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# POSSIBILITIES OF ENVIRONMENTAL ASPECTS AND IMPACTS EVALUATION ACCORDING TO ISO 14001 STANDARD ON THE EXAMPLE OF AN ACADEMIC INSTITUTION

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Environmental aspects and impacts are important components of the international standard ISO 14001:2004. This standard represents a possible way of introducing an environmental management system in an organization. Environmental management systems help in achieving ecologically sustainable development and environmental performance of the organization. This paper introduces a systematic approach for the determination of environmental aspects, possible ways of their evaluation and deals with potentially adverse environmental impacts of an academic institution on the example of the Faculty of Geotechnical Engineering, University of Zagreb. As the significant aspects for the Faculty, within the waste management process, the separation and storage of the waste electrical and electronic equipment (including the fluorescent lamps), toners and hazardous chemicals were determined. Additionally, the use of electricity and the use of natural gas for heating purposes of the Faculty were estimated to be normal, according to the European practice.
**Key words:** ISO 14001 standard, environmental aspect, environmental impact, environmental aspects evaluation.

**Mogućnosti određivanja značaja aspekata i utjecaja na okoliš u skladu s normom ISO 14001 na primjeru visokoškolske ustanove.** Aspekti okoliša i utjecaji na okoliš su važne komponente međunarodne norme ISO 14001:2004. Ova norma predstavlja mogući način uvođenja sustava upravljanja okolišem u neku organizaciju. Sustavi upravljanja okolišem pomažu u postizanju ekološki održivog razvoja i djelovanja organizacije uz zaštitu okoliša. Kroz ovaj rad predstavljen je sustavni pristup postupku određivanja aspekata okoliša, mogući načini njihovog vrednovanja i pronalaženje potencijalnih negativnih utjecaja na okoliš visokoškolske ustanove na primjeru Geotehničkog fakulteta Sveučilišta u Zagrebu. Kao značajni aspekti okoliša Fakulteta, unutar sustava upravljanja otpadom, prepoznati su razdvajanje i skladištenje električnog i elektronskog otpada (uključujući otpadne fluorescentne lampe), toneri i opasne kemikalije. Osim toga, korištenje električne energije te korištenje prirodnog plina za ogrjev prepoznati su i razvrstani u skupinu običnih aspekata okoliša, u skladu s europskom praksom.
**Ključne riječi:** norma ISO 14001, aspekt okoliša, utjecaj na okoliš, vrednovanje aspekata okoliša.

## INTRODUCTION

In last few decades the environmental awareness, and especially the necessity of environmental protection, have risen up resulting in the development of internationally recognized standards, regulations, directives, concepts, etc., with the main goal of the protection of our environment. The concern for the environment, according to the standard ISO 14001:2004, should be concentrated to „the surroundings in which an organization operates, including air, water, land, natural

resources, flora, fauna, humans, and their interrelation“ [1].

The integration of environmental protection into the management of an organization may have multiple aspects. There are four reasons why every organization should take environmental factors into account in its management processes: ethical, economic, legal and commercial [2]. It could take the form of a management systems like the one proposed by the international standard ISO 14001:2004 or EMAS (Eco-Management and Audit Scheme on the basis of Regulation (EC) No. 1221/2009 of the European Parliament and of the Council) and sometimes it is informal with individual initiatives [2-6]. As the environmental management system (EMS) accepted around the world, the EMS according to the standard ISO 14001 has been developed, presenting a formalized structure for the environmental management system which can be independently assessed for compliance.

In the last decade EMSs have mostly been introduced to manufacturing companies and small and medium size enterprises (SMEs), although they could be introduced to any kind of the organization.

Nowadays it is not unusual to study the environmental aspects and impacts from the systems like local authorities – municipalities and small towns [7] and also the new models for the evaluation of the environmental impacts are suggested [8].

