TANMEAH BASSMAH PRESS
Universal Journal of Future Intelligence: Innovations and Artificial Intelligence (UJFIIAI)
اَلْمَجَلَّة اَلْعَالَمِيَّة لِلذَّكَاءِ اَلْمُسْتَقْبَلِيّ: اَلِابْتِكَارَاتُ وَاَلذَّكَاءُ اَلِاصْطِنَاعِيُّ
Journal Homepage: *https://tanmeah.com/* ***Volume 3, Issue 1, 2026***

The Role of Using Artificial Intelligence Applications in Achieving Sustainable Development Goals in the Kingdom of Saudi Arabia

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C H R O N I C L E
Article history:
Received: January, 11, 2026.
Received in revised format: April, 014, 2026.
Accepted: May, 15, 2026.
Available online: June, 30, 2026.

Keywords:

Artificial Intelligence Applications, Sustainable Development Goals, Saudi Arabia.

الكلمات الدالة:

تطبيقات الذكاء الاصطناعي، أهداف التنمية المستدامة، المملكة العربية السعودية.

A B S T R A C T

This paper aimed to identify the role of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia. The descriptive analytical approach was used, where the researchers designed a questionnaire consisting of (39) items, its validity and reliability were confirmed. The study sample consisted of (150) Faculty member at the University of Ha'il. After analyzing the data using means, standard deviations, and a t-test, the results showed that there is a role for using artificial intelligence applications in achieving sustainable development goals in their various economic, social, and environmental fields in the Kingdom of Saudi Arabia. In light of these results, a set of recommendations were developed, the most prominent of which is the need to benefit from artificial intelligence applications in serving society, enhancing the requirements of sustainable development in all fields, especially services, industrial, and preserving the natural sources of wealth in the Kingdom of Saudi Arabia.

الملخص

هدفت هذه الدراسة إلى تحديد دور تطبيقات الذكاء الاصطناعي في تحقيق أهداف التنمية المستدامة في المملكة العربية السعودية. استُخدم المنهج الوصفي التحليلي، حيث صمّم الباحثون استبيانًا يتألف من 39 بندًا، وتم التحقق من صحته وموثوقيته. تألفت عينة الدراسة من 150 عضوًا من أعضاء هيئة التدريس بجامعة حائل. بعد تحليل البيانات باستخدام المتوسطات والانحرافات المعيارية واختبار t، أظهرت النتائج وجود دور لتطبيقات الذكاء الاصطناعي في تحقيق أهداف التنمية المستدامة في مختلف المجالات الاقتصادية والاجتماعية والبيئية في المملكة العربية السعودية. وفي ضوء هذه النتائج، وُضعت مجموعة من التوصيات، أبرزها ضرورة الاستفادة من تطبيقات الذكاء الاصطناعي في خدمة المجتمع، وتعزيز متطلبات التنمية المستدامة في جميع المجالات، لا سيما الخدمات والصناعة، والحفاظ على الموارد الطبيعية في المملكة العربية السعودية.

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http://doi.org/10.70568/UJFIIAI.3.1.2

JEL Classification: *O33, O44, Q01, Q56, O53.*

1. Introduction

Artificial Intelligence is becoming increasingly ubiquitous, and thus the consequences of its use can be seen in many different aspects of life. Artificial intelligence has many positive impacts and produces social benefits. AI applications can improve and facilitate living conditions, health, justice, wealth creation, enhance public safety and mitigate the impact of human activities on the environment and climate (Montreal Declaration, 2018). Artificial intelligence is a tool that can help people do their jobs faster and better, thus creating many benefits. AI can also facilitate new tasks, leading to benefits in all aspects of life (Kinderlerer, 2021). It is necessary to take advantage of the capabilities of artificial intelligence in development processes for the purpose of sustainability, human behavioral responses, finding ways to mitigate the natural resources crisis, and integrating artificial intelligence solutions with sound human habits and taking into account social aspects (Nishant, et, al., 2020). In short, sustainable social development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Circular Ecology, 2024). The effects of artificial intelligence are related to the level of operations of companies, as it affects operational and financial performance, accounting performance, market-based performance, and thus sustainability performance. Artificial intelligence strategies are not limited to simply clarifying what the organization wants to achieve through the application of artificial intelligence, but it facilitates specific processes, plans, and time periods to achieve these goals or complete a specific stage of work. There is also an AI strategy that will likely require significant adjustments to how the organization is structured, the level of collaboration between departments, and how data is managed throughout the organization, and it is therefore necessary to first determine the relative advantage and compatibility in AI achieving organizational goals and strategies in order to achieve sustainable development for firms and the market (Micallef and Gupta, 2021). It is impossible to ignore the role of sustainable development in industrial production, which represents a necessity to address climate change and the environmental crisis resulting from it, and the efficiency of resource use can directly lead to significant progress in the environmental performance of manufacturing companies through artificial intelligence (Sarkis, and Zhu, 2018).

Machines can perform tasks faster and with greater accuracy than humans, improving the productivity of organizations, especially in manufacturing industries and supply chain operations. The use of artificial intelligence reduces the time needed to complete some key work in operations, improving the error rate and lag times by Automating a series of tasks such as using AI in barcode vehicle licensing to automate visual recognition, where license plates improve efficiency compared to when they were formed by a human employee. Replacing human labor with machines also includes reducing or eliminating errors made by human employees, increasing transparency, and thus further improving results and quality (Demlehner & Laumer, 2020). Artificial intelligence can be used in different types of sustainability in proportion to processes and outputs, as a specific type of artificial intelligence technology can be directed to suit economic, environmental, or social sustainability (Badghish & Soomro, 2024). Improving the quality in organizations' outputs can reduce pollution and ensure environmental sustainability (Asongu and Odhiambo, 2019). Quality is linked to the procedures implemented by state institutions, to develop cultural and legal visions that develop social, economic and financial activities that directly affect resistance to environmental pollution resulting from the various activities of institutions (Hassan, et, al., 2020). Technological innovation is an essential driver of industrial transformation as well as modernization. Increasing quality and efficiency in the modern era, technological innovation is important in economic restructuring and improvement (Wang and Li, 2020).

Globally, the growing economic importance of AI may lead to increased inequality due to educational and computing resources being unevenly distributed across the world (Skene, 2022). Another related issue is the use of AI to produce algorithmic (commercial and political) propaganda based on big data (also known as "big push"), which is spread via social media by autonomous AI agents with the aim of manipulating and producing public opinion (Petit, 2018). The circular economy focuses on technology and can achieve economic gains while relieving pressure on the environment. This circular economy approach has been met

with positive reception by organizations in the public, private and civic sectors, and concerns have been raised about some so-called circular economy practices that are promoted as "sustainable" but can lead to harmful impacts on the environment and society (Velenturf & Purnell, 2021); (Skene, 2022). Technological innovation related to the environment in particular is a powerful technology that has a greater positive impact on the environment than traditional technological innovation. Technological innovation benefits the environment by taking advantage of green energy and reducing the use of fossil fuels. These technologies may help countries improve the efficiency of their production processes, and it is necessary to prevent Climate change, encouraging green economic growth, and significantly reducing carbon dioxide emissions (Zhang et al., 2016) (Dong et al., 2022).

