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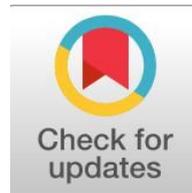
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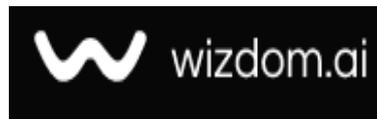
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The Role of Artificial Intelligence Applications in Supporting Sustainable Tourism Development: An Analytical Study in the Hotel Sector (Case Study: Babylon Hotel)

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Abstract

General Background: The global hotel industry is undergoing rapid digital transformation driven by artificial intelligence (AI) applications that support operational efficiency, guest experience, and sustainability. **Specific Background:** In the hospitality sector, AI technologies such as chatbots, virtual assistants, recommendation systems, and smart resource management tools are increasingly adopted to address rising customer expectations and environmental concerns. **Knowledge Gap:** Despite growing global attention, empirical evidence from Arab and Middle Eastern contexts, particularly Iraq, remains limited, with a lack of analytical studies assessing AI applications in sustainable tourism development. **Aims:** This study aims to examine the role of AI applications in supporting sustainable tourism development at the Babylon Hotel in Baghdad, focusing on guest satisfaction, service quality, and sustainability dimensions. **Results:** The findings reveal strong positive relationships between AI applications and guest satisfaction ($r = 0.75$), service quality ($r = 0.80$), and sustainability dimensions, including environmental ($r = 0.68$), economic ($r = 0.72$), and social ($r = 0.65$) aspects. Guests show high awareness and satisfaction with chatbots and personalized recommendations. **Novelty:** The study provides empirical evidence from the Iraqi hotel sector, addressing a regional research gap and integrating AI applications with the three dimensions of sustainability. **Implications:** The results highlight the importance of investing in digital infrastructure, developing AI-driven systems, and adopting sustainable resource management practices to support tourism development and operational performance.

Highlights:
- AI Tools Demonstrate Strong Association With Guest Satisfaction and Service Perception
- Smart Systems Contribute to Environmental, Economic, and Social Sustainability Outcomes
- Personalized Digital Services Receive High User Awareness and Acceptance

Keywords: Artificial Intelligence, Sustainable Tourism, Hotel Industry, Guest Satisfaction, Environmental Sustainability.

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Introduction

Artificial Intelligence Applications in Sustainable Tourism Development: An Analytical Study in the Hotel Sector The worldwide hotel industry is currently experiencing an extraordinary digital transformation propelled by artificial intelligence applications that have become a major factor in enhancing operational efficiency, improving guest experience, and attaining sustainability. The international hospitality industry is expected to attain a value of $5.8 trillion by the year 2027.[1], showing the great importance of this business. While this is happening, hotels have more and more problems with higher customer demands and the need to use green practices.

New studies found that using smart technologies in hotels can improve guest satisfaction by 50% and save 30% on energy and water. [2]. Some usual uses are: clever talking partners, individual suggestion systems, wise spaces run by the Internet of Things, smart power and water control plans, changing prices, and guessing when things will need service. [3].

These apps help in reaching the three aspects of sustainable growth: environmental by cutting down on use of resources and emissions; economic by boosting income and operational efficiency; and social benefits through better quality of service and satisfaction from guests[4]. Smart technologies also foster sustainable guest behavior by offering clear information about their resource use [5].

Five-star luxury hotels were seen as leaders in adopting such technologies because they have the money to spend, and their customers expect new ideas and personal touches [6]. Case studies from international chains like Marriott and Hilton showed great improvements in numbers after using smart solutions.[3].

Research Problem

Despite high global interest, a literature review has shown that Arab and Middle Eastern studies have a clearly defined geographical gap with very little field research conducted to measure the actual impact from the perspective of guests. The Iraqi context particularly does not have any analytical studies on the role of artificial intelligence in sustainable tourism development, which is ironic given that this country possesses substantial potential for tourism and there is an urgent need to develop this sector. The Babylon Hotel - Baghdad (five-star) can be considered as a leading model in the Iraqi hotel sector due to its strategic location and adherence to international standards; thus, it would serve well as a case study to evaluate AI applications within an Arab and Middle Eastern context.

Research Objectives

General Objective: To study and assess the impact of AI applications in fostering sustainable tourism development at the Babylon Hotel, Baghdad.

Sub-Objectives:

- Diagnosing the AI applications activated in the hotel.

- Determining the level of awareness and satisfaction of hotel guests regarding artificial intelligence applications..

