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MCIS 2011 Proceedings

Mediterranean Conference on Information Systems (MCIS)

2011

HOW GREEN ARE E-GOVERNMENT SERVICES?

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Abstract

Nowadays, organizations, governments, and cross-national bodies are turning their attention to the question of how we can create a sustainable society. As government is one of the main stakeholders that could enhance sustainability and the transition from government to e-government seems to be one of the main strategic choices of each government, a question arises on how much green are e-government services. Initially, e-government strategies targeted at reengineering public processes in order to produce a cost effective public sector and eliminating bureaucracy. Despite the fact that economic burdens and cost reduction remains a critical dimension, a new dimension, that refers to the environmental impact of e-government services, should be taken into account by governments during the configuration of their strategies. However, there is limited research on the environmental impact of e-government services and the development of a method that estimates the environmental impact of e-government services is necessary. This paper introduces an approach for assessing the environmental impact of e-government services by using a process based method and makes a first estimation of the environmental impact of e-government services. The results indicate that e-government services have different environmental profiles and that governments should take into account this parameter for setting priorities towards the enhancement of sustainability and the reduction of environmental impacts.

Keywords: e-government services, green IS, sustainability, environmental impact

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1 INTRODUCTION

Governments started e-government strategies to renew the public sector, eliminate existing bureaucracy and therefore reduce costs (Riedl, 2003; Tambouris, et al., 2001). Furthermore, governments aim at increasing the convenience and accessibility of government services and information to citizens. Fully integrated e-government services can enable the seamless information flow between organizations (IDA, 2003) and can provide ways of working not only within governments but also in their interaction with the administration, enterprises and public sector. As public budgets are shrinking all over the world and society is increasingly calling for more accountable public administration, governments try to reduce administration costs. The main source of these costs is the traditional use of paper as the linkage element between public agencies. Integrated electronic processes between public agencies can be the solution to reduce these costs and create a more efficient public sector (Joia, 2004).

As cost reduction seems to be a major issue, many efforts have focused on the estimation of the administrative burdens that involve services in the public administrations and in the public sector in general. The eGovernment Economics Project (eGEP) is an EU-lead initiative to measure the overall impact and assess the return-on-investment of eGovernment projects (European Commission - DG INFSO, 2006). Furthermore, the cost of providing a service by public agencies perspective has estimated by using a business process modeling approach combined with activity based costing method (Zampou, et al., 2009). Additional, an examination of whether investments in information and communications technologies are cost – effective has been conducted (Bergener, et al., 2008; Cresswell, 2006).

Even though, economic burdens and cost reduction are one of the main priorities of government policies, the environmental burdens of administrative processes connected to sustainability issues have come to the societal and governmental forefront. As the future of our ecosystem and society is dependent on our ability to reverse or limit the effects of our activities, organizations, governments, and cross-national bodies are turning their attention to the question of how we can create a sustainable society (Watson, 2008). Today many industries and businesses have accepted their responsibility in the deterioration of the natural environment and environmental responsibility has emerged as an inescapable priority for business leaders in every country (Porter and Kramer, 2006).

Governments should not ignore the current condition and should ensure eco-efficiency (DeSimone, et al., 1997), eco-equity (Gray and Bebbington, 2000), and eco-effectiveness (McDonough and Braungart, 1998) by adopting environmental strategies. According to Elliot (2011), governments should change their current behavior to improve the level of quality of the natural environment by reducing environmental degradation. A commitment to change behavior to realize this objective has been made by the governments of 192 countries through their ratification of the United Nations Framework Convention on Climate Change (UNFCCC, 2007). Furthermore, Gladwin et al. (1995) noted the necessity for appropriate public policies to push and pull organizations toward sustainability. Similar policies are needed for inducing citizens to environmental sustainable choices. As public participation is necessary for sustainability initiatives to be successful but the roles for individuals and the means of motivating them to profoundly change their current behaviors remain unclear (Garling and Schuitema, 2007; Myers and Macnaghten, 1998; Wolf et al., 2009; Elliot, 2011), governments should inform citizens about sustainability issues but also corporations can and should lead the way by helping to shape public policy and driving change in consumers' behavior (Hart, 1997).

Before governments designate their environmental strategy, there is the need to assess the environmental impact of the current processes and services provided by the public sector. So far, there is no approach that takes into account the environmental implications of e-government services and evaluates them based on different environmental factors.

The purpose of this paper is to approach e-government services from an environmental perspective and assess them based on environmental criteria. In our research, we used a process-based method in order to specify the parameters that configure the environmental profile of e-government services and

that differentiate them in terms of their environmental impacts, make a first estimation of the environmental impacts of e-government services and test our assumption that different services have different environmental profile depending on their characteristics. We estimated the environmental impact of e-governments services from the citizens' view. For the estimation of the environmental impact, we calculated the carbon emissions and the paper consumption that e-governments services cause and based on the results we identified the environmental profile of each service.

