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Methodology to prioritize initiatives of sustainable information technologies

Metodología para priorizar iniciativas de tecnologías de la información sostenibles

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Abstract

At the beginning of the digital economy, the society strives to fulfil the objectives for sustainable development and the information and communication technologies can be one of the keys to success. However, at the present time, all its potential is not properly used to solve the problems associated with organizational sustainability. This research proposes a methodology for the prioritization of sustainable technologies and information systems initiatives in technological entities using the method for Interactive Decision Making as the main mathematical foundation. The results of the application of the methodology allowed prioritizing the main practices related to use of laptops, internal and external communication of initiatives for energy saving and implementation of energy management systems.

JEL code: Q56, M15, C38

Keywords: Information systems and technologies; Sustainability; TODIM method

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Resumen

En los albores de la economía digital, la sociedad se esfuerza por cumplir los objetivos propuestos para el desarrollo sostenible y pueden ser las tecnologías de la información y las comunicaciones una de las claves para el éxito. Sin embargo, en la actualidad, no se aprovecha correctamente todo su potencial en la solución de las problemáticas asociadas a la sostenibilidad organizacional. La presente investigación propone una metodología para la priorización de iniciativas de las tecnologías y sistemas de información sostenibles en entidades tecnológicas utilizando como principal fundamento matemático el método para la Toma de Decisión Interactiva. Los resultados de la aplicación de la metodología permitieron priorizar las principales prácticas relacionadas con el uso de computadoras portátiles, la comunicación interna y externa de iniciativas para el ahorro de energía y la implementación de sistemas de administración de energía.

Código JEL: Q56, M15, C38

Palabras clave: Sistemas y tecnologías de la información; Sostenibilidad; Método TODIM

Introduction

In recent decades, Information and Communication Technologies (ICTs) have contributed significantly to innovation, economic growth, and development in countries and regions around the world, but there are still doubts about the role of information technologies in building increasingly sustainable societies. ICTs contribute to the generation of greenhouse gases and environmental pollution during their manufacture, use, and waste, but at the same time, they are considered a fundamental tool for monitoring, mitigating, and adapting to climate change, according to the Economic Commission for Latin America and the Caribbean (ECLAC, 2012). Furthermore, they constitute a facilitating element of educational opportunities, whether through mass education, online information, or support for the training of people (Pattinson, 2017)

According to Gartner (2007), direct emissions from Information and Communication Technologies during their life cycle represent 2.1% of global emissions, while other more recent studies express that ICTs can minimize the environmental impact of 97.9% of the remaining emissions. In this way, ICTs open a new phase in globalization and constitute a fundamental component of the strategies for achieving the seventh Millennium Development Goal: ensuring environmental sustainability (ECLAC, 2012).

For these reasons, for several years now the international scientific community has been addressing issues related to the impact of ICTs on sustainable development, specifically on organizational sustainability through Green Information Systems (Green IS) and Green Information Technology (Green IT).

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Green IS refer to the development and implementation of information systems that contribute to the sustainability of business processes. For its part, Green IT focus on the energy efficiency of the technological means used for the production of computer services and their recycling in a way that does not affect the environment. (Plasencia-Soler, Marrero-Delgado, Nicado-García and Aguilera-Sánchez, 2017).

Green IT/IS practices represent a recent trend, with a wide field of application and aim at efficiency and effectiveness in the design, manufacture, development, and use of ICT in ways that contribute to the sustainability of organizations. For these reasons, it is necessary to identify and prioritize Green IT/IS initiatives in organizations and especially in entities that use information technology (IT).

On the other hand, for the prioritization of decision alternatives, Multiple-Criteria Decision Analyses (MCDA) are commonly used for the analysis of decisions. One of these methods, recognized for considering the behavior of decision-makers, is the Interactive and Multicriteria Decision Making (TODIM for its acronym in Portuguese) method. The international scientific community references the TODIM method as the only multi-criteria method based on the Prospect Theory, a theory developed by the Irish psychologists Kahneman and Tversky in 1979, allowing to simulate the behavior of decision-makers under risk conditions.

The objective of this research is to develop a methodology for prioritizing Green IT/IS practices in IT user entities that contribute to organizational sustainability through the Interactive and Multicriteria Decision Making method.

