International Journal of Innovative Research and Scientific Studies, 8(1) 2025, pages: 2618-2633

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

Green economy in the sports sector and the impacts of future climate change: An analysis of opportunities and challenges for economic sustainability

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Abstract

The study aimed to investigate the contribution of green economy technologies to confronting climate change in the Saudi sports sector. The researcher relied on the descriptive approach for the purposes of the study and chose the descriptive survey method because it was appropriate for the study methodology to achieve the objectives. The course included representatives of the sports industry in the Kingdom of Saudi Arabia. The study sample consisted of 1,420 individuals who were selected based on different categories within the study community. Two questionnaires were applied as data collection tools, indicating a strong focus on technology applications and the implementation of green and environmentally friendly policies by some sports institutions in the Kingdom of Saudi Arabia. Findings: The results demonstrated a strong positive relationship between the use of green economy technology and confronting climate impacts in the sports sector. It is believed that such technologies constitute a powerful tool for predicting the sustainability of the sports ecosystem in the Kingdom of Saudi Arabia. The practical implications of this study emphasize that integrating renewable energy sources, eco-friendly materials, and smart systems into sports facilities not only minimizes environmental harm but also promotes economic diversification aligned with Vision 2030. Additionally, they improve resource efficiency, such as water and energy management, while fostering positive societal attitudes toward sustainable sports practices.

Keywords: Climate change, Sustainability, Economic opportunities, Green economy, Social responsibility, Technology.

DOI: 10.53894/ijirss.v8i1.5036
Funding: This research is supported by the Deanship of Scientific Research at King Faisal University, Saudi Arabia, grant number (KFU250759).
History: Received: 20 January 2025 / **Revised:** 22 February 2025 / **Accepted:** 27 February 2025 / **Published:** 28 February 2025

Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.
Transparency: The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Institutional Review Board Statement: The Ethical Committee of the [Scientific Research Ethics Committee at King Faisal University, Saudi Arabia has granted approval for this study (Ref. protocol No KFU-REC-2024-SEP-ETHICS2584).
Publisher: Innovative Research Publishing

1. Introduction

Smart technologies promote sustainable development while dealing with multiple city challenges through their integration into urban spaces. Saudi Arabia leads the Gulf Cooperation Council countries toward a green economy by focusing on renewable energy adoption for environmental sustainability [1]. The application of smart technologies during urban renewal reveals potential to revitalize fading urban zones through smart governance and infrastructure and economic systems which correspond to Saudi Arabia's National Vision 2030 [2]. Solar-based smart cities around the world implement digitized platforms with big data methods to enhance resource management while minimizing environmental pollutants while addressing privacy dilemmas and equality deficits in digital access [3]. These technological breakthroughs collaborate to shift cities from conventional to pluralistic urban settings which produces better human well-being together with sustainable urban systems [3, 4]. Multiple environmental elements and various economic conditions create different local challenges for climate change due to different ecological setups between regions. The main cause of global warming stems from human-generated greenhouse gases but the local consequences profoundly affect farming demands together with water supplies and population wellness that affect marginalized communities especially [5, 6]. Studies show regional warming from both worldwide anthropogenic sources and local factors plays an equal part in the climate change effects on West Asia and East North America [7]. The rise of severe weather events demands immediate action through adaptation strategies because these events both increase social disparities and endanger long-term community development [8, 9].

Modern institutions require contemporary administrative techniques because they need to face up to their challenges and changing societal needs [10]. The competitive market requires organizations to use employee engagement strategies for objective accomplishment because motivated employees generate superior performance outcomes [10, 11]. Organizations need to prioritize employee work life quality because it promotes employee dedication and motivation that results in superior organizational outcomes [12]. The development of modern work environments which remove performance barriers will help motivate staff and raise their operational results [10, 11]. Administrative management achieves sustainable development together with organizational effectivity through the integration of systemic approaches [12]. Institutions need to focus on both employee wellness programs with innovative workplace practices as they strive to succeed in their dynamic and complex environments [10]. Smart technologies reshape the sports industry through specific enhancements of athlete performance along with audience interaction and data protection measures. Sports technologists who invest in applications like wearables and IoT provide real-time performance analysis through athletic performance monitoring so coaches and athletes can benefit [13]. Big data analytics together with artificial intelligence wartime sustainable sports development through enabling organizations to deploy decision-making processes that optimize operations and service quality [14, 15]. Smart sports equipment market values are increasing rapidly because consumers need product solutions which fit their diverse requirements [13]. There are urgent demands to resolve data security as well as privacy problems which block complete utilization of these technologies. Strategic implementation of these advancements serves as a critical path for sports institutions to succeed in adapting to industry changes [16]. Sport organizations will integrate real/virtual element grafting technologies alongside new systems to achieve better player team performance while enhancing fan engagement under competition conditions. Smart technologies serve as a fundamental solution which enables sports institutions to match the dynamics of sports business while facing existing challenges of the industry.

Current times demand smart technology implementations in sports institutions because they boost operational effectiveness and improve service and preserve sustainability. Sports organizations can optimize resource distribution and improve customer engagement through IoT and big data technology and AI systems for real-time analysis [17-19]. AI big models enhance athlete training methods as well as athletic competition strategies and develop advanced service delivery solutions [19]. The integration of smart technologies into sports venues produces dual benefits as it both enhances facility security and power efficiency while finally enabling fan interaction [17]. The sports industry experiences digital transformation with challenges of high initial costs and technical complexity because it enables competitiveness and better customer experience satisfaction [14, 20]. Climate change exerts substantial effects on sports sectors; therefore, Saudi Arabia should implement intelligent technology to establish a green economy while reducing environmental repercussions. Studies show that event planners in the sports industry adopt climate adaptation strategies to some extent, yet they lack preparation against climate change impacts [21]. The sports industry enhances economic advancement by hosting events and constructing facilities enabling digital and sustainable innovation opportunities [22]. People advocate for critical systemic reorganization of sports activities, which must focus on community-based low-impact solutions to handle climate problems [23]. Academic evidence shows that sports facilities leave a large carbon imprint, so it becomes essential to control energy usage to achieve sustainability targets [24]. Strategic policy integration together with technological developments needs to address the climate change and economic development challenges that currently face the sports sector [25]. Science shows that the sports sector stands among the most climate-sensitive economic sectors because it depends heavily on natural factors that are resistant to changing climate patterns, thus making climate change a significant

development challenge facing global economic policies, including sports organizations. The research examines how smart technology applications in Saudi sports sector contribute to green economy, green sports development, and climate change mitigation.