The paper is organized as follows. Section 2 presents a literature review of the field of e-government, green IS and sustainability. Section 3 shows analytically the methodology for assessing the environmental impact of e-government services. Section 4 presents the results of the research. Finally, Section 5 summarizes the basic conclusions, underlines the limitations of our research and specifies the next steps of our future research.

2 LITERATURE REVIEW

The digital governments tend to simplify drastically the flow of information between the different public agencies and the citizens. Online e-government services are expected to lead to an important reduction in the use of documents and e–mails. Consequently, it is anticipated that the provided services bring significant improvement (Dawes, et al., 1999). In order to estimate the anticipated improvement and the benefits of e-government services, different approaches have evolved. One approach looks at e-government services from a technical perspective. It focuses on the identification of the reasons-problems that hinder the adoption of new technologies. It also examines the way that these technologies solve the particular problems and finally assesses the gains of this decision (Abramson and Means, 2001; Fountain, 2001; Ho, 2002; Moon, 2002).

Another approach assesses the benefits of e-government services by having as focal point the citizen, his satisfaction and the degree of confidence for the government and the public administration. The supporters of e-government believe that the confidence of citizens towards the government as well as their satisfaction can be improved via the use of e-services. This can be achieved by providing higher level of services or by enhancing citizens' participation in governance. In the last approach, known as electronic democracy (Fountain, 2001), the technology undoubtedly plays an important role in strengthening democracy (Thomas and Streib, 2003).

In the frame of this approach, extensive studies and researches that refer to the quality in the development and the provision of e-government services have been elaborated (Halaris, et al., 2007). Some of these approaches for the control of the quality are the following:

- Customer satisfaction level in e-government (e.g.-CSI) (Kim, et al., 2005)
- American Customer Satisfaction Index for e-government (egov-ACSI) (American Customer Satisfaction Index, 2006)
- Quality of Norwegian public web sites (Jansen and Olnes, 2001)
- European top of the web (e-Government Unit, DG Information Society, European Commission, 2004)
- Interactive e-government (Barnes and Vidgen, 2003)
- User satisfaction of e-government services (Horan and Rayalu, 2006)

Furthermore, approaches that refer to electronic services in general can also be applied in the case of e-government services, taking into account the unique characteristics of this field. Indicatively, these are the Consumer perspective of e-service quality (Zhang and Prybutok, 2005) and the E-service quality (Lee and Lin, 2005).

Another approach refers to the cost assessment of e-government services either by citizens-businesses or from the perspective of the public sector. Zampou et. al. (2009) focus on the assessment of the administrative burdens that are caused by the services offered by the public administrations and the public sector in general. By using a business process modeling approach combined with the method of Activity Based Costing, they estimated the cost of e-government services and identified the most "expensive" services in terms of administrative burden. The eGovernment Economics Project (eGEP),

which is an EU-led initiative, has measured the overall impact and has assessed the return-on-investment of eGovernment projects (European Commission - DG INFSO, 2006). On the other hand, the Standardized Model of Cost (Organisation of the International Standard Cost Model Network, 2008) determines and estimates the administrative burdens imposed by regulation for businesses. Additional, some research effort has been conducted on eGovernment Project cost analysis (Becker, et al., 2008; Cresswell, 2006; Scholl, H.J., 2005) in order to recognize the cost factors around the service provision towards citizens and businesses. Last but not least, researchers have examined whether investments in information and communications technologies are cost–effective by using cost benefit analysis (Lu and Zhang, 2003) or a business process model-based evaluation (Becker et al, 2008).

However, there is no attempt up-to-now to assess e-government services by taking into account their environmental implications and evaluates them based on environmental factors, such as the anticipated carbon emissions, the reduction of paper consumption, energy use etc. Most of the past efforts have focused on greening IT in public sector and more precisely at reducing the energy consumption and carbon emissions of ICT infrastructure e.g. processors and chipsets, monitors, printers.

In literature, there are some research efforts that figure out policies and initiatives for environmentally sustainable outcomes and evaluate government policies at transnational, national, state, and local government levels (Elliot, 2011). The issues that they deal with extend from medical conditions afflicting children exposed to waste products (Tyshenko et al., 2009) to sustainable transportation systems (Elliot, 2011; Jeon and Amekudzi, 2005). Progress in evaluation of environmental development initiatives at all levels is constrained by the absence of universally accepted sets of indicators, as a result of "the ambiguity of sustainable development, the plurality of purpose in characterizing and measuring sustainable development, and the confusion of terminology, data, and methods of measurement" (Parris and Kates, 2003). A new suite of metrics is required to evaluate the diversity of policy outcomes since the effectiveness of a metric depends on the primary policy goal (IPCC, 2009). These efforts also include consideration, implementation, and evaluation of environmental governance; establishing mechanisms to resolve policy-level tensions between stakeholders; policy formulation, implementation, and assessment; and analysis of costs and outcomes of policy and regulatory compliance (Elliot, 2011).

