

Analysis of Green IT Challenges for Macedonian Companies

Daniela Gavrilovska, Vladimir Zdraveski, and Dimitar Trajanov

Abstract — The Green IT concepts, very popular among large companies worldwide, seems to have many obstacles in some areas/communities, despite the possibility of saving money. The contribution of this paper to the scientific discussion of Green IT is based on the research done among Macedonian companies and we comment on the challenges they are faced with in implementing Green IT concepts and we introduce a few recommendations for next steps.

Keywords — benefits, Green IT, obstacles, profit

I. INTRODUCTION

Green IT is a large set of initiatives, aimed at directly decreasing the amount of CO₂ emissions from IT equipment. It is not only focused on preventing pollution in the environment, but also tries to utilize IT services in order to assist in an organization's impact on the environment globally. Therefore, Green IT consists of a systematic approach in implementation of the concepts of ecology (pollution prevention, recreation of products, using clean technologies) in design, production, procurement and other parts of the industry.

Green IT initiatives' influence in the IT industry become important with the increased use of computers since the early 90's. The late 90's and early years of the 21st century are witnesses of the first regulations in this field. Recent years are proof of companies' involvement in the process of development and application of Green IT concepts in practice.

In 2005 the first Council of green electronics was established, it focused on electronics and their sustainability. A product of this council is the electronics devices and environment evaluation tool (EPEAT) [1].

The ICT industry has a very large impact (almost a tenth) on the total electrical energy consumption in the European Union. The impact on the total carbon emissions and personal computers' consumption reach around 10% (up to 50%) of the total electricity bills of companies, even increasing by 5% per year.

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The above leads to a conclusion that companies have to start implementing Green IT, but they have to believe in these concepts and their long-term benefits. The only way to persuade them to implement Green IT is to provide them financial charts and explain to them the revenue model behind the Green IT concepts [2][3][4].

II. THE OVERALL STATE IN MACEDONIA

Companies in Macedonia seem to be familiar with most of the Green IT concepts and some of them have already gone very far in the implementation process. Below, we will do a brief analysis of some of the concepts, identifying their implementation stage and commenting on the reasons for a successful implementation or the obstacles to a late implementation.

The overall picture of the implementation level of Green IT in Macedonia is shown in Fig. 1. One third of the companies already have some local implementation, following the global trends of Green IT, but obviously almost 70% of them have not made any improvement.

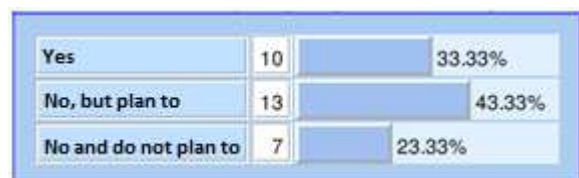


Fig. 1. The overall picture

Most frequently mentioned parts of Green IT are virtualization, cloud computing, data center management and organizational motivation factors. Each of them seems to have its own challenges, depending on the type and size of the company.



Fig. 2. Companies profiles

The data collected in a survey among 30 companies in Macedonia is used in this analysis, but also some of the comments and conclusions are based on the informal

discussions with representatives of most of the companies, revealing the main factors responsible for implementation or lack of implementation of the Green IT concepts [5]. The survey is described in details in [6] and here we will use some of the conclusions and measurements done in that work. The profiles of the companies that filled the survey form is shown in Fig. 2.

III. ANALYSIS

A. Virtualization

Virtualization is probably the easiest way to implement Green IT in organization of any type or size, because it provides a better utilization of computer hardware.

The lack of complications and the obvious benefits seem to be the key factors, so most of the companies in Macedonia have already migrated some part of their software onto a virtual infrastructure. The main benefit of this is smaller bills for electricity. A physical server needs almost the same amount of energy, regardless of the processing load, which leads to a conclusion that a reduction in number of servers means less power consumption and less money spent on it.

Other benefits are the lack of coolers and the lack of useless old hardware in the future, which also spares money and equipment replacement effort, usually done until few years ago.

Mainly, companies virtualize their servers and storages, but cases of desktop, application and network virtualization are very rarely found.

The actual percentage of the implementation of virtualization concepts among companies in Macedonia is presented in Fig. 3. Although considered as a good rate of implementation, we have to note that some of the companies are not yet aware of the benefits of virtualization [7] or want to get a last breath out of their existing hardware.

