The Impact of Green ICT Adoption in Organizations of Developing Countries

تأثير تبني تقنيات المعلومات والإتصالات في منظمات الدول النامية

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ملخص:

تعد تكنولوجيا المعلومات والاتصالات الخضراء (Green ICT) مصطلحاً جديداً يتبع الشراء والاستخدام في كيفية استخدام تكنولوجيا المعلومات والاتصالات لتقليل الجوانب المختلفة لتأثيرنا البيئي ويمضي في معالجة كيف يمكن لاستخدام التكنولوجيا الذكية أن يجعل العديد من العمليات الأخرى أكثر فعالة.

تصف هذه الورقة العوامل التي تؤثر على المنظمات التي تتبنى (تكنولوجيا المعلومات والاتصالات الخضراء) في العراق. تم توزيع العديد من الاستبيانات على مديري المنظمات العراقية حيث تم استخدام نظام المنطق الضبابي لتحليلها. وجد الباحثون العديد من النتائج في هذه الورقة ، وأهمها تبني تكنولوجيا المعلومات والاتصالات الخضراء من قبل المنظمات في العراق ربما تتأثر بعدة عوامل هي التكاليف، والتشريعات الحكومية، والضغوط السياسية والاجتماعية، وتنوير المصلحة الذاتية، والمسؤولية البيئية. نظام الأعمال، والفرص الجديدة للسوق وهذا التأثير يمكن أن يكون سلبياً أو إيجابياً حسب الظروف البيئية والسياسية.

الكلمات المفاتيح: تقنيات المعلومات والإتصالات, تقنيات المعلومات والإتصالات الخضراء, الدول النامية, المنطق المضبب

Abstract

Green information and communication technology (Green ICT) is a new term that follows purchasing and using though into how ICT is possible used to minimize various aspects of our environmental impact and goes on to address how the use of smart technology could make many other processes more efficient.

This paper describes the factors that influence on organizations that adopt (Green ICT) in Iraq. Many questionnaires were distributed among managers of Iraqi organizations, where fuzzy logic system is used for analyzing them. the researchers find many results in this paper, the most significant result is the adoption of Green ICT by organizations in Iraq are probably affected by several factors which are costs, government legislation, political and social pressures, enlighten self-interest, the responsibility of environmental system business, and new opportunities of the market and this effect can be negative or positive according to the environmental and political conditions.

Key words: ICT, Green ICT, Developing Countries, Fuzzy Logic

Introduction:

The beginning of ICT was in the United States of America and developed countries such as United Kingdom, France, Russia, S. Korea, and Japan, but this technology delayed in developing countries because of many factors like social, financial, and environmental factors.

Many researchers mentioned that using ICT in all sectors will consume more energy, therefore, they suggested to change the method of using ICT by using the resources in a responsible manner and reducing not useful outcomes, according to this it's compulsory to change the orientation into an active and efficient information and communication technology; to fulfill a high return in less energy.

Most of the organizations in developed countries turned to use the Green ICT in their activities, but in developing countries, many problems faced organizations to adopt Green ICT. In this paper, the researchers try to clarify the term of ICT, Green ICT concept, drivers of Green ICT, and studying the impact of Green ICT adoption in of developing countries.

I-The Concept of ICT:

I-1-The Definition of ICT:

Information and Communication Technology (ICT) can be stated as the facilities, tools, processes, and equipment's that supplies the desired environment with the hardware infrastructure and the services for the transmission, storing, generation, processing and disseminating all forms of information including voice, text, data, graphics, and video[(1)].

It can be defined as a field of work and study that "includes technologies such as laptop and desktop computers, software, peripherals and the Internet that are intended to fulfill information processing and communications functions" [(2)].UNESCO gave ICT another definition, which illustrates ICT as "the combination of information technology among other related technologies, in exact communication technology" [(3)].

Unwin views ICT as an umbrella activity which veils any communication device or application such as radio, television, cellular phones, computers and network hardware, satellite systems, software and so on; as well as different applications and services associated with them such as distance learning and video conferencing [(4)].

Torero and Braun provided a broader definition of ICT which involves equipment and services. Where, ICT "includes industrial computation (hardware, networks, software, Internet, and related services); electronic data processing and display (such as photocopiers, calculators, cash registers, and scanners, as well as a myriad of descent well-known machines specifically tailored to production and manufacturing); related services and telecommunications (such as fixed and cell phones, instant messaging, facsimile machines, teleconferencing and so on.); and services and audiovisual equipment (including digital cameras, television, radio, DVDs, video, compact discs, MP3 players and so on" [(5)].