There is no doubt that artificial intelligence can interact and help humans perform at higher levels. It is emerging as the most powerful innovation of the future and is unpredictable to a certain level. It is a fundamental driver of the next industrial revolution and will therefore revolutionize social, economic and environmental changes (Dai, et, al., 2020). Makarius, et, al., (2020) indicates that the efficiency of operations by using artificial intelligence to automate tasks or increasing human intelligence in organizations can improve business performance by increasing efficiency indicators. Automating tasks through artificial intelligence involves replacing human labor and intelligence with automated labor and intelligence, an automation of tasks and organizations may relieve some employees of routine and repetitive tasks, enabling them to focus on other knowledge-intensive activities that add greater value to the organization, thus increasing their productivity. Therefore, the importance of the current study emerged in revealing the ability of artificial intelligence to achieve sustainability goals related to service development, industry, investment, and preserving natural resources for future generations.

Threats to aspects of sustainability mean that there is a risk that elements of non-renewable energy resources (such as minerals and oil) will not be widely conserved or damaged, and can create threats of serious decline in the quality of these resources, their destruction or extinction. Sustainability issues arise when there is a risk of losing natural qualities that people value in a difficult or irreversible manner. Whenever such risks exist, there is a degree of urgency to take measures. Sustainability includes measures to reduce the use of material resources, adopt a long-term investment approach, use renewable manufacturing resources instead of depleted resources, redesign production processes with products, protect services that are valuable for living and continuity, increase the well-being of individuals, improve services and speed up the completion of routine tasks. Economic sustainability can be described as actions that support the long-term economic growth of companies or countries while at the same time preserving natural resources. Despite a generally shared understanding of the types of business practices (such as using harmful manufacturing techniques, producing food waste) that contribute to climate change, very few organizations have moved towards economic sustainability (Schneider Electric Blog, 2022). Therefore, the problem of the current study emerged in revealing the role of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in the services, industrial fields and preserving natural resources. Thus, this study aims to identify the role of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in the services, industrial fields and preserving natural resources in the Kingdom of Saudi Arabia. While in this paper the Definition of terms are:

Artificial intelligence (AI): systems are software (and possibly also hardware) systems designed by humans, that given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge, or processing the information, derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can either use symbolic rules or learn a numeric model, and they can also adapt their behavior by analyzing how the environment is affected by their previous actions. (European union, 2020, p:9).

Sustainability: is the ability of human communities around the world to maintain their independence and have access to the resources required to meet their needs, meaning that secure sources of livelihood are available to everyone.

https://www.mcgill.ca/sustainability/files/sustainability/what-is-sustainability.pdf

The main question: The role of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in the service and industrial fields and preserving natural resources in the Kingdom of Saudi Arabia. It is divided into the following sub-questions:

The first question: What is the role of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in service fields?

The second question: What is the role of using artificial intelligence applications in achieving the goals of sustainable development in the Kingdom of Saudi Arabia in the industrial fields?

The third question: What is the role of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in the field of preserving natural resources?

Previous studies

The following is a review of some previous studies related to the topic of the current study, presented in order of publication date from oldest to newest. For example, Makridakis (2017) indicates to the impact of the industrial and digital (information) revolutions has, undoubtedly, been substantial on practically all aspects of our society, life, firms and employment. Will the forthcoming AI revolution produce similar, far-reaching effects? By examining analogous inventions of the industrial, digital and AI revolutions, this article claims that the latter is on target and that it would bring extensive changes that will also affect all aspects of our society and life. In addition, its impact on firms and employment will be considerable, resulting in richly interconnected organizations with decision making based on the analysis and exploitation of "big" data and intensified, global competition among firms. People will be capable of buying goods and obtaining services from anywhere in the world using the Internet, and exploiting the unlimited, additional benefits that will open through the widespread usage of AI inventions. The paper concludes that significant competitive advantages will continue to accrue to those utilizing the Internet widely and willing to take entrepreneurial risks in order to turn innovative products/services into worldwide commercial success stories. The greatest challenge facing societies and firms would be utilizing the benefits of availing AI technologies, providing vast opportunities for both new products/services and immense productivity improvements while avoiding the dangers and disadvantages in terms of increased unemployment and greater wealth inequalities. (Brougham, 2018) studied futurists predict that a third of jobs that exist today could be taken by Smart Technology, Artificial Intelligence, Robotics, and Algorithms (STARA) by 2025. However, very little is known about how employees perceive these technological advancements in regards to their own jobs and careers, and how they are preparing for these potential changes.

A new measure (STARA awareness) was created for this study that captures the extent to which employees feel their job could be replaced by these types of technology. Due to career progression and technology knowledge associated with age, we also tested age as a moderator of STARA. Using a mixed-methods approach on 120 employees, we tested STARA awareness on a range of job and well-being outcomes. Greater STARA awareness was negatively related to organizational commitment and career satisfaction, and positively related to turnover intentions, cynicism, and depression. (Jarrahi, Mohammad, 2018) studied artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. Artificial intelligence (AI) has penetrated many organizational processes, resulting in a growing fear that smart machines will soon replace many humans in decision making. To provide a more proactive and pragmatic perspective, this article highlights the complementarity of humans and AI and examines how each can bring their own strength in organizational decision-making processes typically characterized by uncertainty, complexity, and equivocality. With a greater computational information processing capacity and an analytical approach, AI can extend humans' cognition when addressing complexity, whereas humans can still offer a more holistic, intuitive approach in dealing with uncertainty and equivocality in organizational decision making. This premise mirrors the idea of intelligence augmentation, which states that AI systems should be designed with the intention of augmenting, not replacing, human contributions. (Lee, et.al, 2019) studied steel defect diagnostics is considerably important for a steel-manufacturing industry as it is strongly related to the product quality and production efficiency. Product quality control suffers from a real-time diagnostic capability since it is less-automatic and is not reliable in detecting steel

surface defects. In this study, we propose a relatively new approach for diagnosing steel defects using a deep structured neural network, e.g., convolutional neural network (CNN) with class activation maps. Rather than using a simple deep learning algorithm for the classification task, we extend the CNN diagnostic model for being used to analyze the localized defect regions within the images to support a real-time visual decision-making process. Based on the experimental results, the proposed approach achieves a near-perfect detection performance at 99.44% and 0.99 concerning the accuracy and F-1 score metric, respectively. The results are better than other shallow machine learning algorithms, i.e., support vector machine and logistic regression under the same validation technique.

Keding, Christoph. (2020) studied understanding the interplay of artificial intelligence and strategic management: four decades of research in review. As artificial intelligence (AI) is enabling the automation of many facets of management and is increasingly used in a wide range of strategic tasks, it is necessary to better understand its relevance for strategic management. However, research on the interplay of AI and strategic management is unbalanced and lacks a coherent structure due to its multidisciplinarity. This article contributes to the emerging academic discussion by systematically reviewing and categorizing the substantial amount of research that has been conducted since the first article in the field was published in 1979. Furthermore, it introduces a comprehensive framework that integrates and synthesizes existing concepts. The framework displays the structure of the research field by classifying 58 relevant articles into two research scopes: condition-oriented research, which explores antecedents for leveraging the use of AI in strategic management, and outcome-oriented research, which studies the consequences of AI in strategic management at both the individual and the organizational level. Given the exponential potential of AI to reshape the field in its current form and the need for a realistic assessment of its impact, this review proposes promising research avenues for studying the quantifiable effects of the interplay of AI and strategic management based on the developed framework. (Coombs, et. al, 2020) study entitled: The strategic impacts of Intelligent Automation for knowledge and service work: An interdisciplinary review.

