

Article



# A Multicriteria Approach for Assessing the Impact of ICT on EU Sustainable Regional Policy

## Christiana Koliouska \* and Zacharoula Andreopoulou

Laboratory of Forest Informatics, Faculty of Forestry and Natural Environment, Aristotle University of Thessaloniki, P.O. Box 247, 54124 Thessaloniki, Greece; randreop@for.auth.gr

\* Correspondence: ckolious@for.auth.gr; Tel.: +30-694-691-7724

Received: 26 March 2020; Accepted: 3 June 2020; Published: 15 June 2020



**Abstract:** As a global actor, the European Union (EU) plays a leading role in international efforts to promote sustainable development globally. All sustainable objectives and targets need Information and Communication Technologies (ICTs) as key catalysts, since ICTs constitute tools of unprecedented power which help people to face the growing challenges of rising population, poverty, epidemics and climate change. Policy makers in the EU are increasingly putting ICTs into relations with sustainable regional development. This paper aims to study and assess the impact of ICT on the EU regional policy in terms of sustainable development by applying the multicriteria approach, PROMETHEE II, using the software Visual PROMETHEE. The criteria that were used in this research are the criteria that both the European Commission and member states define to assess the ICT implications of new EU legislation since 2010. The results revealed that the impact of ICT on EU sustainable regional policy has gotten stronger in the last two decades.

Keywords: ICT; EU regional policy; sustainable development; multicriteria approach; policy assessment

### 1. Introduction

Information and Communication Technology (ICT) advancements not only bring new opportunities, but also bring to light new risks for the achievement of sustainable development (SD) goals [1]. ICT proved to accelerate the worldwide socio-technological progress through knowledge transfer, marketing goods or services, network externalities and the development of cooperative relationships [2]. The contribution of ICT in addressing the major challenges of sustainable energy, climate change and sustainable development is highlighted by researchers, entrepreneurs, decision-makers and policy-makers [3]. The integration of ICT into social development and economic growth provides better opportunities for enhancing competitiveness and satisfying human needs [4,5].

The initiatives required to help ICT enable transformation to sustainable development and global competitiveness are as follows [6]:

- Improve the four inter-related dimensions of ICT (the 4C Framework): Computers, Connectivity, Content, (human) Capacity.
- The successful application ICT for sustainable development depends on the scalability and the sustainability.
  - ICT constitutes just a means of achieving sustainable development.
  - Active efforts are required to foster global inclusion.
  - Sustainable ICT should be economically feasible and create end-user value.
  - ICT for sustainable development research and practice should be participatory, collaborative and empowering for the solutions to be globally consistent and relevant.

- Sustainable ICT should become a globally recognized and funded industry.
  - Inspire and effectively engage all relevant stakeholders to have a shared vision to implement sustainable ICT.
  - Develop metrics to quantify the level of success and effectiveness and consider new academic rigor.
  - Focus on the challenges of modernization.
  - Plan innovative models for research and development.

ICT is supposed to trigger the co-evolutionary process that will meet sustainable development goals in the EU through the efficient use of natural resources [7]. National and regional agencies involved in activities related to the agenda about digital inclusion and web accessibility in rural and underserved areas should adopt a new technology, engage community participation and incorporate sustainable development as essential factors to link ICT with community development and prosperity [8]. ICT solutions constitute vehicles for sustainable development in a more effective and cost-efficient way, as they have great potential to assist poor people to improve the quality of their life [9].

Information and knowledge are essential to achieve regional development and economic growth, since they are performed as primal components of socio-economic activities for strategic management in developing countries [10]. According to OECD Report Greener and Smarter in 2010, ICT is a crucial component for green growth and green economy [11] as it promotes smart growth, "development that is economically sound, environmentally friendly and supportive of community livability–growth that enhances our quality of life" [12,13]. Realtime data streaming will support the process of effectively monitoring the impact of regulations regarding the environment and society [14]. The multimedia distributed systems such as ICT, communication networks and smart media are widely used for electronic data interchange (EDI) [15]. The international community has integrated many goals in public policy to ensure environmental sustainability since it constitutes part of global socio-economic well-being [16,17]. The sustainable management of natural resources plays a vital role in the achievement of global sustainability goals [18]. The aim of sustainable development is to "promote the human well-being, meet the basic needs of the poor and protect the welfare of future generations (intraand inter- generational justice), preserve environmental resources and global life-support systems (respecting limits), integrate economics and natural environment in decision-making, and encourage public involvement in development processes" [19,20]. However, the current framework for sustainable development is completely different from the framework developed over past years, as new factors (e.g., multinational corporate companies and civil society organizations) and modern ICT (computerized communication channels, such as Internet) influence the environmental and socio-economic aspects of the development [21].