I-2-The ICT Fundamental Classification of the Environmental Effects:

However, nowadays ICTs are used under economic conditions; they do not contribute all the time to dematerialize and may even have negative environmental impacts. Generally, there are three levels of ICT that show influences on the environment which must be taken into account [(6),(7)]:

(1) - Asabere, N. and Enguah, S. (2012). Use of Information & Communication Technology (ICT) in Tertiary Education in Ghana: A Case Study of Electronic Learning (E-learning). International Journal of Information and Communication Technology Research. 2(1), 62-68.

(2)- Statistics Canada (2008). Information and communications technologies (ICTs), Available on www.statcan.gc.ca/pub/81-004-x/def/4068723-eng.htm.

(3) - UNESCO (2002). Information and communication technology in education, Available on www.unesdoc.unesco.org/images/0012/001295/129538e.pdf .

(4) - Unwin, T. (ed.). (2009). ICT4D. Information and communication technology for development. Cambridge: Cambridge University Press.

(5) - Torero, M., and Braun, J.V. (2006). Information and communication technologies for development and poverty reduction: The potential of telecommunications. International Food Policy Research Institute. Washington, DC.

(6) - Kohler, A., Erdmann, L., (2004). Expected environmental impacts of pervasive computing. Human and Ecological Risk Assessment 10 (5), 831-852.

'First-order' or 'primary' effects: effects of the ICT hardware existence (production environmental impacts, use, recycling and disposal of ICT hardware). 'Second-order' or 'secondary' effects: ICT indirect environmental effects is stated due to its power of changing processes (such as production, transport or consumption processes), resulting in a decrease or increase of the environmental impacts of these processes. 'Third-order' or 'tertiary' effects: environmental effects on the medium-term or long-term adaptation of behavior (e.g. consumption patterns) and structures of economic to the availability of ICT and the services it provides.

The issue is that over the past years various groups have applied slightly different meanings to the term; often based on the objectives of the survey or policy they were considering at the time. A literal definition of the term means, "The ability of an activity to function or tolerate for a certain period of time or perhaps indefinitely". Unfortunately, for computing, telecommunications, and related technologies there is no agreed standard on how we should measure these impacts.

I-3-The Environmental Role of ICTs :

ICTs play a big role in obtaining many social and environmental targets [(8)], as shown in table 1.

Table n°1: The Role of ICT to Achieve Environmental and Social Targets

Target	Role of ICTs
Enucleate poverty and hunger	• Increase access to market information and reduce transaction costs for poor farmers and traders • Increase efficiency, market access, competitiveness of developing country firms • Enhance developing countries ability to participate in global economy and to avail comparative advantage in factor costs (particularly skilled labor)
Achieve universal basic education	• Increase supply of trained instructors through ICT-enhanced and distance training of teachers and networks that link instructors to their colleagues • Enhance the effectiveness and efficiency of education ministries and related bodies through technology applications and ICT-enabled skill development • Broaden availability of quality educational materials/resources through ICTs
empower women and Promote gender equality	• Deliver educational and literacy programs specifically aimed for poor women and girls using appropriate technologies • Affect public opinion on gender equality through communication or information programs using a range of ICTs.
Reduce child mortality, improve maternal health, and combat diseases	• Enhance delivery of fundamental and in-service training for health workers • Increase information sharing and monitoring on disease and famine • Increase rural caregivers access to specialist support and remote diagnosis • Increase reproductive health information access, including information on Agency for International Development (AIDS) prevention, through locally appropriate content in local languages
Ensure environmental sustainability	• Remote sensing technologies and communications networks authorizes more effective resource management, monitoring and mitigation of environmental risks • Raise access to/awareness of sustainable development strategies, in areas such as agriculture, sanitation and water management, mining, etc. • Greater monitoring and transparency of environmental abuses/enforcement of environmental regulations • Facilitate exchanging knowledge and networking among policymakers, practitioners and advocacy groups

Source: Tongia et al., 2005

(7) - Thabit, Thabit Hassan, Hadj Aissa, Sid Ahmed, and Harjan, Sinan Abdullah, (2016). The Use of Fuzzy Logic to Measure the Risks of ICT in E-Audit, Revue des Recherches Economiques, No.15, 30-46..

