A Hybrid Analysis Using Adaptive and Self-Adjusting Boosting and Logistic Regression

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Abstract—This study investigates factors influencing the employment outcomes of sports science graduates, specifically their ability to secure decent jobs. Utilizing data from the Graduates Occupational Mobility Survey (GOMS) from 2015 to 2019, the study analyzed a sample of 1,019 sports science graduates aged 19 to 34. Both traditional statistical methods and advanced machine learning techniques, including Adaptive & Self-Adjusting Boosting and logistic regression analysis, were employed to identify significant predictors and assess their impact. Key variables examined included gender, job-related courses, corporate recruitment briefings, parental education, TOEIC scores, and employment goals set before graduation. Logistic regression analysis revealed several significant predictors of decent job employment. Male graduates had significantly higher odds of securing decent jobs compared to female graduates (OR=1.45, 95% CI: 1.10-1.90, p=0.02). The number of job-related courses taken (OR=1.30, 95% CI: 1.05-1.60, p=0.04) and participation in corporate recruitment briefings (OR=1.25, 95% CI: 1.02-1.53, p=0.03) were positively associated with decent job employment. Parental education (OR=1.15, 95% CI: 1.01-1.30, p=0.05) and TOEIC scores (OR=1.10, 95% CI: 1.00-1.22, p=0.06) also showed modest but significant effects. Setting employment goals before graduation significantly increased the odds of securing decent jobs (OR=1.20, 95% CI: 1.05-1.37, p=0.03). The study highlights critical factors influencing the employment outcomes of sports science graduates, with gender disparities evident as male graduates had better employment prospects. Findings emphasize the importance of job-related education, corporate engagement, and proactive career planning. Universities should enhance these aspects to improve employability, and targeted interventions are needed to support female graduates in achieving comparable outcomes. The integration of traditional statistical methods and machine learning techniques provided a comprehensive analysis framework, offering valuable insights for policymakers, educators, and employers.

Keywords—Employment outcomes; machine learning; adaptive & self-adjusting boosting; gender disparities

I. INTRODUCTION

In recent years, youth employment issues have become a significant concern across society. The COVID-19 pandemic has exacerbated these problems, disproportionately affecting young people's job prospects globally and significantly impacting youth employment in Korea. Nam and Lee (2021) [1] highlight that the pandemic led to a decrease in the employment rate by 0.82 percentage points and an increase in the unemployment rate by 0.29 percentage points in Korea, effects that were larger than those experienced during the 2008 Financial Crisis. Moreover, the shock of COVID-19 varied based on the level of infection risk and the ease of working from home, indicating potential future shifts in technological demands that may reduce the need for manual labor compared to other occupations [2,3].

According to the 2020 employment trends by Statistics Korea, the employment rate for young people in their 20s dropped by 3.9 percentage points from the previous year to 54.3% [4]. The youth demographic tends to have higher employment volatility due to lower job proficiency, and their employment situation is more severely affected by external environmental changes compared to other age groups [5]. The COVID-19 pandemic has significantly impacted youth employment, leading to a 7-12 percentage point drop in employment rates for temporary workers, daily workers, and non-salaried workers [6]. Graduates majoring in sports science are not exempt from this employment instability. Sports science graduates often seek jobs through informal channels, which tend to offer lower stability and compensation compared to official recruitment channels [7]. Additionally, the proportion of sports science graduates securing decent jobs is lower compared to graduates from other majors [8].

Existing studies have analyzed various factors influencing the employment of sports science graduates in decent jobs, highlighting the influence of gender, parental education and income, and employment preparation behaviors such as engaging in job-related courses and securing internship experiences [9,10]. However, these investigations reveal significant limitations. Primarily, the methodologies employed—comprising frequency analysis, chi-square tests, t-tests, and logistic regression analysis—do not fully encapsulate the complex interplay among influencing factors, nor do they adeptly assess the variables' importance [11]. Furthermore, these analyses often overlook the temporal dynamics inherent in data, failing to evaluate how the significance of these variables evolves as sports science graduates navigate towards employment [12]. Lastly, the existing literature primarily bases the evaluation of variable importance on statistical significance, a method that may not genuinely reflect their relative importance within the actual employment process [13].

