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Original research papers

THE IMPACT OF SMART TECHNOLOGIES ON STRENGTHENING THE GREEN ECONOMY TO COMBAT CLIMATE CHANGE AND SUSTAIN THE SAUDI SPORTS SECTOR

AHMED K. HASSAN[1], ABDULMALEK K. BURSAIS[1], MOHAMED FRIKHA[1], ALBUJULAYA NAIF[1], AMMAR ALYOUSEF[1], SAMAR ABDEL HALIM GAMAL ELDIN[2]

[1] *King Faisal University, College of Education, Department of Physical Education, Saudi Arabia*
[2] *University Ajman, College of Media, Department of Public Relations, United Arab Emirates*

Mailing address: Ahmed K. Hassan, Department of Physical Education, College of Education, King Faisal University, Prince Faisal bin Fahd bin Abdulaziz Street, Al-Ahsa 31982, Saudi Arabia, e-mail: amohhamed@kfu.edu.sa

Abstract

Introduction. Smart technologies enable the improvement of urban infrastructure to create well-being benefits as well as intellectual growth through modernized structural connectivity. Developments in smart urban concepts have gained popularity across developed nations, making them the next step from sustainable cities and essential for sustainable development. The study aimed to demonstrate the contribution of smart technologies to the green economy and confront climate changes in the Saudi sports sector. ***Material and methods.*** The researchers adopted a descriptive method for study purposes, and they selected descriptive survey study design since it best fitted to meet the objectives of the study. This approach was considered to be suitable because it matched the objectives of the research. The study included representatives of the sports industry of Saudi Arabia, such as sports clubs, federations, employees of sports facilities, and individuals who hold positions as presidents, board members, executive directors, administrators, specialists, and committee members. The study sample comprised 1,416 people who were chosen based on various categories within the studied population. Three questionnaires were applied as data collection tools, showing that the strong emphasis was put on smart technology applications and the implementation of green and environmentally friendly policies by some sports institutions in Saudi Arabia. ***Results.*** The outcomes proved to show a robust positive relationship between smart technology utilization, the green industry, and climate change mitigation. ***Conclusions.*** Smart technologies are believed to be a powerful tool for predicting the sustainability of sports ecosystems in Saudi Arabia. Unfortunately, it can be expected that smart technology will be the focus of study in this area. Possible future research areas would involve smart technologies for an advanced action of sustainable practices, probing long-run effects of smart technology adoption, and investigating hybrid schemes for incorporating smart technologies in sports for the sustainability of sports venues in Saudi Arabia.

Key words: smart technology, investment projects, global warming, sports institutions

Introduction

The twenty-first century technological developments have offered a decent solution to some of the problems that have afflicted cities. These include ways to enhance human well-being, support intellectual and cultural growth, and create an integrated infrastructure through technological development and harnessing, particularly smart technology. These solutions can be applied to support sustainable development in a variety of areas to sustain urban prosperity and well-being, offer services and intelligent lifestyle options, and help cities transition from typical to pluralistic urban environments [1]. Smart technologies like the internet of things (IoT) and renewable energy are one of the leading forces supporting the green economy and fighting climate change in the Gulf Cooperation Council countries. The shift to renewable energy sources is imperative for environmental sustainability in Saudi Arabia as for the sports sector [2].

This technological boom paved the way for the emergence of the concept of smart cities as an extension of sustainable cities and as an aspect of sustainable development in developed countries [3]. Smart cities have become an inevitable strategy to meet the needs of citizens and achieve their ambitions while at the same time saving resources and preserving them for future generations [4]. To communicate effectively, individuals and institutions in the public and private sectors need to use digital methods [5], which is a fundamental component of modern life. Along with the digital revolution, smart devices, and electronic messaging, various types of urban environments have emerged. Smart cities vary in the degree of their intelligence [6], they can be built on a completely new basis or be upgraded from an already existing urban city. There are three types of smart city management: virtual, digital, and intelligent [7]. Being a part of the smart city management process, the city can attain all its goals at the humanitarian, social, technical, and economic levels because of its importance [8].

Climate change is a problem that travels on a global scale; however, the effects can be local, which means that the response can be different for each area; this is because of the diverse ecological systems of each region. Despite this, climate change has always been the dominant global issue addressed [9], due to its dramatic effects that affect the existence of mankind on Earth, and climate change represents one of the most dangerous threats to sustainable development [10]. Some of the economies of the world remain in their infancy mainly depending on sec-

tors that demand weather conditions to enable production, the economy's supply chain and its development will be negatively impacted as climate change advances [11]. These conditions affect the ability of the people to continue their normal life. Since climate change has the potential to have negative effects not only on Earth but also on all economic and social levels, attention has turned to studying this issue, which has become a fundamental pillar in the future of nations [12]. This is according to the development of the study of climate [13]. One of the industries thought to be most vulnerable to the possible effects of climate change is sports.

The sustainable development concept appeared as a response to negative economic development methods and changing opinions regarding growth and development. The concept includes the three areas of nature, society, and economy, aiming to meet human needs without compromising vital systems. The development concept of sustainability focuses on resolving problems arising from resource exhaustion and contamination alongside global warming effects and demographic expansion and equality disparities. The approach aims to unite environmental protection with development activities, and it works to satisfy essential human requirements and support social equality between cultures, and it safeguards environmental cohesion [14]. The three dimensions of sustainable development, namely nature, society, and economy, are interconnected and should be seen as elements of a holistic system [15]. The sustainable development mission aims to safeguard the environment as it delivers well-being and peace to every person worldwide, including future generations by 2030 [16]. The basic objective of sustainable development, which is viewed as the new path out of the development crisis in both developed and developing nations, is to progress all its dimensions by establishing the right conditions for success [17]. Applied research on the sustainable development process has demonstrated the significance of this idea in the areas of economics, society, and the environment. What adds to its significance is that it encompasses the human dimension, which is the all-encompassing advancement of society whenever this issue is brought up, and because of the strategic changes in many areas that led to the opening of markets and the liberalization of commerce at the start of the twenty-first century, it was regarded as the final manual for global development [18].

The demands and difficulties that institutions face in their different forms force them to look for contemporary administrative techniques and strategies that will enable them to meet these difficulties [19]. Additionally, given the fierce competition and the numerous changes that have occurred in our day and age, institutions of all kinds have started to take seriously the idea of harnessing the energies of their employees to help them achieve their goals [20]. The quality of work life as an element makes employees have dedication and motivation to work. Consequently, this results in great outcomes in the performance of the organization [21]. The main purpose is to ensure a work environment that would help employees grow professionally and as people, since this directly leads to better results [22]. Innovative work atmospheres, for instance, can become a part of the enlisting of increased performance levels [23]. Thus, organizations should give the greatest attention to work life and provide them with the opportunity to have an environment that is free from barriers and motivation towards boosting performance and other needs [24].