Since the environmental impact of an organization is connected with the overall performance of the organization, efficiency of an EMS in the organization is based on the understanding and recognizing the activities that could significantly influence the environment. As the first step and the most important, in the process of the identification and evaluation the impacts, the environmental aspects should be identified and evaluated. By the definition from ISO 14001 standards [1], the environmental aspect is an element of an organization’s activities or products or services that can interact with the environment and a significant environmental aspect has or can have a significant environmental impact. Or, from [9], an aspect (or element) is a constituent part of the business in which an organization is engaged. Additionally, environmental impact is any change to the environment, whether adverse or beneficial, wholly or partially resulting from the organization’s environmental aspects.

The identification of environmental aspects using one or more different procedures, should take into account: emissions to air, releases to water, releases to land, use of raw materials and natural resources, use of energy, energy emitted, e.g. heat, radiation, vibration, waste and by-products and physical attributes, e.g. size, shape, color, appearance. In addition to those environmental aspects an organization can control directly, an organization should also consider aspects that it can influence. However, in all circumstances it is the organization that determines the degree of control and also the aspects it can influence. Environmental impacts are categorized in the same way.

According to the intention to expand the introduction of EMS systems to as many organizations as possible, in this paper a specific organization for the identification and evaluation of environmental aspects and impacts is chosen – an academic institution – the Faculty of Geotechnical Engineering of University of Zagreb. The process of the EMS introduction to the organization will be explained later by the identification of proper aspects and impacts.

## METHODS

### Methods for Environmental Aspects

It is usual to use the following methods in the process of identification of environmental aspects [9], [10]:

**1.** *Value chain method*: the focus is on the aspects that are obvious through „chain" from organization to suppliers, through production, distribution and disposition of the products. It usually involves the Life Cycle Assessment.

**2.** *Method of materials identification:* the focus is on the materials and their substantial parts used in the production, like dangerous agents or chemicals etc.

**3.** *Method of compliance with legal requirements*: the focus is on the legal requirements that are proposed from the government or local environmental agencies. Aspects that are not regulated by legislative are not taken in account.

**4.** *Process flow chart method:* the focus is on „breaking" the organization into smaller parts/processes that can be controlled. It is followed by the identification of related aspects in every single process.

The environmental aspects of the Faculty of Geotechnical Engineering were identified combining all four methods, especially the identification of materials and the compliance with legal requirements.

### Environmental Impacts Evaluation

In the standard ISO 14001 it is suggested to use the classification of environmental aspects in the same way as in the environmental impacts classification. Additionally, the organization could, instead of the assessment of the each product, use the categories of the products, services or activities to identify, among them, the most significant ones.

The environmental impacts could be identified in the same way as the environmental aspects.

### Selection of the Criteria for the Estimation of Significance of Aspects/Impacts

Environmental impacts could be estimated and evaluated in several ways. Every organization has it's own procedure for the impacts assessment due to its specificity – either to the staff or because of the organization's activities. It is usual to give the numerical values (e.i. intensities) to the different criteria of the environmental aspects and impacts or describing attributes – like minimal, low, high, catastrophic, etc… like it is proposed in typical risk assessment methods, e.g. [11]

In the case of using numerical values, it is commonly used the numerical scale with 3, or more frequently, with 5 different numbers, e.i. levels of the intensity.

The most used criteria in the process of the environmental impact assessment are severity, probability and frequency.

Severity is related to the level of the exposition of the environment to the impact, including air, water, soil, natural resources, flora, fauna, humans, etc.

**Scale of severity (**5-catastrophic, very dangerous, must be repaired or regenerated, 4- serious, hard to repair, 3-moderate, could be repaired, 2-minor effects that are easily remedied 1-harmless, negligible impact)

Probability is used as the indicator of the possibility of something to happen.

**Scale of probability (**5-almost certain, 4-likely, 3-possible, 2-rare, 1-almost incredible).

Frequency describes how often some impacts could occur in the environment of an organization.