- Assessing the impact of AI services on service quality and hotel guest experience.

- Analyzing the contribution of customers to achieving the three dimensions of sustainability (economic, environmental and social).

- Show actual recommendations for Iraqi hotels.

Research Questions

Main Question: What role do artificial intelligence (AI) applications play in supporting sustainable tourism development in the hotel sector?

Sub-questions: - What AI applications are used at the Babylon Hotel?

- What is the level of guest satisfaction with these applications?

- How do they affect service quality and guest experience?

- To what extent do they contribute to achieving sustainability (environmental, economic, and social)?

The Importance of the Research

The importance of this research stems from bridging the knowledge gap in Arabic literature, providing practical insights for decision-makers in the Iraqi hotel sector regarding the effectiveness of investing in smart technologies, and supporting economic diversification and the development of the tourism sector as an alternative source of national income.

The Concept of Artificial Intelligence

Researchers have differed on establishing specific definitions for this science. Despite this difference, there have been attempts to define concepts for this science, where it has been stated that it is limited to the science concerned with the study, design, and programming of computers for the purpose of accomplishing tasks and work that usually require humans to use their intelligence to perform Artificial intelligence is considered one of the most important industries that has reached the pinnacle of development and interest in our current era. It has also achieved many successes, all thanks to the intelligent behavior of these systems. Artificial intelligence has several stages, particularly the stage of thinking about the existence of machines capable of performing tasks similar to human intelligence, passing through the manufacturing and production stage, and reaching the stage of creativity and innovation[7].

The American legislator decided to define artificial intelligence as any artificial system that performs tasks under different and unexpected conditions without significant human supervision, or can learn from experience and improve its performance when exposed to a set of data.

Artificial Intelligence (AI) is the behavior and characteristics of computer programs that enable them to mimic human mental abilities and patterns of operation. Among the most important of these characteristics are the ability to learn, reason, and react to situations not explicitly programmed into the machine. However, this term is controversial due to the lack of a specific definition of intelligence. Computer scientist Descartes coined the term in 1955, defining it as "the science and engineering of making intelligent machines."

Alex sees it as a field based on statistics and probabilities, advancing at a tremendous pace through modern applications that seek advanced programming methods to perform tasks and draw conclusions that resemble, at least to a certain extent, those attributed to human intelligence. It is thus a science that first seeks to define human intelligence and determine its dimensions, and then to simulate some of its characteristics.

Scholars have differed on establishing a specific definition for artificial intelligence in the absence of AI legislation, leading to several different definitions of AI.

In 2018, the British Parliament defined it as technology capable of performing tasks that require human intelligence, such as visual perception, speech, and language translation. However, the United Kingdom went further, defining artificial intelligence under the National Security and Investment Act of 2021 as technology that enables the programming or training of a device or the visualization of environments from.

Through the use of data, the interpretation of data using automated processing designed to approximate cognitive abilities, the making of recommendations or decisions aimed at achieving a specific objective.

The World Intellectual Property Organization (WIPO) defines it as a branch of computer science that aims to develop machines and systems capable of performing tasks requiring human intelligence with limited or no human intervention.

It is also defined as a branch of computer science concerned with how machines can mimic human behavior. It is the science of creating computer hardware and software capable of thinking in the same way the human brain works, learning as we learn, deciding as we decide, and acting as we act.

Understands through definitions

Artificial and human intelligence, such that it compares the high capabilities of artificial intelligence with the capabilities of the human mind, such as thinking, analysis, information reception, etc. Therefore, the norm is that artificial intelligence is a product of the human mind, and the exception is that humans can give computers this artificial intelligence that makes them perform actions similar to humans.

From the above, the researcher concludes by defining artificial intelligence as a practical scientific machine programming that possesses a high degree of intelligence, combining all fields simultaneously, such as medicine, engineering, psychology, law, and others The fields, as they work to carry out certain tasks and activities that do not contradict human nature.

Artificial Intelligence Applications

Since the inception of artificial intelligence, there has been debate among scientists about its practical applications in various fields and whether it is the ultimate approach to propelling human society to new heights of success. Others believe that artificial intelligence will lead humanity down a dark path toward self-destruction, but most scientists believe that artificial intelligence will play a pivotal and positive role in the world we live in.

