ENVIRONMENTAL PERFORMANCE IMPROVEMENT AND ENVIRONMENTAL MANAGEMENT SYSTEMS (EMS) IN UNIVERSITIES. SPECIAL FOCUS IN THE TEI OF PIRAEUS CAMPUS

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EXTENDED ABSTRACT

Nowadays, an increasing number of Educational Institutions have become aware of their environmental impacts, together with their social and environmental responsibilities and have started taking an active role towards that direction. Environmental Management Systems (EMS) have been primarily implemented in companies and organisations in order to improve their environmental performance by setting goals and starting activities for reducing or mitigating these impacts and trying to certify their achievements. Although these tools and practices have extensively been used by industries and corporations, the ideas of Standardisation, Environmental Consciousness and Performance in Educational Institutions have been followed quite later, with the majority of organisations, at least at European Level, balancing between standardised environmental systems applications (ISO 14001, EMAS) and not standardised ones, fulfilling each campus' needs. Respectively, in Greece the progress of EMS applications in Universities has been rather limited, with only a few exceptions, although many Universities show increased interest in improving their environmental performance. Acknowledging the above, the aim of this research is to highlight the main environmental impacts of a University Campus, to focus in activities that would improve the environmental performance and define the steps that a university must follow for the design and successful implementation of an Environmental Management System (EMS). The Campus of TEI of Piraeus has been served as a case study for the implementation of the ideas of the present work providing / mapping some qualitative and quantitative data concerning its energy consumption, mobility issues, types of activities and resulting solid and liquid wastes, working hours and end users.

Having that as a ground information field, and seeking to be more realistic and effective, the work makes suggestions for the development and implementation of an EMS in TEI of Piraeus, stressing also the fact that, in case this EMS is certified, TEI of Piraeus will be the first TEI of the country with a certified EMS.

The work is a part of ongoing research and development activity in the field taking place in our Labs in TEI of Piraeus.

Keywords: Environmental Management System, ISO 14001, TEI of Piraeus, energy performance, universities environmental impacts

1. INTRODUCTION – AIMS AND SCOPE OF THE WORK

Educational institutions and more precisely University Campuses (UCs) are challenged to take a leadership role in the issues of sustainability, due to their high societal impact, as they train the next generation of decision-makers, the youngsters and they are very well respected from the society in general. To that end, universities can have a vastly greater
impact on sustainable development and education than any other single sector of society as they can provide experiential knowledge, a knowledge that once acquired, remains always a possession of the individual. On top of that, the application of EMSs in UCs can provide the opportunity to any laboratory and/or department of the school to assemble an environmental policy / envelope with specific aims and goals.

In terms of popularity at the moment the most commonly applied EMS are the international standard ISO 14001 and the EU-regulation Eco-management and Audit Scheme (EMAS). At the time of this study, the total number of ISO 14001-certified organisations at EU level with the latest data available (2010, data from Eco-Innovation Observatory, 2013a), reaches approximately 99,000 companies with the assorted number for EMAS registered organisations and sites to be almost 13,000 (2010, data from Eco-Innovation Observatory, 2013b). Narrowing down the figures for Greece, the resulting ones for ISO 14001 are reaching ~600 companies and for EMAS ~900 sites and organisations.

In general the research and academic institutions are seeking to improve their environmental performance and comply with environmental legislation by applying energy conservation measures, wastes management, recycling and other similar actions, (Alshuwaikhat M.H., Abubakar I., 2008). In Greece at the moment only few and limited examples (University of Macedonia, University of Aegean), are applying -or had applied in the past- a formal EMS, either EMAS and/or ISO 14001. On the contrary, at European level many colleges and universities are widely recognising their own goals by providing methodologies for achieving environmental sustainability and expressing their desire to act as cutting edge examples of these increasingly high priority principles and practices (Disterheft et al., 2012).

However, for UCs the list is quite smaller and not very well documented. According to the latest available data from ESYD (Hellenic Accreditation System) from the total of the 12 accredited bodies for the assorted Standard (ELOT EN ISO/IEC 17021), under the specific accreditation field of EMSs according to ELOT EN ISO 14001, only two have the NACE Code: 85.41 which refers to tertiary education. The communication with them evidenced that, although there were some coordinated efforts on the side of ISO 14001 form Greek UCs (the ones aforementioned) at the moment no renewals are made.

