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The Impact of Integrating Sustainability Principles in The University Education Environment Through Smart Systems

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Abstract :

This research aims to demonstrate the impact of integrating sustainability principles in the university education environment through the use of smart systems, with a focus on the role of artificial intelligence in improving the efficiency of resource use and enhancing the quality of the educational process. The research is based on the premise that integrating smart technologies with sustainability principles contributes positively to achieving a more efficient and sustainable university environment on both environmental and educational levels. The research adopted a descriptive-analytical approach, collecting data through questionnaires and interviews, targeting a sample of students and faculty members from several universities. The data were analyzed to reveal the nature of the relationship between the use of smart systems and the level of sustainability implementation within the university environment. The results showed a statistically significant positive relationship between the use of smart systems and the achievement of sustainability. These systems contributed to rationalizing energy consumption, improving resource management, and supporting data-driven decision-making. The results also revealed some challenges, most notably the weakness of the technological infrastructure, the need for human resource training, and ethical and technical challenges.

Keywords: Sustainability, University Education, Smart Systems, Artificial Intelligence, Sustainable Development.

JEL Classification Codes:334

INTRODUCTION

Higher education institutions are among the most fundamental pillars in building modern societies, given their pivotal role in preparing human capital capable of addressing contemporary challenges. In light of the rapid changes the world is witnessing, new concepts such as sustainability and digital transformation have emerged, representing a global trend that universities are striving to adopt to achieve a balance between economic development and the preservation of environmental and social resources. In this context, integrating sustainability principles into the university environment presents both a significant challenge and an opportunity. The role of universities is no longer limited to traditional education; it has expanded to include promoting environmental awareness, achieving resource efficiency, and contributing to the Sustainable Development Goals adopted by the United Nations. Hence, the importance of employing modern technologies, particularly artificial intelligence, becomes evident as an effective means to support this trend. Intelligent systems, including technologies such as machine learning and big data analytics, are promising tools for improving the efficiency of educational and administrative processes within universities. This is achieved through optimizing energy consumption, managing resources more effectively, and developing interactive and sustainable learning environments. These systems also contribute to enhanced data-driven decision-making, which supports the achievement of long-term sustainability goals. Despite the growing interest in implementing smart systems in higher education, there is a pressing need to study the effectiveness of integrating these systems with sustainability principles and to measure their real impact on improving the learning environment. Therefore, this research aims to highlight the nature of the relationship between smart systems and sustainability in higher education and to analyze the extent to which this integration contributes to achieving a more efficient and sustainable learning environment.

1. Research methodology

A. Research Problem: The problem lies in the gap between adopting sustainability principles and implementing smart systems, as the integration between them remains unclear or not scientifically measured. Furthermore, there is a significant lack of studies addressing the impact of this integration on improving and developing environmental and educational performance within universities, particularly in Arab educational settings.

B. Research objectives: This research aims to achieve several main objectives, including:

- Analyzing and evaluating the role of AI-based smart systems in supporting the application of sustainability principles within the university environment.
- Measuring the impact of integrating sustainability principles with smart systems on the efficiency of environmental and educational performance and learning outcomes in higher education institutions.
- Identifying and measuring the level of sustainability application in the university environment from the perspectives of students, faculty members, and the academic community.
- Identifying and exploring the nature of the relationship between the use of smart systems and achieving sustainability in higher education institutions.

C. Research importance :The significance of this research lies in highlighting the role of integrating AI-based smart systems with sustainability principles in developing the university learning environment. This contributes to enhancing resource utilization and improving the quality of education within the university setting. Furthermore, the research provides a distinguished scientific, practical, and applied foundation that supports the achievement of sustainable development goals. This research also assists decision-makers in adopting innovative solutions to improve environmental and educational performance in universities.