On the contrary, in the supply chain and e-commerce research field, many researches that treat issues related to green practices and the assessment of environmental impacts of producing and delivering a product to the final consumer have been conducted.

In the supply chain literature, there are different research efforts that could classified into three categories based on the problems that they focus on. The first category refers to the importance of Green Supply Chain Management the second one to green design and the last one to green operations (Srivastava, 2007). In the first category, the literature focuses on the necessity and importance of Green Supply Chain Management and shows up how the perspective changes from greening as a burden to greening as a potential source of competitive advantage (van Hoek, 1999). As far as green design is concerned, there exist different efforts that emphasize both environmentally conscious design (ECD) and life-cycle assessment/analysis (LCA) of the product. The aim is to develop an understanding of how design decisions affect a product's environmental compatibility (Glantschnig 1994; Navin-Chandra, 1991). Madu et al. (2002) present a hierarchic framework for environmentally conscious design (Srivastava, 2008). The literature on green operations involves all operational aspects related to reverse logistics and network design (collection; inspection/sorting; pre-processing; network design), green manufacturing and remanufacturing (reduce; recycle; production planning and scheduling; inventory management; remanufacturing: re-use, product and material recovery) and waste management (source reduction; pollution prevention; disposal) (Srivastava, 2007).

In e-commerce, Fichter (2003) sorted out the environmental consequences of e-commerce and distinguished them in three main categories (Fichter 2001; Berkhout and Hertin 2001):

- First-order effects. E-commerce presupposes the availability of an ICT infrastructure (PCs, mobile phones, servers, routers, etc.). The production and use of the ICT infrastructure cause material flows, use hazardous substances, and lead to energy consumption and electronic waste.

- Second-order effects. E-commerce is transforming economic processes and markets. E-markets, virtual business networks, and the digitalization of products and services entail environmental consequences, for example, for resource productivity, transportation, and land use. These effects may be either beneficial or damaging to the environment.
- Third-order effects. E-commerce causes structural change of the economy and affects lifestyles and consumption patterns, which, in turn, indirectly affect the environment. If the rate of efficiency improvements (e.g., the miniaturization of devices) is lower than the growth rate of consumption (e.g., more devices used), we have the so-called rebound effect (Fichter, 2008).

Furthermore, some efforts have emerged in the area of e-commerce that compares the traditional vs. electronic channel of commerce. Weber et al. (2009) compares e-commerce versus traditional retail systems' energy use and greenhouse gas emissions through a case study of a product chosen to represent the retail process. Matthews (2002) conducted an LCA study, reviewing energy and cost impacts of logistics networks for the retail of books in Japan and the U.S.Abukhader (2002) proposed a methodology for assessing 'green supply chains' for e-commerce and analyzed the eco-efficiency of e-commerce supply chains (Abukhader, 2004). In another effort, the delivery of print products by digital means is examined (Toffel, 2004). Sivaraman et al. (2008) examined alternative logistics systems for DVD rental. Kim (2008) also examined book-retailing logistics. Williams and Tagami analyses the energy consumption for selling books via ecommerce and conventional retail (Williams and Tagami, 2003). Siicavirta (2003) studied the potential of e-commerce grocery home delivery to reduce greenhouse gas emissions in Finland.

3 RESEARCH CONTEXT AND APPROACH

In this paper, we present an approach for assessing the environmental impact of e-government services. The context of our research has been the e-government services provided by the Citizen Service Centers in Greece. The Citizen Service Centers are one-stop administrative shops that currently provide 1.046 services to citizens. Citizens can apply to these centers for the accomplishment of one of these services and can be served through different communication channels (e.g. face-to-face, web portal, call center). This context presents special interest for research, as these services are used extensively by citizens and are diverse in terms of both outcome and process followed. In addition, some of the steps, that constitute the process of providing a service, are executed electronically and the rest of them are executed following the traditional way in some cases. Consequently, services are provided in a combined way both online and offline.

Our preliminary research consists of two phases. In the first phase, we depicted the current process of service offering and identified the characteristics that differentiate the services from the citizens' perspective. Then, based on these characteristics, we categorized the various services in order to create classes of services with similar features. Our goal was to identify groups of services with similar environmental profiles. In the second phase, we made an initial estimation of the environmental impact of each of these classes by calculating the carbon emissions and the paper consumption. By estimating the environmental burden caused by offering these services in a mixed way (offline, online), we can estimate the environmental gain that can be achieved through the online delivery of these services in the form of e-government services.