Acknowledging the above, the aim of this research is to highlight the main environmental impacts of a University Campus in general, to focus in activities that would improve the environmental performance and define the steps that a university must follow for the design and successful implementation of an Environmental Management System (EMS). The Campus of TEI of Piraeus has served as a case study for the implementation of the ideas of the present work providing / mapping some qualitative and quantitative data concerning its energy consumption, mobility issues, types of activities and associate wastes, working hours and end users. In addition, some specific actions are suggested for the improvement of the environmental behaviour of TEI of Piraeus and the first steps for the development of an EMS (more specifically ISO 14001) are analysed.

It should be noticed that the present work is part of ongoing research activity taking place in our Labs (including dissertations, publications and EMS development) trying to identify the environmental impacts of TEI of Piraeus campus, to take specific actions for their mitigation and to develop and implement an EMS to be certified with ISO14001 or EMAS standard. Furthermore, it should be highlighted that these incentives will make TEI of Piraeus a pioneer amongst the Greek Technological Educational Institutes in terms of environmental behaviour.

2. THE ENVIRONMENTAL PERFORMANCE AND ISSUES OF UNIVERSITY CAMPUS (UC)

Assessing environmental aspects and impacts of a UC can be particularly difficult. The complex operation of a campus, the participation of different groups (students, academic staff and employees), the laboratories, recreation areas, parking areas, the vague organisational structure as well as the differentiated operational time-intervals of the various human groups and facilities make the identification and prioritisation of environmental aspects and impacts a very challenging task. In order to identify potential environmental concerns, the environmental effects of various institutional activities from office work to production processes and laboratory operation should be considered. The major environmental impacts of UCs are mainly distinguished into direct and indirect, depending on whether the activities that generate them originate from the basic and essential activities of the University or its administrative control.

Table 1. Environmental core indicators (EMAS, 2013)

<table>
<thead>
<tr>
<th>Environmental key area</th>
<th>Input/Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy efficiency</td>
<td>Total annual energy consumption (in kWh)</td>
</tr>
<tr>
<td></td>
<td>Total renewable energy use as a percentage of total annual consumption of energy (electricity and heat)</td>
</tr>
<tr>
<td>Material efficiency</td>
<td>Annual mass-flow of materials used (excluding energy carriers and water) (in tn)</td>
</tr>
<tr>
<td>Water</td>
<td>Total annual water consumption (in m³)</td>
</tr>
<tr>
<td>Waste</td>
<td>Total annual generation of waste (in tn)</td>
</tr>
<tr>
<td></td>
<td>Total annual generation of hazardous waste (in tn)</td>
</tr>
<tr>
<td>Use of land</td>
<td>Use of land (in m² of built-up area)</td>
</tr>
<tr>
<td>Traffic and mobility</td>
<td>Number of cars, buses that are used for the transportation of students and personnel</td>
</tr>
<tr>
<td>Emissions</td>
<td>Total annual emission of greenhouse (in tn of CO₂ equivalent)</td>
</tr>
<tr>
<td></td>
<td>Total annual air emission (in tn)</td>
</tr>
</tbody>
</table>

The environmental aspects of the University may also be hierarchically ranked on the basis of their environmental significance into two main categories: Non-significant and significant. Although ISO 14001 requires organisations to identify their significant aspects, it gives no guidance on how to do so; this is left entirely upon to the individual firm or organization. Judgements about whether aspects are or are not significant will always to some extent be subjective but should be made as consistent as possible by establishing a well documented methodology for evaluation. The evaluation of aspects shall be done according to specific prioritisation factors, which may include the following:

- The extent of the environmental impact
- The severity of the environmental impact or magnitude of positive impact regarding its indirect aspects
- The duration of environmental impact
- The likelihood of the impact to happen
- The institution’s possibility to control and potential to make changes
- Legislation, market and other demands
- The local society’s environmental principles and standards

In the following section a short review of the implementation status of EMS in UCs in EU, USA and in Greece will be cited acknowledging the key priority areas as well as the type of the environmental aspects, in each case that is described. In any case, the description of the EMS implementation in UCs as well as the focus of the present work takes into consideration the environmental core indicators as they are recorded in Table 1.