A significant recent technological development concerns the automation of knowledge and service work as a result of advances in Artificial Intelligence (AI) and its sub-fields. We use the term Intelligent Automation to describe this phenomenon. This development presents organizations with a new strategic opportunity to increase business value. However, academic research contributions that examine these developments are spread across a wide range of scholarly disciplines resulting in a lack of consensus regarding key findings and implications. We conduct the first interdisciplinary literature review that systematically characterizes the intellectual state and development of Intelligent Automation technologies in the knowledge and service sectors. Based on this review, we provide three significant contributions. First, we conceptualize Intelligent Automation and its associated technologies. Second, we provide a business value-based model of Intelligent Automation for knowledge and service work and identify twelve research gaps that hinder a complete understanding of the business value realization process. Third, we provide a research agenda to address these gaps. Wang et al. (2020) study entitled, Toward an understanding of responsible artificial intelligence practices. Artificial Intelligence (AI) impacts all aspects of human and business activities today. There is an urgent need to understand how AI can be designed to operate responsibly and behave in a way that meets stakeholder expectations and applicable regulations. The study seeks to fill the gap by exploring responsible AI practices and identifying potential benefits when implementing responsible AI practices. 10 Responsible AI cases from different industries were selected to better understand the use of Responsible AI in practices. Four responsible AI practices were identified, such as governance, ethical design solutions, risk monitoring, training and education, and five strategies were recommended for companies considering adopting responsible AI practices.

(Kaklis, 2021) studied Sustainability and environmental compliance in ship operations is a prominent research topic as the waterborne sector is obliged to adopt ”green ” mitigation strategies towards a low emissions operational blueprint. Fuel-Oil- Consumption (FOC) estimation, constitutes one of the key components in maritime transport information systems for efficiency and environmental compliance. This paper deals with FOC estimation in a more novel way than methods proposed in literature, by utilizing a reduced-sized feature set, which allows predicting vessel’s Main- Engine rotational speed. Furthermore, this work aims to place the deployment of such models in the broader context of a cutting-edge information system, to improve efficiency and regulatory adherence. Specifically, we integrate B-Splines in the context

of two Deep Learning architectures and compare their performance against state-of-the-art regression techniques. Finally, we estimate FOC by combining velocity measurements and the predicted with vessel-specific characteristics and illustrate the performance of our estimators against actual FOC data. (Anne, et, al., 2021) studied the pressure that the human species exerts on the natural environment through the extraction of materials and generation of wastes is widely recognized. Circular economy has emerged as a potential solution to make better use of resources. Positioned as a technology-focused concept that can generate economic gains while alleviating pressure on the environment, circular economy enjoys a positive reception by organizations in public, private and civic sectors and, increasingly, academia alike. However, concerns have been raised regarding some purported circular economy practices being promoted as 'sustainable' yet resulting in detrimental impacts on environment and society. We briefly revisit the systems ecology literature that construed the context for both circular economy and sustainable development. Values and principles in core sustainable development literature are analyzed to offer a foundation against which circular economy can be discussed. We then analyze and critically reflect upon the strengths, shortcomings and theoretical flaws within the values and principles that emerged from the evolving circular economy literature. We propose a value framework and set of ten principles for the design, implementation and evaluation of a sustainable circular economy. We finish with a call for action for both practitioners and a research agenda for academia. (Waltersmann, et, al., 2021) studied sustainability improvements in industrial production are essential for tackling climate change and the resulting ecological crisis. In this context, resource efficiency can directly lead to significant advancements in the ecological performance of manufacturing companies.

The application of AI also plays an increasingly important role. However, the potential influence of AI applications on resource efficiency has not been investigated. Against this background, this article provides an overview of the current AI applications and how they affect resource efficiency. In line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, this paper identifies, categorizes, and analyzes seventy papers with a focus on AI tasks, AI methods, business units, and their influence on resource efficiency. Only a minority of papers was found to address resource efficiency as an explicit objective. Subsequently, typical use cases of the identified AI applications are described with a focus on predictive maintenance, production planning, fault detection and predictive quality, as well as the increase in energy efficiency. In general, more research is needed that explicitly considers sustainability in the development and use phase of AI solutions, including Green AI. This paper contributes to research in this field by systematically examining papers and revealing research deficits. Additionally, practitioners are offered the first indications of AI applications increasing resource efficiency. (European Commission, 2021) studied the Commission is proposing the first-ever legal framework on AI, which addresses the risks of AI and positions Europe to play a leading role globally. The AI act aims to provide AI developers, deployers and users with clear requirements and obligations regarding specific uses of AI. At the same time, the regulation seeks to reduce administrative and financial burdens for business, in particular small and medium-sized enterprises (SMEs). The AI act part of a wider AI package, which also includes the updated Coordinated Plan on AI. Together, the Regulatory framework and Coordinated Plan will guarantee the safety and fundamental rights of people and businesses when it comes to AI. And, they will strengthen uptake, investment and innovation in AI across the EU. The AI act will be the first-ever comprehensive legal framework on AI worldwide. The aim of the new rules is to foster trustworthy AI in Europe and beyond, by ensuring that AI systems respect fundamental rights, safety, and ethical principles. The AI act targets General-purpose AI also known as foundation models or advanced generative AI. These AI systems can perform a wide range of functions and adapt to different tasks. In the future, they might gain economy and societal relevance, and therefore need to be regulated by proper safeguards, such as human oversight, transparency, and accountability.

The study by Mostaghel, et al. (2022) noted that increased digitalization has enabled innovation, and practical examples from the retail industry have captured the attention of marketing scholars, with rapid development in the academic field. The pace of change has significantly accelerated during the Covid-19 crisis. In seeking to (1) investigate the unique characteristics of digitalization enabled retail business model innovation, (2) understand how does digitalization influences changes to the retail business model innovation dimensions, and (3) identify the areas for future research related to retail business model innovation, this

study systematically reviews the literature. Employing four databases, a sample of 170 articles were chosen. Based on bibliometric and network analysis and visualization, the major researchers, articles, and topics were rigorously identified. Finally, the results revealed the unaddressed issues in this research area. The study ends with theoretical and managerial implications. (Enholm, et, al., 2022) indicated that AI is a wide-ranging set of technologies that promises several advantages for organizations in terms of added business value. Over the past few years, organizations are increasingly turning to AI in order to gain business value following a deluge of data and a strong increase in computational capacity. Nevertheless, organizations are still struggling to adopt and leverage AI in their operations. The lack of a coherent understanding of how AI technologies create business value, and what type of business value is expected, therefore necessitates a holistic understanding. This study provides a systematic literature review that attempts to explain how organizations can leverage AI technologies in their operations and elucidate the value generating mechanisms. Our analysis synthesizes the current literature and highlights: (1) the key enablers and inhibitors of AI adoption and use; (2) the typologies of AI use in the organizational setting; and (3) the first- and second-order effects of AI. The paper concludes with an identification of the gaps in the literature and develops a research agenda that identifies areas that need to be addressed by future studies. Thus, Figure 1. shows the research model of this study.