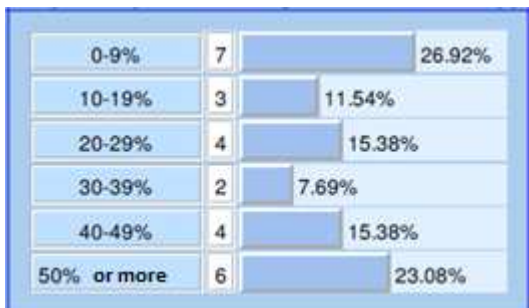


Fig. 3. Virtualization infrastructure in Macedonia

B. Cloud computing

Questions and doubts of what is and what is not a cloud are present among companies in Macedonia, but generally they are aware of the big picture and the main advantages. They mainly see the cloud as a step forward in the way towards virtualization, i.e. virtualization without the need to own the hardware [8].

According to our survey, only 10% of Macedonian companies use cloud services and an additional 23% are in the phase of migrating some of their services in to the cloud. Compared to Symantec's survey in 2009 and other

analysis done worldwide [9][10], we may conclude that Macedonia actually follows the Green IT trends [11].

C. E-waste

E-waste is a generic term representing old, useless devices, that are made of components with a power supply. In the set of e-waste belong devices with batteries, but also solar and wind powered devices.

On the contrary with the previous two Green IT concepts, this one is not something that Macedonian companies are very familiar with in details, except for the fact that they know that can profit from selling the old equipment or replacing it for a new one with a surcharge. They actually take part in old-new equipment replacements initiatives or equipment recycling events. The exact numbers, on their participation frequency in similar events, collected from the survey form are shown in Fig. 4.

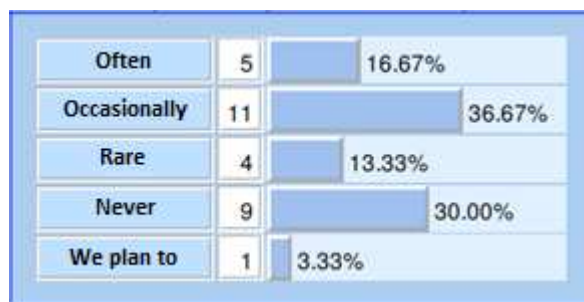


Fig. 4. Companies participation frequency in equipment replacement or recycling events

On the other hand, about a third of the companies, that do recycle their equipment, know about the ethics and common rules in recycling of e-waste [12], but the other part of them either do not recycle the equipment at all or are not familiar with the proper terms of recycling, presented in Fig. 5.

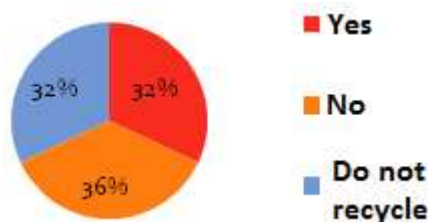


Fig. 5. Recycling terms familiarity

D. Data center management

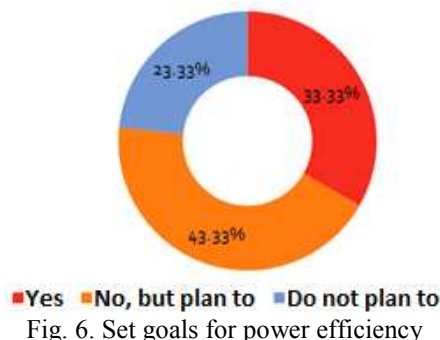


Fig. 6. Set goals for power efficiency

The fast growth of e-society actually causes more and more data centers to appear and improves the existing ones. Green data centers can help us to reduce the greenhouse gases, which in turn means reducing the global warming.

Unfortunately, most of the companies in Macedonia do not have goals for power efficiency improvements of their IT departments. But almost half of them plan to do so, which is quite an optimistic fact, shown in Fig. 6.

More than a half of the respondents analyze the electricity bills, Fig. 7, but only 23% of them monitor the part which represents the costs of the IT equipment. 13.33% of the respondents are not able to estimate the amount of the electricity bill, which leads to a conclusion that these companies are barely aware of the IT equipment impact on the total electricity costs [13].