Sports technologists are currently more focused on the adoration of technology proliferation and today invest in smart technologies, applications and machine learning with aims to bargain value through the improvement in customer services, operating dins and revenue being positioned as key. The utilization is imperative because of the need to observe quality and maintain information security and the environment's parameters [25, 26]. Consequently, sports technologies have had a substantial impact on athletic achievements. This includes the ability of athletes and coaches to monitor, analyze, and enhance performance, as well as fan engagement which has been made possible via data-driven decision making [27]. The implementation of big data analytics and artificial intelligence in sports is fast becoming a focal point supplying inputs into the sustainability of sports development agenda [28]. Sport bodies will use new technologies and technologies such as grafting real and virtual elements, to improve the performance of their players and teams, strengthen engagement of fans, and maintain attention during competitions. In conclusion, smart technologies can be arguably the key for the institutions in sports to catch up with the dynamics of the sports business and to deal with the increasing challenges of the industry.

Recently, sporting institutions have been paying more attention to modernization processes and have started using smart technologies, applications, and machine learning to develop value by providing better service to their customers, making operations faster and increasing income sustainability. Intelligent technologies can satisfy the quality demand, guarantee information security and safety, as well as meet or achieve environmental standards [25, 26]. With the advent of these technologies, sports achievement has been greatly augmented by offering athletes and other coaches opportunities to monitor, analyze, and progress improvement as well as engage fans and guide the decision-making based on the data [27]. Big data as well as artificial intelligence, which are increasingly used in sports, play a significant role, obviating the need for scholars to seek tools for sustainable sports development [28]. Using cutting-edge technologies including the combination of the simulated and real element helps to boost the performance of players as well as teams, engage fans, and attract consumers affected by the pandemic. In fact, the integration of smart technologies in sports organizations is a necessity if the institutions are to remain competitive and satisfy these changing expectations.

The sports sector enjoys the position among most climate-sensitive economic sectors affected directly by emerging climate effects and practices, as it relies mainly on natural factors and environmental features that are considered weak to change in climate conditions, and therefore climate change has become one of the major issues that affect economic development concept and policies in countries in general and sports organizational policies in particular. The traditional perception of climate change as an environmental or scientific problem has constraints. In this paper, the researchers have discussed how smart technologies can fill this gap by showing their role in an improved green economy, green sporting, and climate change in the Saudi sports industry.

The Significance of Research

The role of smart technologies in developing the green economy and the rest of Saudi sectors to address climate change and support the sector of sports is of great scientific importance. Institutes across the globe are becoming more and more technologically advanced in their policy making and strategic planning, and there is a clear need for research that will provide us with the understanding how these technologies can support the green economy to deal with climate change and green sports. Such research is necessary for adapting and improving

approaches to the professions that are aligned with the rapidly developing area of information technology. This helps to bridge the gap between technology and professionalism. Moreover, the theoretical contribution should be focused on the efficiency of introducing smart technologies by sports institutions and the positive impact it would have on the expansion of the green economy for the improvement of the sustainability of the sports sector of the country. As of today, the government of Saudi Arabia, as declared in the Sustainable Development Plan for 2030, allied with foreign entities and professional associations alike, is spearheading a movement that focuses on smart technologies and their potent multi-sectorial effects, which is a growing global trend. Moreover, it also produces observable data on how the green economy uses smart technologies to make the world safe for climate change, allowing the sports industry to become sustainable.

Research Questions

Following the established research objectives, the authors have developed these specific questions for investigation:
Q1: *What is the reality of applying smart technologies in the Saudi sports sector?*
Q2: *What is the reality of the green economy opportunities in the Saudi sports sector?*
Q3: *What are the causes of climate change and ways to confront them in the Saudi sports sector?*
Q4: *Is there a correlation between the use of smart technologies and both supporting the green economy and confronting climate change for the sustainability of the Saudi sports sector?*
Q5: *Can the use of smart technologies contribute to supporting the green economy and confronting climate change in the Saudi sports sector?*

Material and methods

Participants

The research involved employees from sports organizations in Saudi Arabia, including sports clubs, sports federations, sports facilities personnel, and employees holding different positions such as chairpersons, board members, executive directors, sports directors, administrators, specialists, and committee members. The sample also purposely had representation of these groups within the whole study population. The main aim of the research was to test the hypothesis on the influence of smart technologies to build the green economy and to cope with global warming. The study proposed an innovative statistical technique that had not been applied before in the Saudi context. This study answered the research questions using self-administered questionnaires which assisted in the collection of quantitative data. All eligible employees working in sports institutions in Saudi Arabia (n = 1416) participated by receiving the questionnaire and detailed instructions concerning completion. Participation was based on volunteerism, uncompensated and with no money dished out, thus it preserved the autonomy of the participants. Questionnaires were formulated in Arabic in addition to foreign languages to improve response rates. The questionnaire comprised two sections: the initial part of the questionnaire asked for details including gender, and experience (see table 1), Table 2 also elaborates the number of respondents in the major sample for each part. The table goes on to enumerate the sections, to which those participants and percentage are ascribed. The second section of the questionnaire was created to obtain answers to specific research issues. We used both valid scales and empirical studies to generate questionnaire items. The study design is illustrated in Fig. 1. The study employed a descriptive method: in particular, the survey studies method because it suits the objectives of the research as well as the study procedures. Descriptive methods emphasize description, interpretation, analysis, and establishment of relationships between existing phenomena. Therefore, it is appropriate for this study that is based on smart technologies, green economy, and climate change in the Saudi sports sector.

Table 1. Demographic characteristics

Characteristics	Profile	N	Percentage
Gender	Male	915	64.62%
	Female	501	35.38%
Experience	Less than 5 y	282	19.92%
	5-15 y	618	43.64%
	16-25 y	516	36.44%

Table 2. Description of the study sample

No	Organizational departments	Basic sample	Percentage
1	chairpersons on the board of directors	120	8.47%
2	board members	200	14.12%
3	executive directors	204	14.41%
4	sports directors	246	17.37%
5	administrators	210	14.83%
6	specialists	208	14.69%
7	committee members	228	16.10%
Total		1416	100%