3. THE EMS IMPLEMENTATION IN UCs - EXISTING EXPERIENCE - IMPLEMENTATION STATUS IN GREECE

Considering EMS implementation background in UCs, ISO 14001 started being applied in educational institutions in 1996 in the University of Queensland in Australia and several
campuses followed after that. According to a recent survey (Disterheft et al., 2012) 47 universities in Europe have been identified to pursue an EMS at the campus (the 47 universities identified with an EMS either formal - ISO 14001, EMAS - or non formal one, are located in 14 different countries).

In USA, the Environmental Protection Agency (EPA) back in 2000 (EPA, 2000), issued an Enforcement Alert to “Universities and Colleges Not Receiving Top Marks for Environmental Compliance” and insisted that Educational Institutions should hold the same standards as industry. In that issue, several enforcement actions were acknowledged providing useful resources and suggestions for how educational institutions could ensure environmental compliance and thus avoid EPA enforcement actions. Considering the implementation status of EMS in US UCs, apart from ISO 14001, Osnabruck model and another under development by the South Carolina Sustainable Universities Initiative, are the only two EMS models “that have been proposed specifically for colleges and universities, although several guides are now available” (Savely et al. 2007). Similar results gained from an internet research conducted in over sixteen US Universities, (random sample, based on the availability of the required information) evidenced that UCs although in their majority were implementing an EMS (an informal one, campus-specific and oriented), the goals and the overall strategy over the model of green procurement, reduction of energy use and minimisation of carbon footprint, seemed to be uniformly adopted. Their priority strategy seems to embrace the following principles:

- Reduced use of conventional fuels
- Selling of the recyclables
- Selling of the produced RES in the local network (balancing off the UCs' needs).

As far as the Greek UCs are concerned, at the moment there are just a few coordinated efforts in terms of application of a formal EMS either in an integrated campus basis and/or in a sole department. These are presented as follows:

**University of Macedonia (UOM):** The University of Macedonia (UoM), Economic and Social Sciences, is one of the first Greek Universities (2005) implementing an EMS under the principles of EMAS. The University has almost 15,500 students and 863 employees. The project was co-financed by LIFE-Environment, European Commission, DG Environment. The main partner in the project’s implementation is the Municipality of Thessaloniki. The major improvements made from EMAS implementation during the period 2004-2008 (EU-EMAS, 2013) include very specific and promising reduction of resources usage, recycling quantities and behavioural changes: i.e. reduction of paper consumption per faculty and staff member from over 60kg in 2004 to 20kg in 2008, increased share of purchased recycled paper (from zero in 2004) to above 70% in 2008, recycling of electronic devices and purchased photocopy and printer toners at a rate of almost 85%. Minimisation of UC’s energy use despite the continuous increase in the intensity of the University premises’ use and an increase in the number of faculty staff and students, through energy-saving measures and techniques in the refrigerating, heating and lighting system.

**Athens University of Economics and Business (AUEB):** In June of 2008, the senate of AUEB introduced an environmental assessment strategic plan for environmental protection and assorted actions including both cultural and behavioural changes. The main points were: Recycling points-centres, energy reduction use, introduction of natural gas, green roofs, introduction of ecological criteria in equipment purchasing, fried oils - batteries - tonners, electronic material and papers recycling.

**Aristotle University of Thessaloniki (AUTH):** The AUTH was also committed to the adoption of fundamental practices of integrated environmental management with main goals being the energy saving in public spaces, encouragement and spread use of renewable energy, reduction of air pollution - sustainable mobility, encouragement and dissemination of organic farming and traditional forms of farming and amelioration of the quality of life in general both of the members of the university community and visitors. To
achieve these objectives, the AUTH has proposed and implemented a program of integrated Environmental Management (IQM) based on the following pillars:

- Reforms in organization and administration
- Energy production and saving
- Sustainable mobility management, transportation and parking accessibility
- Reuse, preventing production and efficient production waste management
- Renovation and beautification of the campus and green management
- Environmental awareness and participation.

4. THE TEI OF PIRAEUS (TEIP) CASE -UNIVERSITY CAMPUS ENVIRONMENTAL IMPACTS

The TEIP is located in Aegaleo Municipality in West Attica. Today (March 2013), TEIP consists of two Faculties, the Faculty of Management and Economics and the Faculty of Applied Technology. The building area-complex comprises the administration building, the maintenance department, the central auditorium used for conferences and other formal ceremonies, and six adjacent buildings (buildings A, B, C, D, E, Z) of which D is a four-storied building, C has only one floor and the rest are three-storied buildings.