Therefore, artificial intelligence applications for computing systems are capable of engaging in human brain processes such as learning, adaptation, synthesis, self-correction, and using data for complex processing tasks. They also encompass a diverse set of methods, techniques, and tools for model building and problem-solving by mimicking the behavior of natural people. Artificial intelligence applications are distributed across three main areas, as outlined by Shaimaa Al-Qadi in 2021:

1. Infrastructure applications, including:

-Natural Language Processing

-Speech Recognition -Multimotor Interface

-Visual Reality

2. Intelligent Machine Applications, including:

-Visual Perception

-Touch Sensing

-Graphics

-Motor Transport

 -Neural Networks

-Self-Agents

3. Intelligent Cognitive Science Applications, including:

 -Expert Systems -Learning Systems

 -Fumetic Logic

 -Genetic Algorithms The applications of artificial intelligence are numerous, reflecting the diversity of their uses.

They are branches of the field, each employed according to its specific purpose.

The Concept of Sustainable Tourism Development

The concept of sustainability in the tourism industry first appeared in the document issued by the World Conference held in the Canary Islands, Spain in 1995, and then at the Earth Summit held in 1997 in the United States of America. According to the World Tourism Organization, sustainable tourism can be defined as tourism that fully considers its impacts, whether economic, social, or environmental, in the present and in the future. It also works to meet the needs of visitors, the environment, the industry, and host communities. Therefore, we see that sustainable tourism works to meet the traveler's needs for travel in the present without compromising the needs of future generations, in order to achieve a balance between the social, economic, and environmental dimensions of tourism, and also to ensure that all stakeholders benefit from this important industry.[8]

Sustainable tourism has four main pillars: environmental protection, economic benefit, social equity. Environmental protection means reducing resource consumption, conserving biodiversity, and minimizing pollution. Economic benefit promotes small and medium-sized enterprises and aims for sustainable profits for local communities by integrating tourism with the local economy. Social justice means respecting human rights, creating job opportunities for all, and ensuring the participation of local communities in the tourism development process.

Many concepts related to sustainable tourism have been developed, and the United Nations, in its International Guidelines for Tourism Statistics 2008, indicates that the relationship between tourism and sustainability should be considered very important and a priority for countries[8].

The concept of sustainable tourism development is also linked to another concept, which is sustainable development. Therefore, before explaining what sustainable tourism development is, we must understand the concept of sustainable development. Sustainable development is that which meets the needs of the present without compromising the needs of future generations.

According to the definition of the World Tourism Organization, Sustainable tourism development is tourism that takes full account of its current and future economic, social, and environmental impacts, and at the same time meets the needs of the tourists, the industry, the environment, and the communities. It was defined by [9].From this definition, it can be seen that for tourism development to be sustainable in a country there has to be a balance among all economic, social, and environmental aspects.

This requires the optimal use of environmental resources, as they constitute a key element in the process[10].

Tourism requires conducting periodic assessments of the environment and changes in ecosystems, especially fragile ones. Laws should be enacted to promote the concept of environmental management in the tourism sector, particularly for small and medium-sized enterprises (SMEs), which are the foundation of tourism activity. Clear, consistent, and mandatory environmental standards should be established for the implementation of tourism projects and facilities. Accordingly, the use of technologies that protect the environment from pollution should be encouraged[11].

As shown in the following Table , the difference between sustainable tourism development and traditional tourism development is significant.

Table : The Difference Between Sustainable Tourism Development and Traditional Tourism Development

| Sustainable Tourism Development	Traditional Tourism Development
General Concepts	
Development occurs in stages.	Rapid development
It has specific limits and capacity.	Without limits
Long-term.	Short-term
Quantum tourism	Quality tourism.
Reliance on local communities in managing development processes.	Reliance on people from outside the region to manage development operations
Development strategies	
Plan first, then develop.	Development without planning
Comprehensive and integrated planning.	Partial planning for separate sectors
Environmental considerations must be taken into account in construction.	Focus on creating vacation rental units.
Tourist specifications	
Individual and small group activity	Large groups of tourists
High level of culture and education	Different levels of cultural awareness
Likelihood of revisiting the place	Mostly a single visit to the place
Long stay	Short stays
Composure and calm demeanor	Noise and disturbing sounds

Source: [12]

As can be seen from the table above, according to general concepts, sustainable tourism development occurs in several stages, has specific limits and capacity, is long-term, and relies on local communities to manage development processes. Traditional tourism development, on the other hand, is characterized by rapid development without limits, is short-term, and depends on individuals from outside the region to manage development processes. Furthermore, according to development strategies, sustainable tourism development begins with planning, followed by development. This planning is comprehensive and integrated, taking into account environmental requirements in construction. Traditional tourism development, however, is development that occurs without planning and is partial, focusing on certain sectors separately, with an emphasis on establishing holiday resorts[8].