The structure of this research is as follows: the first section deals with the impact of ICT on sustainable development and Green IT/IS practices or initiatives proposed by different academics, as well as the fundamentals of the Interactive and Multicriteria Decision Making method. The second section describes the methodology for prioritizing Green IT/IS practices in IT entities. The third section presents the main results of the application of the procedure in an IT user entity. Finally, the conclusions of the research are presented.

Sustainability and Information and Communication Technologies

The increasing diffusion of Information and Communication Technologies (ICTs) to all sectors of society has drawn the attention of the international scientific community to the negative and positive effects of ICTs on sustainable development. On the one hand, the global production of technological goods and services currently accounts for about 6.5% of global gross domestic product (GDP), and the ICT services sector alone employs about 100 million people (UNCTAD, 2017); on the other hand, ICTs contribute to the generation of greenhouse gases and environmental pollution during their manufacture, use, and waste (ECLAC, 2012).

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According to Molla (2013) the adverse effects are mainly associated with emissions and wastes related to information technologies (IT), thus the process of getting the design, production, use, and recycling of the product or service technology (Cai, Chen, and Bose, 2013) is known as *Green IT* (Sustainable Information Technologies). On the other hand, the positive effects refer to the development and use of information systems to improve ecological sustainability (Dedrick, 2010) through automation, computerization, and transformation (Molla, 2009) of the products and business processes of an organization (Watson, Boudreau, and Chen, 2010; Jenkin, Webster, and McShane, 2011). This approach is called Green IS (Sustainable Information Systems).

The study and incorporation of practices related to sustainable information technologies and systems into the activities of IT user organizations is an emerging field of research today (Dalvi-Esfahani, Abdul-Rahman, and Zakaria, 2015). Research carried out by Murugesan (2008); Silva *et al*. (2013); Esfahani *et al*. (2015); and Nanath and Pillai (2017) motivation towards the adoption (strategic or idealistic/altruisticallows summarizing, in Table 1, the primary practices of Green IT/IS exposed in the scientific literature.

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Table 1

Practices for the sustainability of information technologies and systems

Green IT practices	Green IS practices
Centralizing the supply of technological equipment.	Virtual working practices and virtual encounters
Buying eco-friendly paper and cartridges.	Implementation of environmental management systems
Virtualization of servers	Certification in Environmental Management Systems
Monitoring server power consumption	Use of advanced logistics systems
Virtualization of networks	Dematerialization
Cloud use	Establishment of environmental objectives
Extension of the life cycle of technological equipment	Monitoring of IT-related environmental indicators
Use of laptops	Implementation of an energy management system
Installation of light client equipment	Internal and external communication of energy-saving initiatives
Recycling of equipment and components	Intelligent sensors for the control and optimization of energy flows
Activation of power management functions on computers	Monitoring and analysis of waste and emissions
Installation of energy management applications	Intelligent manufacturing
Sharing multifunctional printers on the network	Use of advanced automation technologies
Default setting for double-sided sheet printing on printers	Building automation

Source: own elaboration

A review of the scientific literature done by Chan and Johansson (2014) shows how most publications on sustainable information technologies and systems focus primarily on the environmental aspect. It is towards this aspect that the main criticisms of the Green IT/IS approach have been directed.

Research on the sustainability of ICTs is aimed at reductions in energy consumption or the development of software applications that support the mitigation of environmental impacts,

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ignoring the potential to add value to business processes, as well as the holistic nature of sustainability, which also incorporates economic, social, cultural, legal, technological, and institutional aspects, among others.

On the other hand, the introduction of practices associated with sustainable information technologies and systems is relevant for the ICT sector, due to its high dependence on and use of information technologies (Ruth, 2009)

For the reasons stated above, the identification and prioritization of Green IT/IS initiatives is vital for the sustainable management of entities using information technology. The Interactive and Multicriteria Decision Making (TODIM) method has been selected for this purpose.

Interactive and Multicriteria Decision-Making Method

The Interactive and Multicriteria Decision Making (TODIM) method was introduced in the early 1990s through the publications of Gomes and Lima (1991; 1992), and it is based on the Prospect Theory. This theory aims to evaluate the behavior of human beings when making decisions under risky conditions. Irish researchers Kahneman and Tversky (1979) observed that people in situations where there is a chance of winning tend to be more conservative, which means choosing to earn less safely than to take a higher risk to earn more. On the other hand, in scenarios of loss, people choose to run the risk of having more significant losses if there is the possibility of not having losses over accepting smaller losses.