**Table 2.** Population (approx.) as recorded in TEIP for the Spring Semester 2010-11

<table>
<thead>
<tr>
<th>Department</th>
<th>Active Students</th>
<th>Employees</th>
<th>Professors</th>
<th>Number of rooms/Laboratories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Engineering</td>
<td>2000</td>
<td>7</td>
<td>13</td>
<td>33</td>
</tr>
<tr>
<td>Automation Engineering</td>
<td>1100</td>
<td>5</td>
<td>15</td>
<td>32</td>
</tr>
<tr>
<td>Electronic Computer Systems Eng</td>
<td>1700</td>
<td>6</td>
<td>13</td>
<td>24</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>1200</td>
<td>6</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>Electronic Engineering</td>
<td>3100</td>
<td>5</td>
<td>23</td>
<td>35</td>
</tr>
<tr>
<td>Civil Engineering</td>
<td>1500</td>
<td>6</td>
<td>12</td>
<td>22</td>
</tr>
<tr>
<td>Accounting</td>
<td>1800</td>
<td>7</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Business administration</td>
<td>2500</td>
<td>6</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Textile Engineering</td>
<td>800</td>
<td>2</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15700</strong></td>
<td><strong>50</strong></td>
<td><strong>122</strong></td>
<td><strong>203</strong></td>
</tr>
</tbody>
</table>

The UC holds both close-type spaces like classrooms, amphitheatres, administrative and secretary offices, cafeterias and dinning areas, as well as open type ones like parking areas, courts and walk-in passages. In addition, there is a nursery and a health centre. In terms of population, the university community is mainly student-based in a percentage of over 90% with the remaining being either professors and university assistances or employers in the departments and in the UC’s services (Table 2). All these activities operate under different and discrete time-intervals, resulting assorted environmental impacts from each one of the engaged population.

The main environmental impacts of the operation of the UC Campus of TEI of Piraeus are the following:

- Use of electricity
- Use of thermal energy (Natural Gas and Oil)
- Use of water
- Use of paper
- Use of electronic devices
- Solid Waste
- Use of land
- Transportation - increased traffic in the area
- Noise

In terms of energy needs for lighting, heating and cooling loads as well as mechanical loads from the assorted laboratories, these are covered by electricity provided by the
PPC network (approximately 3.5 GWh for the years 2009-2010, Figure 1). Heating needs for the same period have been covered by natural gas and partially by heating oil. In terms of air emissions from traffic loads, according to a conducted research for a set of random weeks, the average numbers of cars in TEIP parkings was approximately 750 in a rush hour with the associated number for bikes being at least at 1/5 (Figure 2). Furthermore, significant footprints seem to be created by the waste generated from the canteens for light brunches (Table 3). These wastes-materials -if doing some very rough estimates for final energy demand in kWh per kg of material- in order to be reproduced acquire about 150MWh of electrical energy to be consumed.

Table 3. Daily average waste - production, as recorded in the restaurant and the cafeterias of TEIP

<table>
<thead>
<tr>
<th>Material/ type of waste</th>
<th>Quantity</th>
<th>kWh acquired per kg of material to be reproduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic coffee glasses (thermo-resistant not)</td>
<td>1800</td>
<td>30960</td>
</tr>
<tr>
<td>Soft drink tins</td>
<td>500</td>
<td>8170</td>
</tr>
<tr>
<td>Tetra pack juice boxes</td>
<td>180</td>
<td>3096</td>
</tr>
<tr>
<td>Tetrapack chocolate milk boxes</td>
<td>170</td>
<td>2924</td>
</tr>
<tr>
<td>0.5 lt plastic water bottles</td>
<td>550</td>
<td>9460</td>
</tr>
<tr>
<td>Soft-plastic food packaging</td>
<td>230</td>
<td>3956</td>
</tr>
<tr>
<td>Packaging sachets (mainly paper based)</td>
<td>600</td>
<td>10320</td>
</tr>
<tr>
<td>Towels (Napkins)</td>
<td>8000</td>
<td>52000</td>
</tr>
<tr>
<td>Straws</td>
<td>1700</td>
<td>29240</td>
</tr>
<tr>
<td>Printing machine rollers</td>
<td>100</td>
<td>650</td>
</tr>
<tr>
<td>Large paper boxes</td>
<td>70</td>
<td>455</td>
</tr>
<tr>
<td><strong>Sum (approximately)</strong></td>
<td><strong>13900</strong></td>
<td><strong>151200</strong></td>
</tr>
</tbody>
</table>

5. MITIGATION OF ENVIRONMENTAL IMPACTS-SUGGESTED ACTIONS

Considering the data gathered and the mitigation of environmental impacts, the suggestions for TEIP may be summarised under the following priority axes:

- Reduction of fossil energy use
- Renewable energy exploitation
- Wastes and papers recycling
- Reduced use of electricity
- Sustainable transportation and shared mobility.