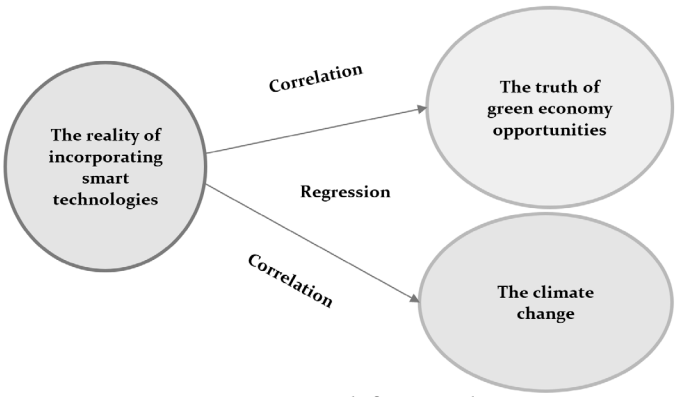

Fig. 1. Research framework

Research Instruments

We used three questionnaires. The first objective was to apprehend the reality of incorporating smart technologies in the Saudi sports industry. It was made up of 27 phrases. The questionnaire included six different dimensions: supporting infrastructure (SI), suitability (S), effectiveness (E), training and development (TAD), automation of processes and systems (APAS), digital services provided (DSP). The second objective was to reveal the truth of green economy opportunities in the Saudi sports sector, which was composed of 23 phrases. The questionnaire included five different dimensions: green economy (GE), green laws (GL), green administration (GA), green sys-

tems (GE), and green products (GP). The third objective was to identify the role of smart technologies in confronting climate change in the sports sector, and it consisted of 33 phrases. The questionnaire included four dimensions: environmental and climate sustainability (EACS), efficiency and sustainable improvement (EASI), innovation and development (IAD), awareness and education (AAE). To measure the participants' responses to the three questionnaires, a three-point Likert scale was utilized (3 points "yes," 2 points "to some extent," and 1 point "no"). This offers a balanced means of eliciting their views on the items of the survey. Therefore, the chosen approach meets the purpose of getting insights from respondents simply and clearly. Cronbach's alpha method was used to check both measurement tools for consistency and verification of validity. The reliability coefficients reached 0.87 for the first questionnaire, while the second questionnaire yielded 0.81 and the third questionnaire produced 0.89. The research precision regarding this research field is supported by the calculated coefficients. The baseline study was prolonged for two months, from October 15th until December 12th, during 2023. The research was conducted under the authorization of the Ethical Committee from the Scientific Research Ethics Commission at King Faisal University in Saudi Arabia on 21 July 2023 (Ref. No. protocol Ref. No. KFU-REC-2124).

Statistical analysis

Statistical analysis included a linear correlation by means of Pearson's r, while reliability was established with the aid of Cronbach's Alpha. Percentage, mean and standard deviation were also used, alongside the chi-square test for randomness, the KMO measure of sampling adequacy and regression analysis. The study data analysis was done using IBM SPSS 26 software, which was also designed by a US based company named IBM Corporation, located in NY, Armonk. To achieve the stipulated degree of statistical rigor, the starting point was probability of occurrence of the phenomenon by chance, which was estimated at $p < 0.05$.

Results

The mean response to all incoming statements of the questionnaire (responses to the reality of applying smart technologies in the Saudi sports sector) ranges between 1.73 and 2.62, and the average scores on the axes spanned from 1.92 to 2.30. The questionnaire response scored 2.13 on average. A significant X^2 value supports the importance of testing at the specified 0.05 level for both questionnaire results and smart technology implementations in Saudi sports. While KMO for the questionnaire axes (supporting infrastructure (SI), suitability (S), effectiveness (E), training and development (TAD), automation of processes and systems (APAS), digital services provided (DSP)) reached 0.752, 0.874, 0.790, 0.715, 0.758 and 0.778, respectively, KMO was 0.794, which was acceptable, and Bartlett's test of sphericity was significant (Fig. 2 and Tab. 3).

The mean response to all incoming statements ranges between 1.35 and 2.58 for all queries in the statement section. The average answers to the questionnaire about green economy potential in Saudi sports fell between 1.82 and 2.33. Overall survey responses averaged 2.06. The X^2 values are significant at the level of significance (0.05) for the questionnaire data on the truth of green economy opportunities in the Saudi sports sector. While KMO for the questionnaire axes (green economy (GE), green laws (GL), green administration (GA), green systems (GE), and green products (GP)) reached 0.823, 0.802, 0.726, 0.723 and 0.689, respectively, KMO was 0.775, which was acceptable, and Bartlett's test of sphericity was significant (Fig. 3 and Tab. 4).

The mean response to all incoming statements of the questionnaire (responses to the truth of green economy opportunities in the Saudi sports sector) ranges between 2.31 and 2.89, and the average response to the axes ranged between 2.62 and 2.78, while the average response to the questionnaire was 2.72. The X^2 values are significant at the level of significance (0.05) for the questionnaire data on the role of smart technologies in confronting climate change in the sports sector. While KMO for the questionnaire axes (environmental and climate sustain-

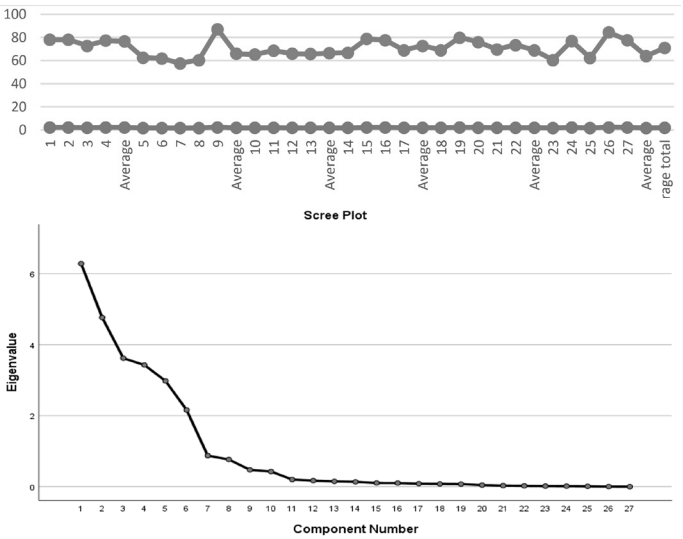

Fig. 2. Scree plot response to the questionnaire

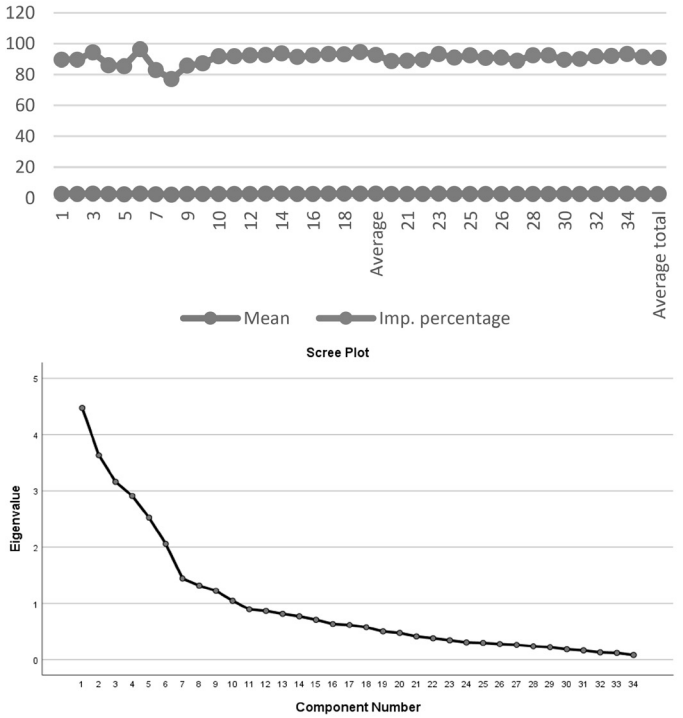

Fig. 3. Scree plot response to the questionnaire

Table 3. The questionnaire data on the reality of applying smart technologies in the Saudi sports sector