The Prospect Theory can be represented through a value function, as shown in Figure 1. Above the horizontal axis are positive values or profit bands, and below this axis is the band of losses or negative values (Rangel and Gomes, 2007)

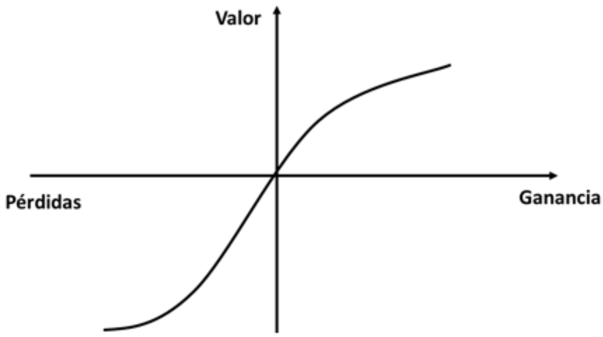

Figure 1. Prospect theory value function

Source: own elaboration based on Gomes and Lima (1992)

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The following stages describe the procedure for the Prospect Theory development: (i) peer comparisons between the criteria and the expressed value judgments; (ii) determination of a reference criterion; (iii) assessment of the alternatives in relation to each criterion, with the performance of each criterion expressed on an ordinal scale; (iv) formation of a relative domain matrix; (v) calculation of the measurements of the global values of each alternative; and (vi) prioritization of all alternatives based on their global values (Rangel, Gomes, and Moreira, 2009; Qin, Liu, and Pedrycz, 2017)

The TODIM method is distinguished by some of the characteristics enunciated in other MCDAs. It is a tool technically accessible to academics who do not even have advanced knowledge about multi-criteria methods. It provides a classification through which it recommends a particular decision, encompasses the use of qualitative and quantitative criteria, ranks criteria hierarchically, and works with the interdependence of criteria (Rangel *et al*., 2009).

However, according to Paredes-Frigolett (2016) and Yu, Wang, and Wang (2016), the main advantages of the TODIM method are as follows: First, it takes into account the behavior of decision-makers according to the Prospectus Theory. The value function is based on profit and loss and not on the actual position of the decision-makers, which is the conventional approach used by other MCDA methods, based on the theory of utility proposed by von Neumann and Morgenstern (1944). Second, the potential value of gains and losses, which can be adjusted by the loss factor, can be used to reflect risk preferences.

The result of these characteristics and advantages is the extensive range of extensions and modifications proposed by international academics and scientists in recent years, as well as the diversity of fields of application of the method, specifically in subjects related to sustainable development. These include the modelling of innovation and responsible research (Paredes-Frigolett, 2016), the selection of green suppliers (Qin *et al*., 2017; Zhou, Dou, Liao, and Tan, 2018), the location of waste energy plants with a sustainable approach (Wu, Wang, Hu, Ke, and Li, 2018), the evaluation of sustainable cities (He and Wu, 2017), and the selection of sustainable and renewable energy alternatives (Turgut and Tolga, 2018) to mention some of the most current studies.

For these reasons, the TODIM method has been selected as part of the methodology for prioritizing Green IT/IS initiatives in the search for organizational sustainability.

Proposed methodology for the prioritization of Green IT/IS practices

The research proposes a methodology for the prioritization of the Green IT/IS of an organization based on the integration of the TODIM method, as shown in Figure 2.

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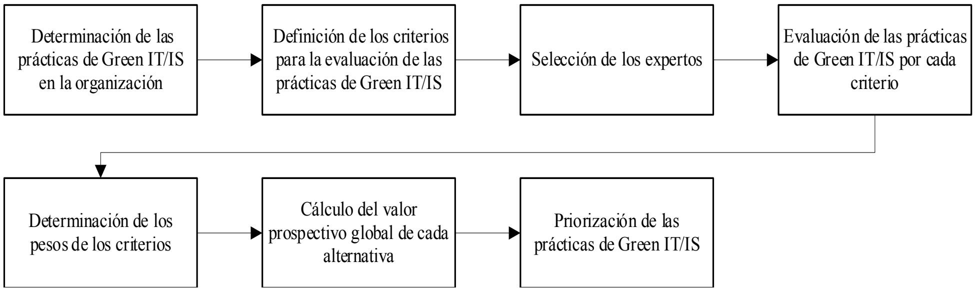

Figure 2. Methodology for the prioritization of Green IT/IS practices

Source: own elaboration

The steps that make up the procedure for prioritizing Green IT/IS practices are:

Step 1. Definition of Green IT/IS practices in the organization

This step defines the practices for the sustainability of information technologies and systems that will be prioritized by management. For this purpose, a diagnosis of the current situation of the organization under study can be made, identifying the main issues relating to the design, use, development, and reuse of both the technological equipment installed and the services and computer products used or developed.