The above priority axes are based on the main environmental impacts of the TEI Campus as these have been identified in this work as well as on the main environmental indicators shown in Table 1. Serving that, the initial implementation phase should be accompanied by a visual identity of the project (Figure 3) with the assorted logo “Making a first step - Opening green roads”. This poster will be adopted / altered according to each of the initiatives / mitigation measures to be adopted (Figures 4, 5).

Furthermore, corrective actions and mitigation measures should include the next improvements / measures / actions in order to proceed to the EMS implementation:

- Reduction by 10% of total annual electricity consumption to the total number of hours of operation in the university (kWh/h operation)
- Reduction by 10% of total annual consumption of thermal energy to the total number of hours of operation in the university (kWh/h operation)
- Reduction by 20% of the total annual paper consumption per employer (kg paper / number of employees)
- Increase by 30% the total percentage of waste to be recycled
- Reduction by 20% of the daily number of vehicles at the university
Increase by 30% of the percentage of students and permanent staff who have attended environmental workshops and seminars

Design and implementation of an integrated EMS that will accordingly be certified (either following ISO 14001 or EMAS)

Creation of a Sustainability Task Force that will monitor all the activities related to the environmental management of the TEI Campus

Introduce a set of metrics by which to measure and track the environmental footprint of the Campus

Increase awareness of the environmental impacts of activities of the UC and disseminate information about environmental sustainability at TEI of Piraeus.

The starting point for the planning of an environmental management and control system is to identify all the environmental aspects included in the organisation’s activities and to determine the methodology for locating the environmental aspects and assessing the environmental impacts. The actions and targets to be set by the University are based on the environmental policy to be developed, according to significant or not significant impacts. Considering that, an EMS has started being developed following the principles of ISO 14001:2004. The proposed Handbook for EMS implementation in TEI of Piraeus (and in any specific laboratory if this is the scope) should cover the following sections and actions: 1. Scope 2. Environmental Policy 3. Definitions and Abbreviations 4. Planning (4.1 Environmental Aspects - 4.2 Legal and Other Requirements - 4.3 Objectives - 4.4 Environmental Management Programs) 5. Implementation and Operation (5.1 Structure and Responsibility - 5.2 Training, Awareness, and Competence - 5.3 Communication - 5.4 Document Control - 5.5 Operational Control - 5.6 Emergency Response and
6. Checking and Corrective Action (6.1 Monitoring and Measurement - 6.2 Nonconformance and Corrective/Preventive Action - 6.3 Control of Records - 6.4 Environmental Management System Audit) - 7. Management Review. From that step, appropriate documentation for internal and external documentation and reporting must also be prepared and submitted in a regular, date-oriented, basis.

Of the main critical success factors are (Evangelinos et al., 2009) the active participation of faculty and staff members, the training/education of the student population which is constantly changing, the constant and substantial support of the University’s authorities and the availability of the necessary financial resources for the related investments.

7. CONCLUSIONS and FURTHER WORK
The global community rightly looks to universities to provide leadership in addressing sustainability challenges, building on the core mission of research, teaching and learning. One important aspect of that leadership is to take stock of the University Campus environmental impacts and to explore ways in which the environmental sustainability of our campus can be enhanced. The present work described a part of the TEI of Piraeus research activities in the assessment and mitigation of the UC environmental impacts and the development and implementation of an integrated Environmental Management System for TEI. Concluding, as evidenced it is essential to identify the procedures of the organisation that affect the environment, to define the objectives that lead to reducing the environmental impacts, to quantify and to adopt the appropriate implementation approach which will ensure the continuous application to achieving them. Also it’s very important to acknowledge that successful EMS cases do not always include standardised schemes but promising and campus oriented methodologies and approaches.

REFERENCES