

Modern Sport

Volume 24
Issue 3 *Special Issue of the Third International
Scientific Conference, Titled (Artificial
Intelligence and Its Role in the Cognitive
Creativity of Sports Science)*

Article 13

7-25-2005

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Recommended Citation

Hassan, Mahfoodh Faleh; Allawi, Abdul Amir Hashim; and Khalaf, Firas Hadi (2005) "Determining the Probable Responsibility of the Head Coach and Fitness Coach for Match Outcomes Using Bayes' Theorem," *Modern Sport*: Vol. 24: Iss. 3, Article 13.
DOI: <https://doi.org/10.54702/2708-3454.2084>

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SPECIAL ISSUE ARTICLE

Determining the Probable Responsibility of the Head Coach and Fitness Coach for Match Outcomes Using Bayes' Theorem

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Abstract

Bayes' Theorem represents a fundamental principle in probability and statistics. It describes how to update the probability of a hypothesis based on new evidence. It provides a mathematical rule for reversing conditional probabilities, allowing us to determine the probability of a cause given an observed effect. Bayes' Theorem is also considered one of the key tools in machine learning applications. This study uses Bayes' Theorem to determine the probability of a team's loss and the percentage responsibility of the head coach and fitness coach. Its importance lies in developing a probabilistic model to reveal the likelihood of defeat and the proportional responsibility of each coach. The research sample includes 10 football experts and coaches from clubs and institutions in Basrah. A questionnaire was used to gather expert opinions on the estimated contribution of four roles (head coach, fitness coach, goalkeeping coach, and psychological consultant) and the potential error rate for each. The data were analyzed using Bayes' Theorem to calculate the probability of team loss and the responsibility percentage of the coaching staff. The study concludes that the probability of team loss is estimated at 13.65%, and the head coach (58.60%) and the fitness coach (38.46%) are mainly responsible for this loss. The researchers recommend that responsibility be distributed among all members of the coaching staff rather than attributed to a single individual, and this achieves one of the sustainable development goals of the United Nations in Iraq which is (Quality Education).

Keywords: Bayes' Theorem, Conditional probability, Event, Inverse probability, Likelihood, Prior probability

1. Introduction

According to the theory of probability and statistical reasoning, Bayes' Theorem describes the likelihood of an event based on prior knowledge of conditions that might be related to the event (Hargreaves, 2009). For example, suppose the performance of the head coach and fitness coach influences a team's loss. In that case, Bayes' Theorem can better estimate match outcomes by factoring in their influence levels.

Bayes' Theorem, named after British mathematician Thomas Bayes (1701–1761), offers a mathematical model for reasoning under uncertainty and making

inferences based on evidence (Jøssang, 2006). It is widely applied in data analysis, machine learning, artificial intelligence, and decision-making processes.

The significance of this study lies in designing a probabilistic model using Bayes' Theorem to identify the likelihood of defeat and the distribution of responsibility among coaching staff. This helps clarify each coach's role in match outcomes.

Accordingly, based on practical training data, this research applies Bayes' Theorem to estimate the responsibility percentages of the head coach and fitness coach. Coaches need theoretical and applied knowledge across all training domains to lead teams

Received 21 February 2025; revised 7 March 2025; accepted 17 March 2025.
Available online 25 July 2025

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<https://doi.org/10.54702/2708-3454.2084>

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effectively (Nash & Collins, 2006). A coach's responsibility goes beyond training and physical development to include the overall well-being of athletes (Smoll, 2002; Kliff, 2009).

Research Problem

Assigning responsibility and accountability for match outcomes requires decisive decision-making, which in itself constitutes a challenge—particularly in the case of a team's loss. From this premise, the present study poses the following question: *What is the proportion of responsibility borne by the head coach and the physical trainer in the event of the team's defeat?*

Research Objectives

1. To determine the probability and percentage of the team's loss based on Bayes' Theorem.
2. To identify the probability of the head coach's and the physical trainer's responsibility for the team's loss using Bayes' Theorem.

Research Hypotheses

1. As estimated by Bayes' Theorem, the success or failure of the coaching staff determines the probability and percentage of loss.
2. Using Bayes' theorem, there is a probability and percentage of responsibility attributable to the head coach and fitness coach in case of loss.

Theoretical Background: Bayes' Theorem

Bayes' Theorem, also known as Bayes' law, provides a mathematical framework for reversing conditional probabilities—enabling inference about causes from observed effects (Jøsang, 2016). One of its primary applications is Bayesian inference, which uses observed data to update beliefs or estimate unknown parameters (Colfer, 2004).

