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The Green Cloud Computing: An Approach to Technological Sustainability: Case Study

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Abstract

The research paper dealt with the concept of green cloud computing and its role in achieving technological sustainability through applying the case study approach as it is one of the approaches that are concerned with interpretation, analysis and research behind phenomena, relying on the standardized interview as a tool for data collection. Green cloud computing at the Deanship of Communications and Information Technology. The paper came out with several results, including: that the physical and technological readiness of institutions play an important role in achieving sustainability, and that green computing ensures the sustainability of data preservation through automated synchronization. This is in addition to the research paper coming out with several recommendations, including: Developing a scheme that measures the ratio between the benefit of applying green cloud computing and the financial cost in order to achieve financial readiness for institutions.

Keywords: cloud computing - green cloud computing - technological sustainability.

Introduction

Green cloud computing includes three interrelated models: Software as a Service (SaaS), Storage as a Service (StaaS), and Processing as a Service (PaaS), and its compatibility with the environment is critical for the future of these services through virtualization techniques to provide an effective hardware and equipment environment. The idea has attracted the attention of many organizations, due to the reduction of expenses that can be achieved by reducing investment in hardware and software.

The concept of sustainability entered the field of interest of software and hardware developers and users in the past few years, as technological development had begun to take a high curve of growth and prosperity, which resulted in rapid growth in energy consumption. And a desire to preserve the environment by reducing the negative effects that have arisen over the past years. So governments are putting pressure on technology makers to comply with environmental regulations and to develop products and services that minimize negative impacts on the ecosystem.

Hence, several concepts related to sustainability emerged, such as green information and communication technology, environmental informatics, sustainable computing, and green computing, and the consequent positive and negative effects of that relationship in the present and the future.

Here, we shed light on the extent to which green cloud computing contributes to achieving technological sustainability, as theoretical and applied studies are concerned with presenting the latest achievements in the field of scientific research to protect the environment and the extent to which the concept of sustainability is achieved.

Research problem

The problem of the study stems from the interest in achieving sustainability, as sustainability is one of the most important projects sought by Vision 2030 of the Kingdom of Saudi Arabia, where the development of green cloud computing is closely related to the development of green data centers, as data centers are the core of cloud computing. The data center of the Deanship of Communications and Information Technology has achieved the international standard Uptime Tier 3 regarding the design, construction and operation of the data center. In compliance with Imam Abdulrahman bin Faisal University's role in implementing the Kingdom's Vision 2030, the Deanship of Communications and Information Technology achieved ISO accreditation in applying best practices for the ISO22301:2019 Business Continuity Management System as the first educational entity in the Kingdom. The Deanship also continued its achievement by fulfilling the requirements of the international standard ISO20000 for the management system of electronic services through sustainability systems and standards. Cloud computing is considered more important to protect the technological environment if the organizational processes and procedures in institutions are based on the principle of green computing. To achieve technological sustainability in the Deanship of Communications and Information Technology.

The importance of research and justifications for its selection:
The importance of the study stems from the importance and novelty of the concept of green cloud computing and its connection to the achievement of technological sustainability. Therefore, many studies must be conducted on what green cloud computing is and what are its advantages and disadvantages, as well as measuring the extent to which technological

sustainability is achieved related to environmental protection from electronic waste and other negative effects resulting from development. The rapid and successive era of the industrial revolution.

Research limits

Objective Limits: Green Cloud Computing: An Approach to Technological Sustainability.

Spatial boundaries: Deanship of Communications and Information Technology - Imam Abdul Rahman Bin Faisal University.

Time limits: The research was applied in the academic year 2023 AD / 1444 AH

Research aims:

- Provide a brief overview of what green cloud computing is.
- Referring to the most important mechanisms and practices of applying green cloud computing.
- Determine the most important contributions of green cloud computing in protecting the technological environment.
- Studying the advantages and disadvantages of green cloud computing.
- Exploring the extent to which technological sustainability is achieved through green cloud computing at the Deanship of Communications and Information Technology.
- Coming up with suggested recommendations to support the achievement of technological sustainability.