According to the EU Green Paper on Innovation in 1995, the key factors to boosting innovation potential are the following: environmental policy, regional industrial policy, technology policy, education and training policy, research policy (RP), competition policy, Small and Medium Enterprises (SMEs) policy and taxation policy [22]. In today's digital era, the EU encourages the international cooperation in research and innovation as a key success factor in sustainability [23,24]. Sustainable regional and local development constitutes an integrated approach to the planning and development of our regions [25] but cooperation among different authorities is essential [26,27]. Regional Policy aims to create employment opportunities, support business agility and business competitiveness, while promoting sustainable economic growth to all European regions [28]. EU regional policy funding focuses on four categories [29]:

- Information and Communication Technology (ICT).
- Research and Innovation (R&I).
- Enhancing the competitiveness of Small and Medium-sized Enterprises (SMEs).
- Transitioning to a low-carbon economy.

The main aim of the current policies and strategies for regional development is the flow of money from the rich nations to the poor nations, as well as the support to confront regional challenges through funding programs [30]. Aiming to create empowering partnerships among EU regions and EU member states in the context of these policies' implementation, the EU adopts some practices, such as monitoring and policy evaluation, in order to enhance the effectiveness of the policies [30]. The European Commission's involvement in regional development can be traced back to 1957 when the Treaty of Rome required the community to ensure "harmonious" development by reducing regional differences and the backwardness of less-favored regions [31].

According to the latest Eurobarometer regarding "Citizens' awareness and perceptions of EU regional policy" in 2017, almost 80% of the EU citizens were convinced that EU regional policy investments had a positive effect on their region or city, while almost half of the EU citizens supported the idea that EU regional investments should continue [32]. In order to be effective, a policy, such as regional policy, necessarily involves multiple partners operating at different spatial scales and different governance levels [33]. There are four structural funds: the European Regional Development Fund (ERDF), which is intended to finance large infrastructure projects and has the largest weight in the budget; the European Social Fund (ESF), which is the main financial instrument assisting the EU in realizing the strategy and the main objectives of its implementing policy; the European Agricultural Guidance and Guarantee Fund (EAGGF—Guidance Section), which accelerates the reformation of the agricultural structure; the Financial Instrument for Fisheries Guidance (FIFG), which is the specific fund for the reform of the structure of the fisheries sector [34]. The structural actions represent approximately one-third of whole the budget of the EU [34]. Infrastructure expenditures by are addressed to low-growth, low-employment and low-productivity regions [35].

It is widely accepted that EU regional policy has been an important contributing factor to the promotion of EU political regionalism and decentralization [36]. This is primarily as a result of the Funds of Partnership principle, taking into consideration that there are competent regional authorities and they get actively involved in the developing and implementation of regional aid [36]. Whereas a succession of income transfers may lead to a series of possible reductions in regional disparities, it should not be confused with the process of convergence on the regional level, which would be the successful implication of regional policies [37]. An emphasis on endogenous growth models has developed, and in connection with this, the intention to enhance the competitiveness among EU regions in contrast with simply getting involved in redistributive activities characterized by former regional policy interventions [38].

The European Regional Policy Research Consortium (EoRPA), originally launched in 1978, and was funded by government departments in Austria, Finland, France, Germany, Italy, the Netherlands, Norway, Poland, Sweden, Switzerland and the United Kingdom. It involves the monitoring and analysis of national regional policies in 30 European countries, and the study of the inter-relationships between EU Cohesion policy and EU Competition policy control of state aid [39].

The objective of this study is to investigate the impact of ICT on EU regional policy in the terms of sustainable development by applying the multicriteria approach, PROMETHEE II, using the software, Visual PROMETHEE. This approach was used for the assessment of the impact of ICT and for the ranking of the EU regional policies.

#### 2. Materials and Methods

EU regional policies are retrieved from the official European Union website (www.europa.eu). The first step was to record the regulations, the directives, the decisions, the communications and other acts regarding the regional issues. EU sustainable regional policies form the alternatives. After the collection of the policies, a two-dimensional table was developed in order to find out the existence or lack of criteria that both the European Commission and member states have defined and proposed in order to assess the ICT implications of new EU legislation since 2010 [40]. These criteria constitute the variables X1, X2, ..., X12 (Table 1). Variable X1 refers to the requirement of the design of information rich