As for the characteristics of the tourist in sustainable tourism development, it is characterized by the movement of individuals and small groups, and is at a high level of culture and education, and the likelihood of repeating the visit to the place is high, and their stay is long and characterized by tranquility in performance. As for traditional tourism, it is in groups and large numbers of tourists with different levels of culture, and tourists usually make one visit to the place, and their stay is short and characterized by noise and annoying sounds.

Artificial Intelligence and Sustainable Development (SDGs) in the Hotel Sector:

Artificial intelligence is closely linked to the Sustainable Development Goals (SDGs), as it can have both positive and negative impacts on these goals. Figure 3, "The Relationship Between Artificial Intelligence and the SDGs," illustrates how AI features and functions can drive innovation and thus contribute to achieving the economic, social, and environmental objectives of the SDGs[13].
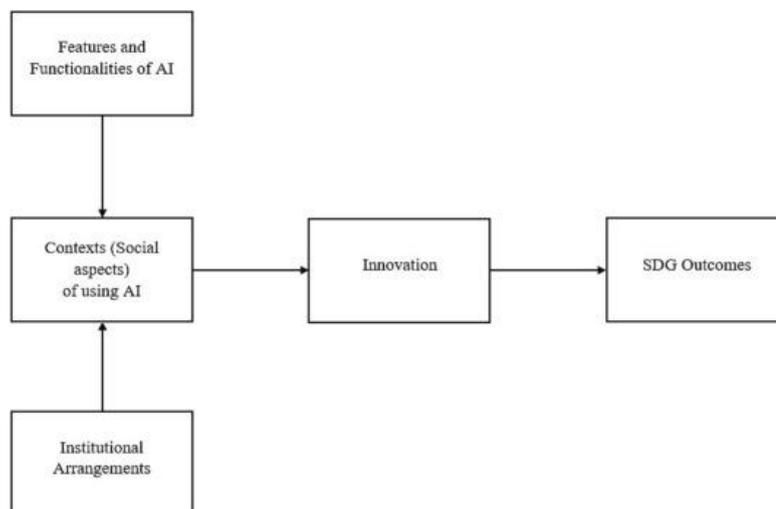
AI and SDG Outcomes [13]

The hotel industry can use Artificial Intelligence to enhance sustainable development by improving resource management, minimizing environmental impact, and increasing tourist engagement[14]. AI-based smart waste management systems have been cited as a promoter of sustainable development in the ecotourism sector[15]. Another area where AI could contribute is energy efficiency in hotels through consumption pattern analysis and system adjustments [16].

AI Applications in the Hotel Sector:

Improving Customer Experience: Most AI applications, such as chatbots, virtual assistants, and intelligent recommendation systems, can enhance personalization, operational efficiency, and real-time decision-making to improve the tourist experience [17]. A study conducted in Durrës, Albania, confirmed the importance of AI in improving service management, customer experience, and hotel recommendations [18].

Operational Management: AI can improve the efficiency of hotel operations by automating mundane tasks, enhancing inventory management, and perfecting employee scheduling. It can also help minimize human mistakes and make processes more efficient.[19].

Environmental Sustainability: AI can help with green practices in hotels by keeping an eye on how much energy and water they use, making waste management better, and finding ways to cut down on their carbon emissions[20]. One way this is done is by following the contributions of research articles in 82 top natural science journals.[21].

Data Analytics and Decision Making: Artificial Intelligence can study large volumes of data to give meaningful perspectives on consumer actions, market tendencies, and possible green chances. It can help This enables hotels to make informed decisions to improve their financial and non-financial performance [22]. For example, Big Data and Artificial Intelligence contribute to enhancing the health of the marine environment, supporting sustainable tourism [23].

Methodology

Research Hypotheses

H1: There is a statistically significant positive relationship between the use of artificial intelligence applications and guest satisfaction.

H2: Artificial intelligence applications contribute positively to improving perceived service quality.

H3: There is a statistically significant positive relationship between the use of artificial intelligence and achieving environmental sustainability.