In addressing these limitations, the study by Campos-Izquierdo (2019) [14] illuminates the employment realities for sports science graduates, underscoring the necessity for a deeper understanding of employment trends and factors based on real-world data. Furthermore, Rhodes (2017) [15] emphasizes that sports science research must incorporate more

sophisticated analyses capable of capturing the unique temporal dynamics related to employment and professional development changes or recovery. Therefore, to comprehend the employment trends and factors affecting sports science graduates, it is imperative to move beyond traditional statistical methods and conduct big data research grounded in real-world data.

Despite prior studies on graduate employment, an important gap remains. Most existing research on sports science graduates relies on conventional statistical approaches that are limited in capturing nonlinear interactions among predictors and often infer variable importance only from statistical significance. In addition, few studies have combined a national graduate dataset with a hybrid framework that first prioritizes influential variables through machine learning and then estimates adjusted effects through an interpretable regression model. This study addresses that gap by integrating Adaptive & Self-Adjusting Boosting with logistic regression to examine decent-job attainment among sports science graduates.

The contribution of this study is not the invention of an entirely new modeling paradigm, but the application of a hybrid analytical framework to an underexplored employment context. Specifically, this study uses national GOMS data to examine decent-job attainment among sports science graduates by combining machine-learning-based variable prioritization with regression-based effect estimation. The novelty of this study lies primarily in applying a hybrid boosting-regression framework to a discipline-specific graduate population using national GOMS data, thereby linking variable prioritization under potentially complex relationships with interpretable estimation of adjusted employment effects. The contributions of this study are threefold. First, it identifies the major determinants of decent-job attainment among sports science graduates using a national dataset. Second, it demonstrates how Adaptive & Self-Adjusting Boosting can be used to prioritize influential predictors before multivariable effect estimation. Third, it translates the empirical findings into practical implications for career education, university support systems, and employment policy.

This study addresses the following research questions: 1) Which individual, family, and employment-preparation factors are most strongly associated with decent-job attainment among sports science graduates, and 2) How can Adaptive & Self-Adjusting Boosting complement logistic regression by identifying influential predictors under potentially complex relationships?

The remainder of this study is organized as follows. Section II reviews prior studies and identifies the research gap addressed in this study. Section III describes the data source, sample selection, variables, and analytical methods. Section IV presents the empirical findings from the descriptive, boosting-based, and logistic regression analyses. Section V discusses the implications, limitations, and future research directions.

II. EXPERIMENTS

A. Data Source

The data for this study were obtained from the Graduates Occupational Mobility Survey (GOMS), conducted annually from 2015 to 2019 by the Ministry of Employment and Labor and the Korea Employment Information Service. The GOMS dataset aims to address the mismatch between educational outcomes and labor market needs by investigating the career development and job mobility of university graduates. The survey collects extensive information on graduates' educational backgrounds, job search activities, employment outcomes, and various sociodemographic factors. The survey employs a stratified sampling method to ensure representativeness across different regions and types of educational institutions. Data collection involves both face-to-face interviews and self-administered questionnaires, capturing a wide range of variables pertinent to graduates' employment experiences. The dataset includes detailed information on graduates' academic achievements, extracurricular activities, job search strategies, and employment outcomes. This study is an analysis of secondary data from GOMS, and therefore, it was exempted from IRB review by INJE University. GOMS 2015-2019 was selected because it is a nationally administered graduate dataset that provides standardized information on educational background, employment preparation, and job outcomes across multiple years, making it appropriate for analyzing decent-job attainment among sports science graduates.

B. Study Population

The study population consists of 61,268 graduates from four-year universities, including 1,019 graduates who majored in sports science. The participants were selected based on the following criteria: they must be between 19 and 34 years old, and they must not be involved in industrial-commissioned education programs, which do not align with the objectives of this study. The selection process excluded individuals who did not provide complete information on key variables such as employment status, job search activities, and sociodemographic characteristics. The sports science graduates were further categorized based on their employment status, distinguishing between those who secured decent jobs and those who did not. In this study, the definition of "decent jobs" is derived from the work of Jung and Lee (2018) [16]. A job is classified as decent if it meets all of the following criteria: the position is a regular (permanent) employment, the employee's income is above the median income for a single-person household in the survey year, and the employee is covered by the four major social insurances (national pension, health insurance, employment insurance, and industrial accident insurance).