processes by the legislation, while variable X2 refers to the requirement of the design of new business processes. Variable X3 represents the requirement of large amounts of data gathering in these processes and variable X4 represents the requirement of collaboration between ICT systems of multiple DGs or institutions/organizations. Variable X5 is about the fact that the legislation concerns ICT systems or that ICT is a supporting function of the legislation. The first five criteria/variables describe the level of dependence on ICT solutions of the EU regional policies and the weight of each is 1. The rest of the criteria/variables describe the levels of complexity of the ICT solutions and the weight of each is 0.83. The weights of the criteria were defined according to the method used by the European Commission to assess the ICT implications of EU legislation [40], giving the same importance to the level of dependence on the ICT implications and the level of complexity of the ICT implications. Variable X6 refers to whether the legislation requires new ICT solutions or existing applications can fulfill the requirements, while variable X7 refers to the existence of legacy systems which might hamper the implementation. Variable X8 concerns the imposition of authentication requirements by the legislation and variable X9 concerns the requirement of large amounts of data exchange between member states and/or the Commission. Variable X10 is about the required lead-time of the implementation (urgency), variable X11 is about the requirement of new interoperability specifications and variable X12 is about the imposition of high security requirements on the ICT solution by the initiative. The total amount of criteria achieved by each EU regional policy was also studied.

Category	Variable	Criteria
	<b>X</b> <sub>1</sub>	Does the legislation require the design of information rich processes?
	X2	Does the legislation require the design of new business processes?
Dependence on the ICT solutions	X <sub>3</sub>	Are large amounts of data gathering required in these processes?
	X4	Is collaboration between ICT systems of multiple DGs or institutions/organizations required?
	X <sub>5</sub>	Is the legislation concerning ICT systems or is ICT a supporting function of the legislation?
	X <sub>6</sub>	Does the legislation require new ICT solutions or can existing applications fulfill the requirements?
Complexity of the ICT solutions	<b>X</b> <sub>7</sub>	Are there any legacy systems which might hamper the implementation?
	X <sub>8</sub>	Does the legislation impose authentication requirements?
	X9	Is a large amount of data exchange between member states and/or the Commission required?
	X <sub>10</sub>	What is the required lead-time of the implementation (urgency)?
	X <sub>11</sub>	Are new interoperability specifications required?
	X <sub>12</sub>	Does the initiative impose high security requirements on the ICT solution?

Table 1	<ol> <li>Criteria</li> </ol>	[41].
---------	------------------------------	-------

Furthermore, the impact of ICT was assessed, and the EU regional policies were ranked using the multicriteria analysis, PROMETHEE II. PROMETHEE constitutes a prescriptive methodology which enables the decision-maker to rank the actions regarding his preferences [42]. Two rankings are calculated: the partial ranking is calculated mainly by undisputable preferences (PROMETHEE I), while the complete ranking, which is probably weaker, is obtained according to the decision-maker's requirements, too (PROMETHEE II) [42]. The PROMETHEE IV method solves a choice problematic for an infinite set of actions. It uses the same outranking relation, but the flows are defined on a compact subset of R<sup>″</sup> [43].

The PROMETHEE method includes four processes [44]:

- (1) Define the preferences: this function deals with the decision-maker's preference for an alternative  $x_k$  with respect to another alternative  $x_1$  regarding a criterion.
- (2) Calculate the preference index: this index is used to compare the alternatives in pairs, quantitatively taking into consideration all the defined criteria.
- (3) Construct valued outranking graph: outgoing and incoming flows are determined by means of relevant preference indices.
- (4) Rank alternatives according to the valued outranking graph: determination of the weights is an important step in most multi-criteria methods [45].

The method normalizes the weights of the criteria in order for their sum to be equal to 1.0 (100%) [44]. The PROMETHEE II method is described thoroughly in Brans and Mareschal (2005) [46] and in Andreopoulou et al. (2017) [47].

PROMETHEE provides the researcher with rankings of the alternatives and GAIA with a graphical representation of the decision problem [48]. The GAIA analysis is based on the uni-criterion net flows [42]. GAIA uses the principal components analysis (PCA), a well-known dimension-reduction technique for statistical data analysis [49].

PROMETHEE II methodology was selected in order to evaluate the impact of ICT on EU sustainable regional policies and to rank the policies because [50]:

- there is now so much sensitivity of the estimated relation in small changes.
- the results can be easily interpreted and discussed.
- the use of the superiority relation is applied when the alternatives (sustainable regional policies) have to be ranked from the alternative with the highest score to the alternative with the lowest score.
- the assessment and ranking process of complicated cases of sustainable regional policies is suitable for the application of PROMETHEE II methodology in the way that it seems to be closer to reality.

#### 3. Results

The research through the official European Union website (www.europa.eu) resulted in the retrieval of 50 regional policies, which are presented in the Appendix A. In total, 19 out of the 50 EU regional policies have been established since 2010 (when the European Commission began to assess the ICT implications of EU legislation). Figure 1 presents the partial rankings of the 19 EU regional policies based on the computation of the two preference flows (Phi+ and Phi-).