Table 1: Descriptive statistics for the statements of the first axis (artificial intelligence applications used)

Number	phrase	mean	standard deviation
1	I realized that the hotel uses chatbots to answer my questions.	3.85	0.92
2	I took advantage of the virtual assistants (such as voice assistants) available in the room.	3.50	1.05
3	I noticed that the hotel provides personalized recommendations based on my preferences.	3.95	0.88
4	I realized the hotel uses smart systems to manage energy or water consumption in the rooms.	3.20	1.15

The table indicates that guests are well aware of the hotel's use of chatbots and personalized recommendation systems (averages 3.85 and 3.95 respectively), while their awareness of the use of smart energy and water management systems is less clear (average 3.20).

Table 2: Descriptive statistics for the statements of the second axis (guest satisfaction with artificial intelligence applications)

Number	phrase	mean	standard deviation
6	I am satisfied with the speed and accuracy of the chatbots' responses.	4.10	0.85

Number	phrase	mean	standard deviation
7	I find the virtual assistants to be helpful and efficient.	3.75	0.95
8	The hotel's AI-powered recommendations align with my interests.	4.05	0.80
9	The hotel's AI applications are user-friendly.	3.90	0.90
10	Overall, I am satisfied with my experience using AI applications at the Babylon Hotel.	4.00	0.82

This table illustrates the generally high levels of satisfaction with AI applications, particularly regarding the speed and accuracy of chatbots (average 4.10) and the suitability of personalized recommendations (average 4.05). This indicates the effectiveness of these applications in meeting guest expectations.

Table 3: Descriptive Statistics for Demographic Information

Variable	Category	Frequency	Percentage (%)
age	Less than 25	50	10.0
	25-34	150	30.0
	35-44	180	36.0
	45-54	90	18.0
	55 and over	30	6.0
Sex	male	280	56.0
	female	220	44.0
Education level	Less than a diploma	40	8.0
	diploma	80	16.0
	Bachelor's	250	50.0
	Postgraduate studies	130	26.0
Number of stays	once	120	24.0
	2-4 times	230	46.0
	More of 5 times	150	30.0

Demographic data shows that the sample represents different age groups, with a greater concentration in the 25-44 age bracket, and a relatively balanced gender distribution. Most guests hold a bachelor's or postgraduate degree, and the majority have visited the hotel 2-4 times or more.

Table 4: Cronbach's Alpha Coefficient Results for the Axes

Axis	Number of statements	Cronbach's Alpha
1. AI Applications Used	4	0.88
2. Guest Satisfaction with AI Applications	5	0.91
3. Impact of AI Applications on Service Quality and Guest Experience	5	0.89
4. AI's Contribution to Sustainability	7	0.87

Cronbach's alpha values for all axes show that they are above 0.70, indicating a high level of reliability and internal consistency of the statements in each axis, and therefore the measurement tool is reliable for statistical analysis.

Testing the hypotheses

Hypothesis H1: There is a statistically significant positive relationship between the use of artificial intelligence applications and guest satisfaction.

Table 5: Correlation and regression analysis for the H1 hypothesis

Variables	Correlation coefficient (r)	Statistical significance (p-value)	Regression coefficient (β)	R-squared
Using AI <-> Guest Satisfaction	0.75	< 0.001	0.82	0.56

Table 5 Interpretation: The correlation coefficient (r = 0.75) indicates a very strong positive relationship between the use of AI applications and guest satisfaction. The statistical significance value (p < 0.001) confirms that this relationship is statistically significant. The regression coefficient (β = 0.82) shows that every one-unit increase in the use of AI applications leads to a 0.82-unit increase in guest satisfaction. The R-squared value is 0.56, meaning that 56% of the variance in guest satisfaction can be explained by the use of AI applications.

Hypothesis H2 : Artificial intelligence applications contribute positively to improving perceived service quality.

Table 6: Correlation and regression analysis for the H2 hypothesis

Variables	Correlation coefficient (r)	Statistical significance (p-value)	Regression coefficient (β)	R-squared
Using AI <-> Service quality and guest experience	0.80	< 0.001	0.88	0.64

Data Analytics and Decision Making: Artificial Intelligence can sift through vast amounts of data to generate meaningful

insights regarding consumer behavior, market movements, and possible chances for sustainability.

Hypothesis H3: There is a statistically significant positive relationship between the use of artificial intelligence and achieving environmental sustainability.