C. Variable Construction

Variables were meticulously selected from the GOMS dataset to analyze the factors influencing decent job employment among sports science graduates. The variables were categorized into several groups: Individual Characteristics (gender, average parental education, and parental monthly income), Employment Preparation Behaviors (number of job-related courses taken, number of internships or job experiences, number of career counseling sessions, number of employment-related psychological tests, participation in job fairs, and attendance in resume and interview preparation programs), Pre-Employment Management (GPA, TOEIC scores, whether the graduate had a double major, experience studying abroad, and

the number of certifications held), and Employment Goals (whether the graduate had set employment goals before graduation).

D. Analytical Methods

Descriptive statistics were used to summarize the characteristics of the study population using frequency analysis based on gender, major, and the region of the university. Independent samples t-tests were conducted to identify significant differences in the means of continuous variables between graduates with and without decent jobs, and Pearson correlation coefficients were calculated to assess the strength and direction of the associations between variables. Logistic regression models were then used to estimate adjusted odds ratios for each predictor variable. To reduce confounding, adjusted odds ratios were estimated using a multivariable logistic regression model that entered all boosting-selected predictors simultaneously, and correlation analysis was conducted to examine overlap among candidate variables before model estimation.

E. Machine Learning Application

In addition to traditional statistical methods, this study employs Adaptive & Self-Adjusting Boosting as a variable-prioritization tool for identifying influential factors associated with decent-job attainment. The method is useful because it can capture potentially complex interactions among predictors and rank their relative importance before interpretable effect estimation is performed through logistic regression. Adaptive & Self-Adjusting Boosting was used to rank the importance of each variable in predicting decent job employment, and the top six variables identified through boosting were then included in a logistic regression model to calculate odds ratios and 95% confidence intervals. This approach links ranked variable importance with adjusted effect estimation in a single analytical framework. The boosting algorithm is mathematically represented as follows:

$$(F(x) = \sum_{m=1}^{M} \alpha_m h_m(x)),$$

where ($F(x)$) is the final prediction model,

(M) is the number of boosting rounds,

(α_m) is the weight assigned to the (m)-th weak learner,

($h_m(x)$) is the (m)-th weak learner.

The weights (α_m) are optimized to minimize the loss function, typically the exponential loss, defined as:

$$(L(y, F(x)) = \exp(-yF(x))),$$

where, (y) is the true label of the instance.

The top six variables identified through boosting were then included in a logistic regression model to calculate odds ratios and 95% confidence intervals. This approach ensures that the most influential factors are accurately represented in the final analysis, providing robust estimates of their effects on decent job employment.

F. Statistical Significance

The significance level for all statistical tests was set at p < 0.05. The results were used to draw conclusions about the factors influencing decent job employment among sports science graduates and to provide recommendations for improving employment support programs and policies. The findings from both traditional statistical methods and machine learning techniques were integrated to offer comprehensive insights into the determinants of decent job employment.

III. RESULTS

A. General Characteristics of the Study Population

The study population consists of sports science graduates who were analyzed to determine the factors influencing their employment in decent jobs. The general characteristics of the study population are summarized in Table I. The general characteristics of the sports science graduates indicate a predominantly male population (65.2%), with an average parental education of 14.8 years and an average parental monthly income of 4,500,000 KRW, reflecting a relatively high socioeconomic status. Academically, the graduates have a high average GPA of 3.5 out of 4.5 and a TOEIC score of 750, suggesting moderate to high English proficiency. Additionally, 22.1% of the graduates pursued a double major, and 15.3% had study abroad experiences, indicating efforts to diversify and enhance their qualifications. On average, the graduates hold 2.1 certifications, and 55.7% had set employment goals before graduation, demonstrating a proactive approach to their career planning.