(8) - Tongia, Rahul, Subrahmanian, Eswaran, and Arunachalam, V. S., 2005, Information and Communications Technology for Sustainable Development, Allied Publishers Pvt. Ltd., Bangalore, India..

II-The Concept of Green ICT:

II-1-The Definition of Green ICT:

The Information and communication technology (ICT) term is used widely in organizations, which consumes a lot of resources and produces useful and not useful outcomes [(9)]. Dawood et al., Brown, and Unhelkar defined (ICT) as "the technology used to create, process and store data regarding receiving it to the beneficiaries" [(10)].

Kristiansson mentioned that the used technology consumes extra energy in all sectors. Therefore, he suggested changing the method of using (ICT) via the use of resources in a responsible manner, providing recycle techniques and identifying new techniques, reducing not useful outcomes [(11)], according to this it's a must to change the orientation into an active and efficient information technology to achieve a high return in less energy.

The term Green information and communication technology (Green ICT) refers to a survey of using computers and information technology resources in a more responsible and efficient from the environmental perspective [(12)], Desktop, Laptop, etc. computers consumes natural resources such as, raw materials used to manufacture it and power used to operate it and issues for dumping it after termination.

The definition of Green ICT according to Murugesan is "working to enhance design phase, producing and using information technology device systems and their related software and communications in an active and efficient manner, and using it as a tool in trading business with a tiny impact on environment and enhance sustainability"[(13)].

II-2-The Drivers of Green ICT:

Many researchers (i.e. Dawood et. al., Broberg, and Nidumolu) aforesaid that reducing environmental pollution and emissions of harmful gases may cost the organization extra finance.

However, in the latest years, many organizations had the ability to reduce the pollution hugely and gaining a great profit synchronously [(14)], the cause about this procedure is the six green information technology drivers, which are the motivation of implementing green information technology. Figure 1 depicts the basic six drivers of Green ICT.

1. Costs

Cost driver aids the Green ICT till it conducted efficiently, ensures the elimination of extra costs, saves the organization's sources of loss and dissipation via the implementation of Green ICT and enhance organizations ability to limit the unnecessary and costly steps and practices[(15)], it also has the ability to reduce instruments and machines which occupies space and uses a lot of energy by using virtual simulation techniques in database [(16)]. However, it's significant to calculate the Green ICT costs that are used instead of the standard traditional information technologies and comparing the outcome cost of both of them.

(9) - Dawood, Harith A., Thabit, Thabit H., and Jasim, Yaser A., 2015, Proposed Approach to Apply Green Balanced Scorecard at Iraqi Environment, 2nd International Conference on Ecology, Environment and Energy, Ishik University, Erbil, Iraq.

(10) - Brown, C. V., DeHayes, D.W., Hoffer, J. A., Martin, E. W., & Perkins, W. C., (2009), Managing Information Technology, 6th ed, New Jersey, Pearson Education, Inc, USA.

(11) - Kristiansson, E. (2008). Green IT: What does it take for Scania InfoMate to become a Green IT solution provider? Borås, Sweden.

(12) - Thabit, Thabit H., and Raewf, Manaf B., 2016, The Impact of Voluntry Disclosure on SMEs in Developing Countries, Journal of Global Business and Social Entrepreneurship (GBSE), 4(5), 19-31.

(13) - Murugesan, S. (2010). Making IT Green. IT Professional, March/April,4-5.

(14) - Broberg, E. (2009). Grön IT-Motiv, åtgärder & tillvägagångssätt för hållbara IT-lösningar.Sweden: Mälardalens Högskola.

(15) - Unhelkar, B. (2011). Green IT Strategies and Applications: using environmental intelligence. Boka Raton, FL, USA: Taylor and Francis Group, LLC.

(16) - Nidumolu R., Prahalad, C. K., & Rangaswami, M. R. (2009) Why Sustainability is Now the Key Driver of Innovation. Harvard Business Review, 89(9).