1.1. The Significance of the Research

The development of Saudi Arabia's green economy, alongside its other sectors, as well as climate change mitigation through sports, depends strongly on smart technologies. The world's academic institutions continue to become more technologically advanced in their policy development, while research is needed to explain the role these technologies play in green economic solutions to climate change and green sport initiatives. Research needs to be conducted to enhance and adjust existing professional approaches that relate to the rapid technological development in information technology. Such efforts narrow the distance between modern technology innovations and professional standards. The proposed theoretical work should investigate how sports institutions benefit from the implementation of smart technology and how it will expand green economic growth for sustained sports sector development throughout the country. The government of Saudi Arabia declared through the Sustainable Development Plan for 2030 its intention to work with professional associations as well as foreign entities while leading a planned initiative that focuses on powerful smart technologies and their cross-sector impact according to global developments. The implementation of this system enables researchers to observe data about sustainable practices that smart technology provides for addressing climate change within the sports industry.

1.2. Objectives

This research examines how smart technologies contribute to the Saudi sports sector's green economy while assessing their effects on handling future climate opportunities and challenges for achieving sustainable economic performance.

1.3. Research Questions

To support the research objectives these specific questions are being evaluated:

Q1: What are the existing opportunities for the green economy within the Saudi sports sector?

Q2: Is there a significant relationship between the utilization of smart technologies and their role in supporting the green economy as well as addressing climate change to ensure sustainability in the Saudi sports sector?

Q3: To what extent can the integration of smart technologies enhance support for the green economy and mitigate the effects of climate change in the Saudi sports sector?

2. Literature Review

Due to insights from study by Qian, et al. [26] Saudi sports facilities have clear potential to adopt green economy measures because implementing energy-efficient designs together with sustainable practices results in lower environmental impact with enhanced energy output. Wang [27] shows that the integration of extensive green technologies and sustainable cultural development in sports communities will solve present challenges. According to Szathmári [28] the sports sector faces both possibilities and management obstacles when integrating green economy strategies for future climate conditions. The sports industry causes substantial environmental damage which requires sustainable practices that follow both environmental economic principles and negative growth measures according to Dewi and Alif [29]. A green economy transition supports growth and innovation through climate risk management although funding constraints and resistance from conventional sectors impede its development. This Sele and Mukundi [30] emphasized how climate change creates economic stress that promotes green employment growth while pointing out the requirement of powerful international collaboration to steer this shift. According to Saha [31] the green economy represents an essential solution for climate challenges as well as requiring social and political organizations for achieving sustainable progress. According to McCullough [32] the sports industry needs to establish forward-thinking strategies to reduce environmental impact as it accepts the climate-related challenges. The sports industry requires implementation of Degrowth principles according to Szathmári [28], to reduce its environmental impact while promoting community-supported resource redistribution. According to Lyu [33] society shows increasing interest in green stadiums as studies show sports fans pay higher stadium tickets prices for facilities utilizing renewable energy solutions. Kamaruddin, et al. [34] show how sporting games can teach young players about environmental awareness through gaming content that includes sustainable development subjects. Research by Yang, et al. [35] establishes how the digital economy boosts green productivity in sporting goods manufacturing companies throughout the supply chain.

3. Materials and Methods

3.1. Research Sample

Research involved employees from sports facilities located throughout the Kingdom of Saudi Arabia within sports clubs and federations. The researchers purposefully selected participants who reflected these categories in the whole

research community. A new statistical method which had not previously been used in Saudi applied through this research. A series of self-administered questionnaires enabled researchers to obtain quantitative data for answering the research questions. The questionnaire containing detailed instructions reached all sports institution workers in Saudi Arabia (total n=1420). Participants joined the study out of free will and received no compensation while financial aid was also avoided since participant independence remained protected. Foreign language versions of the questionnaires enhanced the response volumes by accompanying the questionnaire in its Arabic form. The questionnaire divided itself into two parts: the first section needed demographic information including gender and experience (see Table 1) while Table 2 presented the main sample distribution. The following sections with their respective percentages define the distribution of participants as displayed in the table. The research questions received answers through the second section of the questionnaire design. The questionnaire items originated from valid measures as well as experimental studies. Figure 1 illustrates the study design. The research employs the survey method as part of the descriptive approach which best matches the study objectives and procedures. The descriptive approach emphasizes description together with interpretation analysis and the development of correlations among current phenomena. This research should employ smart technologies together with green economy and climate change analysis within the Saudi sports sector because it provides a suitable basis for investigation.

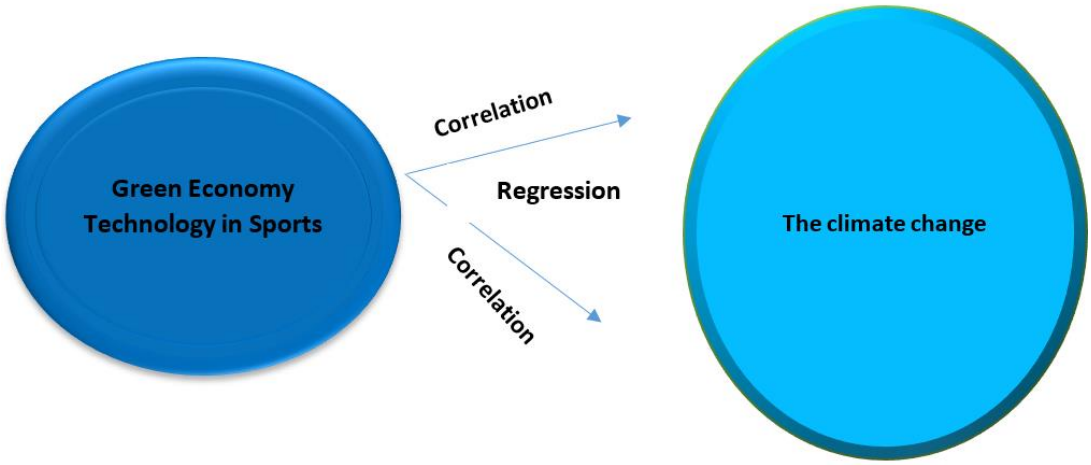

Figure 1.
Research framework.

Table 1.
Demographic characteristics

Characteristic	Profile	N	Percentage
Gender	Male	917	64.58%
	Female	503	35.42%
Experience	Less than 5 y	274	19.30%
	5-15 y	660	46.48%
	16-25 y	486	34.22%

Table 2 displays information about a research study carried out within different organizational departments. This table shows both the key population size and questionnaire examples distributed among departments. A department list follows in which participant totals from both the core sample are presented. A total of 1420 participants make up this research study.