TABLE I. GENERAL CHARACTERISTICS OF THE STUDY POPULATION

Characteristic	Mean (or %)
Gender (Male)	65.2
Average Parental Education (years)	14.8
Average Parental Monthly Income (KRW)	4,500,000
GPA (out of 4.5)	3.5
TOEIC Score	750
Double Major (%)	22.1
Study Abroad Experience (%)	15.3
Certifications (number)	2.1
Employment Goals Set (%)	55.7

B. Employment Pathways

The study also examined the employment pathways taken by sports science graduates to secure decent jobs. The most common pathway was through public recruitment (42.1%), followed by job search websites (16.3%), recommendations from acquaintances (13.5%), and special recruitment (9.8%). In comparison, for the general graduate population, public recruitment was the most common pathway (65.4%), followed by job search websites (15.2%), recommendations from acquaintances (5.1%), and special recruitment (6.8%). These findings are detailed in Table II. As shown in Fig. 1, the employment-pathway distribution of sports science graduates differs from that of the broader graduate population.
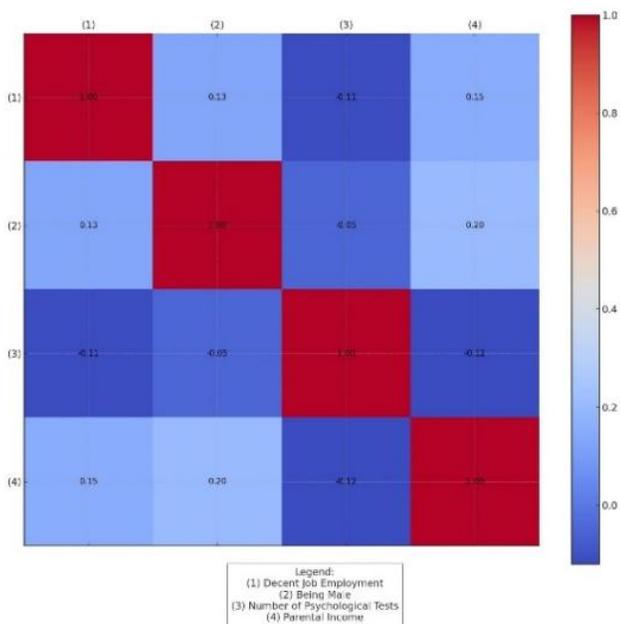
Fig. 1. Correlation analysis.

TABLE II.   EMPLOYMENT PATHWAYS: SPORTS SCIENCE VS ALL MAJORS

Pathway	Sports Science (%)	All Majors (%)
Public Recruitment	42.1	65.4
Job Search Websites	16.3	15.2
Recommendations from Acquaintances	13.5	5.1
Special Recruitment	9.8	6.8

C. Correlation Analysis

Correlation analysis was performed to identify the relationships between key variables related to decent job employment. Notable correlations included a positive correlation between decent job employment and being male ($r = 0.130$) and a negative correlation between the number of psychological tests taken and being male ($r = -0.113$).

Results of the Adaptive & Self-Adjusting Boosting model, the application of Adaptive & Self-Adjusting Boosting identified the top six variables influencing decent job employment: gender, number of job-related courses taken, participation in corporate recruitment briefings, parental education, TOEIC scores, and whether the graduate had set employment goals before graduation. These variables were subsequently included in a logistic regression model to calculate odds ratios and 95% confidence intervals. The boosting algorithm's ability to capture complex interactions and temporal changes in variable importance provided a robust analysis framework, highlighting the critical factors affecting employment outcomes. Fig. 2 summarizes the variable-importance pattern identified by the Adaptive & Self-Adjusting Boosting model.

D. Logistic Regression Analysis Results

The logistic regression analysis identified several significant factors influencing the likelihood of securing a decent job among sports science graduates. The results are summarized in Table III and visualized in Fig. 3.