D. Research hypotheses: The research is based on the following hypotheses:

- Hypothesis 1: There is no statistically significant correlation between integrating sustainability principles and smart systems in the university environment.
- Hypothesis 2: There is no statistically significant effect of smart systems and integrating sustainability principles on achieving a healthy university environment.
- Hypothesis 3: There is no statistically significant effect of integrating sustainability and smart systems on achieving a healthy university environment.

E. Research Community and Sample: The research community consists of all higher education institutions, while the research sample consists of a group of faculty members and students in all higher education institutions, who were selected in a (random/stratified) manner to ensure representation of different disciplines and academic levels.

2. Literature review: The impact of integrating sustainability principles in the university education environment through smart systems

2.1 The concept of sustainability: Sustainability is a modern concept that aims to balance the needs of the present without compromising the ability of future generations to meet their own needs. It encompasses three main dimensions: environmental, economic, and social, which work together to ensure balanced and sustainable development. This concept has become central to various sectors, including higher education, where universities strive to adopt sustainable practices that contribute to the efficient use of resources and the promotion of environmental awareness, in line with the Sustainable Development Goals adopted by the United Nations. From this perspective, sustainability is defined as To adopt a new way of thinking and dealing more responsibly with the surrounding environment. This does not mean that there is a specific method to achieve this, as sustainability means dealing consciously with the environment and natural resources (Al-Shammari and Jiyad, 2020:5) Sustainability may then be defined as maintaining well-being over a long, perhaps even an indefinite period. This covers largely the environmental dimension of the triple bottom line, but environment and sustainability are not synonymous. On the one hand, some forms of environmental degradation are both relatively easily reversed and highly noxious in the present—many forms of air and water pollution, for instance. These have a strong well-being aspect. Indeed, in the EU Guidelines for Impact Assessment they appear both under the environmental and the social dimension. On the other hand, what we bequeath to future generations also includes cultural heritage: art and cultural landscapes as well as infrastructure, technology and institutions (Kuhlman and Farrington, 2010: 3441)

2.2 Sustainable dimensions: Sustainability is a comprehensive framework that aims to balance meeting the needs of the present without compromising the ability of future generations to meet their own needs. The concept of sustainability is based on three key, interconnected dimensions that work together to ensure sustainable and inclusive development (Al.Shuaili, 2024: 8)

- Environmental Dimension: The environment is the habitat or medium in which humans live along with other living and non-living organisms. These components depend on each other in a balanced and integrated manner. For this balance to be maintained, it must not be disrupted, harmed, or its resources wasted.
- The social dimension refers to the relationship between humanity and nature, emphasizing that humanity is the foundation and ultimate goal of development. Sustainable development here seeks to improve reality, achieve well-being and happiness, enhance livelihoods, ensure fair gender equality, and provide all social services such as health, education, and employment opportunities. It also aims to ensure fairness for future generations by taking their interests into account.

- The economic dimension: Sustainable development here seeks to regulate projects and entrepreneurship, provide job opportunities, and invest resources sustainably without harming them, while increasing individuals' access to goods and services. It also involves adapting curricula and educational programs to the requirements and needs of the labor market.

2.3 The concept of university education: University education refers to education undertaken within colleges or university institutes after obtaining a secondary school diploma. The duration of study in these institutions varies from two to four years, and it is the final stage of formal education. It encompasses all types of studies, training, or specialized training that take place after secondary school at a university or other educational institution recognized as a university by the official state authorities. The names of these educational institutions vary; there are: university, college, and academy. The university is the highest-ranking institution in higher education. Other names are used for the university and its affiliated institutions, such as: college, institute, academy, and higher school. These names cause confusion because they carry different meanings from one country to another. Although the word "college" is used to refer to an institution of higher education, countries following British or Spanish traditions use the word "college" to refer to a private secondary school. Similarly, an academy may refer to a higher education institution or a school (Masoudi and Khadija, 2020: 170) University education also defines a university as a social institution comprising a group of individuals who disseminate knowledge and work towards its advancement through scientific research, human resource development, and the transmission of cultural heritage. University buildings, such as lecture halls, libraries, and so on, do not in themselves constitute a university, although they are all essential to its formation. The university's primary aim is to serve and elevate society, as well as to develop and grow it. (Abdul Aziz Al-Gharib Saqr, 2005, 50)