Table 2.
Description of a sample study.

No	Organizational departments	Basic sample	percentage
1	board members	350	24.65%
2	administrators	510	35.91%
3	specialists	560	39.44%
Total		1420	100%

3.2. Research Instruments

We used two questionnaires. Identifying the facts regarding green economy technology adoption within Saudi Arabia's sports industry was the study's core research goal. It was made up of 23 phrases. The questionnaire included five different dimensions that included Awareness of Green Technologies (AGT), Opportunities for Green Economy in Sports (OGES), Challenges Facing Green Technology Adoption (CFGTA), Impact of Climate Change on Sports (ICCS), and Future Prospects of Green Economy in Sports (FPGES), with descriptions available in Appendix A. In the second questionnaire, a total of 33 phrases made up the section to show the role of green economy technology in confronting climate change in the

sports sector. The survey contained four different sections that measured: environmental sustainability (ES), economic opportunities (EO), technological integration (TI), and social responsibility (SR) (more information about the sections can be found in Appendix B). The three-point Likert scale was adopted to assess the participants' responses, with options ranging from 3 points "Applies" to 2 points "Somewhat applies" and a single point "Does not apply." The survey instrument creates an equal method to capture participant opinions about each statement. The selected method effectively fulfills its objective to extract straightforward information from survey subjects. We checked the questionnaire's validity and reliability through Cronbach's alpha method to determine the internal consistency coefficient. The reliability measurements show a 0.82 coefficient for the first questionnaire and 0.88 for the second questionnaire. The research shows good accuracy because of these recorded coefficients. The baseline research extended from Jun 4th to July 9th of 2024.

3.3. Statistical Analysis

A linear correlation using Pearson's r along with Cronbach's Alpha method proved reliability in the study detection process. The analysis included percentage values together with mean, standard deviation and the chi-square test for randomness and KMO measure of sampling adequacy and regression analysis. IBM SPSS 26 served as the software platform for data analysis in the study and this program was developed by the American technology company IBM Corporation headquartered in NY, Armonk. The statistical process demanded an initial setting of $p < 0.05$ as the acceptable chance probability of phenomenon emergence.

4. Results

The research data about applying smart technologies and green economy opportunities together with the role of smart technologies in combating climate change in Saudi sports appears in Figures 2, 3.

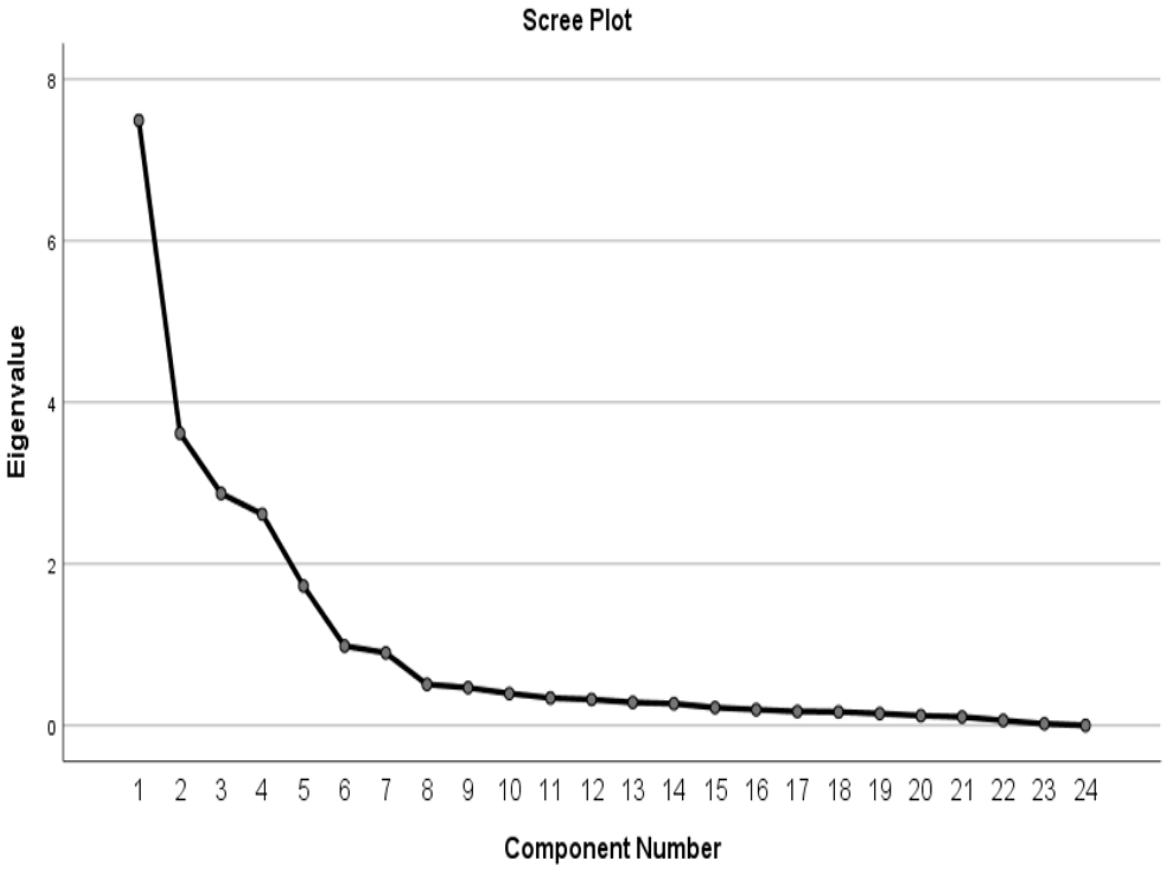

Figure 2.
Scree plot response to questionnaire of green economy technology.

Table 3 demonstrates differing questionnaire answers and X^2 values that show the state of green economy technology adoption in Saudi sports sector organizations. The individual mean answers for the statements spanned from 1.35 points to 2.58 points, and the mean response averages across axes fell between 1.87 and 2.33. The whole survey scored 2.08 points, suggesting that participants demonstrated a moderate level regarding green technology applications in sports.

Table 3.
Mean, SD, and (X^2) for the questionnaire data on green economy technology in the Saudi sports sector.