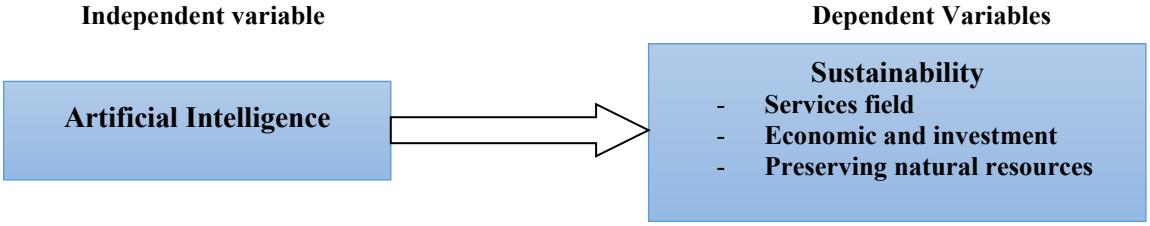

Fig. 1. Conceptual Model

Study Hypothesis:

H01: There is no significant role at the level ($\alpha \leq 0.05$) for using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in service fields.

H02: There is no significant role at the level ($\alpha \leq 0.05$) for using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in the industrial fields.

H03: There is no significant role at the level ($\alpha \leq 0.05$) for using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in the preserving natural resources fields.

2. Methodology

This part discussed the methods and procedures, which were used in this study, deals with the following: Participants of the study, design of the study, instrument of the study, validity of the tool, reliability of the tool, procedures of the study and statistical analysis.

3.1 Research Design

This study is based on the descriptive analytical method, to achieve the objectives of this study "identify the role of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in the services, industrial fields and preserving natural resources in the Kingdom of Saudi Arabia". The data was collected by reviewing the theoretical literature and previous studies related to the subject of the study. The quantitative survey questionnaire was used to get data from the sample of the study. This method is based on a scientific, accurate and integrated description of the existing situation or problem using a descriptive analysis. It is also based on the facts associated with it and unlimited to describing the phenomenon. It includes analyzing data, measuring, and interpreting it, arriving at an accurate analysis and results using statistical and inferential analysis and evaluating solutions and proposals to address them.

3.2 Study population

The study population consists of faculty number at University of Ha'il, the reason behind choosing the selected sample is that they deal with the main concepts related to the study variables. Study sample: It was consisted of (150) faculty number at University of Ha'il, and they were randomly selected from the population of the study, the tables below illustrate the sample distribution according to the personal variables. Table (1) shows Frequency and percentage for the participants according to Gender.

TABLE 1. FREQUENCY AND PERCENTAGE ACCORDING TO GENDER

Category	Frequency	Percentage
Male	78	52.0
Female	72	48.0
Total	150	100.0

Table (1) shows that the percentage for "Gender" highest reached (52.0%) for (Male), but the lowest percentage was (48.0%) for (Female). Table (2) Frequency and percentage for the participants according to Age.

TABLE 2. FREQUENCY AND PERCENTAGE ACCORDING TO AGE

Category	Frequency	Percentage
Less than 35 years	14	9.3
35 – 45 years	39	26.0
46 – 55 years	61	40.7
More than 55 years	36	24.0
Total	150	100.0

Table (2) shows that the percentage for "Age" highest reached (40.7%) for (46 – 55 years), but the lowest percentage was (9.3%) for (Less than 35 years). While Table (3) shows Frequency and percentage for the participants according to academic ranking.

TABLE 3. FREQUENCY AND PERCENTAGE ACCORDING TO ACADEMIC RANKING

Category	Frequency	Percentage
Professor	14	9.3
Associate professor	32	21.3
Assistant professor	37	24.7
Part time doctor or others teachers	67	44.7
Total	150	100.0

Table (3) shows that the percentage for "Academic rank" highest reached (44.7%) for (Part time doctor or others teachers), but the lowest percentage was (9.3%) for (Professor). While Frequency and percentage for the participants according to Years of experience variable are shown in Table (4).

TABLE 4. FREQUENCY AND PERCENTAGE ACCORDING TO EXPERIENCE

Category	Frequency	Percentage
Less than 5 years	14	9.3
5 - 10 years	46	30.7
11 - 15 years	54	36.0
More than 15 years	36	24.0
Total	53	100.0

Table (4) shows that the percentage for "years of experience" highest reached (36%) for (11 - 15 years), but the lowest percentage was (9.3%) for (Less than 5 years).

3.3 Study Instrument

The study was based on a questionnaire consisting of three parts: the first was personal information about the participants, the second was about artificial intelligence applications and consisted of (15) items, and the third was about the impact of artificial intelligence on services, industry, investment, and the preservation of

natural resources, consisting of (24) items. The questionnaire was constructed with the help of some previous studies such as (Waltersmann, et, al., 2021), (Brougham, 2018), (Wang, et al., 2020) and (European Commission, 2021), and the indicators of validity and reliability were confirmed by applying it to a pilot sample before the final application to the original sample. The researchers used five Likert scale to include five degree, were given Strongly agree (5), Agree (4), Neutral (3), Disagree (2), Strongly Disagree (1), and by setting signal (√) in front of the answer, which reflect the degree of consent, it has also been relying on the following classification of the rule on the averages as follows: Less than the 2.33 Low agreement degree. From 2.34 to 3.66 Medium agreement degree. More than the 3.67 High agreement degree.

3.4 Validity of the study tool

Face validity: The researcher presented the questionnaire to (8) arbitrators specialized in the field of artificial intelligence in Saudi Arabia universities, in addition to arbitrators from the department of Sustainable Development. The arbitration process aims to verify the validly of the questionnaire and its paragraph to scale, and after presenting the questionnaire to the arbitrators in its initial form, it was modified according to the arbitrator's notes, as the questionnaire came out as it is in results tables.

Inter-item correlation test (Pilot study= 30): For extracting the validity indicators for all the items of questionnaire, the correlation coefficients between each item and the total dimension to which it belongs was extract, the below tables show that Artificial intelligence applications scale validity (Pilot study= 30) Table (5) shows the correlation coefficients between each item of artificial intelligence applications scale and the total degree

TABLE 5. CORRELATION COEFFICIENTS FOR ITEM OF ARTIFICIAL INTELLIGENCE APPLICATIONS SCALE AND THE TOTAL DEGREE (PILOT STUDY= 30)

Item No.	Person correlation	Item No.	Person correlation
1	0.726**	9	0.622**
2	0.729**	10	0.642**
3	0.648**	11	0.686**
4	0.622**	12	0.619**
5	0.634**	13	0.682**
6	0.726**	14	0.734**
7	0.728**	15	0.685**
8	0.643**	**Significant at Sig. (p≤ 0.01)	

Table (5) shows that the correlation coefficients between each item of artificial intelligence applications scale and the total degree for Pilot study, ranged between (0.619 - 0.734), all of them significant at the level of Sig. (p≤ 0.05), which are accepted to apply the scale in this study. while Sustainability scale validity are shown in Table (6).

TABLE 6. CORRELATION COEFFICIENTS BETWEEN EACH ITEM OF SUSTAINABILITY SCALE AND THE TOTAL DIMENSION TO WHICH IT BELONGS (PILOT STUDY= 30)

Item No.	Services field	Economic and investment	Preserving natural resources
1	0.735**	0.791**	0.802**
2	0.810**	0.831**	0.815**
3	0.773**	0.786**	0.825**
4	0.812**	0.817**	0.778**
5	0.763**	0.795**	0.715**
6	0.752**	0.817**	0.824**
7	0.619**	0.812**	0.801**
8	0.710**	0.783**	0.839**

*** Coefficients acceptable and significant at Sig. (p≤ 0.01)*

Table (6) shows that the correlation coefficients between each item and the total dimension to which it belongs for Pilot study, ranged between (0.619 - 0.839), all of them significant at the level of Sig. (p=≤ 0.05), which are accepted to apply the dimensions for Sustainability scale in this study. For Reliability Test, Table (7) shows the Results of the Cronbach alpha reliability coefficient (n= 150)

TABLE 7. RESULTS OF THE CRONBACH ALPHA RELIABILITY COEFFICIENT (N= 150)

Dimension/scale	N of items	Cronbach's Alpha
Artificial intelligence applications	15	0.90
Services field	8	0.89
Economic and investment	8	0.90
Preserving natural resources	8	0.87
Sustainability	24	0.91
Total	39	0.93

Table (7) shows that the internal consistency coefficients for Pilot study ranged between (0.89 - 0.93), and the Cronbach's Alpha coefficient for total of items was (0.93), which are high reliability coefficients to apply the study questionnaire.