No.	Phrase	Mean	Std.	X^2	p-value	Imp. percentage
	The first axis: supporting infrastructure (SI)					
1	The development of plans and programs which support smart technologies persists continuously	2.34	0.85	453.78	0.000	78.00%
2	Operators monitor both software and hardware infrastructure to verify they are appropriate for implementation purposes	2.19	0.91	305.50	0.000	73.00%
3	Information holds significant economic value as a major development factor	2.32	0.88	478.11	0.000	77.33%
4	The infrastructure sustains networks and software systems together with the Internet	2.30	0.86	1562.11	0.000	76.67%
	Average	2.30	0.86	1562.11	0.000	76.67%
	The second axis: suitability (S)					
5	Investment is made in technologies based on self-learning to carry out routine tasks	1.88	0.86	71.92	0.000	62.67%
6	The information provided by smart technologies is relevant to business needs	1.86	0.84	65.61	0.000	62.00%
7	The technologies used are modern and suit the business requirements	1.73	0.85	259.17	0.000	57.67%
8	Smart technologies provide the necessary information accurately that serves the field of work	1.82	0.86	123.93	0.000	60.67%
9	Smart technologies are used in quality control of activities and services	2.62	0.73	1164.56	0.000	**87.33%**
	Average	1.98	0.66	1026.73	0.000	**66.00%**
	The third axis: effectiveness (E)					
10	Smart technologies achieve a degree of success that contributes to achieving clean economy	1.96	0.86	39.83	0.000	65.33%
11	Smart technologies are used to help achieve sustainable development	2.06	0.86	45.93	0.000	68.67%
12	Smart technologies are distinguished by their ability to predict future climate changes	1.98	0.82	0.92	0.631	66.00%
13	Smart technologies work to identify and diagnose problems and develop and evaluate solution alternatives	1.97	0.86	42.73	0.000	65.67%
	Average	1.99	0.83	1891.54	0.000	66.33%
	The fourth axis: training and development (TAD)					
14	People are interested in adding new technology systems to enhance work quality	2.01	0.86	39.54	0.000	67.00%
15	Our organization possesses qualified personnel who are assisting with smart technology training	2.36	0.79	310.73	0.000	78.67%
16	Organizations depend on their human capital to create functional knowledge bases	2.33	0.76	241.26	0.000	77.67%
17	Training programs exist specifically to teach personnel about smart technology fields	2.07	0.88	79.72	0.000	69.00%
	Average	**2.19**	**0.76**	**1124.03**	**0.000**	73.00%
	The fifth axis: automation of processes and systems (APAS)					
18	Work is being done on developing superior methods to convert community needs into implementable programs	2.07	0.94	306.01	0.000	69.00%
19	We ensure the creation of safe and reliable machines and robots	2.40	0.83	557.98	0.000	80.00%
20	The organization implements digital system conversions for existing work procedures through reengineering them	2.28	0.82	216.57	0.000	76.00%
21	Monitoring programs enable social network analysis through a range of social network monitoring tools	2.09	0.94	341.57	0.000	69.67%
22	These systems enable analysis of market trends together with pattern prediction for customer behaviors as well as market signal interpretation	2.21	0.84	1981.03	0.000	73.67%
	Average	2.07	0.94	306.01	0.000	69.00%
	The sixth axis: digital services provided (DSP)					
23	Online advertisements are specifically aimed at customers through their user cookies and website history records	1.82	0.82	77.81	0.000	60.67%
24	The technical services necessary for smart technologies are being developed	2.31	0.84	327.87	0.000	77.00%
25	Electronic platforms together with markets are expanding at a steady pace	1.87	0.84	55.56	0.000	62.33%
26	Many Internet applications together with smart devices provide services which consumers can access	2.53	0.71	684.04	0.000	84.33%
27	The customer profile gets analyzed by using techniques such as cookies and visits as part of the evaluation process	2.33	0.71	247.02	0.000	77.67%
	Average	1.92	0.85	44.04	0.000	64.00%
	Average total	2.13	0.68	1176.86	0.000	71.00%

Table 4. The questionnaire data on the truth of green economy opportunities in the Saudi sports sector

No.	Phrase	Mean	Std.	X^2	p-value	Imp. percentage
	The first axis: the nature of the green economy (NGE)					
1	The organization focuses on the environmental characteristics of services and activities	1.35	0.59	979.18	0.000	45.00%
2	The Foundation works to consolidate the values of environmental preservation in its organizational culture	1.61	0.63	406.25	0.000	53.67%
3	Guidelines are provided for general hygiene and protecting the indoor environment	2.26	0.75	154.36	0.000	75.33%
4	There is a continuation of environmental social responsibility	2.06	0.47	1250.72	0.000	68.67%
5	The organization is concerned with social goals in addition to economic goals	2.06	0.47	1250.72	0.000	68.67%
	Average	1.82	0.59	602.33	0.000	60.67%
	The second axis: green policies (GPo)					
6	Employees are trained to protect the environment	1.47	0.62	595.88	0.000	49.00%
7	The organization adopts its strategy and administrative systems that are consistent with the requirements of the environment	1.75	0.67	300.28	0.000	58.33%
8	The organization applies international specifications standards related to the green economy of the environment	2.37	0.76	300.09	0.000	79.00%
9	The current environmental policy provides an appropriate framework for setting and reviewing environmental objectives	2.16	0.55	788.24	0.000	72.00%
	Average	1.94	0.57	282.46	0.000	64.67%
	The third axis: green administrative systems (GAS)					
10	The environmental aspect is considered in all activities and services	1.98	0.78	19.07	0.000	66.00%
11	Environmental problems are studied	1.92	0.67	298.61	0.000	64.00%
12	The development of green economy programs is monitored in light of changing laws	2.41	0.52	701.51	0.000	80.33%
13	Environmental programs and efforts are supported at all levels	2.77	0.49	1416.28	0.000	92.33%
14	Customers are made aware by obtaining new environmental information	2.58	0.57	709.44	0.000	86.00%
	Average	2.33	0.47	837.18	0.000	77.67%
	The fourth axis: green operations (GO)					
15	Operations are reviewed periodically regarding environmental performance	2.02	0.87	55.69	0.000	67.33%
16	The environment is protected through waste and inefficiency in the use of natural resources	1.71	0.82	218.66	0.000	57.00%
17	The institution seeks to ensure that the technology used is compatible with the requirements of the environment	**2.26**	**0.68**	**275.20**	**0.000**	**75.33%**
18	Services and activities are provided taking into account the requirements of the environment and society	**2.44**	**0.72**	**421.05**	**0.000**	**81.33%**
19	The modern technology available aims to reduce the environmental impact	**2.47**	**0.68**	**467.33**	**0.000**	**82.33%**
	Average	**2.18**	**0.67**	**1014.19**	**0.000**	**72.67%**
	The fifth axis: green product (GP)					
20	The green products brand is positioned in the sports products market	2.00	0.89	95.12	0.000	66.67%
21	There are attractive factors for beneficiaries of green economy services for environmental products	1.89	0.70	210.85	0.000	63.00%
22	The organization resorts to pricing green products based on the value of the product to customers	2.07	0.70	195.48	0.000	69.00%
23	The green economy gives products a competitive advantage over other sports institutions	2.08	0.73	110.97	0.000	69.33%
	Average	2.01	0.65	719.54	0.000	67.00%
	Average total	2.06	0.36	1022.01	0.000	68.67%

