A General Approach to Accreditation of Environmental Laboratories in Turkey

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Abstract- In this study, the accreditation of environmental parameters and types of laboratories accredited by ISO 17025 Standard were compared. In Turkey, environmental laboratories were classified as public, private and university laboratories. Furthermore, environmental parameters considered in this study are water quality parameters and air quality parameters. In current study, 43 water quality parameters in university and 47 water quality parameters in public and private institutions were examined with regard to accredited laboratories in Turkey. Accredited water quality parameters in public and private institutions as different from universities are Total Solid, Ammonia/Ammonia Nitrogen, Total Nitrogen, and Total Kjeldahl Nitrogen. As for air quality parameters, the number of air quality parameters accredited in public and private institutions is approximately twice as air parameters accredited in universities (42 and 26, respectively). The most accredited water parameter is pH, with total of 65, where 44 of them are private, 11 are public and 10 are university laboratories. Chemical Oxygen Demand (COD) and Suspended Solid (SS) are placed in the second order with total of 56. Here, 39 private, 10 public and 7 university laboratories are accredited in terms of COD and 40 private, 10 public and 6 university laboratories are accredited in terms of SS. Conductivity is next remarkable parameter with total of 53 institutions (37 private, 8 public and 8 university laboratories). In air parameters, the most accredited one is the SO_2, with total of 52 institutions (49 private, 2 publics and 1 university laboratory).

Keywords Laboratory accreditation, environmental quality parameters, ISO 17025, quality management system.

1. Introduction

It is a well-knownfact that environmental pollution is considered, water pollution and air pollution first come to mind. The most important and first step to be able to identify the pollution factors, to estimate the dimensions of the pollution and to take precautions is to monitor the pollutants in the medium. The monitoring of the environmental pollutants plays a significant role in the development and implementation of environmental policies. Water quality must be monitored and assessed for the treatment of water resources contaminated by agricultural or industrial activities and also for the protection of natural water resources, which are essential to human and other living organisms. The protection of public health, the providing of aesthetic or social goals of water quality, the determination of the effectiveness of the regulations to be taken for the protection and control of water quality can be listed as the objectives of water quality management [1]. The air like the water is necessary to life. Living organisms would like to be assured that the air that they consumed will not result in harm effects on them [2]. Hence, air pollutants released into the atmosphere must be monitored and evaluated [3]. The accredited laboratories proving that test and analysis results are reliable by third parties and institutions must be preferred for the monitoring of concentrations of pollutants bringing about severe environmental problems such as water pollution and air pollution and the measurement of the environmental parameters employed as an indicator in the control mechanism of the pollutants [4].

Laboratory accreditation can be described as a formal recognition by an authoritative body of the technical competence of a laboratory to perform tests or calibrations. This recognition is given by an accreditation body, which plays role as a third party between the laboratory and its clients, and intends to provide confidence between them. One of the fundamental goals in the presence of accreditation systems is the need to remove technical barriers to international trade, *i.e.* that a product once tested in an accredited laboratory should not need to be retested by the client, since another accredited laboratory in another country would find a similar result [5, 6].

Accreditation provides an independent conformation of organizational competence having policies in place, a quality management system and audit systems to support self-rugalation [7]. Laboratory accreditation evaluates the competencies of all types of laboratories with regard to performing specific tests and calibrations. ISO and the International Electro-Technical Commission (IEC) introduced ISO/IEC 17025 standard, which is significantly related to documenting the process of any analysis performed by a laboratory, owing to the increasing significance of accreditation and international recognition. ISO 17025 consists of the quality management system and technical requirements of the accreditation process [8, 9]. The quality management system of a laboratory is associated with the guarantee of the consistency of test results and their conformity with defined criteria. As for technical requirements for ISO 17025 standard, environment, equipment, reagents, culture media and reference materials, sampling and sample handling, test methods, and quality of performance are considered [10]. The variability of test results and the frequency of errors can be reduced by implementing and monitoring a comprehensive laboratory quality management system [11