**Scale of frequency (**5-continuous – more than 3 times per week, 4-very oft, 1-2 times per week, 3-regular – it happens once a month, 2 intermittent – 3 to 4 times per year, 1-rare less than one time a year)

Other common criteria are: geographical borders (global-local-isolated), control (totally uncontrolled-totally controlled), compliance to the legislation (in compliance-without legal requirements), reporting, concern of shareholders, duration, etc.

**Environmental Impact Assessment**

Every identified impact is related to the number that represents its position according to the assessed criterion. Typically, that information is than summarized as it is shown in the Table 1.

**Table 1.** Example of the environmental impact assessment (adapted from [9])
**Tablica 1.** Primjer procjene utjecaja na okoliš (prerađeno na temelju [9])

| **Aspect:** | |
|---|---|
| **Impact:** | |
| **Questions** | **Score** |
| 1. Can the impact be controlled? | |
| 2. What kind of harm occurs to people or to environment? | |
| 3. Can the impact be corrected? If yes – how? | |
| 4. What is the percentage of probability that this impact will occur? | |
| 5. Does the impact migrate and how large area could be affected? | |
| 6. Is the impact regulated? | |
| 7. What is the duration of the impact when it occurs? | |
| 8. Is this impact of concern to any of the public? | |
| 9. Is this impact of concern to any of the stakeholders? | |
| 10. Is the impact regulated? If yes, by what agency? | |
| Total score: | |

After the rating numbers have been assigned, the cumulative score should be determined. The most common approaches involve addition or multiplication of the individual score values. The overall conclusion is – the higher total score number, the more significant impact (and it's related aspect).

Differences between different approaches – addition or multiplication of the individual scores could be sometimes significant. An example of difference in significance depending on the approach using four criteria is given in the Table 2 and Figure 1.

**Table 2.** An example of a significance assessment of five different impacts using four criteria
**Tablica 2.** Primjer procjene značaja pet različitih utjecaja koristeći četiri kriterija

| Impact | Severity | Probability | Frequency | Duration |
|---|---|---|---|---|
| Impact 1 | 4 | 3 | 1 | 2 |
| Impact 2 | 4 | 1 | 4 | 5 |
| Impact 3 | 2 | 2 | 4 | 2 |
| Impact 4 | 4 | 5 | 3 | 2 |
| Impact 5 | 1 | 5 | 3 | 2 |

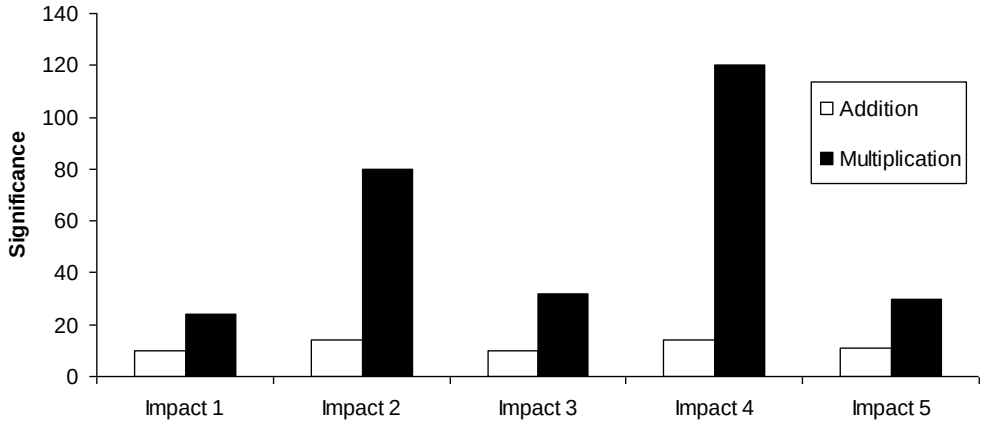


**Figure 1.** Graphical presentation of impact/aspect significance determination using the addition and multiplication of individual score rates
**Slika 1.** Grafički prikaz određivanja značaja utjecaja/aspekata koristeći zbrajanje i množenje individualnih rezultata procjene broja bodova

Since a great difference in significance assessment could occur, it should be decided which approach to use in significance determination. It is usual to use the addition method for the impacts significance determination individual values of attributes are mostly related to each other. On the contrary, when the values assigned to measured attributes (severity, probability, etc.) are mostly unrelated to each other, more adequate method is multiplication of the individual scores.