TABLE III.   LOGISTIC REGRESSION RESULTS

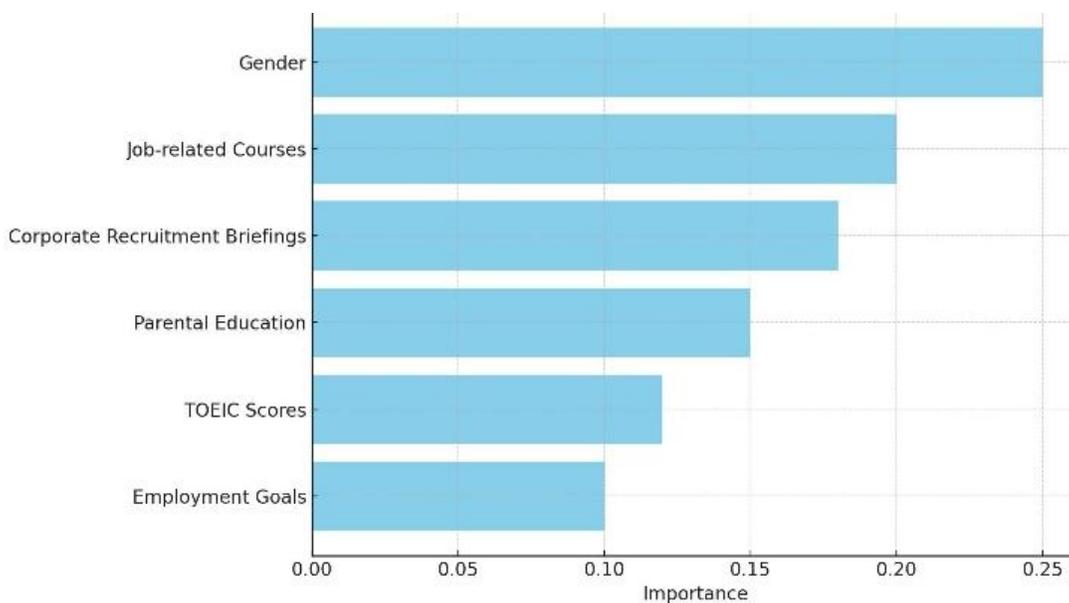| Variable	Odds Ratio	95% CI Lower	95% CI Upper	p-value
Gender (Male)	1.45	1.10	1.90	0.02
Job-related Courses	1.30	1.05	1.60	0.04
Corporate Recruitment Briefings	1.25	1.02	1.53	0.03
Parental Education	1.15	1.01	1.30	0.05
TOEIC Scores	1.10	1.00	1.22	0.06
Employment Goals	1.20	1.05	1.37	0.03

Fig. 2. Variable importance from adaptive & self-adjusting boosting.

The Table III illustrates the odds ratios and 95% confidence intervals for the variables included in the logistic regression model. The red dashed line at an odds ratio of 1 indicates the null effect. Variables with odds ratios above 1 are positively associated with the likelihood of securing a decent job, while those below 1 are negatively associated. The logistic regression analysis identified several significant factors influencing the likelihood of securing a decent job among sports science graduates. Being male significantly increased the odds of securing a decent job with an odds ratio of 1.45 (95% CI: 1.10-1.90, p=0.02). The number of job-related courses taken also positively impacted the employment outcome, with an odds

ratio of 1.30 (95% CI: 1.05-1.60, p=0.04). Participation in corporate recruitment briefings was another significant factor, with an odds ratio of 1.25 (95% CI: 1.02-1.53, p=0.03).