2.4 Components of university education: The university education system is a complex entity comprised of a set of interconnected components that work together to achieve the Sustainable Development Goals, produce knowledge, and develop human capabilities. These components can be divided into four main axes according to recent academic literature (Altbach, 2016:2):

A. Human resources are considered the most important strategic resource in an academic institution and include:
   - Faculty: The role of the university professor is no longer limited to transmitting knowledge, but has become that of a "facilitator of learning and designer of smart learning environments" (Barnett, 2017:5).
   - Students: They represent the core of the educational process, and the modern approach views them as partners in the production of knowledge, not merely recipients.
   - Administrative and technical staff: The supporting forces that manage logistical and technical operations, especially in light of the shift towards smart universities.

B. Physical and technical components: These include the physical and virtual environment in which educational interaction takes place:
   - Campus and infrastructure: This includes classrooms, laboratories, and libraries, which are currently being designed according to "sustainability" standards to become green buildings.
   - Smart systems and digitalization: This includes learning management platforms, information networks, and artificial intelligence technologies that support adaptive learning (Hwang et al., 2020:6).

C. Cognitive and Academic Components: These represent the qualitative aspect and functional objective of the university:
   - Curricula: These are the academic plans that aim to develop intellectual and professional skills, with the necessity of integrating the principles of sustainability and smart systems into their content.

- Scientific Research: The fundamental function that distinguishes university education, and it aims to develop solutions to societal, technological, and environmental problems.

D. Organizational and Governance Components: This refers to the legal and administrative framework that governs the relationship between the aforementioned components:
   - Vision and Mission: The strategic objectives that define the university's direction (e.g., transitioning to a smart, green university).
   - Regulations and Laws: The frameworks that govern admissions, evaluation, quality assurance, and academic accreditation to ensure highly reliable outcomes (Tight, 2019).

2.5 Types of smart systems in education

A. Intelligent teaching systems: are systems that mimic the role of a private tutor by guiding the learner through problem-solving steps. Their strength lies in the "student model" that analyzes common errors and provides immediate feedback (Mousavinasab et al., 2021:33).
B. Adaptive learning systems: These systems focus on the dynamics of the content; where machine learning algorithms adjust the difficulty and course of the scientific material according to the student's level of achievement in real time, thus ensuring that the student remains in a state of continuous mental challenge without frustration (Chassignol et al., 2018:34).
C. Smart Communication Platforms and Virtual Classrooms (Google Meet & Zoom): Google Meet and Zoom are interactive interfaces that support distance and blended learning. They have evolved from simple audio and video communication tools into smart systems that integrate artificial intelligence technologies to enhance the efficiency of academic communication. Their intelligence is evident in features such as real-time translation, automatic meeting summarization, and student engagement analysis (Kuhail et al., 2023:4)

Predictive learning analytics systems rely on data mining to predict students' future outcomes. These systems help university administrations identify students at risk of academic failure and provide them with proactive support (Ouyang et al., 2022:4).

3.1 Field study tool: The field study tool consisted of an opinion questionnaire directed to the academic and administrative staff at the university, in order to identify their opinions on the impact of integrating sustainability principles into the university education environment through smart systems. The questionnaire lists in this study were designed to be the main means of collecting field data in order to achieve the research objectives and test the validity of the study hypotheses. To achieve this, the questionnaire form was designed in the form of scientific and general questions related to the study, where the respondent answers the questions by choosing one of the answers restricted in the form. The questionnaire consisted of (21) questions distributed across three main axes: sustainability, the university learning environment, and smart systems. The responses were formulated according to the five-point Likert scale, with five options given: strongly agree, agree, neutral, disagree, and strongly disagree. The scores of the five-point scale used in the study for the purpose of statistical analysis were classified as follows, according to the items answering the questions:

Table 1 Answers to the Questions

Classification	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Grade	1	2	3	4	5

Source: Prepared by the authors based on SPSS output.