No.	Phrase	Mean	Std.	X^2	p-value	Imp. percentage
	Axis 1: Awareness of Green Technologies (AGT)					
1-	I am familiar with the concept of green economy technology and its applications in the sports sector.	1.35	0.60	968.59	0.000	45.07%
2-	The sports sector in Saudi Arabia is actively adopting green technologies to reduce environmental impact.	1.61	0.64	397.32	0.000	53.76%
3-	Green technologies can significantly contribute to the sustainability of sports facilities and events.	2.26	0.75	157.09	0.000	75.40%
4-	I believe that digital tools play an essential role in promoting green practices within the sports industry.	2.06	0.47	1240.62	0.000	68.71%
5-	Educational programs about green economy technology should be implemented in sports organizations.	2.06	0.47	1244.39	0.000	68.69%
	Average	1.87	0.51	636.25	0.000	62.32%
	Axis 2: Opportunities for Green Economy in Sports (OGES)					
6-	The integration of renewable energy sources in sports venues represents a viable opportunity for economic savings.	1.47	0.62	587.87	0.000	49.15%
7-	Promoting eco-friendly materials in sports equipment manufacturing can enhance the green economy.	1.75	0.67	294.51	0.000	58.33%
8-	Sustainable tourism initiatives in sports can attract environmentally conscious audiences.	2.37	0.76	304.19	0.000	79.01%
9-	Green economy practices in sports have the potential to create new job opportunities in the region.	2.16	0.55	783.93	0.000	72.16%
	Average	1.94	0.57	278.49	0.000	64.67%
	Axis 3: Challenges Facing Green Technology Adoption (CFGTA)					
10-	High initial costs are a significant barrier to implementing green technologies in the sports sector.	1.98	0.78	18.18	0.000	66.15%
11-	Lack of awareness among sports stakeholders hinders the adoption of green economy principles.	1.92	0.67	294.28	0.000	64.01%
12-	Insufficient government policies may limit the progress of sustainable practices in sports.	2.42	0.52	701.75	0.000	80.52%
13-	Resistance to change from traditional methods poses challenges to integrating green technologies.	2.77	0.49	1423.42	0.000	92.30%
14-	Technical expertise and training in green technologies are currently inadequate in the sports industry.	2.58	0.57	714.26	0.000	85.96%
	Average	2.33	0.47	841.15	0.000	77.79%
	Axis 4: Impact of Climate Change on Sports (ICCS)					
15-	Climate change is increasingly affecting the organization and management of outdoor sports events.	2.03	0.87	56.94	0.000	67.54%
16-	Rising temperatures may lead to reduced participation in physical activities and sports.	1.72	0.82	215.67	0.000	57.28%
17-	The use of green technologies can mitigate the negative effects of climate change on sports infrastructure.	2.26	0.68	275.85	0.000	75.42%
18-	Sustainable water management is crucial for maintaining sports facilities in arid regions like Saudi Arabia.	2.44	0.72	425.68	0.000	81.31%
19-	Addressing climate change through green initiatives will improve the long-term viability of the sports sector.	2.47	0.68	471.83	0.000	82.32%
	Average	2.18	0.67	1022.74	0.000	72.77%

Continued

No.	Phrase	Mean	Std.	X^2	p-value	Imp. percentage
	Axis 5: Future Prospects of Green Economy in Sports (FPGES)					
20-	The future of the sports sector depends on its ability to adapt to green economy principles.	2.00	0.89	95.12	0.000	66.83%
21-	Smart technologies can revolutionize how sports organizations implement green practices.	1.89	0.70	210.85	0.000	62.96%
22-	Collaboration between sports entities and environmental experts is necessary for advancing green economy initiatives.	2.07	0.70	195.48	0.000	68.97%
23-	Public-private partnerships can accelerate the adoption of sustainable solutions in the sports industry.	2.09	0.73	110.97	0.000	69.53%
	Average	2.01	0.65	719.54	0.000	67.07%
	Average total	2.08	0.36	1022.01	0.000	69.19%

Analysis of questionnaire data through Table 3 reveals X^2 values exceeding 0.05 significance to indicate signification for the study of green economy technology opportunities in Saudi sports sector. The KMO values obtained for the questionnaire dimensions consisting of Green Technologies (AGT), Opportunities for Green Economy in Sports (OGES), Challenges Facing Green Technology Adoption (CFGTA), Impact of Climate Change on Sports (ICCS), and Future Prospects of Green Economy in Sports (FPGES) reached (0.822, 0.803, 0.736, 0.773, 0.690), respectively. Bartlett's test confirmed statistical significance along with the (0.791) KMO value to indicate acceptable questionnaire validity even though the individual KMO values were (0.822, 0.803, 0.736, and 0.773, 0.690), respectively.

Table 4 presents the responses and X^2 values of the questionnaire assessing the role of green economy technology in addressing climate change within the sports sector. The mean response to all statements falls between (2.49–2.84), while the average responses for each axis range from (2.62–2.78). Overall, the questionnaire's average response is 2.72, indicating a moderate level of agreement among participants regarding the effectiveness and relevance of green technologies in combating climate challenges in the sports industry in Figure 3.

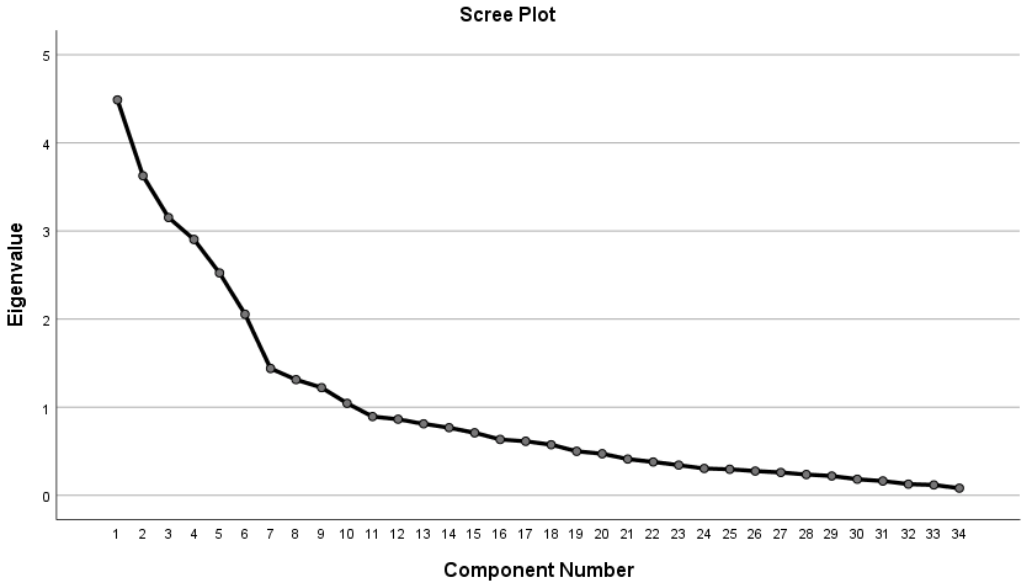

Figure 3.
Scree plot response to questionnaire of green economy technology.