Illustrative Example

Suppose it is known that team losses are linked to the coaching staff's performance (head coach, fitness coach, goalkeeping coach, etc.). In that case, Bayes' Theorem allows a more accurate estimation of the cause of loss by evaluating their specific contributions. This is particularly useful in areas such as machine learning and artificial intelligence when data is incomplete or noisy, as well as in diagnostic and predictive modelling.

Bayes' Mathematical Theorem (Dunning, 2002, p. 33)

Bayes' theorem is stated mathematically as the following equation:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

where A and B are events and $P(B) \neq 0$.

- $P(A|B)$ is a conditional probability: the probability of event A occurring given that B is true. It is also called the posterior probability of A given B .
- $P(B|A)$ is also a conditional probability: the probability of event B occurring given that A is true. It can also be interpreted as the likelihood of A given a fixed B because $P(B|A) = L(A|B)$.
- $P(A)$ and $P(B)$ are the probabilities of observing A and B respectively without any given conditions; they are known as the prior probability and marginal probability.

2. Methodology and Procedures

Research Design

The study employed a descriptive-analytical approach to examine the collected data.

Study Sample

The sample consisted of 10 football experts and coaches from clubs and institutions in Basrah Governorate, representing 40% of the research population. For further details, see [Appendix 1](#).

Data Collection Tools

1. Expert opinion questionnaire – See [Appendix 2](#).
2. Personal interviews with selected specialists – See [Appendix 3](#).
3. Laptop computer – One unit used for data processing

Expert Questionnaire

The questionnaire was designed to collect expert opinions on the proposed training responsibility distribution. It focused on four key team roles:

- Head Coach
- Fitness Coach
- Goalkeeping Coach
- Psychological Consultant

Additionally, experts were asked to evaluate the potential error percentages associated with each role (see [Appendix 2](#)).

Pilot Study

A pilot test was conducted with 6 experts to assess the questionnaire's clarity and feasibility and measure the time needed to complete it. All participants in the pilot study were excluded from the main experiment.

Data Tabulation and Validation

Based on the expert feedback, three proposals were presented in the questionnaire. Proposal 2 received the highest approval rate of 80%, as shown in the following [Tables 1](#) and [2](#):

Main Experiment:

On March 6, 2025, the main experiment was initiated, which involved the preparation of an expert opinion questionnaire and the commencement of data collection and analysis.

Validity and Reliability of the Proposals:

Three proposals were presented (see [Tables 1](#) and [2](#)) through a specially designed questionnaire. The purpose of this process was to determine the most appropriate proposal to be used for data analysis based on Bayes' theorem and its related mathematical principles, in order to assess the probabilities and percentages of responsibility attributed to coaches for the team's defeat.

The majority of experts and coaches selected the second proposal, with an approval rate of 80%. To verify its discriminatory validity, the researcher con-

ducted a follow-up pilot study on a different sample of ten non-expert individuals. The results revealed statistically significant differences at the 5% significance level, with a T-value of 3.55. Furthermore, to confirm the reliability of the proposals in the questionnaire, the pilot study was repeated with the original expert sample, who consistently agreed on the same selected proposal.

Statistical Analysis Tools

The following methods were used:

1. Percentage distributions
2. Bayes' Theorem

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

3. Results and discussion

Coaches' Responsibility and Margin of Error Prior to the Match

Table 3. Illustrates the percentage of each coach's contribution to the team's victory or defeat prior to the match.

Percentage of Contribution to Team Victory Prior to the Match			
Head Coach	Fitness Coach	Goalkeeper Coach	Sports Psychologist
50%	35%	10%	5%
The Percentage of Contribution to Team Loss Prior to the Match			
16%	15%	3%	2%

This table summarizes the perceived impact of each coaching role on match outcomes as reported by the expert panel before the match. The head and fitness coaches were seen as having the most significant influence on victory and defeat outcomes.

Table 1. Proposed Coaching Responsibility Distributions and Expert Approval Rates.

Proposal	Head Coach	Fitness Coach	Goalkeeper Coach	Sports Psychologist	Total Percentage	Acceptance Rate
First	60%	30%	9%	1%	100%	—
Second	50%	35%	10%	5%	100%	80%
Third	55%	30%	13%	2%	100%	—

Table 2. Proposed coaching error percentages and expert approval rates.

Proposal	Head Coach	Fitness Coach	Goalkeeper Coach	Sports Psychologist	Total Percentage	Acceptance Rate
First	18%	14%	2%	1%	35%	—
Second	16%	15%	3%	2%	36%	80%
Third	17%	12%	5%	3%	37%	—



Fig. 1. Model diagram of win and loss percentages for coaching staff members before the match.