Figure n°1: The Basic Six Drivers of Green ICT

Source: prepared by the researchers depending on (Nidumolu et al., 2009)

1. Government Legislation

The governmental legislation increased interest in environmental issues and placed restrictions on organizations to improve environmental activities and reduce their harmful emissions [(17)], where some of the governments enforced the organizations to give a yearly report about their harmful emissions. Governmental legislation is considered one of the powerful drivers because its issued from the government legislation that they must comply to it, through applying Green ICT its more simple to evaluate how the organization comply with the government legislation and it‘s done by environmental labeling initiatives, which limits energy consumption and using harmful chemical materials when manufacturing products, it also encourages to manufacture products from recyclable materials and the need to sustain the organization manufacturing processes [(18)].

2. Political and Social Pressures

This driver could be effective according to the society that the organization is in [(19)], if the social perspective of environment is an important factor for organization success then this driver will be an active factor to change the organization policy to follow the Green ICT, increase the use of its resources efficiently, reduces its harmful emissions and give green organization a competitive feature in markets [(20)].

3. Enlighten Self-Interest

Enlighten self-interest occurs when the organization should be a friendly environment and more suitable with it, the need may come from senior management of the organization to take the good society role of environment or maybe for other competitive reasons to gain a feature that can make it looks better for the consumer compared with other competitors[(21)].

4. The Responsibility of Environmental System Business

The collaboration of organization between each other could be one of the reasons that make the organization suitable to the environment and to the use of Green ICT, therefore, the

(17) - Murugesan, S. (2010). Making IT Green. IT Professional, March/April,4-5.
(18) - Sveriges Riksdag (2012). Miljöbalk (1998:808). Retrieved April 26.
(19) - Unhelkar, B. (2011). Green IT -The Next Five Years. IEEE Computer Society, IT Pro.
(20) - Earth Hour (2012). Biggest Earth Hour Ever Begins the Journey Across the Globe.
(21) - Lamb, J. (2009). The Greening of IT: How Companies Can Make A Difference for the Environment. Michigan, USA: IBM Press/Pearson Plc.

cause of responsibility of the environmental system business driver. However, when the decision is done to enhance the processes and services of the organization which offers the limits of harmful emissions and reducing the use of unnecessary resources, then this will yield pressure on the consumers and suppliers to improve their processes and make them friendly to the environment [(22)].

5. New Opportunities of the Market

Green strategies are an initial orientation therefore, it's a new competitive facility in markets, as usual when a new opportunity is raised in markets many competitions possibilities will appear, which requires the organization to be the best in this field and preserve its place in market, where new opportunities of the market driver assist the integrity of using Green ICT which aids the organization to pose it as a pioneer organization [(23)]. As the sustainable organization is the organization that tries to remove harmful emissions and preserves the environment for recent and future generations. Already some researchers proposed five steps to construct a sustainable organization[(24)], many of them confirmed that the main target of implementing sustainability in the organization is to improve the organization form, truly it also reduces the costs and creates new opportunities of the market [(25),(26)].

II-3-The application of Green ICT:

The green organization has three main fields that affect how it works as well as how it deals with consumers and suppliers, these fields are[(27)]:

- Green Processes
- Green Databases
- Green Coalition

The model depicted in figure 2 provides a facility to classify different application within Green ICT.

Figure n°1: The Main Applications of Green ICT

Source: prepared by the researchers depending on (Unhelkar, 2011)

(22) - Unhelkar, B. (2011). Green IT Strategies and Applications: using environmental intelligence. Boka Raton, FL, USA: Taylor and Francis Group, LLC.
(23) - Lamb, J. (2009). The Greening of IT: How Companies Can Make A Difference for the Environment. Michigan, USA: IBM Press/Pearson Plc.
(24) - Dunphy, D. (2011). Conceptualizing Sustainability: The Business Opportunity. In G. Eweje & M. Perry (Ed.), Critical Studies on Corporate Responsibility, Governance, and Sustainability, Vol. 3, Bingley, UK.
(25) - Nidumolu R., Prahalad, C. K., & Rangaswami, M. R. (2009) Why Sustainability Is Now the Key Driver of Innovation. Harvard Business Review,89(9).
(26) - Dunphy, D. (2011). Conceptualizing Sustainability: The Business Opportunity. In G. Eweje & M. Perry (Ed.), Critical Studies on Corporate Responsibility, Governance, and Sustainability, Vol. 3, Bingley, UK..
(27) - Unhelkar, B. (2011). Green IT -The Next Five Years. IEEE Computer Society, IT Pro.