Table 4.
Mean, SD, and (X^2) for the questionnaire data on the role of the role of green economy technologies in confronting climate change in the sports sector.

No.	Phrase	Mean	Std.	X^2	p-value	Imp.
	Axis 1: Environmental Sustainability (ES)					
1-	Smart technologies can significantly reduce carbon emissions in sports facilities.	2.69	0.46	196.33	0.000	89.5%
2-	Adopting green economy practices enhances environmental sustainability in the sports sector.	2.69	0.46	197.82	0.000	89.6%
3-	Renewable energy sources, such as solar panels, contribute to reducing the environmental impact of sports events.	2.83	0.38	609.09	0.000	94.2%
4-	Water conservation technologies play a crucial role in promoting sustainability in sports venues.	2.58	0.49	34.71	0.000	85.9%
5-	Recycling waste materials in sports facilities is an effective way to support environmental protection.	2.56	0.50	23.84	0.000	85.5%
	Implementing smart irrigation systems reduces water consumption in sports fields.	2.89	0.31	861.43	0.000	96.3%
6-	Using eco-friendly building materials improves the sustainability of sports infrastructure.	2.49	0.50	0.63	0.000	83.0%
7-	Green technologies help mitigate the negative effects of climate change on outdoor sports activities.	2.32	0.47	191.89	0.426	77.2%
8-	Promoting environmental awareness among athletes and fans supports sustainable practices in the sports sector.	2.57	0.50	25.42	0.000	85.6%
	Average	2.62	0.18	1904.94	0.000	87.4%
	Axis 2: Economic Opportunities (EO)					
9-	Investing in green economy technologies creates new economic opportunities for sports organizations.	2.75	0.44	343.10	0.000	91.5%
10-	The adoption of smart technologies can lead to significant	2.75	0.43	363.05	0.000	91.8%

No.	Phrase	Mean	Std.	X^2	p-value	Imp.
	cost savings in sports facilities.					
11-	Green initiatives attract environmentally conscious sponsors and investors to the sports sector.	2.77	0.42	402.49	0.000	92.2%
12-	Sustainable sports tourism contributes to the growth of the local economy.	2.78	0.42	437.29	0.000	92.6%
13-	Energy-efficient technologies improve the financial performance of sports venues.	2.81	0.39	542.88	0.000	93.6%
14-	The integration of green technologies aligns with Saudi Arabia's Vision 2030 goals for economic diversification.	2.74	0.44	339.18	0.000	91.5%
15-	Digital marketing tools can effectively promote green sports initiatives to a wider audience.	2.77	0.42	404.62	0.000	92.2%
16-	Green certifications for sports facilities enhance their market value and competitiveness.	2.80	0.40	523.27	0.000	93.5%
17-	Eco-friendly practices in the sports sector can generate long-term economic benefits.	2.79	0.40	492.18	0.000	93.1%
18-	Partnerships between sports organizations and environmental agencies foster economic sustainability.	2.84	0.37	649.01	0.000	94.6%
	Average	2.78	0.21	1414.73	0.000	92.7%
	Axis 3: Technological Integration (TI)					
19-	Smart technologies can be seamlessly integrated into existing sports infrastructure.	2.66	0.48	138.83	0.000	88.5%
20-	Training employees on green technologies is essential for successful implementation in sports facilities.	2.68	0.47	174.65	0.000	89.2%
21-	Advanced data analytics helps monitor and optimize energy usage in sports venues.	2.69	0.46	199.31	0.000	89.6%
22-	IoT (Internet of Things) devices improve resource management in sports facilities.	2.80	0.40	496.90	0.000	93.2%
23-	Technology-driven solutions enhance the efficiency of waste management systems in sports events.	2.73	0.44	308.62	0.000	91.1%
24-	Smart sensors contribute to better air quality management in indoor sports arenas.	2.77	0.42	402.49	0.000	92.2%
	Average	2.72	0.31	1100.59	0.000	90.6%
	Axis 4: Social Responsibility (SR)					
25-	Sports organizations have a responsibility to adopt green economy practices for the benefit of society.	2.73	0.45	295.71	0.000	90.9%
26-	Engaging communities in green sports initiatives fosters social cohesion and environmental awareness.	2.67	0.47	164.97	0.000	89.0%
No.	Phrase	Mean	Std.	X^2	p-value	Imp.
27-	Educating athletes about the importance of sustainability promotes positive behavioral changes.	2.77	0.42	428.45	0.000	92.5%
28-	Encouraging fans to participate in eco-friendly activities enhances the social impact of sports events.	2.77	0.42	417.54	0.000	92.4%
29-	Green economy technologies improve the quality of life for individuals and communities involved in sports.	2.69	0.46	199.31	0.000	89.6%
30-	Sports organizations should prioritize social responsibility by investing in sustainable practices.	2.70	0.46	233.65	0.000	90.1%
31-	Community involvement in green sports projects strengthens public trust and support.	2.75	0.43	359.01	0.000	91.7%
32-	Promoting environmental sustainability in sports encourages responsible consumer behavior.	2.76	0.43	381.48	0.000	92.0%
33-	The integration of green technologies in sports reflects a commitment to social and environmental well-being.	2.80	0.40	504.03	0.000	93.3%
	Average	2.74	0.28	1340.99	0.000	91.3%
	Average total	2.72	0.14	668.91	0.000	90.5%

From Table 4, it can be seen that the X2 values are significant at the level of significance (0.05) for the questionnaire data on the role of green economy technologies in confronting climate change in the sports sector, while the KMO for the questionnaire axes (environmental sustainability (ES), economic opportunities (EO), technological integration (TI), and

social responsibility (SR)) reached respectively (0.550, 0.730, 0.731, 0.641). However, KMO was 0.655, which was acceptable, and Bartlett's test of sphericity was significant.

Table 5 shows the correlation coefficients between incorporating green economy technologies and confronting climate change in the Saudi sports sector.

Table 5.
Correlation coefficients.