ability (EACS), efficiency and sustainable improvement (EASI), innovation and development (IAD), and awareness and education (AAE)) reached 0.551, 0.727, 0.728 and 0.640, respectively, KMO was 0.654, which was acceptable, and Bartlett's test of sphericity was significant (Fig. 4 and Tab. 5). The correlation values of smart technologies adoption in connection to green economy opportunities and Saudi sports sector's climate change response are presented in Table 6.

This study investigates how smart technology elements (supporting infrastructure (SI), suitability (S), effectiveness (E), training and development (TAD), automation of processes and systems (APAS), digital services provided (DSP)) affect the green economy relationship. A multiple linear regression model analyzed the data (Tab. 5) by incorporating supporting infrastructure (SI), suitability (S), effectiveness (E), training and development (TAD), automation of processes and systems

Table 5. The questionnaire data on the role of smart technologies in confronting climate change in the sports sector

No.	Phrase	Mean	Std.	X^2	p-value	Imp. percentage
	The first axis: environmental and climate sustainability (EACS)					
1	Saudi Arabia benefits from smart technology applications that promote sustainable management of sports facilities	2.69	0.47	193.91	0.000	89.67
2	The implementation of smart technologies decreases the sports sector's damaging effects on the environment throughout Saudi Arabia	2.69	0.46	195.39	0.000	89.67
3	Smart technologies adopted in sports facilities within Saudi Arabia enable the attraction of necessary investments, which lead to better environmental sustainability measures	2.83	0.38	605.56	0.000	94.33
4	The Kingdom of Saudi Arabia requires policies together with laws that support smart technologies implementation at sports facilities to improve environmental sustainability	2.58	0.49	33.56	0.000	86.00
5	Smart technologies improve the heat control and ventilation systems of facilities throughout sports facilities in Saudi Arabia	2.56	0.50	22.88	0.000	85.33
6	Smart technologies used in sports facilities in Saudi Arabia establish better waste control methods and environmental preservation systems	2.89	0.31	857.63	0.000	96.33
7	The usage of smart technologies within sports facilities reduces environmental damage as well as carbon emissions throughout the Kingdom of Saudi Arabia	2.49	0.50	0.82	0.366	83.00
8	Smart technology investments drive sustainable development for sports facilities across the sports sector of Saudi Arabia	2.31	0.46	195.39	0.000	77.00
9	The implementation of smart technologies creates balanced environmental and economic conditions within sports facilities across the Kingdom of Saudi Arabia	2.57	0.50	24.43	0.000	85.67
	Average	2.62	0.18	1917.52	0.000	87.33
	The second axis: efficiency and sustainable improvement (EASI)					
10	Sports facilities throughout the Saudi Kingdom benefit from improved energy resource oversight through the implementation of modern smart technologies	2.75	0.44	340.14	0.000	91.67
11	Sports facilities throughout the Kingdom of Saudi Arabia can achieve more efficient energy and resource usage through the deployment of smart technology	2.75	0.43	360.03	0.000	91.67
12	The Kingdom of Saudi Arabia faces an immediate necessity for smart facilities implementation in sports venues as a response to climate change demands	2.77	0.42	399.37	0.000	92.33
13	Smart technology applications enhance both air quality and water quality standards in all sports facilities throughout Saudi Arabia	2.78	0.42	434.08	0.000	92.67
14	Sports facilities that implement smart technologies in the Kingdom of Saudi Arabia work toward achieving both sustainable development principles and Vision 2030 targets	2.81	0.39	539.46	0.000	93.67
15	Implementation of smart technologies enhances the sustainability of water and energy resources in sports facilities throughout Saudi Arabia	2.74	0.44	336.23	0.000	91.33
16	Sports facilities in the Kingdom of Saudi Arabia benefit from improved energy performance through the deployment of smart technologies to manage their energy operations	2.77	0.42	401.49	0.000	92.33
17	Smart technology implementations in Saudi Arabian sports facilities improve both environmental sustainability management systems and natural resource administration	2.80	0.40	519.89	0.000	93.33
18	Do you believe that employing smart technologies improves the quality of life and the environment surrounding sports facilities in the Kingdom of Saudi Arabia?	**2.79**	**0.41**	**488.86**	**0.000**	93.00
19	The implementation of smart technologies at sports facilities throughout Saudi Arabia creates sustainable conditions for infrastructure construction along with operation implementation	2.84	0.37	645.44	0.000	94.67
	Average	2.78	0.21	1400.45	0.000	92.67
	The third axis: innovation and development (IAD)					
20	The Kingdom of Saudi Arabia strengthens its reputation as an environmentally conscious, sport-focused nation when it makes investments in smart technologies	2.66	0.48	136.72	0.000	88.67
21	Smart technologies drive development and innovation throughout the sports industry of the Kingdom of Saudi Arabia	2.67	0.47	172.34	0.000	89.00
22	To effectively use smart technologies in sports facilities throughout the Kingdom of Saudi Arabia, both public and private entities must strengthen their combined efforts	2.69	0.46	196.88	0.000	89.67