Research questions

What is green cloud computing?

What are the mechanisms and practices of applying green cloud computing?

What are the most important contributions of green cloud computing in protecting the technological environment?

What are the advantages and disadvantages of green cloud computing?

- To what extent is technological sustainability achieved through green cloud computing at the Deanship of Communications and Information Technology?

- What are the proposed recommendations to support the achievement of technological sustainability?

Methodology

The researchers followed the analytical descriptive approach in the case study apartment in this research, which relies on data collection, tabulation and extracting its results in a manner commensurate with the nature of this study.

The case study method is the most appropriate method through which some human subjects can be studied on the basis of studying the phenomenon as it is in reality. Therefore, the researchers used this method in collecting information and data by referring to the theoretical framework of this study and previous studies that dealt with the issue of green cloud computing.

Research community:

The study population was represented by the Deanship of Communications and Information Technology at Imam Abdul Rahman Bin Faisal University.

Research procedures:

- Researches and studies that dealt with the subject of the research and tried to benefit from what other researchers have done and reach points of difference between their research and this research.

- The most important axes related to measuring the extent of applying the concept of green cloud computing at Imam Abdul Rahman bin Faisal University and the extent to which technological sustainability has been achieved.

Research tool:

The research relied on the standardized interview tool as the appropriate tool to achieve the research objectives and answer its questions. An interview form consisting of a set of open and closed questions and multiple choice was prepared. Addressed to the Dean of the College of Communications and Information Technology, Dr. Khaled Adnan Al-Essa.

Building the interview form:

When preparing the interview form, the researchers relied on a number of sources and experiences drawn from different sources - previous studies.

- The simple experience of female researchers in preparing research and interview forms.

Review the vocabulary and objectives of cloud computing and technological sustainability.

The interview form was composed of several axes:

The first axis: the mechanisms and practices of applying green computing.

The second axis: the most important contributions of green cloud computing in protecting the technological environment.

The third axis: Obstacles to the implementation of green computing on technological sustainability.

The fourth axis: Proposed recommendations to support the achievement of technological sustainability.

Previous research:

- Cloud computing is a dynamic field of information and communication technology. Cloud computing technologies have a variety of application areas, due to their reliability, high performance and relatively low cost. The idea of the cloud computing revolution is based on redesigning modern networks and providing promising prospects for environmental protection in addition to economic and technological advantages. Cloud computing can be transformed into green cloud computing. The survey aims to provide updated research guidance regarding green cloud computing [1].

- Cloud computing is the domain of data and advertising technologies. These technologies contain a variety of demand authorities, and they also promote energy efficiency and reduce e-waste. The paper provides an outline of cloud computing, aiming to make updated research guidelines with reference to green cloud computing [2].

The study clearly and explicitly relied on the importance of applying green computing tools Safe disposal of computer waste and cloud computing as one of the most important modern technologies Which overcomes the obstacles that face many institutions, especially educational institutions, in practice Buying many expensive computers and buying authentic software for computer applications In order to break the temporal and spatial barriers between the student, the lecturer, and the administrator, the study sample relied on students from the various departments of the institute, 71 faculty members and their assistants, and 80 An employee and administrator from the Institutes of Environmental Studies and Research and the Childhood Institute, and a methodology was adopted The study

is based on the social survey method for these three groups to identify their knowledge of forms Methods of applying green technology and obstacles to its implementation, and some tools have been used, such as: Questionnaire form (an independent form for each category, and the most important results were obtained The financial and administrative obstacles are the most obstacles to the implementation of green technology methods, and it was recommended The need to hold training courses for all categories of the sample to raise awareness of modern technologies to serve Society and sustainable development to save consumed energy and reduce harmful emissions and radiations [3].

Theoretical framework of the study:
Brief overview of green cloud computing:
Due to the newness of cloud computing technology and given that the technology is still evolving, there is no complete agreement on one and specific definition of cloud computing and its final definition is likely to continue to evolve along with the development of technology.

The word cloud computing has been translated into two words: computing, that is, it is related to the concept of computers and the cloud, which is a reference to the Internet, as it was used to represent data transfer.