The green economy technologies		The confronting climate change				
		ES	**EO**	**TI**	**SR**	**total**
AGT	Pearson Correlation	-.089**	-.091**	.044*	.081**	0.018
	Sig.	0.000	0.000	0.034	0.000	0.355
OGES	Pearson Correlation	1420	1420	1420	1420	1420
	Sig.	.044*	-.053**	0.040	-0.012	0.034
CFGTA	Pearson Correlation	0.036	0.010	0.055	0.568	0.072
	Sig.	1420	1420	1420	1420	1420
ICCS	Pearson Correlation	0.016	.104**	.146**	.141**	.164**
	Sig.	0.443	0.000	0.000	0.000	0.000
FPGES	Pearson Correlation	1420	1420	1420	1420	1420
	Sig.	0.028	0.016	.103**	0.010	.063**
total	Pearson Correlation	0.189	0.438	0.000	0.629	0.001
	Sig.	1420	1420	1420	1420	1420

Note: * Correlation is significant at the 0.05 level.
**Correlation is significant at the 0.01 level.

Analyzing Figure 4 shows a normal pattern of residual values. A straight-line distribution of data points matches the pattern of normal distribution for residuals. The observed data shows close correspondence with the prediction model, therefore supporting the statistical analysis validity.

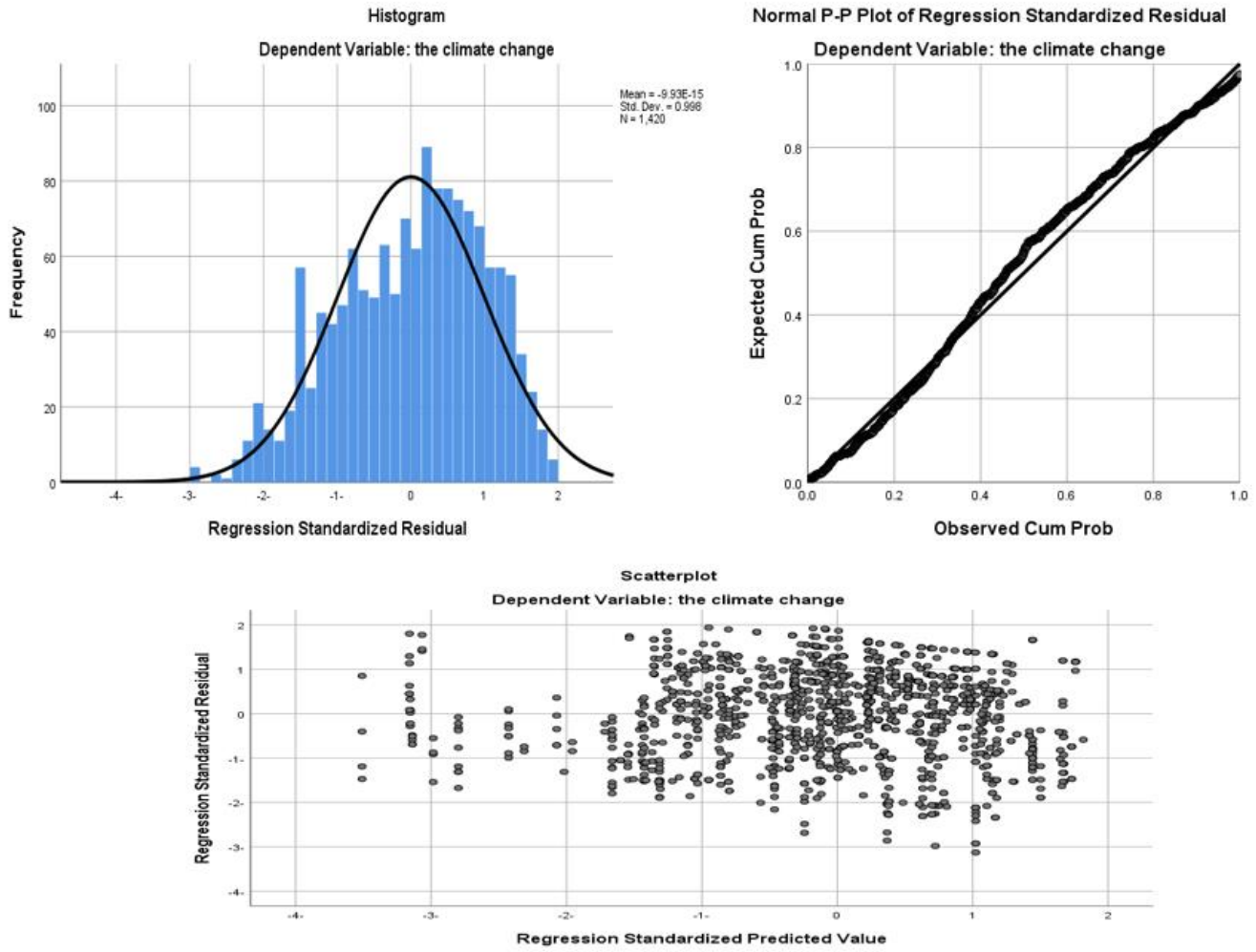

Figure 4.
Multiple regression.

Table 6.
Regression results.

R Square	0.075
F value	23.043
Significance	0.000
Beta of (AGT)	-0.041
Beta of (OGES)	-0.022
Beta of (CFGTA)	0.047

The study utilized a multiple linear regression model to evaluate the connection between green economy technology and climate change variables (Table 5). This research model included independent variables that measured Awareness of Green Technologies (AGT), Opportunities for Green Economy in Sports (OGES), and Challenges Facing Green Technology Adoption (CFGTA), as well as Impact of Climate Change on Sports (ICCS) and Future Prospects of Green Economy in Sports (FPGES). The measurement of green economy technology's role in climate change battle served as the dependent variable. The regression model showed statistical significance through an F-value p = 0.000, which proves both the validity of the model and confirms that green economy technology relates directly to climate change solutions. The explanatory variables together explain 75% of the future green economy trends according to the R^2 value of 0.075, indicating the robust relationship between green economy technology and climate change reduction. Beta coefficient analysis shows that confronting climate change has a statistically significant connection to Awareness of Green Technologies (AGT), Opportunities for Green Economy in Sports (OGES), and Challenges Facing Green Technology Adoption (CFGTA), since their calculated p-values (0.000) fall below the threshold value (0.05). Statistical data revealed that confronting climate change showed no significant link to Future Prospects of Green Economy in Sports (FPGES) because its p-value (0.272) exceeded the applied significance level (0.05). The findings enable representation of the regression model through this equation: Future of Confronting Climate Change = 0.20 + (0.041 × AGT) + (0.022 × OGES) + (0.047 × CFGTA) + Error Term. This equation underscores the importance of awareness, opportunities, and challenges related to green technologies in shaping the future of climate change mitigation within the sports sector. However, it suggests that future prospects, while important, do not significantly influence the current ability to address climate change.