1. Green Processes

The processes and activities that the organization achieves focusing on green ideas and environmental awareness, usually it‘s reformulated from traditional processes constraining on reducing harmful emissions and it could include organization‘s external and internal activities[28], the green processes concept is invented to set principles and criteria for the activities to achieve environment goals, where United States Environmental Protection Agency (EPA) referred that using Green ICT in an intermediate organization for a year will save 60%-70% of energy that‘s used to operate traditional information technology, therefore reduce carbon emissions that 5 million vehicles produce [29]. Green technology also includes organization re-engineering of the used materials for production and how to recycle the electronic waste (e-waste)[30] , the creation of awareness incorporates in updating and improving green processes in organization could be done through traditional information technology via using social networks, personal notes and interactive simulation to communicate with consumers, suppliers and employees to distribute green knowledge culture[31].

2. Green Databases

Database is a set of servers that stores and process data of organization‘s work, which impacts on environment through the huge power that consumes and the space that occupy, therefore its necessary to gain the useful features of Green ICT to improve virtual simulation and invest the benefits of cloud computing to reduce the number of servers used within the organization [32], as the use of the solar energy and natural ventilation and providing them to the database can reduce the harmful emissions [33]. As well as the use of Green ICT can invest to get the features of the tax incentives or competitive advantage to attract customers who are demanding green services.

3. Green Coalition

means that this domain is the ability of institutions to take the process of change to environmentally friendly operations through the adoption of Green ICT, where this field allows unions and consumers to call for serious organizations to preserve the environment, as well as monitor the progress of the organization's work through the protocols and international agreements that links all states with certain controls and specific plans to reduce harmful emissions, an examples of these protocols are Kyoto, ISO 14001 and TCO Protocols[34].

III-The Practical Part:

A survey method using an online questionnaire was employed. This was chosen in due to its advantages, namely: cheaper, better, faster, and easier than other methods. The questionnaire was developed by reference to previous studies such as Velagapudi (2011), Wymenga et al. (2011), and Murugesan (2011).

III-1-Sampling Method:

Target respondents for this study were managers in Iraqi organizations. In Iraq, there is no centralized database that stores information about all Iraqi organizations. Most of data

(28) - Unhelkar, B. (2011). Green IT Strategies and Applications: using environmental intelligence. Boka Raton, FL, USA: Taylor and Francis Group, LLC.
(29) - Unhelkar, B. (2011). Green IT -The Next Five Years. IEEE Computer Society, IT Pro.
(30) - Unhelkar, B. (2011). Green IT Strategies and Applications: using environmental intelligence. Boka Raton, FL, USA: Taylor and Francis Group, LLC.
(31) - Thabit, Thabit Hassan, Hadj Aissa, Sid Ahmed, and Harjan, Sinan Abdullah, 2016,The Use of Fuzzy Logic to Measure the Risks of ICT in E-Audit, Revue des Recherches Economiques, No.15, pp. 30-46 ..
(32) - Unhelkar, B. (2011). Green IT Strategies and Applications: using environmental intelligence. Boka Raton, FL, USA: Taylor and Francis Group, LLC.
(33) - Nidumolu R., Prahalad, C. K., & Rangaswami, M. R. (2009) Why Sustainability Is Now the Key Driver of Innovation. Harvard Business Review,89(9).
(34) - Nidumolu R., Prahalad, C. K., & Rangaswami, M. R. (2009) Why Sustainability Is Now the Key Driver of Innovation. Harvard Business Review,89(9).

sources available in Iraq come from the data which collected and stored by several parties. Based on various data sources, 150 organizations were chosen as the sampling frame for this study and 30 organizations participated in this study.

For the purpose of this paper, 100 questionnaires were prepared by the researchers and distributed to a sample of random managers in 30 organizations in Iraq. The questionnaire consists of 6 perspectives with multi indicators for each one of them. The researchers processed the data of the 100 questionnaires and analyzed them by Fuzzy logic tools and using MatLab R2016a [(35),(36),(37)].

III-2-Measurement:

1. Independent Variables:

The adopted indicators to measure the independent variables were 30 indicators, classified into 6 independent variables. Table 2 depicts the types of independent variables, and a number of their indicators, all of the measures in this paper employed 5-point Likert Scales, passed a reliability test requirement, with Cronbach's Coefficient Alpha value greater than 0.81, and analyzed by Fuzzy logic tools.