Figure 2 presents the complete rankings of the 19 EU regional policies, which are based on the total net preference flow (Phi). According to the results of PROMETHEE I and PROMETHEE II, COM(2012)19 "Waste Electrical and Electronic Equipment (WEEE)" is preferred to all other regional policies. COM(2012)19 has the highest score on Phi (0.5841), followed by Reg.2015/207 "The models for the progress report, submission of the information on a major project, the joint action plan, the implementation reports for the Investment for growth and jobs goal, the management declaration, the audit strategy, the audit opinion and the annual control report and the methodology for carrying out the cost-benefit analysis" and COM(2014)473 "Sixth report on economic, social and territorial cohesion: investment for jobs and growth", while COM(2015)118 "The Agreement on the European Economic Area" has the lowest score. The ranking of PROMETHEE I is confirmed by the ranking of PROMETHEE II.



Figure 1. Partial ranking of EU regional policies.



Figure 2. Complete ranking of EU regional policies.

Figure 3 shows the PROMETHEE diamond, which depicts in a better way the two rankings (Phi+ and Phi-), while the vertical dimension represents the total net flow (Phi) by the complete ranking process. It can be observed that all action cones are located on the left axis (Phi+), which means that the total net flow of the regional policies is less than 1.

Table 2 shows the Phi scores of all the EU regional policies. The values calculated for the total net flows (Phi) present a large spectrum of values between +0.5841 and -0.4123, and that shows a great difference concerning "superiority" between the first and the last case in the ranking of EU regional policies according to the impact of ICT.



Figure 3. PROMETHEE Diamond.

	<b>Regional Policy</b>	Phi+	Phi-	Phi
1	COM(2012)19	0.631	0.0469	0.5841
2	Reg.2015/207	0.3992	0.1391	0.26
3	COM(2014)473	0.3992	0.1391	0.26
4	Reg.1301/2013	0.2556	0.0778	0.1778
5	Reg.1304/2013	0.2556	0.0778	0.1778
6	Reg.1299/2013	0.2556	0.0778	0.1778
7	Reg.1303/2013	0.2556	0.0778	0.1778
8	Reg.231/2014	0.2556	0.0778	0.1778
9	COM(2010)553	0.2556	0.0778	0.1778
10	Reg.1300/2013	0.3401	0.184	0.1561
11	Reg.283/2014	0.2256	0.1983	0.0273
12	COM(2011)776	0.1752	0.1633	0.0119
13	COM(2014)490	0.077	0.3094	-0.2324
14	COM(2011)146	0.077	0.3094	-0.2324
15	Reg.347/2013	0.0667	0.3865	-0.3198
16	Reg.240/2014	0.0547	0.4445	-0.3899
17	COM(2014)494	0.0547	0.4445	-0.3899
18	COM(2013)463	0.0547	0.4445	-0.3899
19	COM(2015)118	0.0564	0.4687	-0.4123

Table 2. Preference flows.

In Figure 4, the GAIA plane is displayed. The red axis is the decision axis, which indicates the direction for the best solution according to the weight vectors on the GAIA plane. Because the direction of the decision axis is in the same direction as the variables X2 "The requirement of the design of new business processes" and X4 "The requirement of collaboration between ICT systems of multiple DGs or institutions/organizations", it can be expected that the PROMETHEE II ranked actions to be stronger on this variable and potentially weaker on variables X8 "The imposition of authentication requirements by the legislation" and X11 "The requirement of new interoperability specifications". COM(2010)553 "Regional Policy contributing to smart growth in Europe 2020" and Reg.1300/2013 "Cohesion Fund and repealing Council Regulation (EC) No 1084/2006" are very close to each other and

they have similar actions, whereas the other policies are in the opposite direction. It can be concluded that they are different from other actions.



Figure 4. PROMETHEE GAIA plane.

# 4. Discussion

Research into the official EU website retrieved 50 regional policies, while 19 out of them have been established since 2010 (when the European Commission began to assess the ICT implications of EU legislation). The fulfillment of these 12 criteria, used by the European Commission, was studied in order to depict the impact of ICT on EU sustainable regional policy. Multicriteria decision analysis and GAIA analysis, are presented to identify the impact of ICT on EU sustainable regional policies.