3.2 Testing and distributing the questionnaire lists: Before finalizing the questionnaire, the researcher conducted the necessary tests to ensure its validity and reliability, thus guaranteeing the

accuracy of the collected data and its ability to measure the phenomenon under study, namely sustainability, the university learning environment, and smart systems.

A. Scale validity test (arbitrator validity) : In order to verify the validity of the questionnaire form, it was presented in its initial form to a group of professors and experts specializing in the fields of (sustainability, university education environment, smart systems). The aim is to survey their opinions on the clarity of the paragraphs, their coherence, and the suitability of the questions to the three axes of the study. The researcher complied with the reviewers' instructions regarding wording, deletion, and addition, until the questionnaire emerged in its final form, which aligns with the research objectives and hypotheses.

B. Reliability Test (Cronbach's Alpha Coefficient): To ensure the consistency of the responses and the suitability of the instrument for field application on the study sample of (85) individuals, a reliability analysis was conducted using Cronbach's Alpha coefficient. The results showed that the coefficient value was (0.700), which is an excellent value as it is greater than the statistically acceptable minimum (0.60). This indicates that the questionnaire has a high degree of reliability and internal consistency, making it a reliable tool for collecting field data.

Table 2: Cronbach's Alpha Coefficient Test for Reliability

Cronbach's Alph	**N of item**
0.700	**85**

Source: Prepared by the authors based on SPSS output.

C. Calculating the consistency validity of the study variables: The researcher in the current study calculated the consistency validity of the study scale by applying it to a pilot sample of (85) individuals. The comparison method was used to identify the differences between the upper and lower groups, where the scores were arranged and the highest (28) observations were identified to represent the upper group, and the lowest (28) observations to represent the lower group (approximately 33% for each group of the total sample). The consistency results showed that all items of the questionnaire were statistically related to their axes with values ranging between (0.580 and 0.812), which are significant values at the level of 0.05.

3.3 Statistical analysis of demographic factors.

A. Educational level

Table (3) Description of the research sample according to educational level

Variables	**Target sample**	**repeat**	**ratio**
Academic qualification	Diploma	2	2.4%
	Bachelor's	24	28.2%
	Higher Diploma	2	2.4%
	Master's	33	38.8%
	Doctorate	24	28.2%
	Other	0	0%
Total		85	100%

Source: Prepared by the authors based on SPSS output.

Table (3) shows that (67%) of the sample members hold advanced degrees (Master's and PhD), which enhances the reliability of the results given the academic experience of the respondents and their direct engagement with sustainability policies, the university education environment, and smart systems.

B. Number of years of experience

Table (4) describes the research sample according to the variable of number of years of experience

Variables	Target sample	repeat	ratio
Academic qualification	under 5 years	43	50.6%
	From 5 to 10 years	20	23.5%
	From 11 to 15 years old	4	4.7%
	From 15 years old and older	16	18.8%
	Other	2	2.4%
Total		85	100%

Source: Prepared by the authors based on SPSS output.

Table (4) shows that approximately half of the study sample (50.6%) have recent experience (less than 5 years), reflecting the vitality of the sample and its ability to interact with intelligent systems, with a balanced representation of long experience to ensure that the impact of these systems is effectively assessed.

3.4 Descriptive statistical analysis of the study variables: This section presents the statistical analysis of the sample data ($N=85) using descriptive indicators (such as arithmetic means and relative importance) and inferential tests (such as correlation relationships and regression models) to analyze the three study axes: sustainability, the university learning environment, and smart systems.