The normal distribution using the Kolmogorov - Smirnov test (KS - test)

This test is used to verify the normal distribution of the study data, and the decision rule is that the data is normally distributed if the value of (p-value ≥ 0.05).

TABLE 8. KOLMOGOROV - SMIRNOV TEST (KS - TEST) FOR NORMAL DISTRIBUTION

Dimensions/scale	Z value	Sig.
Artificial intelligence applications scale	1.608	0.128
Services field	1.664	0.113
Economic and investment	0.984	0.488
Preserving natural resources	0.936	0.545
Sustainability scale	0.584	0.788

Table (8) shows that the levels of statistical significance for (Z) values in the Sample K-S test for dimensions were not statistically significant at the level of (p ≥ 0.05), which shows that the data of the dimensions follow the normal distribution, and suitable for conducting regression analysis.

Statistical treatment: The following statistical treatments through statistical software packages (SPSS . Vs. 26) for data analysis were used:

Frequencies and percentage for demographic information.

Correlation coefficients between each item and the total dimension to which it belongs was extract.

Cronbach-alpha was calculated to extract reliability coefficient of the questionnaire dimensions, and scales.

The normal distribution using the Kolmogorov - Smirnov test (KS - test).

Means and standard deviation for dimensions, scales and total degree of them (n= 150).

Person correlation coefficient between artificial intelligence applications and sustainable development goals in the Kingdom of Saudi Arabia in the (services field, economic and investment, preserving natural resources).

Simple Linear Regression were applied to detect the impact of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia.

3. Findings

This part of the research deals with the practical aspect of this study, as it contains an analysis of the study sample's responses to all paragraphs of the questionnaire in order to identify the role of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in the services, industrial fields and preserving natural resources in the Kingdom of Saudi Arabia, in this part the study hypotheses will be tested, also descriptive analysis of the answers of the study sample on the items of the scales in the study questionnaire were extracted.

3.1 Descriptive Statistics

Means and standard deviations were extracted for the items of the scales of the study questionnaire; the tables below illustrate this. For Artificial intelligence applications scale are:

TABLE 9. MEANS AND STANDARD DEVIATION FOR ARTIFICIAL INTELLIGENCE APPLICATIONS SCALE ITEMS (N=150)

No.	Item	Mean	Standard deviation	Agreement degree	Rank
1	AI improves the performance of all administrative functions	3.80	0.82	High	2
2	AI improves work output	3.81	0.82	High	1
3	Artificial intelligence helps reduce human errors	3.62	0.84	Medium	10
4	AI helps improve communication with colleagues and customers	3.67	0.73	High	8
5	Artificial intelligence helps in the process of planning, setting goals and drawing appropriate strategies in the future	3.73	0.89	High	4
6	AI facilitates better decision-making	3.62	0.87	Medium	11
7	Artificial intelligence accelerates development and growth processes and increases opportunities for innovation	3.73	0.79	High	5
8	AI helps prioritize work	3.77	0.86	High	3
9	AI helps to select the right employees for working conditions	3.71	1.00	High	6
10	AI improves the quality and speed of work	3.56	0.89	Medium	12
11	AI provides accurate data to avoid business risks	3.71	0.92	High	7
12	AI makes it easier for managers to follow up on different stages of work	3.66	0.75	Medium	9
13	AI helps in the process of evaluating employees and identifying their training needs	3.05	1.08	Medium	15
14	AI helps study the market and identify competitors	3.46	0.95	Medium	13
15	AI helps with procurement, marketing and PR processes	3.42	0.91	Medium	14
Total degree		3.62	0.59	Medium	

Table No. (9) Shows that the highest means reached (3.81) out of (5) for item No. (2) “AI improves work output” by high agreement degree, but the lowest means was (3.05) for item No. (13) “AI helps in the process of evaluating employees and identifying their training needs” by medium agreement degree, and means reached (3.62) for total degree of the artificial intelligence applications scale by high agreement degree.

This indicates that artificial intelligence helps in all administrative functions, improving work productivity, setting appropriate goals, and drawing up future strategies that achieve the goals of different institutions, as well as maintaining the sustainability of all natural and human resources. This is consistent with previous studies that examined the impact of artificial intelligence on enterprise management, digital marketing, planning, and business models that offer better value for improving output levels in various fields. A study (Mostaghel, et al., 2022), which analyzed 170 articles from four datasets, pointed to the theoretical and managerial effects resulting from artificial intelligence and digitization. Also, a study by (Coombs, et, al., 2020) illustrates one of the important recent technological developments; the automation of knowledge and service work as a result of advances in artificial intelligence (AI) and its subfields, this development presents organizations with a new strategic opportunity to increase business value.

3.2 Sustainability scale

TABLE 10. MEANS AND STANDARD DEVIATION FOR SUSTAINABILITY DIMENSIONS (N= 150)

No	Dimension	Mean	Standard Deviation	Agreement Degree	Rank
1	Services field	3.43	0.67	Medium	3
2	Economic and investment	3.53	0.66	Medium	1
3	Preserving natural resources	3.55	0.62	Medium	2
Total degree		3.50	0.60	Medium	

Table (10) shows that the highest means reached (3.55) out of (5) for dimension no.(3) "Preserving natural resources", by medium agreement degree, but the lowest means was (3.43) for dimension no.(1) "Services field", by medium agreement degree, and total degree of Sustainability scale means reached (3.50) by medium agreement degree.

Services field

TABLE 11. MEANS AND STANDARD DEVIATION FOR "SERVICES FIELD" DIMENSION (N= 150)

No	Item	Mean	Standard. Deviation	Agreement Degree	Rank
1	Partnerships with friends of the environment can be established to minimize the negative impact of human activities.	3.43	0.96	Medium	4
2	Awareness messages can be sent to the community about the conservation of natural resources	3.25	0.87	Medium	8
3	Raising awareness of the need to reduce sources of water and air pollution	3.54	0.89	Medium	3
4	Take national action that does not interfere with the sustainability of natural resources	3.34	0.89	Medium	6
5	The negative impact of various products on sources of natural wealth can be minimized.	3.63	0.84	Medium	1
6	Guidelines can be distributed to employers on measures to conserve natural resources and not waste them.	3.33	0.94	Medium	7
7	It can contribute to the areas of green environment and reduce risks related to the access of natural resources.	3.37	0.84	Medium	5
8	Establish binding laws for all employers to adhere to procedures for the conservation of natural resources.	3.57	0.91	Medium	2
Total degree		3.43	0.67	Medium	

Table (11) shows that the highest means reached (3.63) out of (5) for item No. (5) "The negative impact of various products on sources of natural wealth can be minimized", by medium agreement degree, but the lowest means was (3.25) for item No. (2) "Awareness messages can be sent to the community about the conservation of natural resources", by medium agreement degree, and means reached (3.43), for total degree of Services field dimension, by medium agreement degree.