From a marketing point of view, it is defined by the Online Dictionary for Library (ODLIS and Information Science) as obtaining software, data, storage spaces, and devices through the network as an information technology service through the program interface without the need to know the physical location or specifications of the service delivery system [4]

Webster dictionary defines it as: "the practice of systematically storing computer data on multiple servers accessible over the Internet."

The concept of green cloud computing is closely related to the concept of green data, because data centers are the core of cloud computing. Where Al-Koumy [5] mentioned, the energy consumed by data centers in 2010 amounted to 1.3% of the total consumption. As the percentage of air pollutant emissions from information technology increased by 1.3% of global emissions in 2002, and in 2020 the percentage reached 2.3%.

As the concept of green cloud computing spread, a group of researchers at Lawrence Berkeley created the National Laboratory and Northwestern University designed a modeling tool called the Cloud Energy and Emissions Research (CLEER) Model. The models save energy from local network software conversion and computing in server farms, to form these cloud server farms [6]. Thus, it can prove its usefulness in achieving vital efficiency in the data centers of Internet companies, especially when the centers adopt the principle of green computing.

The researchers conclude from the previous presentation by defining a summary of green cloud computing as: the recycling and use of computer devices and related subsystems with the least possible harm to the environment while reducing the energy consumed.
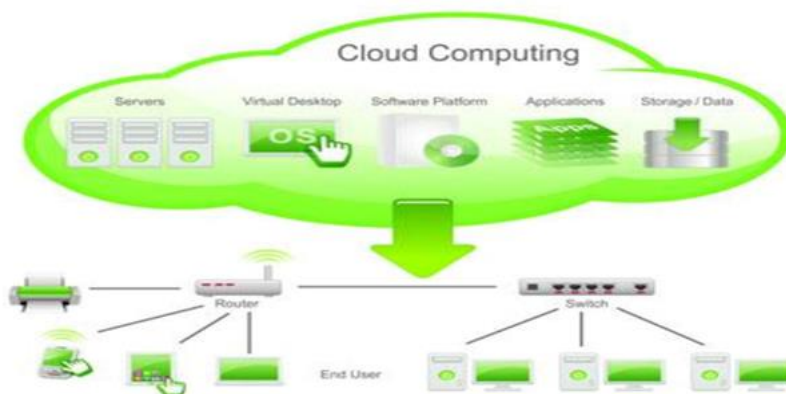

Figure (1): illustrates the concept of green cloud computing

Mechanisms and practices of applying green cloud computing:
Green computing aims to reduce energy consumption from several sources, including computers and electronic devices, and to achieve the effectiveness of mechanisms and practices applied in various institutions. The researchers mention some of the technologies used to achieve the concept of green cloud computing [7].

Software and Development Optimization:
The cost of implementing programs and algorithms being written is still high and consumes computer hardware resources and energy. Therefore, the use of a central server, which reduces the power consumed, is the best solution to support more than one user at the same time.

Power Management:
It means turning off the devices when they are finished, and this is what most devices and operating systems are based on to rationalize energy consumption. It supports screen savers, that is, entering the screen in a state of pause in the event of inactivity.

E-documents:
Electronic papers are defined as the digital form of printed papers. In the last three years, more than 200 million e-books have been downloaded from various websites. Which greatly helped in preserving the environment by reducing the cutting of trees and forests, which in turn can absorb greenhouse gases polluting the environment.

Electronic Waste Disposal:
E-waste is one of the negative impacts on the environment. This is because electronic devices consist of toxic materials and do

not decompose when disposed of. Therefore, it must be properly disposed of in accordance with environmental protection standards from pollution.