The data used for this analysis have been collected through the public authorities supporting the Citizen Service Centers, refer to the 1.046 services that a center provides to citizens and the period covered is 2007-2008.

As this is the preliminary phase of our research, we estimated the environmental impact of e-government services caused only by the use of the service and we used basic assumptions regarding carbon emissions and use of paper. In the next phase of our research, we are going to use Life-Cycle Assessment (LCA) methodology to estimate environmental impact of e-government services both from the citizens' (i.e. use) and the public authorities' perspective (i.e. service provision). We intend to analyze the different phases that are required for providing each service by using LCA and characterize each phase in terms of its environmental impact. Our further goal is to

compare the traditional mixed way (online, offline) of providing a service with the fully electronic one.

The LCA is described as a process for assessing and evaluating the environmental, occupational health and resource-related consequences of a product or service through all the phases of its life, i.e. extracting and processing raw materials, production, transportation and distribution, use, remanufacturing, recycling and final disposal (Gungor and Gupta, 1999). The scope of LCA involves tracking all material and energy flows of a product or service from the retrieval of its raw materials out of the environment to the disposal of the product back into the environment (Arena et al., 2003; Miettinen and Hämäläinen, 1997; Tibben-Lembke, 2002).

In the pertinent literature, we find three approaches of LCA, the process-based LCA, the Economic Input-Output Life-Cycle Assessment (Green Design Institute, 2006) and the hybrid LCA. In a process-based LCA, one itemizes the inputs (materials and energy resources) and the outputs (emissions and wastes to the environment) for a given step in producing a product or executing a service. So, for a simple product, such as a disposable paper drinking cup, one might list the paper and glue for the materials, as well as electricity or natural gas for operating the machinery to form the cup for the inputs, and one might list scrap paper material, waste glue, and low quality cups that become waste for the outputs. However, for a broad life cycle perspective, this same task must be done across the entire life cycle of the materials for the cup and the use of the cup. Therefore, one needs to identify the inputs, such as pulp, water, and dyes to make the paper, the trees and machinery to make the pulp, and the forestry practices to grow and harvest the trees. However, this process-based LCA method, even for a very simple product, can quickly spiral into an overwhelming number of inputs and outputs to include. In order to overcome these issues in process-based LCA methods, the Economic Input-Output Life-Cycle Assessment (EIO-LCA) approach is developed. This eliminates the two major issues of boundary definition and circularity effects of process-based models and it captures all the economy-wide interdependencies. The Hybrid LCA models eliminate the limitations of using the process analysis-based LCA and the EIO-LCA separately. The hybrid models provide desired detail and economy-wide coverage. The EIO-LCA can be used as starting point based on the economic input-output life-cycle assessment database (Green Design Institute, 2006) and then process-based techniques can be used to increase accuracy.

By using LCA methodology, we will extend our approach by including more parameters that could configure the environmental profile of each service. In particular, we will estimate the energy consumptions, the carbon emissions, the paper consumption and other environmental parameters of the offline and online channel. Then, we will test the influence of distance traveled, the transportation mode, the communication channel and the reuse of electronic certificates to the final results. Another parameter that is expected to affect the final results is the location of the Citizen Service Centers and if it is in an urban area or not.

4 PRELIMINARY RESULTS

Citizen Service Centers provide 1.046 different services to citizens. Citizens can apply to these centers for the accomplishment of one of these services and can be served through three different interfaces. The first is a face-to-face interface, giving citizens the possibility to visit an office in their proximity and request a service, e.g. the issuing of a document such as a birth-certificate, identity card, driver's license etc. The second one is a Web Portal giving citizens the possibility to request some of the services online and the third one is a Call Center. For the majority of services only the first interface is provided. For only 104 of the services the web interface is available and only 94 of them can be requested through the Call Center.

Irrespectively of the communication channel used, the process followed by the citizen is similar. The citizen has to submit his/ her request choosing one of the alternative interfaces (Office, Web Portal, Call Center). In most of the cases, the request should be accompanied by a series of prerequisite documents. After that, an officer, who does all the necessary actions and is responsible for the preliminary check of the submitted documents, receives the request. Afterwards, the officer dispatches

the request and the submitted documents to the corresponding public agency that undertakes the examination of the request and the completion of the service, e.g. by issuing the appropriate certificate. The final answer and the released document are dispatched back to the initiating office that has the responsibility to notify the citizen about the response of the public agency. The process is completed when the citizen receives the requested document. The above process is followed for all the services but for 10, which are fully integrated and someone can complete them on-line by making an online application and getting the answer back (attestation / certificate) also electronically in his electronic locker. This process is schematically depicted in Figure 1 below.