3.3 Economic and investment

TABLE 12. MEANS AND STANDARD DEVIATION FOR "ECONOMIC AND INVESTMENT" DIMENSION (N= 150)

No	Item	Mean	Standard. Deviation	Agreement Degree	Rank
1	Foundations for education and training can be laid commensurate with environmental issues of importance.	3.11	1.06	Medium	8
2	The need to pay attention to improving working conditions and workers in all fields.	3.49	0.98	Medium	6
3	Safety initiatives operating in the local community can be supported and funded	3.69	0.78	High	2
4	Encouraging service companies to disclose and be transparent about the environmental impacts resulting from some services.	3.73	0.75	High	1
5	Focus on providing services to members of the local community without prejudice to the rights of others	3.39	0.95	Medium	7
6	Reach out to stakeholders for feedback on healthy waste disposal.	3.65	0.78	Medium	3
7	It is possible to cooperate with government agencies to know the environmental requirements towards green production	3.59	0.83	Medium	5
8	Benefiting from the experiences of developed countries in sustainability measures in the field of services	3.60	0.85	Medium	4
Total degree		3.53	0.66	Medium	

Table (12) shows that the highest means reached (3.73) out of (5) for item No. (4) "Encouraging service companies to disclose and be transparent about the environmental impacts resulting from some services", by high agreement degree, but the lowest means was (3.11) for item No. (1) "Foundations for education and training can be laid commensurate with environmental issues of importance", by medium agreement degree, and means reached (3.53), for total degree of Economic and investment dimension, by medium agreement degree. Table (13) shows preserving natural resources

TABLE 13. MEANS AND STANDARD DEVIATION FOR "PRESERVING NATURAL RESOURCES" DIMENSION (N= 150)

No	Item	Mean	Standard. Deviation	Agreement Degree	Rank
1	Costs can be reduced by reducing waste rates	3.62	0.86	Medium	4
2	Input costs can be reduced while maintaining the same level of work output.	3.38	0.96	Medium	7
3	Market demands can be met and unjustified storage of products can be avoided	3.37	0.81	Medium	8
4	New technologies can be invented at work for better gains and profits.	3.49	0.94	Medium	6
5	Damage or waste materials that may be produced through industrial processes can be minimized.	3.53	0.80	Medium	5
6	Environmental issues are taken into account in all industrial activities.	3.63	0.75	Medium	3
7	Additional revenue can be generated through recycling or the sale of production waste.	3.65	0.84	Medium	2
8	Reduce dependence on traditional energy sources by replacing them with some less polluting energy sources.	3.73	0.90	High	1
Total degree		3.55	0.62	Medium	

Table (13) shows that the highest means reached (3.73) out of (5) for item No. (8) "Reduce dependence on traditional energy sources by replacing them with some less polluting energy sources", by high agreement degree, but the lowest means was (3.37) for item No. (3) "Market demands can be met and unjustified storage of products can be avoided", by medium agreement degree, and means reached (3.55), for total degree of preserving natural resources dimension, by medium agreement degree.

3.4 Hypothesis testing

Before testing Hypothesis, Person correlation coefficient was extracted. Table (14) shows the results of Person correlation coefficient between artificial intelligence applications and sustainable development goals in the Kingdom of Saudi Arabia in the (services field, economic and investment, preserving natural resources)

TABLE 14. PERSON CORRELATION COEFFICIENT RESULTS

Artificial intelligence applications		Services field	Economic and investment	Preserving natural resources	Sustainability
	Pearson Correlation	0.560	0.626	0.568	0.636
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	150	150	150	150

Table (14) shows that there is a statistically significant positive relationship between artificial intelligence applications and sustainable development goals in the Kingdom of Saudi Arabia in the (services field, economic and investment, preserving natural resources) in the Kingdom of Saudi Arabia.

H01: There is no significant role at the level ($\alpha \leq 0.05$) for using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in service fields.

This hypothesis corresponds to the first question: What is the role of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in service fields?".

Due to testing this Hypothesis, (simple linear regression) was applied, table below illustrates this.

Table (15) shows the results of (Simple Linear Regression) analysis to detect the impact of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in Service fields

TABLE 15. SIMPLE LINEAR REGRESSION RESULTS FOR H01

Independent variables	value t	Sig. t	Beta	R	R2	F value	Sig. F	Durbin-Watson	H01 result
Artificial intelligence applications	8.232	.000	.560	.560	.314	67.763	.000	1.111	Rejected

Dependent variable: service fields

Table (15) shows that there is statistically significant impact of (artificial intelligence applications) in achieving sustainable development goals in the Kingdom of Saudi Arabia in service fields, at the significance level ($\alpha \leq 0.05$), where (F) value was (67.763) and (t) value was (8.232), by Sig. (0.000). Where the value of the correlation R. between the artificial intelligence applications and the service fields was (0.560), which is it confirms that the increase or decrease in the artificial intelligence applications leads to an increase or decrease in the service fields. The value of the determination coefficient was R2 (0.314), which reflects that (31.4%) of the change in the service fields results from the artificial intelligence applications. This confirms the invalidity of accepting the first hypothesis, and accordingly the null hypothesis is rejected, and the alternative hypothesis is accepted, which states that there is significant role at the level ($\alpha \leq 0.05$) for using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in service fields.

A study (Brougham, 2018) indicates that one-third of the jobs that exist today could be filled by smart technology, artificial intelligence, robotics, and algorithms (STARA). However, very little is known about how employees perceive these technological developments in relation to their jobs and careers, and how they prepare for these potential changes. Also, the study by Keding, Christoph. (2020) provides a clearer understanding of the interaction between artificial intelligence and strategic management at both the individual and institutional levels, offering a comprehensive framework that integrates and summarizes existing concepts for a more sustainable society. But the study (Makridakis, 2017) shows that the greatest challenge facing societies and businesses is to take advantage of the benefits of artificial intelligence (AI) technologies, which provide broad opportunities for both new products and services and huge productivity improvements while avoiding risks and drawbacks in terms of increased unemployment and wealth inequality for better sustainability. And the study (Lee, et.al, 2019) provides a better diagnosis of defects in some industries such as steel because it is closely related to product quality and production efficiency through an automated vector support algorithm, logistic regression and using a deep neural network (CNN) with activation maps, this diagnostic technique was used to analyze localized defect areas within images to support real-time visual decision-making.

H02: There is no significant role at the level ($\alpha \leq 0.05$) for using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in economic and investment.

This hypothesis corresponds to the second question: What is the role of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in economic and investment?".

Due to testing this Hypothesis, (simple linear regression) was applied, table below illustrates this. Table (16) shows the results of (Simple Linear Regression) analysis to detect the impact of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in economic and investment.