Overall Probability of Team Loss in Any Match

Table 4. Predictive analysis result of team loss.

Prior Probability $P(w)$	Likelihood $P(F w)$	Calculation $P(w) \cdot p(F w)$
$P(w_1) = 0.50$	$P(F w_1) = 0.16$	$0.50 \cdot 0.16 = 0.08$
$P(w_2) = 0.35$	$P(F w_2) = 0.15$	$0.35 \cdot 0.15 = 0.0525$
$P(w_3) = 0.10$	$P(F w_3) = 0.03$	$0.10 \cdot 0.03 = 0.003$
$P(w_4) = 0.05$	$P(F w_4) = 0.02$	$0.05 \cdot 0.02 = 0.001$

$P(F)$ = Total Probability of Loss = $0.1365 = 13.65\%$.

Coaching Staff's Responsibility for Team Loss According to Bayes' Theorem

Based on Table 3 and Fig. 1, the distribution of the coaching staff's responsibility for the team's wins and losses before the match indicates that the most significant share falls on the technical coach (50%) and the physical trainer (35%). This suggests that responsibility is shared among the coaching staff rather than limited solely to the technical coach. According to their training responsibilities, every member of the coaching team plays an active role in the team's success or failure.

The technical coach is responsible for setting tactical plans for each match, carefully selecting players based on their readiness and technical capabilities, and assigning tasks that match the nature and importance of the game. Meanwhile, the physical trainer plays a vital role in preparing players with the necessary fitness and endurance for competitions, as general and specific endurance form the foundation of physical preparedness. It is essential to understand that physical capability is the "fuel" that enables a player to sustain performance throughout the match. Without it, players cannot maintain their performance regardless of their technical skills. Poor physical preparedness can lead to a decline in performance,

complete cessation of activity, or even early injuries during a match.

Hence, the physical trainer's role is no less important than that of the technical coach. The technical coach's responsibilities center around selecting appropriate players, overseeing tactical training, choosing the team for each match, and determining the tactical plan to be executed. The coach must also ensure that players fully understand and effectively implement the tactical instructions during the game (James, 2024).

Football training comprises various physical and tactical training programs to develop the physical, technical, and tactical capabilities required for playing football (McGrayne, 2011). Success in games and competitions demands more than just fitness—it also requires refined motor skills, speed, and power of execution (Power, 2016).

Table 4 presents the probability of losing a match based on Bayesian analysis. According to the initial data regarding the contributions of the technical coach, physical trainer, goalkeeping coach, and sports psychologist, the probability of losing was estimated at 13.65%. This makes it logical to acknowledge the potential for loss before a match and to develop a strategy to mitigate this risk. Assuming a 100% chance of winning is illogical and can lead to overconfidence, eliminating consideration of potential setbacks. Such an attitude can disrupt the team's focus and preparedness after conceding a single goal.

Therefore, a 13.65% loss probability, derived from the coaching staff's influence on match outcomes, keeps the staff and players mentally alert and responsible for minimizing mistakes and executing tactical and physical tasks to avoid defeat. In contrast, approaching a match with zero probability of loss fosters complacency, increasing the risk of underperformance and unexpected defeat, especially if the coaching staff fails to consider possible setbacks.

Table 5. Probability and responsibility percentages of coaching staff for team loss.

P (w F)	Probability	Percentage
P (w ₁ F) Loss due to the Technical Coach	0.5860	58.60 %
P (w ₂ F) Loss due to the Fitness Coach	0.3846	38.46 %
P (w ₃ F) Loss due to the Goalkeeper Coach	0.0220	2.2 %
P (w ₄ F) Loss due to the Psychologist	0.0073	0.73 %

Table 5 shows the estimated probabilities and levels of responsibility for the team's loss after the match. The results confirm that responsibility is shared, with the highest-burden falling on the technical coach (58.60%) and the physical trainer (38.46%). Thus, losses in matches are to be expected, and both the technical and physical coaches must bear the central part of the responsibility. It would be illogical for only one to shoulder the blame, as sports training is a joint system in which both technical and physical aspects contribute to match outcomes. Any deficiency in tactical preparation or physical conditioning can lead to defeat. Signs such as fatigue or reduced endurance among players often reflect inadequate physical preparation, which can cause a team's loss.