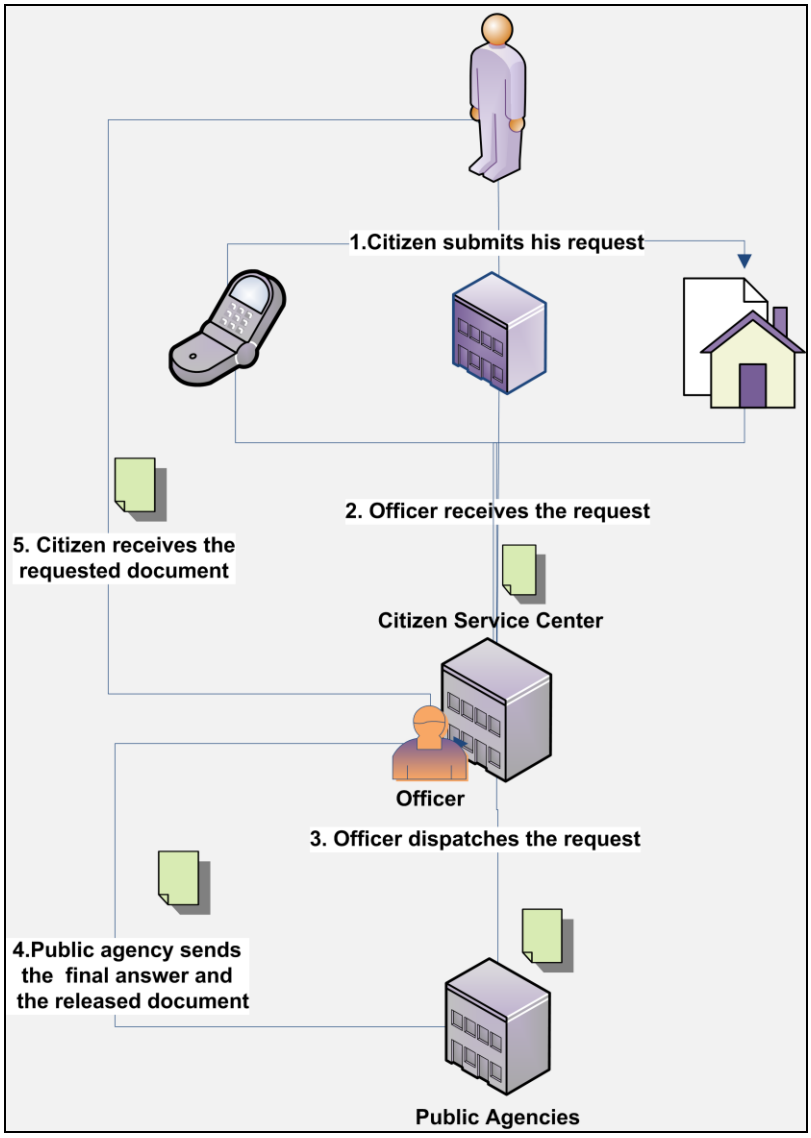

Figure 1. Process for executing and processing a citizen's request

Based on the process described above for handling and processing a citizen's request, we specifically look into the steps a citizen should follow in order to get the service. Our aim was to estimate the environmental impact of each service in terms of carbon emissions and paper consumption. Therefore, we had to identify the factors that could determine the level of carbon emissions and paper consumption. By examining the process that must be followed by a citizen, we concluded that the number of citizens' visits and the number of documents that are issued during the execution and processing of a citizen's request are the main factors that could affect the amount of carbon emissions and paper consumption.

Then, by examining thoroughly the steps that constitutes the process for providing each service, we identify these characteristics of services that differentiate them regarding the factors that are mentioned above. From the citizen's perspective, the various services can be discriminated by four characteristics:

- the degree of electronic integration,
- the number of involved public agencies,
- the number of prerequisites documents to be submitted together with the service request, and
- the type of answer/result

For example, many of the involved public agencies do not cooperate with the Citizen Service Centers, which means that citizens have to collect by themselves the prerequisite documents that are needed in order to submit their request. Furthermore, there are services that do not result in the issuing of a certificate. Based on these characteristics we distinguish five categories of services:

- **Class A.** In this category, we classified the services that can be processed in a full electronic way. There is no need for prerequisites documents. A citizen can submit his request electronically and receive the required certificate in his electronic locker. So, no visits to an office are required.
- **Class B**. In this category, we classified the services with electronic submission or submission via a Call Center. In this case, there is no need for a citizen to submit prerequisite documents. So, for a citizen it is sufficient to visit only the office once to get his certificate. Although, we have to mention that despite the fact that the electronic channel is available, some citizens prefer to execute their transactions in the traditional way by physically visiting a nearby office. In this case, a citizen needs to visit an office twice.
- **Class C.** In this category, we classified the services that do not have as result a document/ certificate that the citizen has to pick-up at the end and there is no need for prerequisite documents to be submitted with the request. In this case, only one visit to the office is needed in order to submit the request.
- **Class D.** In this category, we classified the services that do not have as a result a document/ certificate that the citizen has to pick-up at the end but there are prerequisite documents that need to be submitted together with the request. In this case, the number of visits depends on the number of prerequisite documents.
- **Class E**. In this category, we classified the services that cannot be requested electronically or via the Call Center, there are prerequisite documents but these that can be requested by the office from the cooperating public agencies and the output of the service is a document/ certificate that has to be picked-up physically In this case, a citizen has to visit the office twice in order to submit his/ her request and receive his/ her certificate.
- **Class F.** In this category, we classified the services that cannot be requested electronically or via the Call Center, there are prerequisite documents and these cannot be requested by the office from the cooperating public agencies and the output of the service is a document/ certificate that has to be picked-up physically In this case, the citizen has to visit each one of the non cooperating public agencies to collect the prerequisites documents and in addition visit the office twice in order to submit the request and receive his/ her certificate.

In the following table, we summarize the characteristics of each class.

	Class A	Class B	Class C	Class D	Class E	Class F
Electronic transaction	√					
Electronic submission or submission via Call Center	√	√				
Result	√	√			√	√

Prerequisite documents				√	√	√
Prerequisite documents from non cooperating public agencies				√		√

Table 1. Characteristics of each class

We examined the process followed for each one of the 1.046 services and we classified the services into the above 6 classes. Despite the fact that the most of services are classified in Class F, we notice that the total frequency in this class is not as high as it is anticipated by the number of services. Specifically, in Class B the frequency is much higher than the frequency at Class F. Both the number of services and the total frequency of services in each class are shown in the following figure.

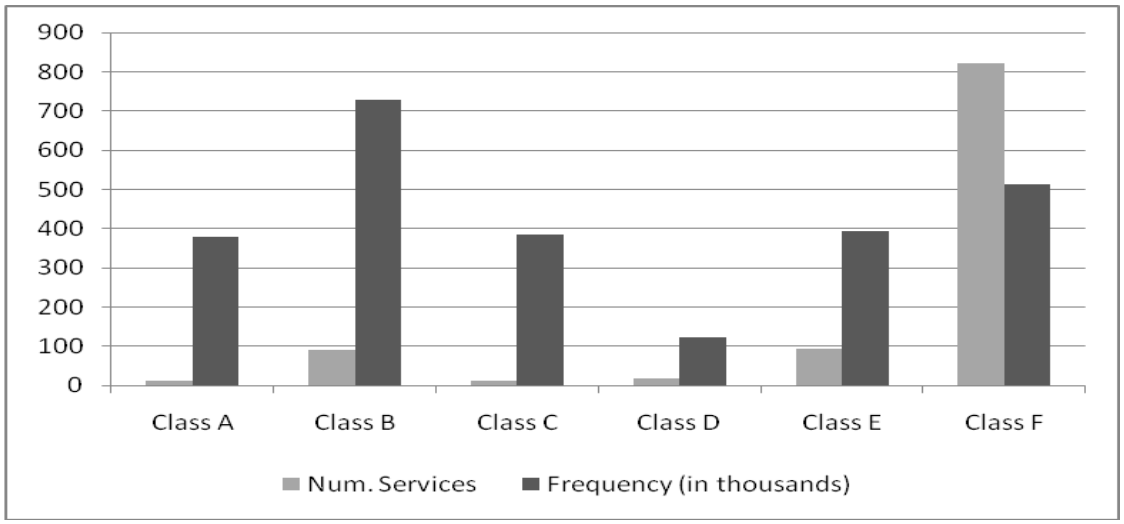

Figure 2. Number of services in each class

Based on this classification, we made a first estimation of the environmental impact of these services from the citizens' perspective. As main environmental impact, we consider the carbon emissions resulting from the physical visit of citizens to Citizen Service Centers. Based on the number and geographic distribution of the Citizens Service Centers, we assume that the average distance a citizen has to travel in order to visit a Service Center is about 5 km. As there are no statistics available about the transportation mode a citizen uses in order to visit an office, but based on the relatively high use of private cars in Greece, we assume that 50% of citizens use their car to visit the Service Center office and the rest 50% go on foot or by public transport. Based on the Greek Association of Motor Vehicle Importers-Representatives (AMVIR) the carbon emissions of an average cubic car are 140 gr/km. Thus, based on the above assumptions, we estimate the average carbon emissions per class of services.

