.8662	<.0001
Likelihood Ratio Chi-Square	4	141.2201	<.0001
Mantel-Haenszel Chi-Square	1	116.2509	<.0001
Phi Coefficient		0.1930	
Contingency Coefficient		0.1895	
Cramer's V		0.1930	

Figure 3: Test Results Quarter vs 4th Down Decision Type using Chi Sq & Cramer's V

D. **Strategic Shifts: Early vs. Late Game Decisions**: Further analysis comparing early and late game situations indicated a clear shift towards more aggressive decision-making in the second half of games. As illustrated in Figure 4, the go-for-it rate rises from 14.85% in the first half (Q1-Q2) to 25.91% in the second half (Q3-Q4). The 11 percentage-point increase suggests that coaches are more willing to take risks as the game nears its conclusion, possibly driven by scoreboard pressure, fewer remaining possessions, or the urgency to maintain momentum. These trends align with the earlier Chi-square and Cramer's V findings, which reiterate the conclusion that game timing plays a crucial role in shaping 4th down decisions.

The FREQ Procedure

Frequency Percent Row Pct Col Pct	Table of half by go_for_it		
	go_for_it		
half	0	1	Total
Early	1686 42.33 85.15 53.19	294 7.38 14.85 36.16	1980 49.71
Late	1484 37.26 74.09 46.81	519 13.03 25.91 63.84	2003 50.29
Total	3170 79.59	813 20.41	3983 100.00

Frequency Missing = 296

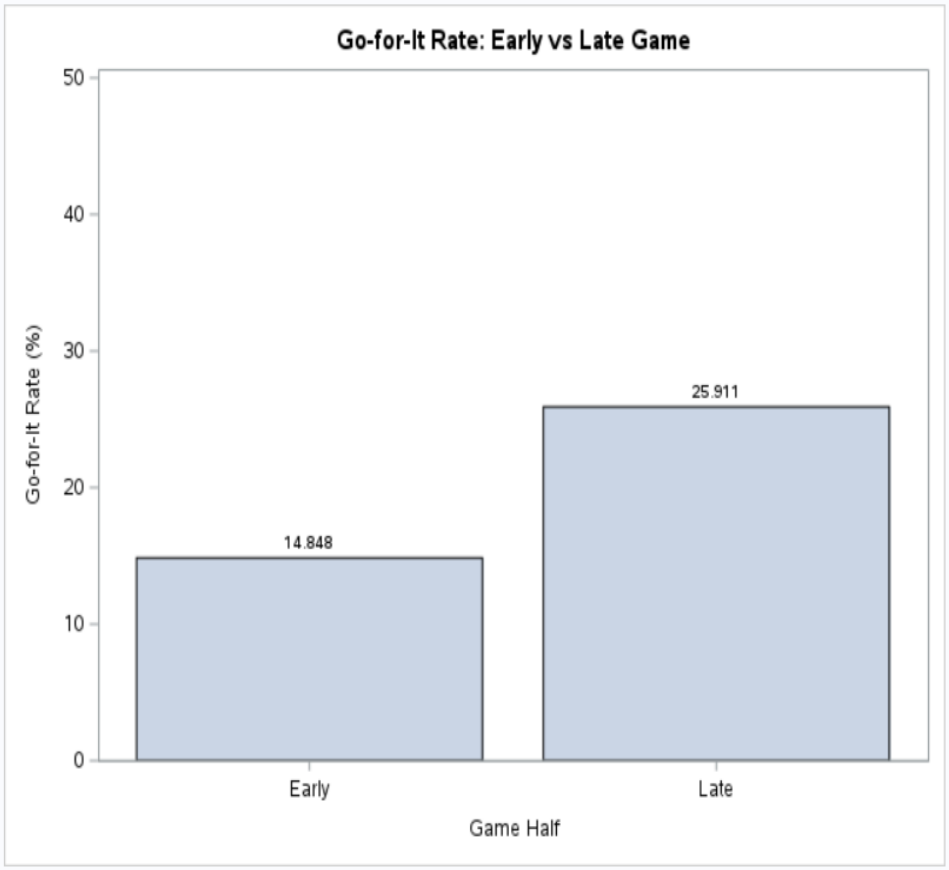

Figure 4: Go-for-it Rate: Early vs Late Game Situations

E. **Interpretation of Odds Ratio**: The odds ratio of 2.01 with a value of 95% confidence interval limits between 1.71 and 2.35, means that teams were approximately twice as likely to go for it on 4th down in the second half (Q3 and Q4) compared to the first half (Q1 and Q2). The confidence interval does not include 1, indicating that the result is statistically significant.

Statistics for Table of half by go_for_it

Odds Ratio and Relative Risks			
Statistic	Value	95% Confidence Limits	
Odds Ratio	2.0056	1.7105	2.3516
Relative Risk (Column 1)	1.1493	1.1134	1.1864
Relative Risk (Column 2)	0.5731	0.5038	0.6519

Sample Size = 3983

Figure 4: Odds Ratio for Go-for-it Rate: Early vs Late Game Situations

5. LOGISTIC REGRESSION MODELING

For this analysis, I used logistic regression to model the probability of a team "going for it" on 4th down as the response variable whilst the predictor variables included: quarter (qtr), game_seconds_remaining, ydstogo, yardline_100 and score_differential.