No.	Phrase	Mean	Std.	X^2	p-value	Imp. percentage
23	The Kingdom of Saudi Arabia needs to promote professional training for smart technologies, which will help facility managers improve their use of these systems	2.80	0.40	493.57	0.000	93.33
24	The Kingdom of Saudi Arabia benefits from smart technology investments through improved sports sector advancement and development	2.73	0.44	305.77	0.000	91.00
25	Investing in smart technologies enhances clean technology and sustainability in the sports sector in Saudi Arabia	2.77	0.42	399.37	0.000	92.33
	Average	2.72	0.31	1086.99	0.000	90.67
	The fourth axis: awareness and education (AAE)					
26	Investing in smart technologies enhances awareness of environmental issues and climate change among audiences and fans in the Kingdom of Saudi Arabia	2.73	0.45	292.89	0.000	91.00
27	The implementation of smart technologies leads to better security and safety measures at sports facilities throughout the Kingdom of Saudi Arabia	2.67	0.47	162.71	0.000	89.00
28	The implementation of smart technologies enhances both protection and security measures for athletes and spectators within sports facilities of the Kingdom of Saudi Arabia	2.77	0.42	425.27	0.000	92.33
29	The population of the Kingdom of Saudi Arabia requires additional information about the advantages that smart technologies bring to sports facilities	2.77	0.42	414.38	0.000	92.33
30	The use of smart technologies enhances environmental awareness and stimulates positive changes in the local community	2.69	0.46	196.88	0.000	89.67
31	There is a need to enhance international cooperation and knowledge exchange in the field of using smart technologies to address climate challenges in sports facilities	2.70	0.46	231.06	0.000	90.00
32	There is a need to enhance awareness and education about the importance of using smart technologies in sports facilities to address environmental and climate challenges	2.75	0.43	356.00	0.000	91.67
33	There is a need to enhance cooperation between the public and private sectors to enhance the use of smart technologies in sports facilities to address environmental and climate challenges	2.76	0.43	378.41	0.000	92.00
34	Educating the public about climate change issues through smart technologies contributes to changing behaviors towards environmental sustainability in the Kingdom of Saudi Arabia	2.80	0.40	500.68	0.000	93.33
	Average	2.74	0.28	1322.90	0.000	91.33
	Average total	2.72	0.14	591.27	0.000	90.67

Table 6. Correlation coefficients

Incorporating smart technologies		The green economy opportunities						Confronting climate change				
		NGE	GPO	GAS	GO	GP	total	EACS	EASI	IAD	AAE	total
SI	Pearson Correlation	.189**	.133**	-.101**	.240**	.239**	.237**	0.034	-0.027	-0.019	.100**	0.046
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.201	0.311	0.478	0.000	0.082
S	Pearson Correlation	.187**	.054*	.369**	.134**	.304**	.322**	.148**	-0.043	.149**	.135**	.166**
	Sig.	0.000	0.043	0.000	0.000	0.000	0.000	0.000	0.105	0.000	0.000	0.000
E	Pearson Correlation	.101**	.187**	.123**	.144**	-0.012	.170**	-0.007	-0.040	0.016	-0.035	-0.033
	Sig.	0.000	0.000	0.000	0.000	0.646	0.000	0.780	0.137	0.549	0.194	0.212
TAD	Pearson Correlation	-0.018	.145**	0.043	.165**	.076**	.130**	0.023	-0.030	-0.004	0.030	0.009
	Sig.	0.506	0.000	0.102	0.000	0.004	0.000	0.378	0.261	0.873	0.255	0.728
APAS	Pearson Correlation	.278**	.166**	.132**	.200**	.232**	.323**	-.064*	-.057*	0.024	-0.001	-0.039
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.016	0.033	0.366	0.981	0.138
DSP	Pearson Correlation	.270**	0.003	0.002	.098**	.356**	.239**	0.010	-.059*	.073**	.058*	0.037
	Sig.	0.000	0.919	0.933	0.000	0.000	0.000	0.707	0.027	0.006	0.030	0.164
Total	Pearson Correlation	.333**	.211**	.173**	.309**	.394**	.455**	0.044	-.082**	.078**	.093**	.059*
	Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.096	0.002	0.003	0.000	0.025

* – Correlation is significant at the 0.05 level (2-tailed); ** – Correlation is significant at the 0.01 level (2-tailed).

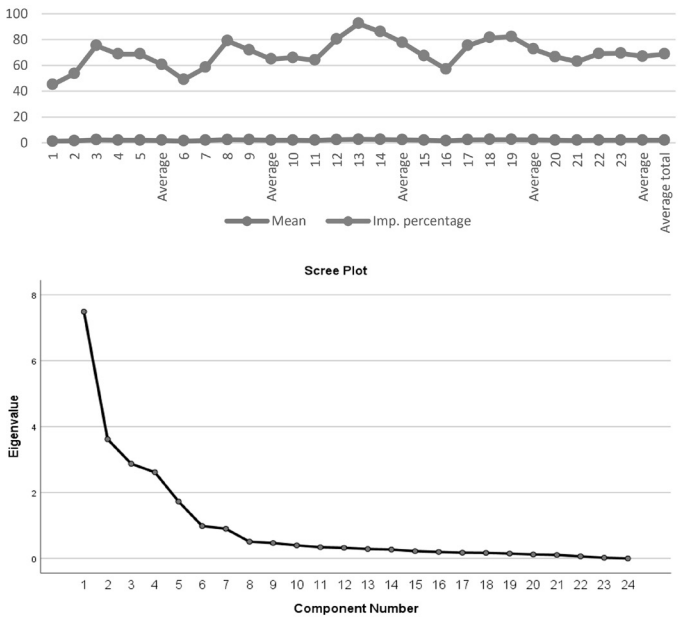

Fig. 4. Scree plot response to the questionnaire

(APAS), digital services provided (DSP) variables while using the level of the green economy variable as the dependent factor. The regression model data indicates its significance through the (F) p = 0.000 value. Analysis indicates that the model is valid since smart technologies show an association with the green economy development. The explanatory variables account for 0.260 of the future variances in the green economy based on the r^2 value which demonstrates their relationship strength. The predictive strength of future green economy depends on suitability (S), effectiveness (E), training and development (TAD), automation of processes and systems (APAS) and digital services provided (DSP) with a statistical significance level at p = 0.000. Table 7 shows that the statistically insignificant relationship between the green economy's reality and supporting infrastructure (SI) yields results in a p = 0.115 value above the 0.05 significance level. The regression model authorizes an expression that follows: future of the green economy = 0.20 + (0.082 * suitability) + (0.038 * effectiveness) + (0.048 * training and development) + (0.073 * automation of processes and systems) + (0.344 * digital services provided) + error term. Additionally, the data points fall along the straight line, which results in normal distribution of residuals, as shown in Fig. 5 and 6.

Table 7. Regression Results

R Square	**0.260**
F value	82.470
Significance	0.000
Beta of (S)	0.082
Beta of (E)	0.038
Beta of (TAD)	0.048
Beta of (APAS)	0.073
Beta of (DSP)	0.344