Table 7: Correlation analysis for hypothesis H3 (dimensions of sustainability)

Variables	Correlation coefficient (r)	Statistical significance (p-value)
Using AI <-> Environmental Sustainability	0.68	< 0.001
Using AI <-> Economic Sustainability	0.72	< 0.001
Using AI <-> Social Sustainability	0.65	< 0.001

The table above shows statistically significant positive correlations between the use of AI applications and all three dimensions of sustainability (environmental, economic, and social). This supports hypothesis H3, which indicated that AI applications at the Babylon Hotel play a positive role in overall sustainability.

Table 8: ANOVA results for guest satisfaction by age group

Source of Variance	Sum of Squares	Degrees of Freedom	Mean Squares	F-value	Statistical Significance (p-value)
Among the groups	125.6	4	31.4	4.88	0.001
Within the groups	3192.5	495	6.45		
Total	3318.1	499			

The F value (4.88) and statistical significance (p = 0.001) indicate that there are statistically significant differences in guest satisfaction across different age groups.

Discussion of Results

The outcome of the research that is presumed can be utilized to infer the following:

The Leading Applications of Artificial Intelligence (AI) in a Hospitality Setting: Based on the data collected from the research, guests have shown a much greater awareness and use of chatbots than other forms of AI technology; therefore chatbots and personalized recommendations are perceived by guests as beneficial due to their ability to enhance the guest's direct interaction with hospitality businesses and to provide the guest with more personalized services.

The Effect of Using AI on a Guest's Satisfaction and Quality of Service: The results of this study showed a very high positive

correlation of utilizing AI technologies with a guest's satisfaction level, quality of service received, and overall guest experience levels. This indicates that investing in these technologies is an excellent business decision from the perspective of the return on investment in the guest experience.

The Contribution of AI in Supporting the Three Elements of Sustainability: The analysis indicated that AI supports three types of sustainability; (1) Economic Sustainability, through its contribution to improving the operational efficiency of hospitality businesses and (2) Environmental Sustainability through its contribution to decreased resource consumption by hospitality businesses.

Guest Demographics: The analysis indicates that there may be demographic differences (i.e., age) in guests' perceptions and interactions with AI applications; thus warranting further development of personalized service design.

Practical Recommendations for the Iraqi Hotel Sector

The results of the research indicate several recommendations for the hotel sector of Iraq:

- Continued investment in digital infrastructure: Hotels in Iraq, including the Babylon Hotel, must invest in upgrading their infrastructure to facilitate and increase the adoption of advanced AI applications.

- Development of Guest-Guest Powered AI Application systems: Based on the results of the research reported above, the following recommendations can be developed for the hotel sector of Iraq;

- Continued investment in digital infrastructure: Hotels in Iraq, including the Babylon Hotel; must continue to invest in upgrading their infrastructure to develop the use of robust and efficient AI applications;

- Focus on Environmental Sustainability through AI:Smart Energy and Water Systems are increasingly being adopted by hotels to utilize Artificial Intelligence (AI) to monitor resources automatically and optimize their consumption rates. For example, AI could use occupancy sensor data to determine whether or not to reduce lighting or to decrease air conditioning when guests are not present in a guest room. Hotels can also utilize AI to sort and track their waste, assisting them in achieving their environmental sustainability goals.

In addition, AI can enhance hotels' operational and economic efficiencies by automating many of the routine functions performed by employees. Examples of AI automation include check-in/check-out procedures, reservation management, and inventory management. Automating the repetitive functions will reduce errors and allow employees to devote more time to providing service to guests.

Lastly, hotels can leverage AI's capabilities in big data analysis to analyze current business trends and guest preferences, as well as to optimize their pricing and marketing strategies.

Social and Interactive Aspects:

- Enabling human capital: Educate and promote ongoing training for staff on how to utilize artificial intelligence technologies as means of enhancing their abilities, stressing that they have a supporting role rather than a substitute role for A.I., when creating a personalized experience.

- Bridging The Gap In Digital Capability: Create user friendly interfaces for all guests to use for A.I. applications, as well as develop and translate A.I. application to fit the various digital experience of both the guests and staff.

- Responsible Innovation Framework: Embracing ethical, privacy, and security, when developing and implementing solutions based on A.I. as a means to develop trust, provide data security, and ensure compliance with both local and international law.

- Collaborative Partnership and Cooperation: Encourage hotels to engage with new technology companies, and local universities to develop unique A.I. solutions to meet the needs of the Iraqi context. The recommendations provided, are based on the theoretical findings and analyses of the previously mentioned scientific research and are designed to help the hotel sector in Iraq to sustainably and efficiently use artificial intelligence applications; thus, improving the competitive level of the hospitality industry, and providing support for total tourism development.

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