TABLE 16. SIMPLE LINEAR REGRESSION RESULTS FOR H02

Independent variables	value t	Sig. t	Beta	R	R2	F value	Sig. F	Durbin-Watson	H02 result
Artificial intelligence applications	9.768	.000	.626	.626	.392	95.413	.000	1.181	Rejected

Dependent variable: economic and investment

Table (16) shows that there is statistically significant impact of (artificial intelligence applications) in achieving sustainable development goals in the Kingdom of Saudi Arabia in economic and investment, at the significance level ($\alpha \leq 0.05$), where (F) value was (95.413) and (t) value was (9.768), by Sig. (0.000). Where the value of the correlation R. between the artificial intelligence applications and the economic and investment was (0.626), which confirms that the increase or decrease in the artificial intelligence applications leads to an increase or decrease in the economic and investment. The value of the determination coefficient was R2 (0.392), which reflects that (39.2%) of the change in the economic and investment results from the artificial intelligence applications. This confirms the invalidity of accepting the second hypothesis, and accordingly the null hypothesis is rejected, and the alternative hypothesis is accepted, which states that there is significant role at the level ($\alpha \leq 0.05$) for using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in economic and investment. European Commission, (2021) proposed the first-ever legal framework for artificial intelligence, addressing its risks, the regulatory framework and coordinated plan would ensure the safety and fundamental rights of individuals and businesses in relation to AI, and would also promote adoption, investment, and innovation in AI across the European Union. These rules aim to enhance the reliability of artificial intelligence by ensuring that AI systems respect fundamental rights, safety, and ethical principles, and must be regulated with appropriate safeguards, such as human oversight, transparency, and accountability. The study (Jarrahi, Mohammad, 2018) emphasized the concept of sustainability through the idea of promoting artificial intelligence without ignoring or replacing human contributions, and thus the future of work and coexistence between humans and artificial intelligence in organizational decision-making. Artificial intelligence has created many organizational processes, leading to a growing fear that smart machines will replace many humans in decision-making, but for a more sustainable society, the focus is on the integration of humans and artificial intelligence and how each can bring its own strengths to organizational decision-making processes. (Wang, Y. , Xiong, M. and Olya, H. 2020) study attempted to provide a clearer understanding of responsible artificial intelligence (AI) practices across all aspects of human and business activities and to act in a way that meets the expectations of stakeholders and applicable regulations, bridging the gap by exploring and identifying the potential benefits when implementing responsible (AI) practices; Key practices such as governance, ethical design solutions, risk monitoring, training and education were identified. Also, a study by (Enholm, et, al., 2022) showed that organizations are still struggling to adopt and leverage artificial intelligence in their operations, and that the lack of a coherent understanding of how AI technologies create business value, and the type of business value expected, necessitates a comprehensive understanding, and identifying patterns of AI use in the regulatory environment while preserving resources for sustainability purposes.

H03: There is no significant role at the level ($\alpha \leq 0.05$) for using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in preserving natural resources.

This hypothesis corresponds to the third question: What is the role of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in preserving natural resources?".

Due to testing this Hypothesis, (simple linear regression) was applied, table below illustrates this. Table (17) shows the results of (Simple Linear Regression) analysis to detect the impact of using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in preserving natural resources.

TABLE 17. SIMPLE LINEAR REGRESSION RESULTS

Independent variables	T value	Sig. t	Beta	R	R^2	F value	Sig. F	Durbin-Watson	H03 result
Artificial intelligence applications	8.393	0.000	0.568	0.568	0.322	70.450	0.000	1.140	Rejected

Dependent variable: preserving natural resources

Table (17) shows that there is statistically significant impact of (artificial intelligence applications) in achieving sustainable development goals in the Kingdom of Saudi Arabia in preserving natural resources, at the significance level ($\alpha \leq 0.05$), where (F) value was (70.450) and (t) value was (8.393), by Sig. (0.000). Where the value of the correlation R. between the artificial intelligence applications and the preserving natural resources was (0.568), which is it confirms that the increase or decrease in the artificial intelligence applications leads to an increase or decrease in the Economic and investment. The value of the determination coefficient was R2 (0.322), which reflects that (32.2%) of the change in the preserving natural resources results from the artificial intelligence applications.

This confirms the invalidity of accepting the third hypothesis, and accordingly the null hypothesis is rejected, and the alternative hypothesis is accepted, which states that there is significant role at the level ($\alpha \leq 0.05$) for using artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia in preserving natural resources. The pressure exerted by humans on the natural environment through the extraction of materials and the generation of waste is widely recognized (Ann et al., 2021). The circular economy has emerged as a potential solution for improving resource utilization. It is a technology- and artificial intelligence-based concept that can achieve economic gains while reducing pressure on the environment, this study (Ann et al., 2021) analyzes the values and principles in core sustainable development literature to provide a foundation for discussing the circular economy, critically considering the strengths, weaknesses, and theoretical shortcomings of the values and principles that have emerged from the evolving circular economy literature, and proposing a value framework and principles for designing and implementing a sustainable circular economy. A study by (Waltersmann, et, al., 2021) also points to improvements in sustainability in industrial production that are essential to address climate change and the resulting environmental crisis, as resource efficiency directly leads to significant improvements in the environmental performance of manufacturing companies. In line with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, this research study identifies, classifies, and analyzes seventy research papers focusing on AI tasks, methods, business units, and their impact on resource efficiency. This study provides the first indications that AI applications enhance resource efficiency, but only a few of the papers were found to address resource efficiency as an explicit objective. However, the study by (Caklis, 2021) went to estimate fuel and oil consumption (FOC) in marine transport information systems to achieve efficiency and environmental compliance for sustainability.

4. Discussion

The findings indicate that artificial intelligence applications are positively associated with the achievement of sustainable development goals in the Kingdom of Saudi Arabia. The overall correlation between artificial intelligence applications and sustainability was positive and statistically significant (($r = 0.636$, $p < 0.001$)). Significant relationships were also found across the three examined dimensions: services (($r = 0.560$)), economic and investment development (($r = 0.626$)), and the preservation of natural resources (($r = 0.568$)). These results suggest that artificial intelligence should not be understood merely as an operational technology, but as an enabling capability that may support interconnected economic, social, and environmental outcomes. Nevertheless, the moderate mean scores reported for artificial intelligence applications and sustainability show that the perceived potential of AI has not yet been translated into uniformly high levels of practical implementation. The results concerning the service field revealed a

statistically significant positive role for artificial intelligence applications ((\beta = 0.560, t = 8.232, F = 67.763, p < 0.001)). Artificial intelligence explained 31.4% of the variance in the service dimension, leading to the rejection of the first null hypothesis. This finding supports the argument that intelligent automation can improve service quality, speed, consistency, and accessibility by reducing repetitive work and supporting more informed decision-making. It is consistent with Coombs et al. (2020), who described intelligent automation as a strategic means of generating value in knowledge- and service-based work, and with Demlehner and Laumer (2020), who linked AI adoption to improved operational efficiency and reduced human error.

However, the explanatory power of 31.4% also indicates that AI applications alone cannot ensure sustainable services. Most of the variance in this dimension remains attributable to other organizational, institutional, and human factors, such as digital infrastructure, employee competencies, data quality, leadership commitment, and service-governance arrangements. The moderate overall mean for the service dimension ((M = 3.43)) reinforces this interpretation. Thus, although respondents recognized the contribution of AI, their responses did not reflect complete confidence in its current implementation. This distinction is important because the availability of AI tools does not automatically produce sustainable service outcomes unless such tools are integrated into well-designed processes and supported by qualified employees. The service-related findings should also be considered alongside the employment and social risks associated with automation. Makridakis (2017) argued that AI can generate productivity improvements and new services, but may simultaneously increase unemployment and wealth inequality. Similarly, Brougham and Haar (2018) found that employees' awareness of smart technologies and automation may negatively affect organizational commitment and career satisfaction while increasing insecurity and turnover intentions. Therefore, the positive contribution of AI to sustainable services depends on whether organizations adopt a human-centred approach. In agreement with Jarrahi (2018), AI should augment human judgment rather than simply replace it, particularly in-service contexts that require ethical reasoning, empathy, contextual understanding, and accountability.