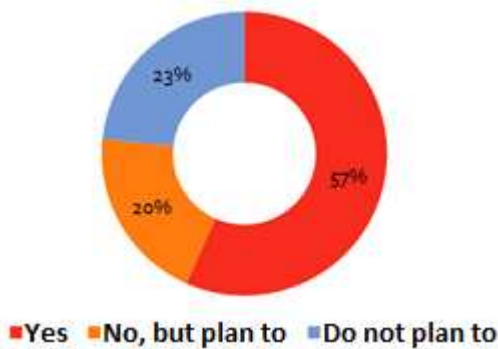


Fig. 7. Electricity bill analysis

In TABLE 1 are shown the respondents votes (5 - strong, 1 - weak) on the impact of the offered power consumption factors. The result is very interesting, since the average impact of each factor is the same (7%). This fact states that the companies are very familiar with the methods for power saving and we can explain that with its tight relation to the electricity bills, that companies are always worried about this.

TABLE 1 : POWER CONSUMPTION FACTORS IN [%].

Factor	5	4	3	2	1	Tot.
Multicore processors	23	63	13	0	0	7
Power efficient CPU	20	73	7	0	0	7
Improved air-flow racks	40	57	3	0	0	7
More efficient systems	33	40	27	0	0	7
Virtualization and consolidation	53	33	3	10	0	7
Improved utilization of the storage devices	27	53	20	0	0	7
Thin clients provisioning	13	40	37	7	3	7
Data duplication avoidance	27	40	13	17	3	7
Liquid cooling of the IT equipment	17	27	30	17	10	7
Fresh air cooling	20	47	27	3	3	7
Power efficient lights	20	37	33	7	3	7
High voltage in AC systems	10	27	47	13	3	7
Solar energy	33	17	40	3	7	7
High level of stand-by equipment efficiency	33	30	27	3	7	7

E. Organizational motivation factors for Green IT

Rules given by the authorities are always crucial for implementation of any concept, including the Green IT concepts. There is an obvious progress in countries that have legislation and laws on Green IT or other environmental concepts, such as the United Kingdom [14]. Macedonia is at the very beginning in terms of existing legislations, except for the law of e-waste management, that is already applied [15].

In TABLE 2 is shown the impact (1 - low, 5 - high) of each of the Green IT acceptance factors, according to the votes of the companies. Again, we got the same average impact, 17%, for each factor. Anyway, it seems that the height of IT costs is very important for the companies and also the competitors behavior seems to be a motivating factor in terms of implementing more and more Green IT concepts [16][17]. On the other hand, companies are always scared of government pressure and implement what is required by regulatory commissions or similar authority, since it is a necessary condition in gaining licenses and certificates of different types.

TABLE 2 : GREEN IT ACCEPTANCE FACTORS IN [%].

Factor	1	2	3	4	5	6	Tot.
Decreasing the IT costs	50	13	20	10	7	0	17
Environment protection	23	50	10	13	0	3	17
Socially accepted brand	3	20	23	30	7	17	17
Government/EU regulations	20	7	37	20	3	13	17
Customers pressure	3	3	3	17	43	30	17
Competitors activities	0	7	7	10	40	37	17

Companies are also aware of the obstacles they are faced with during the process of implementation of Green IT solutions and the main identified problems are shown in TABLE 3, treated with almost the same average level of impact of 20%. Grade 1 stands for "very strong" and grade 5 means "negligible" obstacle.

The high price of Green IT solutions is the main obstacle together with the unclear business model, behind them, TABLE 3. They are not familiar with the fact that although the price of the Green IT solutions is higher than other solutions, the Green IT ones become cheaper in a long term period, because of the benefits, such as lower electricity bills. We consider that Green IT is missing in the strategic plan and goals of the companies and there is obviously a lack of long term analysis from the IT equipment investments.

TABLE 3 : GREEN IT OBSTACLES IN [%].

Obstacle	1	2	3	4	5	Tot.
Green IT solutions price	60	13	7	13	7	20
Unclear business model	13	37	23	17	10	20
Lack of government initiatives	17	23	20	33	7	20
Lack of education and skills	10	27	37	13	13	17
Lack of EU pressure	0	0	13	23	64	17

IV. CONCLUSION

In Macedonia, the Green IT acceptance rate, awareness and motivation depends on the size and the type of the company. Some practices are implemented up to a satisfactory level, but others are not present at all. The most frequently implemented concepts are remote access and control, client education not to leave computers turned on during the night, printing optimization and the concept of virtualization.