The results and conclusions are summarized as follows:

- PROMETHEE II analysis shows that ICT has the strongest impact on COM(2012)19 "Waste Electrical and Electronic Equipment (WEEE)", while Reg.2015/207 "The models for the progress report, submission of the information on a major project, the joint action plan, the implementation reports for the Investment for growth and jobs goal, the management declaration, the audit strategy, the audit opinion and the annual control report and the methodology for carrying out the cost- benefit analysis" is ranked in the second position.
- The same analysis shows that ICT has the weakest impact on COM(2015)118 "The Agreement on the European Economic Area".
- Most EU sustainable regional policies adopt ICT solutions, as most of them contribute positively to their total net flows (Phi).
- The large spectrum of the values of the total net flows (Phi) shows a great difference concerning "superiority" between the first and the last EU regional policies, according to the impact of ICT.
- GAIA analysis depicts that COM(2012)19 has the strongest impact of ICT and COM(2015)118 has the weakest impact of ICT.
- MCDA and GAIA analyses provide similar results in terms of scenario ranking.
- "The requirement of the design of new business processes" and "The requirement of collaboration between ICT systems of multiple DGs or institutions/organizations" are found to be the most robust criteria in the PROMETHEE II ranking.

• "The imposition of authentication requirements by the legislation" and "The requirement of new interoperability specifications" are found to be the weakest criteria.

As most EU sustainable regional policies present positive total net flows, this research confirms that the impact of ICT on EU sustainable regional policy has been getting stronger since 2010. The applied methodology constitutes an efficient planning tool at EU level for the policy makers for the assessment of sustainable regional policies, based on the impact of ICT. Furthermore, the findings of this research can be a supportive tool for the policy makers, as the superior EU regional policies can be used as benchmarks for future policies in terms of sustainable development. ICT adoption shows an enormous potential for accelerating the progress towards SDGs (Sustainable Development Goals), while at the same time it can improve the quality of life of people in fundamental ways [51]. However, it would be very interesting to apply different methods for multiple criteria decision-making because of some disadvantages of PROMETHEE method, such as the paradigm of the underlying method, the determination of the weights and the rank reversal problem [52].

**Author Contributions:** C.K. and Z.A. conceived of the presented idea. C.K. contributed to the design and the implementation of the research, to the analysis of the results and to the xriting of the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

## Appendix A

	Code	Title
1	Reg.1083/2006	General provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund.
2	Reg.1081/2006	European Social Fund.
3	Reg.1082/2006	A European grouping of territorial cooperation (EGTC).
4	Reg.1290/2005	Financing of the common agricultural policy.
5	Reg.2012/2002	Establishing the European Union Solidarity Fund.
6	Reg.1301/2013	The European Regional Development Fund and on specific provisions concerning the Investment for growth and jobs goal.
7	Reg.1304/2013	The European Social Fund and repealing Council Regulation (EC) No 1081/2006.
8	Reg.1299/2013	Specific provisions for the support from the European Regional Development Fund to the European territorial cooperation goal.
9	Reg.1303/2013	Common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund.
10	Reg.1300/2013	Cohesion Fund and repealing Council Regulation (EC) No 1084/2006.
11	Reg.347/2013	Guidelines for trans-European energy infrastructure.
12	Reg.283/2014	Guidelines for trans-European networks in the area of telecommunications infrastructure.
13	Reg.1828/2006	Rules for the implementation of Council Regulation (EC) No 1083/2006 laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund and of Regulation (EC) No 1080/2006 of the European Parliament and of the Council on the European Regional Development Fund.

Table A1. Sustainable regional policies.

	Code	Title
14	Reg.1445/2007	Common rules for the provision of basic information on Purchasing Power Parities and for their calculation and dissemination.
15	Reg.1059/2003	Establishment of a common classification of territorial units for statistics (NUTS).
16	Reg.231/2014	Establishing an Instrument for Pre-accession Assistance (IPA II).
17	Reg.1085/2006	Establishing an Instrument for Pre-Accession Assistance (IPA).
18	Reg.240/2014	The European code of conduct on partnership in the framework of the European Structural and Investment Funds.
19	Reg.2015/207	The models for the progress report, submission of the information on a major project, the joint action plan, the implementation reports for the Investment for growth and jobs goal, the management declaration, the audit strategy, the audit opinion and the annual control report and the methodology for carrying out the cost-benefit analysis.
20	COM(2014)473	Sixth report on economic, social and territorial cohesion: investment for jobs and growth.
21	COM(2009)295	Classification of certain goods in the Combined Nomenclature.
22	COM(2008)371	Fifth progress report on economic and social cohesion Growing regions, growing Europe.
23	COM(2007)273	Fourth progress report on economic and social cohesion Growing regions, growing Europe.
24	COM (2004)107	Arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air.
25	COM(2006)281	The Growth and Jobs Strategy and the Reform of European cohesion policy Fourth progress report on cohesion.
26	COM(2005)192	Third progress report on cohesion: Towards a new partnership for growth, jobs and cohesion.
27	COM(2007)798	Member States and Regions delivering the Lisbon strategy for growth and jobs through EU cohesion policy, 2007–2013.
28	COM(2008)876	Cohesion Policy: investing in the real economy.
29	COM(2008)616	Green Paper on Territorial Cohesion: Turning Territorial Diversity into Strength.
30	COM(2006)30	Time to move up a gear: The new partnership for growth and jobs.
31	COM(2003)690	A European initiative for growth, investing in networks and knowledge for growth and jobs. Final Report to the European Council.
32	COM(2014)490	The urban dimension of EU policies-Key features of an EU urban agenda.
33	COM(2010)553	Regional Policy contributing to smart growth in Europe 2020.
34	COM(2006)675	A contribution by the Swiss Confederation to the European Union military operation in support of the United Nations Organization Mission in the Democratic Republic of the Congo (MONUC) during the election process (Operation EUFOR RD Congo).
35	COM(2006)385	Cohesion Policy and cities: the urban contribution to growth and jobs in the regions.
36	COM (2009)103	Insurance against civil liability in respect of the use of motor vehicles, and the enforcement of the obligation to insure against such liability.
37	COM(2015)118	The Agreement on the European Economic Area.
38	COM(1999)54	Amending Council Directive 66/402/EEC on the marketing of cereal seed.
39	COM(97)172	Amending the boundaries of the less-favored areas in the Federal Republic of Germany within the meaning of Council Directive 75/268/EEC.
40	COM(2002)709	A framework for target-based tripartite contracts and agreements between the Community, the States and regional and local authorities.
41	COM(2003)585	Structural indicator.
42	COM(2003)811	Dialogue with associations of regional and local authorities.