The economic and investment dimension demonstrated the strongest relationship with artificial intelligence applications ((\beta = 0.626, t = 9.768, F = 95.413, p < 0.001)). AI applications explained 39.2% of the variance in this dimension, resulting in the rejection of the second null hypothesis. This comparatively stronger effect suggests that respondents primarily associate AI with productivity, innovation, improved allocation of resources, enhanced competitiveness, and better investment decisions. This finding agrees with Enholm et al. (2022), who indicated that AI can generate organizational value through improved processes, decision support, and first- and second-order business effects. It is also consistent with Keding (2020), who emphasized that AI has become increasingly relevant to strategic management and organizational decision-making. The relatively high mean assigned to encouraging service companies to disclose their environmental impacts further suggests that participants connect economic development with transparency and responsible organizational conduct. Consequently, the economic benefits of AI should not be evaluated solely through cost savings or productivity gains. Sustainable economic value also requires transparent decisions, responsible data use, fair access to digital capabilities, and protection against algorithmic bias. Wang et al. (2020) emphasized that responsible AI depends on governance, ethical design, risk monitoring, education, and training. The European Commission (2021) likewise highlighted human oversight, transparency, safety, and accountability as fundamental safeguards. These considerations are particularly relevant because unregulated AI adoption may strengthen technologically advanced organizations while marginalizing smaller organizations that lack adequate financial, technical, or human resources.

The findings also showed that artificial intelligence applications had a statistically significant positive role in preserving natural resources ((\beta = 0.568, t = 8.393, F = 70.450, p < 0.001)). The model explained 32.2% of the variance in this dimension, leading to the rejection of the third null hypothesis. Respondents particularly recognized the potential of AI to reduce dependence on traditional energy sources and support the transition towards less-polluting alternatives. This result is consistent with Waltersmann et al. (2021), who identified predictive maintenance, production planning, fault detection, predictive quality, and energy-efficiency improvement as important AI applications that can enhance industrial resource efficiency. It also corresponds with Kaklis (2021), who demonstrated how intelligent prediction models can support fuel-consumption efficiency and environmental compliance. The natural-resource findings are also compatible

with the principles of the circular economy. Velenturf and Purnell (2021) argued that technology can contribute to more efficient resource utilization and reduced environmental pressure. Nevertheless, they cautioned that not every practice described as circular or sustainable necessarily generates positive environmental and social outcomes. This warning is relevant to AI because the technology itself consumes energy, requires computing infrastructure, and may create electronic waste. Accordingly, the contribution of AI to environmental sustainability should be assessed by considering its complete environmental footprint rather than focusing only on the efficiencies achieved at the point of application. AI can therefore support resource preservation, but only when its environmental costs do not outweigh the savings it produces.

Across the three dimensions, the economic and investment effect was stronger than the effects on services and natural-resource preservation. This pattern may indicate that the benefits of AI are more immediately visible in productivity, competitiveness, and investment decisions than in environmental or social outcomes, which often emerge over a longer period and require broader institutional coordination. The difference also suggests that organizations may prioritize measurable economic returns when adopting AI, while treating environmental and social benefits as secondary outcomes. A genuinely sustainable approach would require balancing these priorities so that economic gains do not occur at the expense of employment security, social inclusion, privacy, or environmental protection. Although all three null hypotheses were rejected, the results should be interpreted cautiously. The research used a cross-sectional questionnaire administered to 150 faculty members from one university. Therefore, the findings represent respondents' perceptions of AI's role rather than direct measurements of actual changes in productivity, emissions, resource consumption, or service performance. The regression results establish statistically significant associations but cannot, by themselves, demonstrate causality. Faculty members may possess relevant knowledge of AI and sustainability, yet their perceptions may differ from the experiences of policymakers, technology developers, industrial managers, investors, and service users.

Moreover, reliance on self-reported data collected through a single instrument may expose the findings to common-method and social-desirability biases. The moderate (R^2) values, ranging from 0.314 to 0.392, indicate meaningful explanatory capacity but also confirm that sustainable development is influenced by several factors beyond AI adoption. Future studies should therefore incorporate larger and more diverse samples from public institutions, private companies, industrial organizations, and different Saudi regions. Longitudinal studies and objective indicators (including energy consumption, emissions, operating costs, service-processing time, investment returns, and waste reduction) would provide stronger evidence regarding whether AI adoption produces sustained and measurable development outcomes. Overall, the findings provide empirical support for the view that artificial intelligence can contribute to sustainable development in Saudi Arabia, particularly when embedded within a broader system of human expertise, institutional governance, responsible innovation, and environmental accountability. The results align with Saudi Arabia's increasing emphasis on digital transformation and economic diversification. However, they also show that AI is an enabling instrument rather than an independent solution. Its contribution ultimately depends on the objectives for which it is deployed, the quality of its governance, the inclusiveness of its implementation, and the extent to which its economic, social, and environmental consequences are continuously evaluated.

5. Conclusion

This study examined the role of artificial intelligence applications in achieving sustainable development goals in the Kingdom of Saudi Arabia across the service, economic and investment, and natural-resource dimensions. The findings demonstrated significant positive relationships between artificial intelligence applications and all three sustainability dimensions. The strongest contribution appeared in the economic and investment dimension, followed by the preservation of natural resources and the service field. Accordingly, the three null hypotheses were rejected, confirming that greater use of AI applications is associated with stronger perceived achievement of sustainable development goals. The findings show that AI can support sustainable services by improving efficiency, accuracy, accessibility, and decision-making. It can also enhance economic and investment development through innovation, productivity, transparency, and more effective resource allocation. In the environmental field, AI may facilitate energy efficiency,

predictive maintenance, waste reduction, cleaner production, and the transition towards less-polluting energy sources. These contributions demonstrate that AI has the capacity to support several dimensions of sustainability simultaneously rather than producing benefits within one isolated sector. Nevertheless, the results do not imply that AI adoption automatically leads to sustainable development. The moderate mean scores and explanatory power of the regression models indicate that the practical contribution of AI remains dependent on complementary conditions, including reliable digital infrastructure, high-quality data, employee competencies, responsible governance, human oversight, and clear sustainability objectives. AI adoption must therefore be accompanied by policies that address privacy, transparency, algorithmic bias, employment disruption, unequal access to technology, and the environmental footprint of computing systems.

The study concludes that Saudi institutions should approach AI as a strategic and responsibly governed instrument for sustainable development. Investment should focus not only on acquiring advanced technologies, but also on developing human capabilities, integrating sustainability indicators into AI projects, and measuring their actual social, economic, and environmental outcomes. Cooperation among government institutions, universities, technology providers, service organizations, and industrial companies will be essential for transforming the perceived potential of AI into measurable and enduring results. Finally, the study provides useful evidence from the perspective of faculty members at the University of Ha'il, but its conclusions remain bounded by the cross-sectional design, the single-institution sample, and the use of perceptual measures. Future research should employ broader samples, longitudinal designs, and objective performance indicators to determine how specific AI applications influence particular sustainable development goals over time. Within these limitations, the study concludes that AI can meaningfully advance sustainable development in Saudi Arabia when its implementation is human-centred, ethically governed, environmentally responsible, and aligned with long-term national priorities.

Acknowledgment

During the preparation of this manuscript, the author's used AI tool name, e.g., ChatGPT and Claude solely to improve the language, grammar, and clarity of the text. After using this tool, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

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