In recent years, many studies are focused on the importance of laboratory accreditation on especially accuracy of experimental results. The summary of the previous studies performed for the assessment of laboratory accreditation in a variety of topics is listed in the following: Morris and Macey [12] investigated the performance of environmental laboratories with two different studies including the 1997 study implemented between 1994 and 1996, and the 2001 study implemented between 1997 and 1999 in Canada. Biochemical Oxygen Demand (BOD), Total Suspended Solids (TSS), Chloride (CL), Dissolved Iron (DFE), Fecal Coliforms (FCOL) were examined environmental parameters. They concluded that in both studies, accredited laboratories outperformed non-accredited laboratories in all measures. Lopez et al., [13] examined the perceived value of accreditation among individuals who have successfully achieved the Intersocietal Accreditation Commission (IAC) echocardiography accreditation. In their study, an electronic survey was sent to accredited facilities soliciting demographic data along with questions regarding the perceived value of accreditation related to 15 quality indicators. In the result of the study, more than 90 % of respondents reported that maintaining accreditation was important for improved quality and better reimbursement. Middlebrook [14] compared the accredited laboratories with non-accredited laboratories in terms of performance in proficiency testing. In this study, comparisons were made of *z*-scores between accredited and non-accredited laboratories for the data as a whole, as well as for subsets of the data partitioned into groups such as inorganic tests, organic tests and microbiological tests. The study exhibited that the difference between accredited and non-accredited laboratories was much greater than unsatisfactory results were compared.

Furthermore, the general conclusion of the study showed that accredited laboratories continually outperform non-accredited laboratories as a group. Cortez [5] implemented a case study investigating if accredited laboratories perform better than others in a proficiency testing. In this study, 33 parameters including pH, conductivity, alkalinity, bicarbonate, hardness, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, F^{-}, SiO_2, NO_3^{-}, NO_2^{-}, NH_4^{+}, PO_4^{3-}, Fe, Mn, Cu, Zn, Al, Ba, Sr, Cd, Cr, Ni, As, Sb, Se, Hg, Ag, and Pb were examined. The 76 participating laboratories represented all types of laboratories from governmental and regulatory bodies, to public, private, industrial and university laboratories investigated. The results of the study showed that accredited results have a significantly higher percentage of satisfactory results.

2. Materials and Methods

In this study, the status of the accreditation of environmental parameters was evaluated and types of laboratories accredited by ISO 17025 Standard were compared. In Turkey, laboratories were classified as public, private and university laboratories for analysis. In current study, 43 water quality parameters in universities and 47 water quality parameters in public and private institution were examined with regard to accredited laboratories in Turkey. These parameters are pH, conductivity, BOD, Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Hardness, Temperature, Color, Alkalinity, Ammonia, Ammonia Nitrogen, Calcium (EDTA Method), Chlorophyll, Residual Chlorine, Chloride, Chromium, Magnesium, Nitrate/Nitrate Nitrogen, Nitrite/Nitrite Nitrogen, Light Transmittance, Total Solid (TS), Suspended Solid (SS), Ammonium, Ammonium Nitrogen, Total Nitrogen, Phosphate/Orthophosphate Phosphorous, Total Phosphorous, Total Kjeldahl Nitrogen (TKN), Sulfate, Escherichia coli (E. coli) and Coliform Bacteria Count, FCOL, Total Dissolved Solid, Oil-Grease, Turbidity, Total Organic Carbon, Arsenic (As), Cadmium (Cd), Lead (Pb), Iron (Fe), Copper (Cu), Calcium (ICP-MS Method), Zinc (Zn), Aluminum (Al), Manganese (Mn), Nickel (Ni), Silver (Ag), Sodium (Na), Potassium (K).

Accreditation water quality parameters in public and private institution as different from universities are Total Solid, Ammonia, Ammonia Nitrogen, Total Nitrogen and TKN. Furthermore, the number of air quality parameters accredited in public and private institutions is approximately twice as air parameters accredited in universities (42 and 26

respectively). Sulfur dioxide (SO_2), Volatile Organic Carbon (VOC), Particulate Matter (PM10), Hydrogen Cyanide (HCN), Sootiness, Moisture, Carbon monoxide (CO), Carbon Dioxide (CO_2), Oxygen (O_2), Heavy metals (As, Cd, Cr, Cu, etc.) were some of air quality parameters examined in this study.

3. Results

In this study, 184 university laboratories, 11 public and 71 private institution laboratories were examined in terms of their accreditation status in environmental quality parameters. Unfortunately, only 26 universities in Turkey have accredited laboratories and also only 10 of them are accredited in terms of environmental parameters. In this study, 43 water quality parameters and 26 air quality parameters in university laboratories and 47 water quality parameters and 46 air quality parameters in public and private institution laboratories were investigated in accordance with their accreditation status. According to data obtained from TAA, 24 of the private corporation laboratories are not accredited in terms of water parameters and 12 of them are not accredited in terms of air parameters, too. Similar to universities, only one public institution has accredited laboratory with regard to air quality parameters. The current status of water and air quality parameters of the universities and public institutions having accredited laboratories in Turkey are shown in Table 1 and Table 2.

Table 1. Accreditation status of university laboratories.