Table 8. Regression Results

R Square	**0.032**
F value	7.864
Significance	0.000
Beta of	0.082

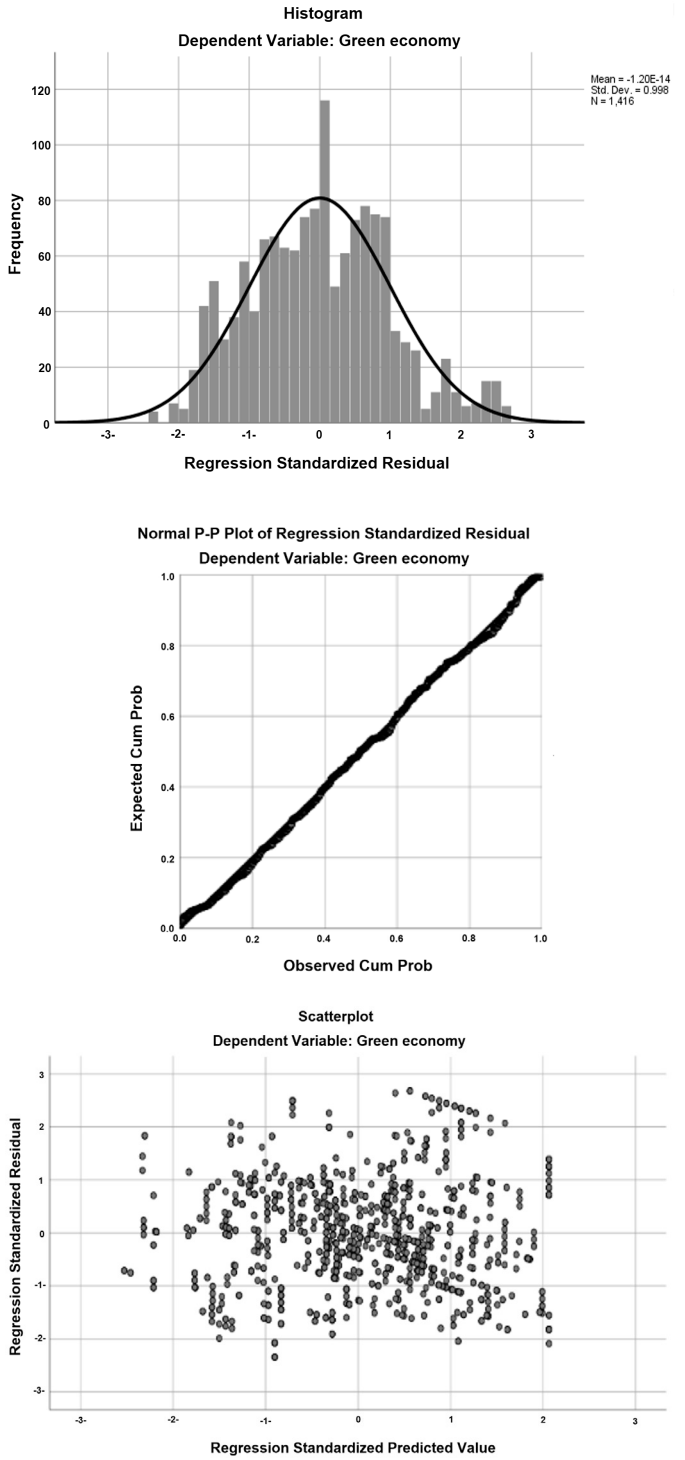

Fig. 5. Multiple regression analysis

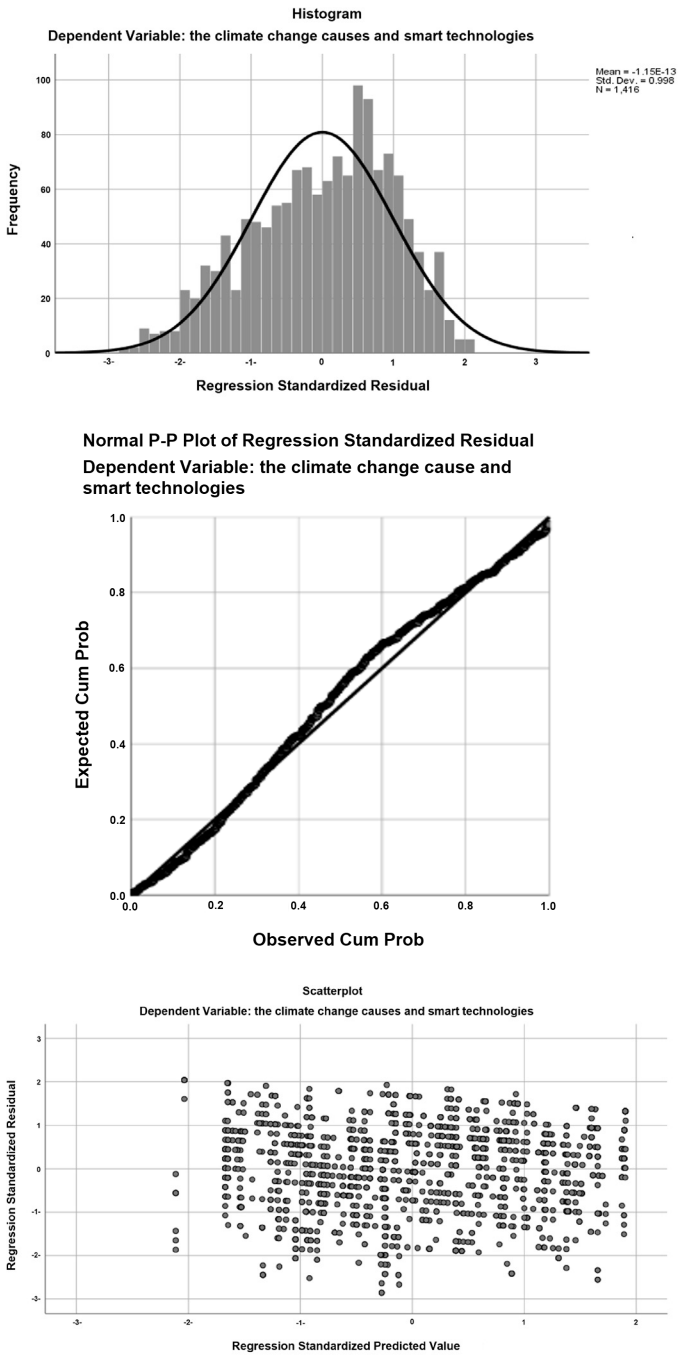

Fig. 6. Multiple regression analysis

Discussion

The survey results on the smart technology implementations in the Saudi sports sector have clearly demonstrated the existence of infrastructure development and the suitability of the applied technologies, with the objective of fostering an environment that permeates clean economy and sustainability, mainly by training and upgrading staff, the automation of processes and systems, and digital services. Smart technologies contributed to the enhancement of the workflow and facilities of Saudi sports to the extent of 71.00%. This, in turn, makes evident the part where technology is being used to achieve these two levels in the sector which is to reduce waste and improve the quality. Researchers link this outcome to the manner in which some institutions seek to apply new technology that enhances the quality of work in addition to the availability of qualified teams and smart-trainer assistants for smart technology. Technology emphasizes the role of human capital by delivering the basis of knowledge and the availability of specific programs to produce smart technology staff in accordance with the institutional needs/requirements. The consideration of these factors comes through the endeavor to present tech-based solutions that on the one hand would be efficient and sustainable, and on the other hand would solve the problems experienced in different fields [29, 30]. The investigations of the role of smart technologies within the realm of sports have been giving hopeful outlooks. One smart device like SmartPaddle provides real-time data exchange between scientists, coaches and athletes, and enhances their performance [31]. The advent of the smart cities phenomenon has been implicated in the development of the Java smart services (SS), thus there is an uptake in data collection accuracy and windness [32]. Technology-based sports info analysis systems like the Smart Dev IT architecture allow multisource data gathering and precise analysis, which become an advantage for sports development in higher education [33]