A. **Stepwise Selection**: This focuses on model building by informing on which variables are added first and how much they improve the model at each step. Specifically, this is a forward stepwise selection starting with no variables and adding the most significant variables step by step. First, the model included ydstogo (yards to go) , which had the strongest impact with a chi-square score of 514.97 and a highly significant p-value. Next, it added score_differential, which also showed a strong influence with a chi-square score of 288.35. In the third step, the model selected qtr(quarter), confirming that the quarter of the game plays an important role in decision-making, with a score of 187.15. After that, the model included yardline_100, which contributed moderately to the model with a chi-square score of 83.19. Finally, game_secs_remaining was added in the last step. Even though it had the smallest chi-square score (19.62), it still made a meaningful and

statistically significant contribution. Each variable entered the model because it added significant predictive value, and the order reflects their importance in explaining the outcome.

Summary of Stepwise Selection							
Step	Effect Entered	Effect Removed	DF	Number In	Score Chi-Square	Wald Chi-Square	Pr > ChiSq
1	ydstogo		1	1	514.9742		<.0001
2	score_differential		1	2	288.3515		<.0001
3	qtr		4	3	187.1497		<.0001
4	yardline_100		1	4	83.1893		<.0001
5	game_secs_remaining		1	5	19.6221		<.0001

Figure 5: Summary of Forward Stepwise Selection

B. Type 3 Analysis of Effects: This shows the final effect significance of all variables in the final model after they are all included. It reports on the Wald chi-square and p-values. Stepwise selection identified the most significant predictors. The Wald chi-square test shows that all five predictors in the model have a statistically significant effect on the outcome. Ydstogo had the strongest effect with a Wald chi-square value of 442.16, making it the most influential predictor. Score_differential followed with a chi-square of 254.99, confirming its strong contribution as well.

Type 3 Analysis of Effects			
Effect	DF	Wald Chi-Square	Pr > ChiSq
qtr	4	34.0994	<.0001
game_secs_remaining	1	19.4772	<.0001
ydstogo	1	442.1604	<.0001
yardline_100	1	73.1255	<.0001
score_differential	1	254.9861	<.0001

Figure 6: Type 3 Analysis of Effects

C. **Interpretation of Odds Ratios for 4th Down Decision Factors**: The odds ratio estimates show that teams are significantly more likely to go for it on 4th down in the earlier quarters compared to the 5th (overtime/end-game), especially in the 1st quarter (OR = 5.22) and 4th quarter (OR = 2.41). However, the wide confidence intervals suggest some uncertainty. As game time runs out, or when the distance to a first down increases, teams become slightly less likely to go for it. Being closer to the opponent's end zone or trailing in score slightly increases the likelihood of a go-for-it decision.

Odds Ratio Estimates			
Effect	Point Estimate	95% Wald Confidence Limits	
qtr 1 vs 5	5.220	0.859	31.722
qtr 2 vs 5	2.902	0.563	14.945
qtr 3 vs 5	1.545	0.328	7.270
qtr 4 vs 5	2.410	0.535	10.852
game_secs_remaining	0.999	0.999	1.000
ydstogo	0.711	0.689	0.734
yardline_100	0.982	0.978	0.986
score_differential	0.921	0.911	0.930

Figure 7: Odds Ratio Estimates

6. Model Fit Assessment

A. **Model Prediction Summary**: The final logistic regression model showed strong predictive power. The model that includes covariates (like quarter, score differential, etc.) has much lower values for AIC (2728.97 vs. 4048.27), SC (2785.61 vs. 4054.56), and -2 Log L (2710.97 vs. 4046.27) than the model with *intercept only*. This indicates that the full model with predictors provides a much better fit to the data. Lower values in these statistics mean the model explains the variability in 4th down decisions more effectively.

Model Fit Statistics		
Criterion	Intercept Only	Intercept and Covariates
AIC	4048.270	2728.970
SC	4054.563	2785.612
-2 Log L	4046.270	2710.970

Figure 8: Model Fit Results

B. **Model Predictive Strength and Discrimination**: The association statistics indicate that the model has powerful predictive ability. With 87.7% concordant pairs and a c-statistic of 0.877, the model can effectively distinguish between plays where teams go for it on 4th down and those where they don't. The high values for Somers' D and Gamma (0.755) further confirm a strong positive relationship between the predicted probabilities and actual outcomes.

Association of Predicted Probabilities and Observed Responses			
Percent Concordant	87.7	Somers' D	0.755
Percent Discordant	12.3	Gamma	0.755
Percent Tied	0.0	Tau-a	0.245
Pairs	2596512	c	0.877

Figure 9: Model Performance Metrics

7. CONCLUSION

This analysis demonstrates that NFL teams make 4th down decisions based on strategic contextual factors rather than random choice. Teams consistently show higher aggression when:

- Playing from behind on the scoreboard (when trailing)
- Operating in the second half (especially quarter 4)
- Positioned closer to scoring territory

The predictive model captures these tendencies with high discrimination power (c-statistic = 0.877) and provides valuable insights into coaching decision patterns. However, I recognized limitations in assuming uniform behavior across all teams and contexts.

I recommend expanding future research to incorporate team-specific tendencies, coaching philosophies, weather impacts, and higher-stakes scenarios such as playoff games. These refinements would further enhance predictive accuracy and provide deeper insights into NFL strategic decision-making.