University	Number of Accredited Water Quality Parameters	Number of Accredited Air Quality Parameters
Dokuz Eylul	43	26
Aksaray	39	0
Mugla Sıtkı Kocman	35	0
Anadolu	26	0
Bogazici	25	0
Balıkesir	24	0
Trakya	14	0
Kahramanmaras Sutcu Imam	10	13
Mersin	2	0
Dicle	2	0

Among universities shown in Table 1, Dokuz Eylul, Aksaray and Mugla Sıtkı Kocman University are very successful in the accreditation of environmental parameters especially water quality parameters. Dokuz Eylul University is superior than other 9 universities in both accredited water and air quality parameters. The Scientific and Technological Research Council of Turkey called as its abbreviation (TUBITAK). TUBITAK has the most accreditation laboratories in terms of environmental parameters. Similar to universities, only one public institution (TUBITAK) has accredited laboratory with regard to air quality parameters in accordance with Table 2.

Table 2. Accreditation status of public institution laboratories.

Accreditation Status of Public Institution Laboratories	Number of Accredited Water Quality Parameters	Number of Accredited Air Quality Parameters
The Scientific and Technological Research Council of Turkey	36	17
Antalya Water and Sewage Authority General Directorate	35	0
Denizli Metropolitan Municipality	32	0
Antalya Metropolitan Municipality	28	0
Kayseri Metropolitan Municipality	27	0
Ministry of Environment and Urbanization	26	0
Izmir Water and Sewage Authority General Directorate	25	0
Istanbul Environmental Management Industry and Trade Company	21	0
Mugla Water and Sewage Authority General Directorate (MUSKI)	7	0
Istanbul Metropolitan Municipality	4	0
MUSKI Bodrum Environmental Laboratory	4	0

There are 82 institutions (71 private and 11 public) accredited in terms of environmental parameters in Turkey. All 11 institutions are accredited in all of water quality parameters while all 71 private institutions are not accredited that. Only 44 (62%) of private institutions with accredited laboratories are accredited in terms of water quality parameters. Hence, it can be said that to be successful in accreditation of water quality parameters for some private

institutions, while some ones have become accredited only on a few water quality parameters. Table 3 exhibits the number of water parameters in accordance with accredited institutions [4].

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Table 3. The number of water parameters in terms of accredited institutions.

Parameters	Number of Accredited Institutions			Total
	Private	Public	University	
pH	44	11	10	65
COD	39	10	7	56
SS	40	10	6	56
Conductivity	37	8	8	53
Oil-Grease	37	8	4	49
BOD	35	7	5	47
Temperature	38	2	2	42

The most accredited water parameter is pH, with total of 65, where 44 of them are private, 11 are public and 10 are university laboratories. COD and SS are placed in the second order with total of 56. Here, 39 private, 10 public and 7 university laboratories are accredited in terms of COD and 40 private, 10 public and 6 university laboratories are accredited in terms of SS. Conductivity is the next remarkable parameter with total of 53 institutions (37 private, 8 public and 8 university laboratories) [4]. As for air quality parameters accredited in university and institution laboratories in Turkey, the most accredited one is the SO_2, with total of 53 (49 private, 2 public and 2 university laboratories) as shown in Table 4 [16]. Air parameters compared to water quality parameters accredited in various institutions accredited only two university laboratories (Dokuz Eylul University and Kahramanmaras Sutcu Imam University).

Table 4. The number of air parameters in terms of accredited institutions.

Parameters	Number of Accredited Institutions			Total
	Private	Public	University	
SO_2	49	2	2	53
Sootiness	49	1	2	52
CO and CO_2	48	2	2	52
O_2	46	1	2	49
NO_x	46	1	2	49
PM_{10}	45	1	2	48
Humidity	42	1	2	45

4. Conclusion

In this study, the status of the accreditation of environmental parameters was evaluated and types of laboratories as public, private and university laboratories accredited by ISO 17025 Standard were compared in terms of the number of accredited environmental quality parameters. In accordance with the result of this study, only three (Dokuz Eylul University, Aksaray University and Mugla Sıtkı Kocman University) of 184 universities in 2016-2017 academic year are more successful in accreditation of water quality parameters, while only one university laboratory (Dokuz Eylul University) shows accreditation in all air quality parameters. Moreover, pH, COD, SS, conductivity, oil-grease, BOD, temperature are the most accredited water quality parameters, respectively and also SO_2, sootiness, CO as well as CO_2 are the remarkable air quality parameters in terms of accreditation status of especially private institution laboratories. In literature, along with the importance of accredited laboratories has been increasing every passing day, the number of studies covering the accreditation status of particularly environmental laboratories is not enough to identify the contents of studies implemented in this area. In this context, this study will shed light on the literature.

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