The table 4 results demonstrate the pursuit of eco-friendly and pro-green programs by Saudi sports institutions. The research illustrates that the role given to green methods in sports organizations enables a deep emphasis on the green economy and therefore sustainability of the environment. The research in point touches upon the integration of green policies, administration and products within these organizations, which offer a comprehensive approach in regard to environment initiatives. There is an agreement that green economy performance indicator is a financial and responsibility tool in sports organizations. Nevertheless, problems like the absence of knowledge of recent environmental technologies among the executive board and inadequate staff coordination hinder the creation of the whole environmental policy and strategy in the organizations. Research revealed that green economic growth has green factors on income per capita, information technology and communication, and human capital that are strategic to sustainability [34]. Therefore, subsidies from the government for sports by reducing regional carbon emissions can make a difference and surely contribute to green development. Research on sports and industries' impacts on infrastructure, including green aggregate productivity, revealed positive outcomes concerning discharges into nature and better workers' conditions [35]. Moreover, the proposal is to include a strong driver that pushes for the participation of college athletic departments in sustainability reporting to also develop the whole campus sustainability strategy [36, 37]. This research tells us that greenness in sports institutions is crucial to pave the pathway to a green future.

The results of table 5 demonstrate the contribution of smart technologies in fighting the climate change in the sports sector of the Kingdom of Saudi Arabia evidencing that the development and application of smart technologies in sports facilities is a major force for creating a cleaner environment, minimizing the negative impact, better waste management and effective attraction of investments. Besides, smart technologies have been proven to be the driving force behind energy conservation, climate change mitigation and environmental management. Utilization of intelligent technologies to a great extent improves the arena of innovation, improvement, and sustainability in the Saudi sports sector. When considering the future of education, there will no doubt be a general agreement about the significance of these investments. Moreover, smart technologies

which are used for defining the environmental factor and improving the safety and security of the sports sector are also a key factor unleashing its influence. Thus, these results demonstrate a significant increase in the influence of smart technology in the Kingdom of Saudi Arabia which is used to address the problems of climate change and sustainability in the sporting arena.

The study offers an outlook regarding the impact of smart technologies on sports fields in Saudi Arabia as a medium for their effective contribution to addressing environmental threats. The results reveal the positive impact that digital transformation has on the functionality and productivity [38]. Furthermore, the part of knowledge management in establishing the sports clubs in the Kingdom was identified, giving a significant role to the knowledge to help the resources, eliminate the drawbacks, and take advantage of the best opportunities reachable in sports organizations [39]. The research found that digitalization and the application of smart technologies are beneficial for sustainability in sports because they provide operational efficiency improvement, environmental impact reduction and overall performance growth, and that they go in line with the country's goals of sustainable environment and economic growth.

Observably, the combined impact of smart technologies, the green economy development, and confronting the climate change in Tables 6, 7, and 8 takes us to this conclusion. The researchers attribute this outcome to the fact of implementing the smart technologies within sports institutions that takes up one of the most important modern approaches to be used to support the green economy developing ideas to deal with climate change fully; therefore, we can predict the level of sustainability of the Saudi sports sector. In conclusion, smart technologies help to facilitate economic growth. The development of green sports emerges as a viable solution to address climate change challenges, ensuring long-term sustainability for the Saudi sports sector. With the growing need for smart technologies in sport-related organizations, which are described by the information-driven instincts, technological progress and informational revolution, the necessity of ensuring the quality standards in provision of services, safety and security of information are essential requirements. This is because the sector calls for the application of quality tools as a machinery to ensure security of the surrounding environment and the adjustment of controls. Executive management approves legal and administrative solutions to put the organization at the vanguard with the others by encouraging free flow of communication and through improvement in assessment and monitoring framework. The results obtained by Jing et al. [13], Dong and Zhu [35], Rong and Cao [40], Dong Y. [41], and Al Ahmed and Hassan [42] indicate that the Green total factor productivity of new infrastructure construction, sports industry, and technology use has led to a significant positive influence of new infrastructure on sports industry. Besides, Bo [43], who made a study on the digital economy aspect to drive and the comprehensive efficiency of sports industry in achieving sustainability and development, stressed the digital economy's role and how it can be employed in improving the total effectiveness of the sports market and contributing to its growth and development sustainability.

Conclusions

Using a sample size of 1416 people and 3 types of questionnaires as the data collection tools, the study was intended to demonstrate the contribution of using smart technologies in the green economy, green sports and climate change mitigation within the Saudi sports sector. The research results showed that there was a concentrated effort to use smart technology and to implement sports which were being green and environmentally sustainable in some Saudi sports institutions. A strong positive correlation was established between the use of smart tech, green economy, and climate change mitigation. On the other hand, smart technologies can be utilized to predict whether the sports industry of Saudi Arabia will continue to be sustainable. The fact remains that smart tech is indeed very likely to be the future research topic in this specific area. Future topics that should be investigated can include how smart technology can facilitate sustainability, the long-term effect of smart technology implementation, or how smart technology can be integrated in innovative methods for sustainable sports practices in Saudi playgrounds.

Limitations and Future Directions

The results of the study are interpreted with several opportunities and important limitations in mind. One of the strengths of this study is the fact that it has a large sample size, since the researchers pursue the accuracy and representativeness of the results, as well as the high level of confidence in the conclusions that were derived from the analyses. Therefore, it is the best opportunity for researchers to clarify detected problems and trends. It can also enhance the understanding of the key influences that underlie the interactions between the green economy, smart technologies, and the confrontation of climate change in the Saudi sports sector. The important limitations of the study. The application and dissemination of smart technologies to overcome climate change problems in the sports sector in the Kingdom of Saudi Arabia may encounter some difficulties, such as the costs of digital infrastructure. The expenditure associated with the generation of technological infrastructure that is suitable for the implementation of smart systems can be quite expensive and this might be one of the impediments to sports institutions in embarking on such a venture. Furthermore, training and skills are deficient, as sporting institutions in the Kingdom of Saudi Arabia look to train their employees on how to use and manage smart technologies, and it takes a bit of time and effort to develop skills and training. Support and privacy issues with smart technologies may arise, including the collection and analysis of athletes' and fans' data. Sports organizations face the challenge of effectively communicating and interacting with the local community as well as with the clients to raise environmental awareness and smart technologies adoption, and this may be a tricky situation because of cultural diversity. Although the fact is that these challenges exist, the introduction of smart technologies to deal with climate change in the sports industry can bring about the enhancement of environmental sustainability and will increase the efficiency of energy and natural resource consumption, mitigating the situation of society and the environment as general. Future topics that should be investigated may include how smart technology can facilitate sustainability, the long-term effect of smart technology implementation, or how smart technology can be integrated in innovative methods for sustainable sports practices in Saudi playgrounds.

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