For this purpose, it is possible to use strategic diagnoses previously made, data and records of information technologies, and communications present in the organization, group work techniques, among other sources and tools. This step concludes with a list of the main practices used or possible to be used by the organization for the sustainability of ICTs.

Step 2. Definition of criteria for the evaluation of Green IT/IS practices

For this step, the proposal is to evaluate the identified Green IT/IS practices through the impact they have on the economy (Eco), society (Soc), and ecology (Ecol), taking into account one of the most influential models for sustainable development today, the “Triple Bottom Line” (TBL) model, as shown in Equation (1).

$$Green\frac{IT}{IS}practices = f(Eco, Soc, Ecol) \qquad (1)$$

With the criteria for the evaluation of Green IT/IS practices defined, the next step is to select the experts who will make their judgments during the development of the research.

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Step 3. Expert selection

The work with experts is of vital importance in the methodology; they are the ones who will have to give their opinions on the impact of each of the Green IT/IS practices on the criteria selected in the previous step. Moreover, they can be used to determine the weights of each decision criterion.

First, it is necessary to calculate the number of experts involved in the research. Therefore, using a probabilistic method and assuming a binomial probability law, the number of experts is calculated through equation (2), proposed by Sarache-Castro, Costa-Salas, and Martínez-Giraldo (2015).

$$ne = \frac{p * (1 - p) * k}{i^2} \quad (2)$$

Where:

ne: number of experts

i: desired level of precision

p: estimated proportion of errors by experts

k: constant associated to the selected level of confidence

It is then necessary to identify pre-selected experts among the candidates, those with a high competence coefficient (*K*). It is proposed to use the method presented by Cabero-Almenara and Barroso-Osuna (2013) and Michalus, Sarache-Castro, and Hernández-Pérez (2015) to calculate the competence coefficient and finally select the experts for the study. Equation (3) presents an example.

$$K = 1/2(Kc + Ka) \quad (3)$$

Where:

Kc: knowledge or information coefficient

Ka: argumentation or substantiation coefficient

With the values obtained, the experts are classified into three broad groups: For *K* values higher than 0.8 and lower than or equal to 1, then there is high influence on all sources; if *K* is greater than or equal to 0.7 and lower than or equal to 0.8, then there is average influence on all sources; finally, if *K* is greater than or equal to 0.5 and lower than or equal to 0.7, then there is a low influence on all sources (Cabero-Almenara and Barroso-Osuna, 2013).

Step 4. Evaluation of Green IT/IS alternatives in each criterion

In this step, the experts evaluate each Green IT/IS practice through its impact on the criteria defined above. A decision matrix is formed, A=(a_{ij}) , comprised of the evaluations emitted by the experts of each initiative in each criterion, where the initiatives of Green IT/IS ($Green\ IT/IS = A_i\ \forall\ i = 1,2, \ldots m$) are located in each row, and each of the evaluated criteria are presented in the columns ($\boldsymbol{Criterios = C_j \forall\ j = 1,2,3}$), see Equation (4).

$$\mathrm{A} = \mathrm{a_{ij}} = \begin{bmatrix} \mathrm{a_{11}} & \mathrm{a_{12}} & \cdots & \mathrm{a_{1j}} \\ \mathrm{a_{21}} & \mathrm{a_{22}} & \ldots & \mathrm{a_{2j}} \\ \mathrm{a_{m1}} & \mathrm{a_{m2}} & \ldots & \mathrm{a_{ij}} \end{bmatrix} \tag{4}$$

A scale of ordinal values is proposed for the evaluation of Green IT/IS initiatives in each criterion, as shown in Table 2.

Table 2

Weighing scale for the comparison of criteria

Ordinal scale	Code
Very low impact	1
Low impact	2
Medium impact	3
High impact	4
Very high impact	5

Source: own elaboration

The coefficient of variation for each alternative (Cv_i) of expert judgments should be below the value of 0.20.