Table n°2: The Types of Independent Variables

Variables	No. of Indicators
Costs	5
Government legislation	7
Political and Social Pressures	4
Enlighten Self-Interest	3
The Responsibility of Environmental System Business	6
New Opportunities of the Market	5

2. Dependent Variable:

The dependent variable is the application of Green ICT. In this paper, respondents were asked about which of Green ICT application can affect the activities of the organization. The scores (yes =1, no =0) were accumulated and this measure is adopted from the study of Gibbs and Kraemer (2004)[(38)].

III-3-The Results:

The results of analyzing the distributed questionnaires are illustrated in Table 3.

Table n°3: Fuzzy Logic Analysis Results

Variables	Relative Importance	Degree of Influence
Costs	77%	70%
Government legislation	38%	30%
Political and Social Pressures	42%	45%
Enlighten Self-Interest	61%	62%
The Responsibility of Environmental System Business	71%	77%
New Opportunities of the Market	80%	65%

(35) - Thabit , Thabit H. , (2013). Adoption The Fuzzy Logic To Enhance The Quality Of The Accounting Information To Operate Balanced Scorecard - Applied on Mosul Bank For Development & Investment in Nineveh Province, M.Sc. thesis in accounting, University of Mosul, Mosul, Iraq.

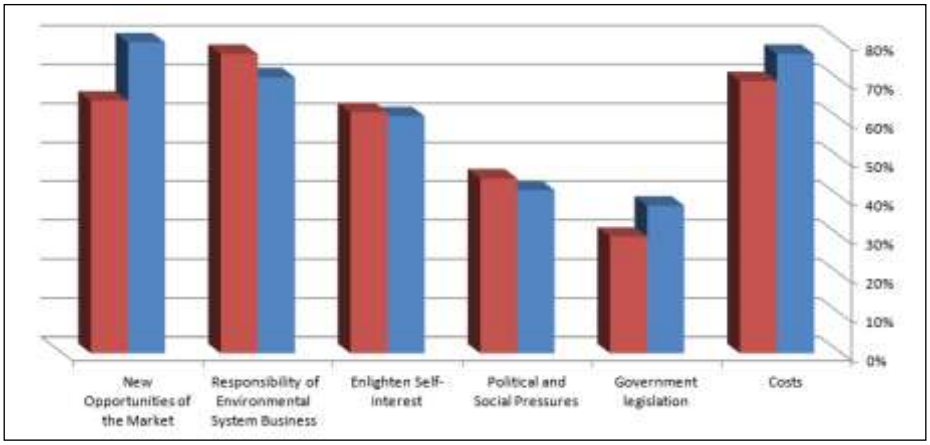
(36) - Thabit, Thabit H., (2015). Applying Fuzzy Logic to Evaluate The BSC's Performance for a Random Private Iraqi Banks Group, International Journal of Banking, Finance & Digital Marketing, Vol. 1, Issue 1, pp. 42-54.

(37) - Al-Hubaity , Qasim M. and Thabit , Thabit H. , (2012). The Use of Fuzzy Logic Model for Decision Making Depending on Multiple Linguistic Criteria: An Accounting Study in Ways of Pricing Products , journal of Tanmiatalrafiain , administration and economic collage , University of Mosul , 110(34) , pp: 105-122.

(38) - Lamb, J. (2009). The Greening of IT: How Companies Can Make A Difference for the Environment. Michigan, USA: IBM Press/Pearson Plc.

Figure 3 illustrates the results of analysis by column chart to show the relative importance and the degree of influence for the main four variables in this paper.

Figure n°3: The column chart for the results of analyzing the questionnaire



Conclusion: Results and suggestions

According to the results, the adoption of Green ICT by organizations in Iraq is affected by several variables which are costs, government legislation, political and social pressures, enlightened self-interest, the responsibility of environmental system business, new opportunities of the market.

The results also show that costs and new opportunities of the market have the big part of the influence on organizations in Iraq because of the development of Iraqi economic. The political and social pressures have a low influence on organizations in Iraq because of the unstable of the political situation in Iraq.

There are good trends to adopt Green ICT by Iraqi organizations according to the analyzed results, whereas most of the results are more than 50%, The Responsibility of Environmental System Business is about 75%, that's mean there is a high degree of environmental awareness.

Endnotes:

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