Physical fitness is defined as the body's capacity to work efficiently. It is divided into general and sport-specific fitness, depending on the nature of the sport and its performance demands (Robert & Casella, 2004). Specialized literature on football emphasizes that it is a team sport involving competition between two teams (Stuart & Ord, 1994). The head coach (technical coach) holds similar responsibilities to those in any team sport, usually selecting his coaching staff (including the physical trainer and goalkeeping coach) and overseeing player recruitment and team selection (Tremblay et al., 2010). Thus, the technical coach is primarily responsible for the team's outcome. In football, the responsibilities of coaches vary depending on their specialization and tenure with the team (Vella et al., 2013).

4. Conclusions

1. A model has been developed to estimate the share of responsibility each member of the coaching staff bears for the team's losses, which can be used or adjusted for further analysis.
2. According to the proposed model and the coaching staff's roles, the probability of team loss in any match is 13.65%.
3. Responsibility for team losses is distributed across the coaching staff, with the highest shares

attributed to the technical coach (58.60%) and the physical trainer (38.46%).

4. The sports psychologist holds the lowest share of responsibility for losses, at 0.73%.

5. Recommendations

1. Use the study's findings to inform and distribute responsibility among the coaching staff for team losses.
2. Avoid blaming one individual solely for a team's defeat; instead, distribute accountability among all coaching staff members.
3. Apply Bayesian theory in classification processes to understand the paths to coaching success and failure.

Conflicts of interest

We, the researchers, affirm that this study has not been previously published in any scientific journal or conference.

Author's contributions

- First Author: Research idea, title, and statistical analysis
- Second Author: Linguistic revision and review
- Third Author: Distribution of the questionnaire and collection of expert opinions

Funding

This research received no external funding.

Data availability

The data that support the findings of this study are available on request from the corresponding author.

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Here is the English translation of the appendices in a formal and academic style suitable for inclusion in a research paper or thesis:

Appendices

Appendix 1

List of Football Experts.

	Expert Name	Specialization	Workplace
1	Prof. Dr. Dhulfiqar Saleh	Football	University of Basrah – College of Physical Education and Sports Sciences
2	Prof. Dr. Luay Kadhem	Football	University of Basrah – College of Physical Education and Sports Sciences
3	Prof. Dr. Aqeel Hassan Faleh	Football	University of Basrah – College of Physical Education and Sports Sciences
4	Prof. Dr. Ghassan Habeeb	Football	University of Basrah – College of Physical Education and Sports Sciences
5	Prof. Dr. Lafta Hameed	Football	University of Basrah – College of Science
6	Asst. Prof. Dr. Abd Ali Jaafar	Football	University of Basrah – College of Physical Education and Sports Sciences
7	Asst. Prof. Dr. Ahmed Abdul Ameer	Football	University of Basrah – College of Physical Education and Sports Sciences
8	Asst. Prof. Dr. Hatem Abdul Redha	Football	University of Al-Maaqal – College of Physical Education and Sports Sciences
9	Asst. Lect. Hussein Hashoos	Football	University of Al-Maaqal – College of Physical Education and Sports Sciences
10	Mr. Mustafa Jawad	Football	University of Basrah – College of Physical Education and Sports Sciences

Appendix 2

Expert Opinion Questionnaire.

Dear Esteemed Expert,

Due to your scientific and practical experience in football, we kindly ask you to select one of the proposed models related to the contribution of training staff members to the outcome of football matches based on each member's role within the coaching team.

With the highest appreciation,

Proposals:

Proposed Training Responsibility Percentages						
Proposal	Head Coach	Fitness Coach	Goalkeeper Coach	Psychological Expert	Total	Selection
First	60%	30%	9%	1%	100%	
Second	50%	35%	10%	5%	100%	
Third	55%	30%	13%	2%	100%	

Proposed Training Error Percentages						
Proposal	Head Coach	Fitness Coach	Goalkeeper Coach	Psychological Expert	Total	Selection
First	18%	14%	2%	1%	35%	
Second	16%	15%	3%	2%	36%	
Third	17%	12%	5%	3%	37%	

Appendix 3

Personal Interview List with Computer Science Specialists.

Personal interviews were conducted with specialists in the fields of computer science and machine learning.

Name of the Specialist	Specialization	Workplace
Asst. Prof. Luay Abdulwahid	M.Sc. in Computer Science – Networks	University of Basrah
Asst. Lecturer Mohammed Mounes	M.Sc. in Computer Science – Data Science	University of Basrah
Asst. Lecturer Zeina Khazaal	M.Sc. in Computer Science – Machine Learning	University of Basrah
Asst. Lecturer Ali Hassan Jabbar	M.Sc. in Computer Science – Networks	University of Basrah
Mr. Asaad Qasim Mahdi	M.Sc. in Computer Science – Machine Learning	Iraqi Drilling Company