5. Discussion

The results show Saudi sports institutions actively pursue eco-friendly and pro-green program implementation. Sporting organizations have demonstrated strong dedication to green methodologies, which strongly support the basic elements of the green economy leading to environmental preservation. These organizations implement green policies and administrative practices and sustainable products within a comprehensive environmental approach according to the research findings. All evaluated studies agree that current green economy technology performance indicators function both as financial tracking tools and social responsibility measures for sports organizations. The dual-purpose nature of this indicator proves the crucial need for organizations to adopt sustainable initiatives that will boost operational efficiency and social impact. Research shows that green economic development depends on three crucial factors, including income per capita, information technology, and human capital, since they facilitate sustainability projects across all sectors, including sports [36, 37]. The application of government sports subsidies creates effective regional carbon emission reduction, which advances sustainable green development for entire communities [38]. Through its improved practices and infrastructure, the sports industry generates both financial expansion and better environmental conditions and worker welfare development [37]. Integrating sustainability reporting at the college athletic level improves campus sustainability efforts by creating an environment of eco-consciousness between all departments [38]. The data validates that environmental initiatives in sports institutions serve as both a tool for attaining environmental targets and sustainable financial development [35].

The study shows how green economy technology helps Saudi Arabia fight climate change through sports facilities, which proves that technology development improves environmental cleanliness while reducing negative effects, enhancing waste management, and attracting investments. Technologies demonstrate real power as the critical element to achieve both energy conservation and environmental management and climate change reduction efforts. Intelligent technologies enable substantial improvements in innovation and sustainably reinforced development across the Saudi sports sector. All parties agree that these investments will shape the educational future. Smart technologies used to establish environmental factors while strengthening sports-sector security and safety systems contribute significantly to the current influence. These findings show a notable rise in smart technology power across the Saudi Kingdom, which enables better implementation of climate change sustainability objectives in sports. According to a study by Alofaysan [39] the Middle East and North Africa region, along with Saudi Arabia and other countries, have experienced accelerated environmental sustainability through renewable energy technologies and green innovations. The technological advancements, including solar power and wind energy systems, lead to decreased carbon pollution and sustainable development opportunities [40]. The incorporation of smart technologies in sports facilities enhances both energy efficiency and safety and security measures, which strengthens sustainability targets [41, 42]. The study highlights the need for stakeholder partnership as a critical factor to reach maximum technology benefits, which will create a sustainable future for the Kingdom [43].

Research findings demonstrate that Saudi sports facilities can implement green economy measures successfully. The integration of sustainable practices with energy-efficient building plans shows potential to improve environmental results and raise energy production, according to Qian, et al. [26]. Wang [27] establishes that sports communities can solve existing difficulties through the combination of sustainable cultural development with extensive green technologies.

Conducting a green economy transformation in sports faces multiple barriers during its implementation phase. Szathmári [23] explains that there exist many promising options to use green strategies for future climate needs, though obstacles from traditional sectors together with management problems remain as implementation hurdles. According to Sele and Mukundi [30] economic stress caused by climate change presents an opportunity for growth in green employment opportunities. Strength through international alliances emerges as an essential requirement for achieving successful management of this transformation. Social and political organizations play a central role in reaching sustainable progress through the green economy, according to Saha [31] whose argument states that it offers vital solutions to climate-related issues. According to McCullough [32]. The public displays growing interest in ecological sustainability because, according to Lyu [33] stadium visitors show willingness towards paying increased admission costs for facilities with renewable power capabilities. The data shows that society is becoming more interested in green sports stadium infrastructure. According to Kamaruddin, et al. [34] interactive media displays an opportunity to educate youth players about environmental awareness through sustainable development integration in sports games.

The digital economy stands as a fundamental driver which boosts environmental productivity throughout the supply chain management of athletic product firms Yang, et al. [35]. Qian, et al. [26] presented a detailed evaluation of the critical situation regarding low-carbon facility design in sports which underscores how whole green technology with smart systems should work together to minimize carbon emissions while enhancing power management systems. The analysis presented here explores methods to tackle climate dangers in sports industries by implementing state-of-the-art technologies along with green operational practices. Strategic planning combined with collaborative activities will assist in overcoming funding barriers and conventional sector resistance to achieve a sustainable future pathway. The implementation of technology in sports institutions represents an essential modern trend in Saudi Arabia to both promote sustainability and combat climate change. Information technology implementation creates vital opportunities for sustainability enhancement through its adoption of advanced Internet of Things (IoT) and artificial intelligence (AI) systems, which sports sectors have already integrated [44]. The technologies support energy efficiency and waste reduction processes, which support Saudi Arabia's Vision 2030 sustainable development objectives [45]. Research demonstrates that public institutions that successfully implement IT discover a direct link between user satisfaction ratings and organizational sustainability assessments; thus, digital capacity enhancements lead to better sustainability achievements [46]. Saudi sports sector sustainability will increase as technology integration deepens in operational frameworks with policy support and public-private partnership development [44, 47].

6. Conclusion, Recommendation and Future Studies

Through administering two questionnaires to 1,420 participants, the study investigated the impact of green economy technologies on climate change mitigation in the Saudi Arabian sports sector. Some Saudi sports institutions demonstrate extensive dedication to implementing green economy technology for environmental sustainability. The research showed positive relationships between these technologies and their effectiveness in minimizing climate change effects in the sports sector. The use of green economy technologies within Saudi sports sector institutions requires improvement to meet current needs. The field needs additional research and development to properly assess how these technologies perform in the long run and what their sustainable impact will be on the environment. Studies confirmed that sustainable technology functions as both an instrument for solving current issues and as the fundamental framework for achieving Vision 2030 sustainable development goals in the Kingdom. The study recommends that Saudi Arabia should dedicate sufficient financial resources toward green economy technology adoption across its sports sector to match sustainable development targets. Educational awareness campaigns need implementation to teach both the public and professional athletes in the sports sector about environmental sustainability values. Sports facilities need modernization through the implementation of eco-friendly technological systems, and designers should create new stadiums powered by renewable energy resources. International partnerships enable Saudi Arabia to gain knowledge about green economy technology from around the world and adjust it for successful application while maximizing benefits.