Table No. (5) presents the descriptive statistics, represented by the arithmetic means, standard deviations, and relative importance of each item, with the ranking of importance determined based on the sample's responses.

sequence	phrases	arithmetic mean	standard deviation	Relative importance %	Ranking of relative importance	z test	tabulated value	Statistical decision
First axis	**Integrating sustainability principles into the university environment**	4.061	0.512	81.22%	-	19.09	1.96	**moral**
1	**There are training programs for faculty members on how to implement sustainability.**	4.224	0.472	84.48%	1	23.90	1.96	moral
2	**The university strives to integrate the concept of university**	4.112	0.908	82.24%	3	11.30	1.96	**moral**

	sustainability into the learning environment.							
3	**The university strives to integrate the concept of university sustainability into the learning environment.**	4.032	0.825	80.64%	4	11.53	1.96	**moral**
4	**Sustainable development concepts are effectively incorporated into the curriculum.**	4.135	0.735	82.70%	2	14.25	1.96	**moral**
5	**University activities (seminars, workshops) reflect a genuine interest in sustainability issues.**	3.961	0.922	79.22%	6	9.62	1.96	**moral**
6	**There is a clear strategy for transitioning towards a sustainable "green university" in the long term.**	3.771	0.732	75.42%	7			**moral**
7	The university has infrastructure that supports sustainability (such as recycling bins and green spaces).	4.192	0.782	83.84%				**moral**

Source: Prepared by the authors based on SPSS output.

Analysis of the results of the first axis: Integrating sustainability principles into the university environment. The axis received high approval with an average of (4.06) and an importance rating of (81.22%). Adopting environmental awareness policies came first with (84.48%) as a pillar of transformation, followed by integrating sustainability into curricula with (82.70%). The Green University Strategy came last with (75.42%), indicating the need to strengthen the future vision despite falling within the high approval range.

Table (6)

sequence	**phrases**	**arithmetic mean**	**standard deviation**	**Relative importa % nce**	**Ranking of relative**	11.62	**tabulated value**	**Statistical decision**

					importance			
the second	**The role of smart systems in supporting sustainability**	3.824	0.654	76.48%	-	11.62	1 **1**.96	**moral**
1	**The university provides training on the use of smart .systems**	3.695	0.921	73.90%	6	8.35	1.96	moral
2	**Smart systems can improve sustainability in university .education**	3.737	0.863	74.75%	5	9.82	1.96	**moral**
3	**E-learning supports environmental sustainabili .ty**	3.686	0.967	73.73%	7	8.15	1.96	**moral**
4	**Smart systems enhance students' awareness of sustainabili .ty concepts**	3.784	0.916	75.69%	4	10.45	1.96	**moral**
5	**Smart systems help conserve energy on .campus**	3.898	0.975	77.97%	1	12.04	1.96	**moral**
6	**Smart systems reduce paper consumption at the .university**	3.873	0.917	77.46%	2	11.21	1.96	**moral**
7	Using smart technologies reduces the need for	3.796	0.835	75.93%	3	10.56	1.96	**moral**

	physical .attendance							

Source: Prepared by the authors based on SPSS output.

Analysis of the results of the second axis: The role of smart systems in supporting sustainability. The axis recorded high agreement with an average of (3.82) and importance (76.48%). (Infrastructure) ranked first with (77.97%), followed by (Awareness Activities) with (77.46%), while (Resource Conservation) came last with (73.73%), while maintaining statistical significance (Z=8.15 > tabulated).