In the following table, we summarize the number of visits and the paper consumption per service in each class. The "*docs*" element in the table refers to the number of prerequisites documents that a citizen should collect by him/herself by visiting public agencies that do not cooperate with Citizens Service Centers. For each of the prerequisite documents at least two visits are required at the responsible public agency. The environmental burden associated with any more visits that may be required in order to issue the prerequisite documents is not taken into account. Furthermore, for the estimation of paper consumption we took into account the number of papers issued during all the process steps for the delivery of a service. These include: the prerequisite documents, the submission paper and the resulting certificate.

Class	Num_Services	Num_Visits	Paper_Consumption (Num of pages)

Class A	12	0	0
Class B	90	1 or 2	1 or 2
Class C	11	1	0
Class D	19	1+2*docs	1+docs
Class E	93	2	2
Class F	821	2+2*docs	2+docs

Table 3. Number of visits and paper consumption per service in each class

For estimating the average carbon emissions and the average paper consumption of a service in each class, we multiply the numbers of visits and the paper consumption by the frequency respectively.

In the following figures, we show the average carbon emissions and the average paper consumption of a service in each class.

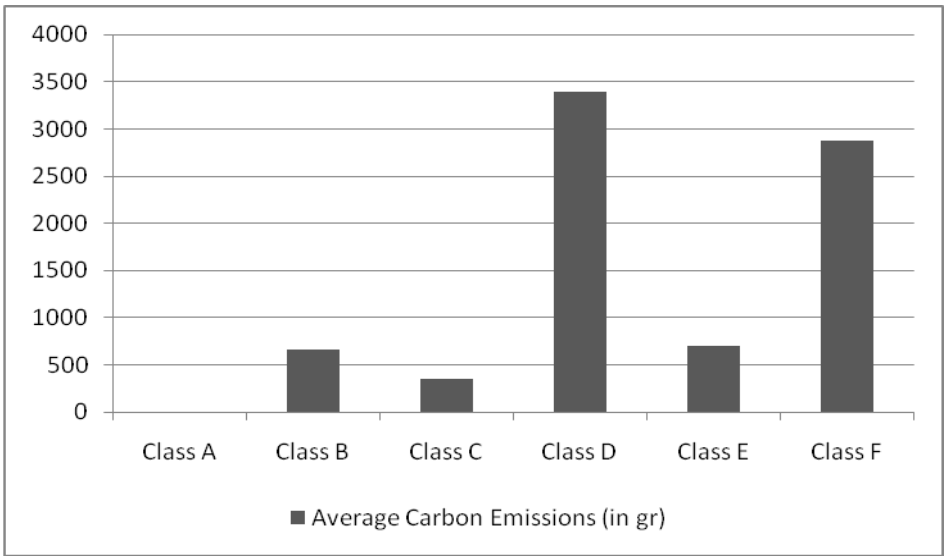

Figure 2. Average carbon emissions per service in each class

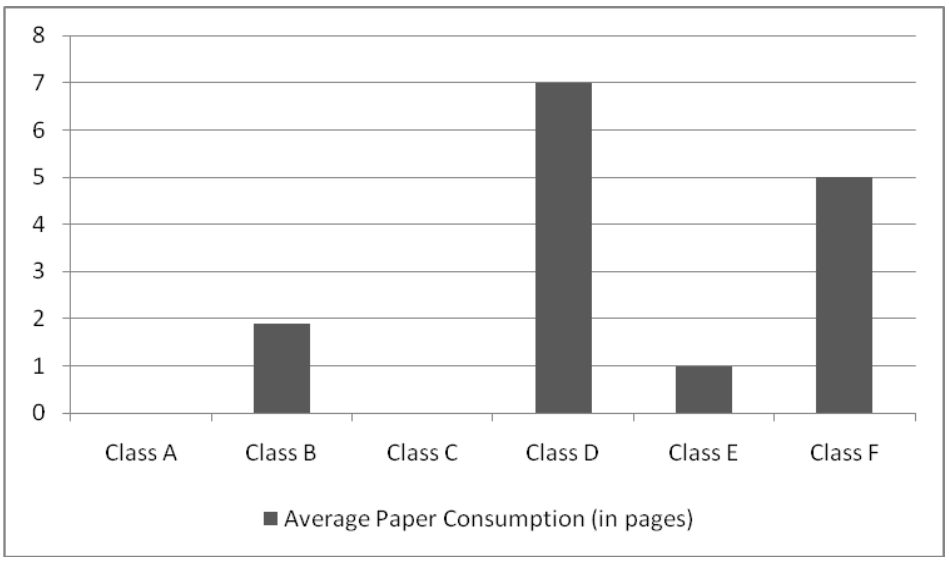

Figure 3. Average paper consumption per service in each class

In Figure 4, total carbon emissions and paper consumptions per class are illustrated.