6.1. Limitations and Future Directions

According to the results of that study, there are some limitations to this study, as it relied on only two questionnaires as data collection tools, which may reduce the depth of understanding of the studied phenomena compared to using multiple tools such as interviews or direct observation. Questionnaires rely on participants' answers, and the results may be affected by the subjectivity of individuals or the inaccuracy of answers due to self-bias or not fully understanding some phrases. The study also focused on the Kingdom of Saudi Arabia without delving into other countries in the region, which may limit understanding of the different contexts of applying green economy technologies in sports across the Middle East and North Africa countries. Some results may be based on theoretical assumptions or preliminary estimates about the impact of green economy technologies, which require more empirical studies to support these results. Future studies need to investigate how sustainable the environmental advantages of green economy technology remain in the face of changing climates, as well as its future development efficacy. Scientists need to study ways of combining these technologies into future sustainable sports strategies, with potential applications that include establishing entirely renewable energy-based smart sports facilities. A research project should evaluate the relationship between enhancing community awareness of the importance of the sports green economy and fan attitudes toward related programs and initiatives.

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Supplementary Materials

Appendix A.

The appendix includes a questionnaire data on green economy technology in the Saudi sports sector.

Table S1.
An applied study at questionnaire data on green economy technology in the Saudi sports sector.

No.	Phrase	Does not apply	Somewhat applies	Applies
	Axis 1: Awareness of Green Technologies (AGT)			
1-	I am familiar with the concept of green economy technology and its applications in the sports sector.			
2-	The sports sector in Saudi Arabia is actively adopting green technologies to reduce environmental impact.			
3-	Green technologies can significantly contribute to the sustainability of sports facilities and events.			
4-	I believe that digital tools play an essential role in promoting green practices within the sports industry.			
5-	Educational programs about green economy technology should be implemented in sports organizations.			
	Axis 2: Opportunities for Green Economy in Sports (OGES)			
6-	The integration of renewable energy sources in sports venues represents a viable opportunity for economic savings.			
7-	Promoting eco-friendly materials in sports equipment manufacturing can enhance the green economy.			
8-	Sustainable tourism initiatives in sports can attract environmentally conscious audiences.			
9-	Green economy practices in sports have the potential to create new job opportunities in the region.			
	Axis 3: Challenges Facing Green Technology Adoption (CFGTA)			
10-	High initial costs are a significant barrier to implementing green technologies in the sports sector.			
11-	Lack of awareness among sports stakeholders hinders the adoption of green economy principles.			
12-	Insufficient government policies may limit the progress of sustainable practices in sports.			
13-	Resistance to change from traditional methods poses challenges to integrating green technologies.			
14-	Technical expertise and training in green technologies are currently inadequate in the sports industry.			
	Axis 4: Impact of Climate Change on Sports (ICCS)			
15-	Climate change is increasingly affecting the organization and management of outdoor sports events.			
16-	Rising temperatures may lead to reduced participation in physical activities and sports.			
17-	The use of green technologies can mitigate the negative effects of climate change on sports infrastructure.			
18-	Sustainable water management is crucial for maintaining sports facilities in arid regions like Saudi Arabia.			
19-	Addressing climate change through green initiatives will improve the long-term viability of the sports sector.			
	Axis 5: Future Prospects of Green Economy in Sports (FPGES)			
20-	The future of the sports sector depends on its ability to adapt to green economy principles.			
21-	Smart technologies can revolutionize how sports organizations implement green practices.			
22-	Collaboration between sports entities and environmental experts is necessary for advancing green economy initiatives.			
23-	Public-private partnerships can accelerate the adoption of sustainable solutions in the sports industry.			

Appendix B.

The appendix includes a questionnaire data on the role of the role of green economy technologies in confronting climate change in the sports sector.

Table S1.

An applied study at questionnaire data on the role of the role of green economy technologies in confronting climate change in the sports sector.

No.	Phrase	Does not apply	Somewhat applies	Applies
	Axis 1: Environmental Sustainability (ES)			
1-	Smart technologies can significantly reduce carbon emissions in sports facilities.			
2-	Adopting green economy practices enhances environmental sustainability in the sports sector.			
3-	Renewable energy sources, such as solar panels, contribute to reducing the environmental impact of sports events.			
4-	Water conservation technologies play a crucial role in promoting sustainability in sports venues.			
5-	Recycling waste materials in sports facilities is an effective way to support environmental protection.			
	Implementing smart irrigation systems reduces water consumption in sports fields.			
6-	Using eco-friendly building materials improves the sustainability of sports infrastructure.			
7-	Green technologies help mitigate the negative effects of climate change on outdoor sports activities.			
8-	Promoting environmental awareness among athletes and fans supports sustainable practices in the sports sector.			
	Axis 2: Economic Opportunities (EO)			
9-	Investing in green economy technologies creates new economic opportunities for sports organizations.			
10-	The adoption of smart technologies can lead to significant cost savings in sports facilities.			
11-	Green initiatives attract environmentally conscious sponsors and investors to the sports sector.			
12-	Sustainable sports tourism contributes to the growth of the local economy.			
13-	Energy-efficient technologies improve the financial performance of sports venues.			
14-	The integration of green technologies aligns with Saudi Arabia's Vision 2030 goals for economic diversification.			
15-	Digital marketing tools can effectively promote green sports initiatives to a wider audience.			
16-	Green certifications for sports facilities enhance their market value and competitiveness.			
17-	Eco-friendly practices in the sports sector can generate long-term economic benefits.			
18-	Partnerships between sports organizations and environmental agencies foster economic sustainability.			
	Axis 3: Technological Integration (TI)			
19-	Smart technologies can be seamlessly integrated into existing sports infrastructure.			
20-	Training employees on green technologies is essential for successful implementation in sports facilities.			
21-	Advanced data analytics helps monitor and optimize energy usage in sports venues.			
22-	IoT (Internet of Things) devices improve resource management in sports facilities.			
23-	Technology-driven solutions enhance the efficiency of waste management systems in sports events.			
24-	Smart sensors contribute to better air quality management in indoor sports arenas.			
	Axis 4: Social Responsibility (SR)			

No.	Phrase	Does not apply	Somewhat applies	Applies
25-	Sports organizations have a responsibility to adopt green economy practices for the benefit of society.			
26-	Engaging communities in green sports initiatives fosters social cohesion and environmental awareness.			
27-	Educating athletes about the importance of sustainability promotes positive behavioral changes.			
28-	Encouraging fans to participate in eco-friendly activities enhances the social impact of sports events.			
29-	Green economy technologies improve the quality of life for individuals and communities involved in sports.			
30-	Sports organizations should prioritize social responsibility by investing in sustainable practices.			
31-	Community involvement in green sports projects strengthens public trust and support.			
32-	Promoting environmental sustainability in sports encourages responsible consumer behavior.			
33-	The integration of green technologies in sports reflects a commitment to social and environmental well-being.			