Table (7)

sequence	**phrases**	**arithmetic mean**	**standard deviation**	**Relative importance**	**Ranking of relative importance**	11.62	**tabulated value**	**Statistical decision**
the third	**The university relies on smart systems to achieve its sustainability goals.**	3.824	0.654	76.48%	-	11.62	**1**.96	**moral**
1	**There is a clear integration between digital transformation and sustainability at the university.**	3.695	0.921	73.90%	6	8.35	1.96	moral
2	**Smart systems help improve the efficiency of managing university facilities.**	3.737	0.863	74.75%	5	9.82	1.96	**moral**
3	**Smart technologies contribute to reducing the university's environmental impact.**	3.686	0.967	73.73%	7	8.15	1.96	**moral**
4	**Smart systems support sustainable decision-**	3.784	0.916	75.69%	4	10.45	1.96	**moral**

	making within the .university							
5	**Your university implements smart solutions (such as energy managemen t systems, e-learning).** **Integrating sustainabilit y concepts into smart educational .systems**	3.898	0.975	77.97%	1	12.04	1.96	**moral**
6	**Integrating sustainabilit y concepts into smart educational .systems**	3.873	0.917	77.46%	2	11.21	1.96	**moral**
7	The effectiveness of these systems in supporting sustainabilit y	3.796	0.835	75.93%	3	10.56	1.96	**moral**

Source: Prepared by the authors based on SPSS output.

Analysis of the results of the third axis: The impact of integration between sustainability and smart systems on the quality of education. The integration axes achieved high agreement with an average of (3.89) and importance of (77.92%), where (stimulating innovation) came first with a percentage of (79.15%), followed by (digital interaction) with a percentage of (78.98%), while (supporting scientific research) came last with a percentage of (78.01%), while it remained statistically significant to exceed the tabulated Z value.

2.7.4 Statistical testing of the main hypotheses.

Main Hypothesis 1: The first main hypothesis (in its null form) states that: "There is no statistically significant correlation between integrating sustainability principles and smart systems in the university environment." To prove otherwise, Pearson's correlation coefficient was used to measure the strength and direction of the relationship between the two variables.

Tables (8) represent the degree of relationship and its testing between integrating sustainability principles and smart systems

Data	Integrating sustainability principles		Smart systems	
Integrating sustainability principles	1	0	0.762	**0**
Smart systems	0.762	0	1	**0**

Source: Prepared by the authors based on SPSS output.

The results of Pearson's correlation coefficient confirmed a significant positive relationship between integrating sustainability principles and smart systems (Sig=0.00 < 0.05); this necessitated rejecting the null hypothesis and accepting the alternative, confirming that expanding the use of smart systems directly enhances the application of university sustainability.

Tables (9) represent the t-test and the linear regression model.

Model variables	Teacher's quantity	standard deviation	test	Morale level
Fixed limit	1.124	0.285	3.943	0.000
X1	0.658	0.058	11.344	0.000

Source: Prepared by the authors based on SPSS output.

$Y_i = 1.124 + 0.658 X_{1i}$

The regression model demonstrated a significant positive effect of integrating sustainability principles (independent variable) into intelligent systems (dependent variable), thus confirming the acceptance of the study's alternative hypothesis.

Table (10) represents the analysis of variance table and the F-test for the significance of the regression model.

Source of Variation	sum of squares	Degree of freedom	Variation	Test F	morale level
Between groups	16.94	1	16.94	128.69	0.000
Within groups	10.92	83	0.1316		
The whole	27.86	84			

Source: Prepared by the authors based on SPSS output.

We note from the analysis of variance table that the F-test value was (16.94) below the significance level of (0.000), which is less than (0.05). Therefore, the estimated model is significant.

Second main hypothesis: The second main hypothesis states that: “There is no statistically significant effect of smart systems and the integration of sustainability principles in achieving sustainable education quality.” To prove or disprove this hypothesis, advanced statistical analysis methods will be used, namely (multiple regression analysis, partial correlation, and analysis of variance table) to measure the combined contribution of the independent variables to the dependent variable, as illustrated in the following tables and analyses.

Tables (11) represent the degree of relationship and testing between smart systems and the integration of sustainability principles.

Data	Integrating sustainability principles		Smart systems	
Integrating sustainability principles	0.762	0	0	**1**
Smart systems	1	0	0	0.751

Source: Prepared by the author based on SPSS output.