## Table A1. Cont.

	Code	Title
43	COM(2011)146	Reform of the EU State Aid Rules on Services of General Economic Interest.
44	COM(2012)19	Waste Electrical and Electronic Equipment (WEEE).
45	COM(2014)494	Guidelines on the application of the measures linking effectiveness of the European Structural and Investment Funds to sound economic governance according to Article 23 of Regulation (EU) 1303/2013.
46	COM(2011)776	Seventh progress report on economic, social and territorial cohesion.
47	COM(2013)463	Eighth progress report on economic, social and territorial cohesion. The regional and urban dimension of the crisis.
48	Dec.2006/702	Community strategic guidelines on cohesion.
49	Dec.1336/97	A series of guidelines for trans-European telecommunications networks.
50	Direct.2008/57	The interoperability of the rail system within the Community (Recast).

#### Table A1. Cont.

### References

- 1. Hilty, L.M.; Seifert, E.K.; Treibert, R. *Information Systems for Sustainable Development*; IGI Global: Hershey, PA, USA, 2005.
- Mohamed, M.; Murray, A.; Mohamed, M. The role of information and communication technology (ICT) in mobilization of sustainable development knowledge: A quantitative evaluation. *J. Knowl. Manag.* 2010, 14, 744–758. [CrossRef]
- 3. Hilty, L.M. *Information Technology and Sustainability: Essays on the Relationship between Information Technology and Sustainable Development;* BoD–Books on Demand: Norderstedt, Germany, 2011.
- 4. Andreopoulou, Z.; Samathrakis, V.; Louca, S.; Vlachopoulou, M. *E-Innovation for Sustainable Development of Rural Resources during Global Economic Crisis*; IGI Global: Hershey, PA, USA, 2013.
- 5. Koliouska, C.; Andreopoulou, Z.; Zopounidis, C.; Lemonakis, C. E-commerce in the Context of Protected Areas Development: A Managerial Perspective Under a Multi-Criteria Approach. In *Multiple Criteria Decision Making*; Springer International Publishing: Cham, Switzerland, 2017; pp. 99–111.
- Tongia, R.; Subrahmanian, E.; Arunachalam, V. Information and Communications Technology for Sustainable Development: Defining a Global Research Agenda; No. Information and Communications Technology for Sustainable Development: Defining a Global Research Agenda; Allied Publishers Pvt. Ltd.: Bangalore, India, 2005.
- 7. Yao, X.; Watanabe, C.; Li, Y. Institutional structure of sustainable development in BRICs: Focusing on ICT utilization. *Technol. Soc.* **2009**, *31*, 9–28. [CrossRef]
- Armenta, Á.; Serrano, A.; Cabrera, M.; Conte, R. The new digital divide: The confluence of broadband penetration, sustainable development, technology adoption and community participation. *Inf. Technol. Dev.* 2012, *18*, 345–353. [CrossRef]
- 9. Mehta, S.; Kalra, M. Information and Communication Technologies: A bridge for social equity and sustainable development in India. *Int. Inf. Libr. Rev.* **2006**, *38*, 147–160. [CrossRef]
- 10. Pade, C.I.; Mallinson, B.; Sewry, D. An exploration of the categories associated with ICT project sustainability in rural areas of developing countries: A case study of the Dwesa project. In *Proceedings of the 2006 Annual Research Conference of the South African Institute of Computer Scientists and Information Technologists on IT Research in Developing Countries*; South African Institute for Computer Scientists and Information Technologists: Pretoria, South Africa, 2006; pp. 100–106.
- 11. Koliouska, C.; Andreopoulou, Z. Classification of ICT in EU Environmental Strategies. J. Environ. Prot. Ecol. 2016, 17, 1385–1392.
- 12. Benedict, M.A.; McMahon, E.T. Green infrastructure: Smart conservation for the 21st century. *Renew. Resour. J.* **2002**, *20*, 12–17.
- 13. Koliouska, C.; Andreopoulou, Z. Exploring the use of smart services in Forestry. J. Environ. Prot. Ecol. 2019, 20, 1434–1439.