Step 5. Determination of the weights of the criteria

In this step, the weights: $\omega_j \in [0,1]$ and $\sum_{j=1}^{n} \omega_j = 1$, associated to each of the decision criteria are determined (C_j). Subjective and objective methods or a combination of these can be used. It is suggested to use the Analytical Hierarchy Process (AHP) or Saaty Method

(2008) because it allows to evaluate the consistency of the experts in their evaluations through the coefficient of inconsistency (*CI*). Additionally, to facilitate calculations, the use of Super Decision software version 2.6.0 is recommended.

Step 6. Calculation of the overall prospective value of each alternative (ξ_i)

In this step, the set of equations proposed by Rangel *et al*. (2009) will be used for the development of the TODIM method. First, the measure of dominance of alternative (i) over alternative (j) is calculated for each decision criterion through Equation (5):

$$\phi_c(\mathrm{i,j}) = \begin{cases} \sqrt{\dfrac{\mathrm{a}_{rc}(\mathrm{W}_{ic}-\mathrm{W}_{jc})}{\sum_{\mathrm{c=1}}^{\mathrm{m}} \mathrm{a}_{rc}}} & \text{si } (\mathrm{W}_{ic}-\mathrm{W}_{jc}) > 0 \\ 0 \quad \text{si } (\mathrm{W}_{ic}-\mathrm{W}_{jc}) = 0 & \\ -\dfrac{1}{\theta}\sqrt{\dfrac{(\sum_{\mathrm{c=1}}^{\mathrm{m}} \mathrm{a}_{rc})(\mathrm{W}_{ic}-\mathrm{W}_{jc})}{\mathrm{a}_{rc}}} & \text{si } (\mathrm{W}_{ic}-\mathrm{W}_{jc}) < 0 \end{cases} \tag{5}$$

Where:
$\phi_c(\mathrm{i,j})$: measure of dominance of the alternative (i) over the alternative (j) with respect to a decision criterion
a_{rc}: substitution rate or ratio of exchange of criteria r and c
W_{ic}-W_{jc}: value measures or weights of alternatives (i) and (j) for criterion (c)
θ: loss mitigation factor
Then the measure of general dominance of each alternative (i) over each alternative (j) with respect to criterion (j) is calculated through Equation (6):

$$\delta(\mathrm{i,j}) = \sum_{\mathrm{c=1}}^{\mathrm{m}} \phi_c(\mathrm{i,j}), \forall(\mathrm{i,j}) \tag{6}$$

Where:
δ(i,j) represents the measure of dominance of alternative (i) over alternative (j)
Finally, the overall prospective value (ξ_i) of each alternative is calculated, taking into consideration Equation (7):

$$\delta(\mathrm{i,j}) = \sum_{\mathrm{c=1}}^{\mathrm{m}} \phi_c(\mathrm{i,j}), \forall(\mathrm{i,j}) \tag{7}$$

The overall prospective value of each alternative lies in the range of $0 \leq \xi_i \leq 1$.

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Step 7. Prioritization of alternatives

Finally, Green IT/IS alternatives or practices are prioritized considering their global prospective values (ξi). The higher the value of ξi , the better the Green IT/IS alternative or practice.

Results of the application of the procedure

In order to create action programs for their implementation, the management of an IT products and services company in Cuba needs to determine the Green IT/IS practices that most influence the sustainable development of the organization.

Firstly, Green IT/IS practices were identified in the organization, considering the particularities of Cuban companies in the sector and some of the most used at the international level, as shown in Table 3.

Table 3
Green IT/IS practices identified in the organization

No.	IT/IS Green practice	Code
1	Virtualization of servers	Virt_serv
2	Monitoring server power consumption	Mon_Energ
3	Virtualization of networks	Virt_redes
4	Cloud use	Comp_nube
5	Use of laptops	Uso_comp_port
6	Installation of light client equipment	Inst_cliente_lig
7	Sharing multifunctional printers on the network	Comp_impr
8	Virtual working practices and virtual encounters	Pract_trab_remoto
9	Implementation of an energy management system	Sist_imple_energ
10	Internal and external communication of energy-saving initiatives	Comu_inter_ext

Source: own elaboration

The number of experts needed for the research was then calculated , which was 9, with an accuracy level of 9%, an estimated error ratio (average) of 1%, and a confidence level of 99%. The nine candidates with the highest competence coefficient were then selected from the pool of expert candidates.

The experts evaluated the impact of each Green IT/IS practice identified in each selected criterion, as shown in Table 4.