The results showed a positive and significant correlation between smart systems and the integration of sustainability principles, with a significance value of (0.00), which is less than (0.05). This confirms the acceptance of the alternative hypothesis that smart systems have a significant effect on promoting sustainability.

Tables (12) represent the t-test and the model of multiple linear regression.

Model variables	Teacher's quantity	standard deviation	test	Morale level
Fixed limit	0.942	0.211	4.466	0.000
X1	0.674	0.118	5.712	0.000

Source: Prepared by the authors based on SPSS output.

$Y_i = 0.942 + 0.674 X$

From the linear regression model above, it is shown that there is a positive effect on both the independent variable, intelligent systems, and the second variable, the integration of sustainability principles. This supports the hypothesis that intelligent systems have a significant effect on the integration of sustainability principles.

Table (13) represents the analysis of variance table and the F-test for the significance of the regression model.

Source of Variation	sum of squares	Degree of freedom	Variation	Test F	morale level
Between groups	18.65	1	18.65	141.62	0.000
Within groups	10.77	83	0.1298		
The whole	29.42	84			

Source: Prepared by the authors based on SPSS output.

We note from the analysis of variance table that the F-test value was (141.62) below the significance level of (0.000), which is less than (0.05). Therefore, the estimated model is significant.

The third main hypothesis of the study (formulated as a null hypothesis) states that: "There is no statistically significant effect of integrating sustainability and smart systems in the university learning environment." To prove or disprove this hypothesis, statistical analysis methods were used, namely correlation coefficient, regression analysis, and analysis of variance (ANOVA).

Tables (14) represent the degree of relationship and testing between the integration of sustainability and smart systems in the university learning environment.

Data	Integration between sustainability and smart systems		University environment	
Integrating sustainability principles	1	0	0.684	0
University environment	0.684	0	1	0

Source: Prepared by the authors based on SPSS output.

The results indicate a statistically significant positive correlation between integration (sustainability and smart systems) and the quality of education; the significance value was (0.000), which is less than (0.05), which necessitates rejecting the null hypothesis and accepting the alternative hypothesis.

Table (15) represents the t-test and the linear regression model.

Model variables	Teacher's quantity	standard deviation	test	Morale level
Fixed limit	0.864	0.360	2.400	0.019
X1	0.534	0.080	6.675	0.000

Source: Prepared by the authors based on SPSS output.

$Y_i = 0.864 + 0.538 X_{1i}$

Source: Prepared by the authors based on SPSS output.

From the linear regression model above, it was shown that there is a positive relationship between the integration of sustainability and smart systems and the quality of education. This supports the hypothesis that there is a significant relationship between the integration of sustainability and smart systems in the university environment.

Table (16) represents the analysis of variance table and the F-test for the significance of the regression model.

Source of Variation	sum of squares	Degree of freedom	Variation	Test F	morale level
Between groups	20.74	1	20.74	178.50	0.000
Within groups	9.13	83	0.110		
The whole	29.87	84			

Source: Prepared by the authors based on SPSS output.

We note from the analysis of variance table that the F-test value was (178.50) below the significance level of (0.000), which is less than (0.05). Therefore, the estimated model is significant.

4. Conclusions and Recommendations:

4.1 Conclusions:

- When sustainability is integrated with smart technologies into the university education process, students become more informed and aware of environmental practices, and acquire practical skills related to sustainability.

- Integrating smart systems helps to introduce modern concepts into the university learning environment within the learning curricula, making education more relevant to the requirements of the future.
- Sustainable smart university environments encourage research in the areas of environmental sustainability and growth, and are geared towards long-term learning outcomes.

4.2 Recommendations:

- Universities should adopt a comprehensive plan to integrate sustainability with smart systems in the university learning environment.
- Conducting periodic reviews to measure the impact of implementing sustainability and smart systems, and working to continuously improve performance.
- Encouraging research projects that link artificial intelligence and sustainability, and providing financial support and incentives for researchers.

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