- Ahmedi, F.; Ahmedi, L.; O'Flynn, B.; Kurti, A.; Tahirsylaj, S.; Bytyçi, E.; Salihu, A. InWaterSense: An Intelligent Wireless Sensor Network for Monitoring Surface Water Quality to a River in Kosovo. *Int. J. Agric. Environ. Inform.* 2018, 9, 39–61. [CrossRef]
- 15. Khosravi, M.R.; Rostami, H.; Samadi, S. Enhancing the Binary Watermark-Based Data Hiding Scheme Using an Interpolation-Based Approach for Optical Remote Sensing Images. *Int. J. Agric. Environ. Inf. Syst.* **2018**, *9*, 53–71. [CrossRef]
- 16. Andreopoulou, Z.S.; Manos, B.; Polman, N.; Viaggi, D. *Agricultural and Environmental Informatics, Governance, and Management: Emerging Research Applications;* IGI Global: Hershey, PA, USA, 2011.
- 17. Andreopoulou, Z.; Koliouska, C.; Galariotis, E.; Zopounidis, C. Renewable energy sources: Using PROMETHEE II for ranking websites to support market opportunities. *Technol. Forecast. Soc. Chang.* **2018**, *131*, 31–37. [CrossRef]
- 18. Calzada-Infante, L.; Lopez-Narbona, A.M.; Nunez-Elvira, A.; Orozco-Messan, J. Assessing the Efficiency of Sustainable Cities Using an Empirical Approach. *Sustainability* **2020**, *12*, 2618. [CrossRef]
- 19. Meadowcroft, J. Sustainable development: A new (ish) idea for a new century? *Political Stud.* **2000**, *48*, 370–387. [CrossRef]
- 20. Grin, J.; Rotmans, J.; Schot, J. Transitions to Sustainable Development: New Directions in the Study of Long Term Transformative Change; Routledge: Abingdon-on-Thames, UK, 2010.
- 21. Elliott, J.A. An Introduction to Sustainable Development; Routledge: Abingdon-on-Thames, UK, 2012.
- 22. Kaufmann, A.; Wagner, P. EU regional policy and the stimulation of innovation: The role of the European Regional Development Fund in the objective 1 region Burgenland. *Eur. Plan. Stud.* **2005**, *13*, 581–599. [CrossRef]
- 23. Dohse, D.; Fornahl, D.; Vehrke, J. Fostering place-based innovation and internationalization–the new turn in German technology policy. *Eur. Plan. Stud.* **2018**, *26*, 1137–1159. [CrossRef]
- 24. Koliouska, C.; Andreopoulou, Z. The Typology for ICT adoption of EU environmental policies. *Wseas Trans. Comput.* **2019**, 18, 46–55.
- 25. Koliouska, C.; Andreopoulou, Z.; Misso, R.; Borelli, I.P. Regional sustainability: National Forest Parks in Greece. *Int. J. Agric. Environ. Inf. Syst.* **2017**, *8*, 29–40. [CrossRef]
- 26. Barnett, M.L.; Henriques, I.; Husted, B.W. Governing the void between stakeholder management and sustainability. *Adv. Strateg. Manag.* **2018**, *38*, 121–143.
- 27. Andreopoulou, Z.; Koliouska, C. Benchmarking Internet Promotion of Renewable Energy Enterprises: Is Sustainability Present? *Sustainability* **2018**, *10*, 4187. [CrossRef]
- 28. European Commission. The EU's Main Investment Policy. 2015. Available online: http://ec.europa.eu/ regional\_policy/en/policy (accessed on 7 February 2020).
- 29. European Union. Regional Policy. 2018. Available online: https://europa.eu/european-union/topics/regional-policy\_en (accessed on 7 February 2020).
- 30. MLIT. An Overview of Spatial Policy in Asian and European Countries. 2016. Available online: http://www.mlit.go.jp/ (accessed on 7 February 2020).
- 31. Michie, R.; Fitzgerald, R. The evolution of the structural funds. In *The Coherence of EU Regional Policy: Contrasting Perspectives on the Structural Funds;* Bachtler, J., Turok, I., Eds.; Routledge: Abingdon-on-Thames, UK, 2013.
- 32. Interreg Europe. Perception and Awareness of EU Regional Policy on the Rise. 2017. Available online: https://www.interregeurope.eu/ (accessed on 7 February 2020).
- 33. McCann, P.; Ortega-Argilés, R. Smart specialisation, entrepreneurship and SMEs: Issues and challenges for a results- oriented EU regional policy. *Small Bus. Econ.* **2016**, *46*, 537–552. [CrossRef]
- 34. Alegre, J.G. An evaluation of EU regional policy. Do structural actions crowd out public spending? *Public Choice* **2012**, *151*, 1–21. [CrossRef]
- 35. Becker, J.; Fuest, C. EU regional policy and tax competition. Eur. Econ. Rev. 2010, 54, 150–161. [CrossRef]
- Baun, M. EU regional policy and the candidate states: Poland and the Czech Republic. J. Eur. Integr. 2002, 24, 261–280. [CrossRef]
- 37. Funck, B.; Pizzati, L. *European Integration, Regional Policy and Growth*; The World Bank: Washington, DC, USA, 2003.
- 38. Hart, M. Evaluating EU regional policy: How might we understand the causal connections between interventions and outcomes more effectively? *Policy Stud.* **2007**, *28*, 295–308. [CrossRef]