In this paper both methods are used and compared.

## RESULTS AND DISCUSSION

The analysis of the environmental aspects and impacts was conducted according to the standard ISO 14001:2004 for an academic institution – Faculty of Geotechnical Engineering, University of Zagreb. The Faculty is placed in the City of Varaždin, Croatia, on one location. It has 60 employees and the capacity of 130 new students every academic year. The data for estimations were taken from the Faculty's archive and all of them present the average value of the last three years (2007-2009).

### Conditions for the Evaluation of the Environmental Aspects

The following attributes for the evaluation of environmental aspects (the significant or non significant aspect) were used: frequency (FREQ), level of control of aspect (CONT), severity for environment (SEV-ENV), severity for the employees (SEV-EMP), legal exposure (LEG), public exposure (PUB).

**Table 3.** Significant environmental aspects – scoring criteria
**Tablica 3.** Značajni aspekti okoliša – kriteriji bodovanja

| Description of the attribute | Score |
|---|---|
| **1) Frequency (FREQ)** | |
| Never happened, but possible | 1 |
| Rare, less than once per year | 2 |
| Occasionally, 1-4 times per year | 3 |
| Oft, more than 4 times per year | 4 |
| Continuously | 5 |
| **2) Level of control of aspect (CONT)** | |
| Total control | 1 |
| Very rare the control of the aspects could be, short time, lost | 2 |
| Periodically control is off | 3 |
| Control is not continues, possibility of control equipment breaks | 4 |
| Totally uncontrolled | 5 |
| **3. Severity for environment (SEV_ENV)** (Including the humans out of the Faculty. This attribute depends both on the quality for the releases e.g. hazardous materials, and on the quantity e.g. using a lot or little heating energy, a lot of raw materials, etc.) | |
| Without measurable impact | 1 |
| Extremely low | 2 |
| Moderate | 4 |
| Important (use of non-renewable resources, use of hazardous materials, without measures for waste management) | 6 |
| Critical – local danger for environment and humans for a longer period | 8 |
| Catastrophic – everlasting contamination/pollution, possible death of humans | 10 |

| | |
|---|---|
| **4. Severity for the employees (SEV_EMP)** | |
| Without measurable impact | 1 |
| Extremely low | 2 |
| Moderate - using personal safety measures causes no measurable impact) | 4 |
| Important – using safety measures, impacts are under control | 6 |
| Very important – influence safety and health of the employees although personal safety measures are used | 8 |
| **5. Legal exposure (LEG)** | |
| There are no legal requirements | 1 |
| There are legal requirements | 6 |
| **6. Public exposure (PUB)** | |
| There is no public exposure | 1 |
| There is public exposure | 2 |
| There is public exposure with shown interests | 3 |

**Evaluation of the Environmental Aspects**

The significance of the environmental aspects of Faculty of Geotechnical Engineering was determined using two methods – addition of the values of the individual attributes and multiplication of the values. The results are shown in the Table 4.

Significance of environmental aspects using addition procedure (SIGNADD) was determined using a formula (1):

SIGNADD = FREQ + CONT + SEV_ENV + SEV_EMP + LEG + PUB

Significance of environmental aspects using multiplication procedure (SIGNMUL) was determined using a formula (2):

SIGNMUL = FREQ·CONT·SEV_ENV· SEV_EMP·LEG·PUB

The final assumption states that for the values of the SIGNADD greater than 20 and/or the values of the SIGNMUL greater than 2000 the aspect is characterized as significant environmental aspect.