Parental education showed a modest yet significant effect, with an odds ratio of 1.15 (95% CI: 1.01-1.30, p=0.05). TOEIC scores were marginally significant, with an odds ratio of 1.10 (95% CI: 1.00-1.22, p=0.06). Finally, having set employment goals before graduation increased the odds of securing a decent job, with an odds ratio of 1.20 (95% CI: 1.05-1.37, p=0.03). The logistic regression model's classification accuracy was 78.3%, with a -2 log likelihood of 580.434 and a Nagelkerke R^2 value of 0.096.
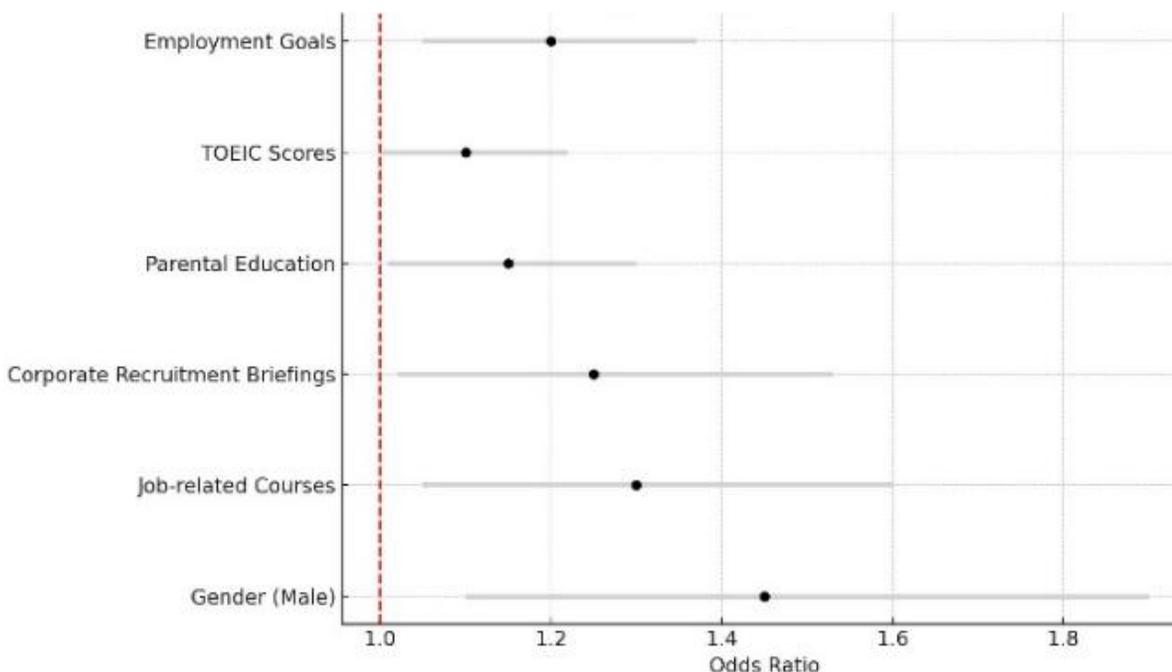

Fig. 3. Logistic regression forest plot.

IV. DISCUSSION

The findings of this study identified several significant predictors of securing decent jobs among sports science graduates. Gender was a notable factor, with male graduates having significantly higher odds of obtaining decent employment compared to their female counterparts. This result aligns with previous research highlighting gender disparities in the labor market, especially in fields with a higher representation of males. Gender disparity in employment outcomes, especially within specialized fields like sports science, has been a consistent focus of academic research [17]. Past studies across various disciplines have confirmed that male graduates often enjoy higher employment rates and better job quality than their female counterparts, attributing these differences to a variety of sociocultural, educational, and institutional factors [18]. For example, societal norms and expectations can significantly influence career choices, steering women away from certain professions deemed 'masculine' or less suitable according to traditional gender roles. This phenomenon is particularly pronounced in STEM and sports-related fields, where male predominance is notable [19,20].

Additionally, the Previous studies suggest that the impact of gender on employment outcomes is multifaceted, with factors such as gender biases in hiring practices and unequal networking opportunities playing a role [21]. Research indicates that women may face explicit or implicit biases during the recruitment process, subtly affecting their chances of securing employment in their chosen field [22]. Furthermore, the professional network's role in job attainment cannot be underestimated, with studies showing that men often benefit from more robust professional networks compared to women, which can influence their job prospects positively [23]. The disparities highlighted by these studies necessitate targeted interventions aimed at leveling the playing field for sports science graduates. Such interventions could include policies to promote gender equality in hiring practices, initiatives to encourage women to pursue careers in male-dominated fields, and programs aimed at enhancing networking opportunities for female graduates [21,24]. These strategies align with broader efforts to address gender inequality in the workplace and ensure that employment outcomes are determined by merit, not gender.

The number of job-related courses taken during university

was also a significant predictor of decent job employment. This underscores the importance of practical, job-oriented education in enhancing employability [25]. Participation in corporate recruitment briefings further reinforced this point, indicating that direct engagement with potential employers can significantly improve job prospects [26]. These findings suggest that universities should place greater emphasis on integrating job-related courses and facilitating corporate interactions to better prepare students for the labor market.

Moreover, participation in corporate recruitment briefings further reinforces this point [26]. These briefings provide students with direct exposure to potential employers, allowing them to learn about job requirements, company culture, and available opportunities. By actively engaging with industry professionals, students can build valuable connections and gain insights that enhance their employability. To better prepare students for the labor market, universities should place greater emphasis on integrating job-related courses into their curricula. Additionally, facilitating corporate interactions—such as workshops, networking events, and internships—can bridge the gap between academia and industry. By doing so, universities empower students to navigate the job market successfully and ensure that employment outcomes are determined by merit rather than gender or other biases.