According to companies' answers to the questionnaire,

we strongly recommend them to hire consultants that will explain them the Green IT concepts and the business model available behind them, thus providing them the required knowledge for Green IT motivation and awareness. The companies should learn more about the types of virtualization as well as the wide range of cloud services available, depending on the size and type of the company. They will also need some level of education in the field of e-waste and equipment recycling, although the main problem generators seems to be the equipment sellers and not the companies that use the hardware themselves.

The government's regulations and laws play a very important role in the implementation of the Green IT concepts. The law of e-waste, that forces the companies to treat e-waste with a certain care and following recycling principles. Also the equipment sellers have to provide a service for collecting back the old, useless equipment from their customers and do the recycling process on their own.

Although, companies are already aware of the IT equipment impact on the total electricity bill, they do not do or plan much about tracing and estimating these costs. We think that they should simply start to measure them and they will find out how important would be any investment or improvement in terms of Green IT data centers or other Green IT equipment.

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REFERENCES

- [1] EPEAT, <http://www.epeat.net/>
- [2] Molla, A. "Organizational Motivations for Green IT: Exploring Green IT Matrix and Motivation Models", PACIS 2009 Proceedings, 2009.
- [3] Dick, Geoffrey N. and Burns, Max, "Green IT in Small Business: An Exploratory Study" (2011). SAIS 2011 Proceedings. Paper 20.
- [4] Dedrick, Jason (2010) "Green IS: Concepts and Issues for Information Systems Research," Communications of the Association for Information Systems: Vol. 27, Article 11.
- [5] Ere, Koray; Loeser, Fabian; Schmidt, Nils-Holger; Zarnekow, Ruediger; and Kolbe, Lutz M., "Green It Strategies: A Case Study-Based Framework For Aligning Green It With Competitive Environmental Strategies" (2011). PACIS 2011 Proceedings. Paper 59.
- [6] D. Gavrilovska, V. Zdraveski, D. Trajanov, "Implementation of Green IT concepts in R. Macedonia", *ETAI 2013*, Ohrid, September 2013.
- [7] M. Uddin, A. A. Rahman, "Virtualization Implementation Model for Cost Effective & Efficient Data Centers", *IJACSA*, Vol. 2, No. 1, January 2011.
- [8] Murray, S. and Watson R. "The Value of Green IT: a Theoretical Framework and Exploratory Assesment of Cloud Computing", *Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future*, June 2012, Bled, Slovenia.
- [9] Bharathi, Vijayakumar and Raman, Ramakrishnan and Pramod, Dhanya, A Principal Component Analysis to Identify the Green IT Factors that Impact ERP Adoption in Indian Small and Medium Enterprises (March 1, 2013). *European Journal of Social Sciences*, Vol. 37, No. 4, pp. 559-582, March 2013.
- [10] Khan, S., Razak A. H. and Kumar V. K. " Prioritization of Green IT Parameters for Indian IT Industry Using Analytical Hierarchy Process", *World Journal of Social Sciences* Vol. 1. No. 4. September 2011. Pp.179-194.
- [11] Hanne, F. Z. " GREEN-IT: Why Developing Countries Should Care?", *IJCSI International Journal of Computer Science Issues*, Vol. 8, Issue 4, No 1, July 2011.
- [12] Schulep M. et al. 2009. Recycling: from E-waste to Resources. StEP Initiative, UN University-UN Environmental Programme
- [13] Otto VanGeet, Best Practices Guide for Energy-Efficient Data Center Design, National Renewable Energy Laboratory (NREL), U.S. Department of Energy, 2011
- [14] UK environmental laws <http://www.legislation.gov.uk/all?theme=environment>
- [15] Macedonian law for electornic and electrical waste management <http://www.moep.gov.mk/WBStorage/Files/Nacr%20Zakon%20za%20upravuvanje%20so%20elektricna%20i%20elektronska%20oprema.pdf>
- [16] Molla, Alemayehu and Abareshi, Ahmad, "Green IT Adoption: A Motivational Perspective" (2011). PACIS 2011 Proceedings. Paper 137.
- [17] Rohit Nishant, Thompson S.H. Teo, and Mark Goh. "Do Green IT Announcements Improve Market Value Of Firms?" PACIS 2011 Proceedings (2011).