- 39. Bachtler, J.; Mendez, C. EU Cohesion Policy and European Integration: The Dynamics of EU Budget and Regional Policy Reform; Routledge: Abingdon-on-Thames, UK, 2016.
- 40. European Commission. *Method for Assessing ICT Implications of EU Legislation*. 2010. Available online: http://ec.europa.eu/idabc/servlets/Doc792e.pdf?id=32704 (accessed on 7 February 2020).
- 41. Koliouska, C.; Andreopoulou, Z.; Golumbeanu, M. The Contribution of ICT in EU Development Policy: A Multicriteria Approach. In *Advances in Operational Research in the Balkans*; Springer: Cham, Switzerland, 2020; pp. 111–123.
- 42. Mareschal, B.; De Smet, Y. Visual PROMETHEE: Developments of the PROMETHEE & GAIA multicriteria decision aid methods. In *Industrial Engineering and Engineering Management*; IEEM: Beijing, China, 2009; pp. 1646–1649.
- 43. Brans, J.P.; Vincke, P.; Mareschal, B. How to select and how to rank projects: The PROMETHEE method. *Eur. J. Oper. Res.* **1986**, *24*, 228–238. [CrossRef]
- 44. Yu, X.; Xu, Z.; Ma, Y. Prioritized multi-criteria decision making based on the idea of PROMETHEE. *Procedia Comput. Sci.* **2013**, *17*, 449–456. [CrossRef]
- 45. Tsolaki-Fiaka, S.; Bathrellos, G.D.; Skilodimou, H.D. Multi-Criteria Decision Analysis for an Abandoned Quarry in the Evros Region (NE Greece). *Land* **2018**, *7*, 43. [CrossRef]
- 46. Brans, J.P.; Mareschal, B. PROMETHEE methods. In *Multiple Criteria Decision Analysis: State of the Art Surveys;* Springer: New York, NY, USA, 2005; pp. 163–186.
- 47. Andreopoulou, Z.; Koliouska, C.; Zopounidis, C. Multicriteria and Clustering: Classification Techniques in Agrifood and Environment; Springer: Cham, Switzerland, 2017.
- 48. Macharis, C.; Brans, J.P.; Mareschal, B. The GDSS promethee procedure. J. Decis. Syst. 1998, 7, 283–307.
- 49. Mareschal, B. Visual PROMETHEE 1.4 Manual; Visual PROMETHEE: Brussels, Belgium, 2013; p. 1.
- 50. Zopounidis, C. *Analysis of Financing Decisions with Multiple Criteria*; Anikoula Publications: Thessaloniki, Greece, 2001.
- 51. International Telecommunications Union. ICTs for a Sustainable World. 2018. Available online: https://www.itu.int (accessed on 7 February 2020).
- 52. Macharis, C.; Springael, J.; De Brucker, K.; Verbeke, A. PROMETHEE and AHP: The design of operational synergies in multicriteria analysis: Strengthening PROMETHEE with ideas of AHP. *Eur. J. Oper. Res.* **2004**, 153, 307–317. [CrossRef]



© 2020 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).