**Table 4.** Results of estimation of the aspects' significance
**Tablica 4.** Rezultati procjene značaja aspekata

| Environmental aspect | Impact | FREQ | CONT | SEV_ENV | SEV_EMP | LEG | PUB | SIGNADD | SIGNMUL | Significance (YES/NO) |
|---|---|---|---|---|---|---|---|---|---|---|
| Waste *(paper)* | - water quality and soil contamination - landfill area enlargement | 4 | 2 | 2 | 1 | 1 | 1 | **11** | **16** | NO |
| Waste water | - water quality and soil contamination | 3 | 2 | 4 | 2 | 6 | 2 | **19** | **576** | NO |
| Waste *(toners)* | - water quality and soil contamination - landfill area enlargement | 3 | 4 | 6 | 6 | 6 | 1 | **26** | **2592** | YES |
| Waste *(electrical and electronic equipment incl. lightbulbs)* | - water quality and soil contamination - landfill area enlargement | 4 | 3 | 6 | 6 | 6 | 2 | **27** | **5184** | YES |
| Use of electricity | - climate change - pollution of the atmosphere | 4 | 1 | 2 | 2 | 6 | 2 | **17** | **192** | NO |
| Use of natural gas *(for heating)* | - depletion of the natural resources - pollution of the atmosphere | 4 | 1 | 4 | 4 | 6 | 1 | **20** | **384** | NO |
| Uncontrolled discharges of natural gas | - climate change - greenhouse effect | 1 | 2 | 2 | 6 | 1 | 2 | **14** | **48** | NO |
| Chemicals - general | - water quality and soil contamination | 4 | 3 | 4 | 4 | 1 | 1 | **17** | **192** | NO |
| Harmful chemicals *(concentrated acids/bases and solvents)* | - water quality and soil contamination | 4 | 2 | 6 | 8 | 6 | 1 | **27** | **2304** | YES |

**Use of Electricity and Heating Energy**

In Table 5 the energy indicators for Faculty of Geotechnical Engineering (FGE) are shown. The minimal and maximal values are taken from [12] and they represent a usual range for companies in Sweden.

**Table 5.** A comparison of the energy indicators, according to [12]
**Tablica 5.** Usporedba energijskih indikatora, prema [12]

| Type of energy | Unit | Faculty of Geotechnical Engineering | Minimum | Maximum |
|---|---|---|---|---|
| Heating | $MWh/m^2$ | 0.13 | 0.09 | 0.28 |
| Electricity | $MWh/m^2$ | 0.02 | 0.07 | 0.36 |
| Heating and electricity | $MWh/m^2$ | 0.16 | 0.19 | 0.50 |
| Heating | MWh/employee | 8.20 | 5.1 | 20.2 |
| Electricity | MWh/employee | 1.71 | 3.6 | 26.1 |
| Heating and electricity | MWh/employee | 9.92 | 10.6 | 32.5 |

Energy indicators for FGE are very close to or under the minimum and that is the reason why they haven't been assigned to the significant aspects of the FGE.

**CONCLUSIONS**

Environmental aspects within Faculty of Geotechnical Engineering of University of Zagreb has been identified and evaluated according to the standard ISO 14001.

One aspect – energy use – has been evaluated and compared to the energy use in different companies in the western Europe (Sweden) and results the showed that the energy consumption of the Faculty is in normal range, between minimum and maximum values, with the tendency to the minimum range of the consumption. Therewith could be concluded that the Faculty rationally uses electricity and energy for the heating.

As an academic institution with two research laboratories, it is typical for the Faculty that there is a significant environmental aspect – hazardous chemicals, that was recognized during the procedure of identifying the aspects.

Within the domain waste management – two significant aspects have been recognized – waste toners from the printers/photocopy machines and waste electrical and electronic equipment including fluorescent light bulbs, which belong to the hazardous waste.

During the significance assessment both approaches (addition method and multiplication method) were used to evaluate the significance of the aspects and showed similar results in ranking the aspects, but the clearer differences are noticed using the multiplication method. It could be assumed that for an academic institution and for the chosen attributes for the ranking, since the measured attributes are not closely related to each other, multiplication method could give better results in aspects evaluation.

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