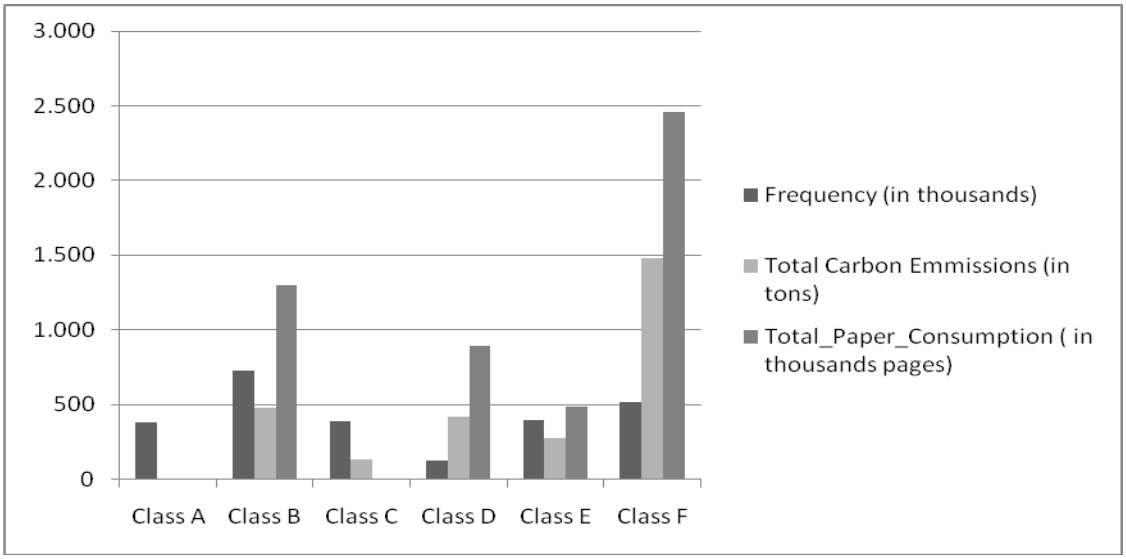

Figure 4. Total carbon emissions and paper consumption in each class

5 DISCUSSION AND RESULTS

By estimating the environmental burden caused by offering the above services offline, we can estimate the environmental gain that can be achieved through their online delivery as e-government services. The results of our preliminary research indicate that certain classes of e-government services can result in significant environmental savings compared to other classes. It appears that the number of visits combined with the number of prerequisite documents configure the environmental profile of an e-government service. The environmental profile and the carbon footprint of each service can be taken into account in order to select some representative services in order to conduct further in-depth research.

Furthermore, our results estimate the environmental impact caused by the current mix (online and offline) of offering the various services. We have a first estimation of the environmental consequences of providing almost manually the majority of e-government services. It is shown that the services that require a citizen to submit documents that are issued by public agencies that do not directly cooperate with the Citizen Service Centers have the greatest impact on the environment. Also, the total impact of services of Class B, where the electronic submission is provided, is remarkable. Even though the web portal and the call center are provided, most of the citizens prefer to visit the Citizen Service Centers in order to submit their request. This indicates that citizens feel more confident to use the traditional way and demonstrates that the first step governments in the direction towards enhancing sustainability and reducing environmental impact is to promote and increase the adoption of the already provided e-government services. This is also an interesting area for further research, i.e. to study whether communicating the environmental gain achieved through online transactions can drive the adoption of e-government services.

Based on the results, we conclude that e-government services can provide solutions to the environmental problem. The possibility for a citizen to fully request and get a service online would render, except for important cost savings for the public authorities and increased citizen satisfaction, reductions of carbon emissions and paper consumption. Paper use does not only create a problem of waste and exploitation of natural resources, but also has a significant impact on global warming (Counsell, 2006). However, further analysis is required in order to estimate more precisely the impact of e-government services. The results of such a study could support strategic choices of governments regarding the development of e-government services, promote the notion of environmental friendly e-government services and the creation of a more environmental conscious public sector.

Our preliminary research has several limitations that should be handled in the next phase. First, the estimation of environmental impact was made taking into account only the citizens' perspective. We

ignored the environmental impact, e.g energy consumption of executing a service in a fully electronic way. Furthermore, we estimate the carbon emissions based on rough assumptions about the transportation mode that the citizens' use and the distance travelled. We also do not examine the legal requirements and the legal obstacles that could be raised during the electronization of the e-government services.

In our future research, we will select the most representative services of each class taking also into account the frequency of execution. We will then compare the traditional way of providing a service with the electronic one by using a hybrid method of LCA. Our analysis will include the different phases that are required for providing the service and will characterize each phase in terms of its environmental impact. Finally, we will make a sensitivity analysis to show how the parameters of the distance traveled, the transportation mode, the communication channel provided and the reuse of electronic certificates affect the final results.

Aknowledgments

This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heracleitus II. Investing in knowledge society through the European Social Fund.

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