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Table 4

Sample of the evaluations of all the Green IT/IS practices for each criterion

Green IT/IS practice	Economic	Social	Ecological
Virt_serv	4	2	3
Mon_Energ	2	2	5
Virt_redes	1	1	2
Comp_nube	2	3	3
Uso_comp_port	5	2	5
Inst_cliente_lig	4	1	4
Comp_impr	3	2	3
Pract_trab_remoto	1	5	3
Sist_imple_energ	1	5	4
Comu_inter_ext	1	5	4

Source: own elaboration

Then, the weight (ω_j) of each criterion was calculated through the Saaty method. The previously selected experts made the pair comparisons between the criteria, using a numerical scale, indicating how many times one criterion is more important than another. Table 5 displays the results.

Table 5

Weights of the decision criteria

	Economic	Social	Ecological	
Economic	0.00	1.50	5.20	0.50
Social	0.67	0.00	0.18	0.20
Ecological	0.19	5.66	0.00	0.30

Source: own elaboration

The coefficient of inconsistency (*CI*) of the expert evaluations was calculated, and it was less than 0.10, indicating that there was consistency between them. The values were then normalized, obtaining, as shown in Table 6, the normalized matrix of Green IT/IS initiatives evaluated in each criterion. Table 6 also shows the replacement rate (a_{rc}) between each criterion and the reference criterion selected for this case, that is, the economic criterion.

Table 6

Green IT/IS Initiative Standard Matrix

No.	Green IT/IS practice	Economic	Social	Ecological
1	Virt_serv	0.167	0.071	0.083
2	Mon_Energ	0.083	0.071	0.139
3	Virt_redes	0.042	0.036	0.056
4	Comp_nube	0.083	0.107	0.083
5	Uso_comp_port	0.208	0.071	0.139
6	Inst_cliente_lig	0.167	0.036	0.111
7	Comp_impr	0.125	0.071	0.083
8	Pract_trab_remoto	0.042	0.179	0.083
9	Sist_imple_energ	0.042	0.179	0.111
10	Comu_inter_ext	0.042	0.179	0.111
		1.000	0.400	0.600

Source: own elaboration

In the next step, it is necessary to obtain the values of Φ_c (i,j) according to Equation (5) presented in the section above. To this end, first, the differences of the weights W_{ic}-W_{jc} are determined, as shown in Table 7 for the economic criterion, then the measure of dominance of alternative (i) over alternative (j) is calculated with respect to each decision criterion (See Table 8).

Table 7

Values W_{ic} - W_{jc} for the economic criterion

	1	2	3	4	5	6	7	8	9	10
1	0.000	-0.083	-0.125	-0.083	0.042	0.000	-0.042	-0.125	-0.125	-0.125
2	0.083	0.000	-0.042	0.000	0.125	0.083	0.042	-0.042	-0.042	-0.042
3	0.125	0.042	0.000	0.042	0.167	0.125	0.083	0.000	0.000	0.000
4	0.083	0.000	-0.042	0.000	0.125	0.083	0.042	-0.042	-0.042	-0.042
5	-0.042	-0.125	-0.167	-0.125	0.000	-0.042	-0.083	-0.167	-0.167	-0.167
6	0.000	-0.083	-0.125	-0.083	0.042	0.000	-0.042	-0.125	-0.125	-0.125
7	0.042	-0.042	-0.083	-0.042	0.083	0.042	0.000	-0.083	-0.083	-0.083

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8	0.125	0.042	0.000	0.042	0.167	0.125	0.083	0.000	0.000	0.000
9	0.125	0.042	0.000	0.042	0.167	0.125	0.083	0.000	0.000	0.000
10	0.125	0.042	0.000	0.042	0.167	0.125	0.083	0.000	0.000	0.000

Source: own elaboration

The calculation of W_{ic}-W_{jc} and Φc (i,j) are carried out in the same way for social and ecological criteria.