Recycle: (B. Sahah,2014) [8]
. Recycling these devices is a very difficult process, as burying computers and their components results in harmful chemicals that may leak into water networks. Burning them causes the emission of toxic gases that pollute the air and threaten human life. Therefore, we must recycle them in special ways to extract the basic materials that make them up for reuse and benefit from them. The results of the interview with the Deanship of Communications and Information Technology at Imam Abdul Rahman Bin Faisal University indicate that the term green computing is not used, but the concept is applied to reduce the efficiency of spending in the university by applying the methods associated with green computing represented in the following practices:
(Using a central server that supports more than one user at the same time, the ability of a group of users to share the same physical device by dividing it into virtual devices, activating energy saving modes for devices, electronic papers instead of printed papers, disposing of electronic waste by renewing and recycling old electronic devices) .

The need for green cloud computing: (M. Pirani,2022) [9]
Due to the successive development in the information technology industry and the risks it causes to the environment such as pollution due to electronic waste, so if the information technology sector continues to grow and increase, the need for green cloud computing has become inevitable, but it is marred by some obstacles that prevent access to achieving goals; Where green cloud computing is concerned with reducing the energy consumed by computers and electronic devices, reducing the dangerous radiation emitted from them, increasing the profits of institutions, raising energy efficiency through the product life cycle, and raising the possibility of recycling. Therefore, it is based on identifying the specifications of the most efficient computers in energy use, and designing algorithms and systems for efficiency related to computer technologies. This is what many research studies in the technology industry [10] are based on. Along with studies of the need for green cloud computing to reduce paper usage, which will undoubtedly result in reducing tree cutting and protecting the natural environment and the technological environment.
Where the results of the interview revealed that adopting the idea of recycling computer devices does not increase the production of the institutions, but it performs the purpose as required only, while high productivity requires the presence of modern devices. Thus, it reduces spending efficiency and material savings, and reduces environmental pollution by adopting electronic paper instead of traditional paper, in addition to ensuring the sustainability of data preservation through automatic synchronization.

Advantages of green cloud computing: (A. Patil,2022) [11]
- Significantly reduces the need to create physical documents and files that can also be stored and shared within the cloud
- Reduces electrical energy consumption.
- Working to provide cash savings.
There is no infrastructure cost.
- There are no administrative or organizational problems.
- Data control.
- It is based on preparing backups and restoring data.

Huge cloud storage.

Disadvantages of green cloud computing:
Despite the multiple advantages of green cloud computing, there are several obstacles that stand in the way of organizations and institutions to adopt green cloud computing: (B. V and V. S,2022) [12]
The implementation cost is very high. The initial green computing investment is considered as high by small and medium-sized enterprises. Green computing is still not affordable for everyone.
- Evolving and catching technology It will be difficult to adapt to the green cloud computing technology that is being developed, so it is very difficult for everyone to recognize it immediately.
- It is difficult to control the technical problems associated with it.
This was confirmed by the standardized interview of the Deanship of Communications and Information Technology, where the interview indicated that the cornerstone for adopting the application of green cloud computing is financial resources and the size of the establishment, which may not be commensurate with the uses of green cloud computing, in addition to the lack of awareness of the concept among human resources in institutions.

Conclusions
Green cloud computing is a new approach followed by organizations to achieve sustainability in general and technological sustainability in particular. In the future, it is expected that the relationship between green cloud computing and technological sustainability will continue in a positive relationship with producers of communications and information technology devices and companies that provide electronic services to reduce the negative outputs of hardware and software. The research discussed the contribution of green cloud computing to achieving technological sustainability in the following points:
Reducing energy consumption from non-renewable sources to a minimum and replacing them with renewable ones.
Cloud computing reduces paper waste by relying on electronic files and documents.
Recycling devices has a positive effect on environmental pollution in general.
Green computing ensures the sustainability of data preservation through automatic synchronization.
- Using a central server that supports more than one user at the same time.

Recommendations:
Spreading awareness of the concept of green cloud computing and its relationship to technological sustainability among technology users in general and human resources in institutions in particular. And promoting methods of activating green cloud computing.
- Developing a scheme that measures the ratio between the benefit of applying green cloud computing and the financial cost in order to achieve the financial readiness of the institutions.
- Improving the technical capabilities of the facility to adopt the concept of green computing, and providing specific mechanisms to ensure its continuity.
Availability of annual contracts and participation with technical companies to reduce material resources.

Reviewer

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