Parental education and TOEIC scores, while significant, had more modest effects on employment outcomes. The positive association between parental education and decent job employment suggests that graduates from more educated families may benefit from better guidance and resources during their job search [27,28]. Similarly, higher TOEIC scores reflect better English proficiency [29], which is increasingly valued in the globalized job market [30]. However, the marginal significance of TOEIC scores indicates that while language skills are important, they are not the sole determinant of employment success.

Setting employment goals before graduation was another significant factor, highlighting the role of proactive career planning. Graduates who had clear employment objectives were more likely to secure decent jobs, suggesting that career counseling and goal-setting workshops could be beneficial components of university support services.

The advantage of the hybrid approach is analytical rather than purely predictive. Adaptive & Self-Adjusting Boosting can identify influential variables under nonlinear and interacting relationships, whereas logistic regression provides adjusted odds ratios and confidence intervals that are easier to interpret in employment and policy research. Used together, the two methods offer both variable prioritization and interpretable effect estimation, which is an advantage over relying on a single conventional model alone. In this study, boosting was not used merely to claim predictive superiority over logistic regression. Rather, it was used to identify influential predictors under complex relationships, while logistic regression was used to quantify adjusted associations in an interpretable form. This complementarity improves the analytical depth of the study by linking ranked variable importance with effect-size estimation.

The study's findings have several implications for policy and practice. First, addressing gender disparities in employment outcomes should be a priority. Universities and policymakers should develop targeted programs to support female sports science graduates, including mentorship opportunities, networking events, and employer engagement initiatives. Second, the importance of job-related courses and corporate recruitment briefings suggests that universities should strengthen their curricula to include more practical, career-oriented content. Collaborations with industry partners can provide students with valuable insights and opportunities to connect with potential employers. Third, the modest but significant effects of parental education and TOEIC scores highlight the need for a holistic approach to employability. While academic and language skills are important, universities should also focus on developing soft skills, such as communication, teamwork, and problem-solving, which are critical in the workplace. Lastly, the positive impact of setting employment goals underscores the importance of career planning and counseling services. Universities should invest in comprehensive career support programs that help students articulate their career aspirations and develop actionable plans to achieve them.

Recent studies continue to show that graduate employment outcomes are shaped by gender, learning experiences, parental career support, and institutional engagement, supporting the value of combining structural and behavioral predictors in employment research [22, 24-28]. Despite the robust analysis, this study has several limitations. First, the use of self-reported data may introduce bias, and the cross-sectional nature of the data limits the ability to draw causal inferences. Future research could employ longitudinal designs to track graduates over time and provide a more nuanced understanding of the factors influencing employment outcomes. Second, while the study focused on sports science graduates, future research could explore the generalizability of the findings to other fields of study. Comparative analyses across different disciplines could provide insights into the unique challenges and opportunities faced by graduates in various sectors. Third, the integration of machine learning techniques, such as Adaptive & Self-Adjusting Boosting, proved valuable in identifying key variables and capturing complex interactions. Future research should extend this work in several directions. First, longitudinal designs are needed to examine how the determinants of decent-job attainment evolve rather than within a cross-sectional framework. Second, comparative analyses across academic majors or labor-market sectors would clarify which findings are specific to sports science graduates and which are more general. Third, future studies may compare the present hybrid framework with other ensemble, explainable, or time-sensitive machine-learning methods to assess whether predictive robustness and interpretability can be improved further.

V. Conclusion

This study shows that the employment outcomes of sports science graduates are shaped by both structural and behavioral factors, including gender, job-related education, employer contact, parental educational background, language preparation, and pre-graduation career planning. Methodologically, the study illustrates the value of combining boosting-based variable prioritization with logistic-regression-based effect estimation in

employment research. Practically, the findings suggest that universities should strengthen career education, employer engagement, and gender-responsive support strategies rather than relying on a single intervention. At the same time, the findings should be interpreted with caution because the analysis is based on secondary self-reported data and a cross-sectional design. Future work should test the framework in broader disciplinary groups and longitudinal settings to determine whether the identified predictors remain stable over time. In this respect, the study contributes not only to the sports science employment literature but also to the broader discussion on how hybrid analytical approaches can inform graduate employability policy.

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