Table 8

Values of Φ_c (i,j) for the economic criterion

	1	2	3	4	5	6	7	8	9	10
1	0.000	-0.408	-0.500	-0.408	0.144	0.000	-0.289	-0.500	-0.500	-0.500
2	0.204	0.000	-0.289	0.000	0.250	0.204	0.144	-0.289	-0.289	-0.289
3	0.250	0.144	0.000	0.144	0.289	0.250	0.204	0.000	0.000	0.000
4	0.204	0.000	-0.289	0.000	0.250	0.204	0.144	-0.289	-0.289	-0.289
5	-0.289	-0.500	-0.577	-0.500	0.000	-0.289	-0.408	-0.577	-0.577	-0.577
6	0.000	-0.408	-0.500	-0.408	0.144	0.000	-0.289	-0.500	-0.500	-0.500
7	0.144	-0.289	-0.408	-0.289	0.204	0.144	0.000	-0.408	-0.408	-0.408
8	0.250	0.144	0.000	0.144	0.289	0.250	0.204	0.000	0.000	0.000
9	0.250	0.144	0.000	0.144	0.289	0.250	0.204	0.000	0.000	0.000
10	0.250	0.144	0.000	0.144	0.289	0.250	0.204	0.000	0.000	0.000

Source: own elaboration

Then the general dominance measure δ(i,j) of each alternative (i) over each alternative (j) is calculated according to Equation (6). The results appear in Table 9. Finally, the global prospective value (ξ_i) of each alternative is calculated, taking into consideration Equation (7), as shown in Table 10.

The values of ξ_i allow the decision-maker to order or prioritize each of the Green IT/IS alternatives identified according to the following criteria: economic, social, and ecological.

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Table 9

Measure of general dominance δ(i,j)

	1	2	3	4	5	6	7	8	9	10
1	0.000	-0.279	-1.227	-0.324	0.273	-0.331	-0.289	-0.354	-0.262	-0.262
2	-0.226	0.000	-1.238	-0.346	0.250	-0.523	-0.286	-0.573	-0.447	-0.378
3	0.426	0.387	0.000	0.355	0.531	0.379	0.380	0.260	0.298	0.298
4	-0.218	-0.293	-1.191	0.000	-0.043	-0.302	-0.278	-0.169	-0.078	-0.078
5	-0.719	-0.500	-1.527	-0.846	0.000	-1.016	-0.839	-0.861	-0.735	-0.735
6	-0.220	-0.232	-0.930	-0.593	0.320	0.000	-0.508	-0.635	-0.331	-0.331
7	0.144	-0.160	-1.135	-0.204	0.333	-0.187	0.000	-0.262	-0.171	-0.171
8	-0.482	-0.458	-1.149	-0.453	-0.314	-0.504	-0.528	0.000	0.091	0.091
9	-0.786	-0.496	-1.275	-0.758	-0.352	-0.595	-0.832	-0.304	0.000	0.000
10	-0.786	-0.496	-1.275	-0.758	-0.352	-0.595	-0.832	-0.304	0.000	0.000
Total	-2.868	-2.529	-10.949	-3.926	0.647	-3.674	-4.012	-3.202	-1.634	-1.566

Source: own elaboration

Considering the results of the methodology, the management of the organization should prioritize practices related to laptop use, internal and external communication of energy-saving initiatives, implementation of energy management systems, virtualization of servers, and monitoring of server energy consumption.

Table 10

Prospective global value of each alternative

Green IT/IS practice	ξ_i	Order
Virt_serv	0.69692383	5
Mon_Energ	0.72615053	4
Virt_redes	0	10
Comp_nube	0.60566604	8
Uso_comp_port	1	1
Inst_cliente_lig	0.62739896	7

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Comp_impr	0.59823264	9
Pract_trab_remoto	0.66808298	6
Sist_imple_energ	0.8033047	3
Comu_inter_ext	0.80921995	2

Source: own elaboration

For each of the Green IT/IS practices selected, the decision-maker must draw lines of action that allow the implementation of the prioritized Green IT/IS practices for the contribution to the sustainable development of the organization.

Conclusions

Information and communication technologies are called to play an essential role in the fulfillment of the 2030 Agenda for sustainable development. For organizations, in particular, Green IT/IS practices represent a challenge and an opportunity in the pursuit of sustainability not only in the technological field but also in the social, ecological, and cultural dimensions.

The proposed methodology is based on the combination of the Interactive and Multicriteria Decision Making method, along with expert work and the Analytical Hierarchy Process, which provides management with a robust and coherent procedure for determining the main initiatives of sustainable information technologies and systems in an organization.

The results of applying the proposed methodology in an ICT entity allow management to focus on Green IT/IS practices that most affect sustainability. For the selected case study, the use of laptops, internal and external communication of energy-saving initiatives, implementation of energy management systems, server virtualization, and monitoring of server energy consumption were prioritized.

Finally, the proposed methodology could be used to determine other practices or initiatives for the sustainable development of organizations, so that future work should be aimed at its implementation in other fields of application of sustainability sciences.

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