

Effectiveness Assessment of Industrial Effluent Standard Implementation in Addis Ababa City, Ethiopia

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Abstract- Environmental pollution control and environmental management, in general, are major aspects of development processes especially in the perspective of sustainable development. It is, therefore, quite essential for decision-makers to appreciate the need to look at industrial development and environmental protection measures which go side by side.

Data were collected from 40 industries, including food, chemical, tannery & abattoirs and medical industries all which dispose effluent. The study found that the standards implementation status of industrial effluents is very low. This was due to inadequate monitoring and enforcement. Irregular inspections and lack of commitment by government agencies to respond to violations of standards affects the inconsistency of monitoring and implementation results of which are poor compliance attitude and practices of industrial operators. Thus, only 45% of industries have adequate treatment facilities and 60% are not sure that the effluent standard is essential to reduce environmental pollution. In addition, 60% believe that standards are very important to protect industries from environmental pollution, almost half of the industries have not designated qualified personnel and 70% never submit environmental performance reports. The study suggests strengthening monitoring and enforcement to ensure industry compliance of standards.

Key words: Compliance practice, Effective implementation, Industrial Effluent, Monitoring & Enforcement,

1. Introduction

Industrialization is the engine for socio-economic transformation of countries. It is favored for creating employment opportunities, bringing competitive advantage, and generating dynamism in the economy[1]. A glance at the successes of the developed world revealed that industrialization significantly increased production and productivity and hence it has successfully altered the economic structure as well as the social composition of the population. Industrialization and industrial development also signify the political power of countries and their relative influence across the globe[2].

Urbanization, industrialization, and population have increased very rapidly across the globe including developing countries. As population increases and cities become more industrialized, the volume and composition of wastes generated increases. This is especially significant for cities in the developing world where populations and economies are rapidly expanding and the

infrastructure necessary to manage the ensuing problems is inadequate[3].

In developing countries such as Ethiopia, the intention to achieve a rapid growth rate of development can rely on expanding industrial sectors, particularly the largest manufacturing capacities, to accelerate overall economic growth and create employment opportunities for millions of people. According to Cochran, the vision of the industrial development plan in the country is to build an industrial sector with the highest manufacturing capability in Africa which is diversified, globally competitive, environmentally friendly and capable of significantly improving the living standard of the Ethiopian people by the year 2025[4]. However, breakthrough of industrialization process that began in 18th century in Europe, (where the industrial revolution propelled the quality of life since then) marginalized environmental protection. Environmental values and its relationship to human being were underestimated and misunderstood as industrialisation became a global phenomenon which has led to the over-utilization and extreme exploitation of ecological resources[5]. Industrial development has accelerated with corresponding environmental pollution through a wide range of pathways. Environmental pollution, in turn, affects the sustainable industrial development and human health[6].

Noting the significance of development that promotes environmental sustainability, the Ethiopian government in its vision of industrial development plan, recognizes that while advocating to build the highest manufacturing industrial sector in Africa, protection of ecosystems and society must come first [7]. One important piece of legislation that governs pollution control is the industrial pollution legislation of 2008 that specifies the discharge limit for 12 industrial sectors based on environmental pollution proclamation No. 300/2002. Its purpose is to serve as a mitigation for industrial wastewater discharge problem. Other provisions include the enshrinement of environmental issues into the country's constitution, formulation of environmental policy and strategy, enactment of environmental pollution control and environmental impact assessment proclamations [8].

Industries utilize natural resources and release both useful products and wastes into the environment ref. They contaminate many sources of drinking water, release unwanted toxins into the air and reduce the quality of soil ref. As a result, several environmental disasters have been caused, some of which have yet to be brought under control.

In Ethiopia, the generation of industrial waste, including hazardous waste, is increasing rapidly as a result of industrialization, urbanization, and the implementation of a new economic policy and industrial. Annually more than four million liters of wastewater discharged to open space and rivers around Addis Ababa lacks proper treatment[9]. This as noted by Gebre and Van Rooijen[10], is a source of great concern in most developing countries where some people solely rely on untreated river water for daily consumption and survival. Unregulated effluent disposal is largely responsible for water pollution, eutrophication, and hypoxia [11]. In Ethiopia for instance, most people use rivers for daily consumption such as drinking water, washing clothes, fetching animals and irrigation further made the impact of industrial effluent discharge more serious ref. and in big cities like Addis Ababa, river water with untreated industrial effluent is used for construction, car wash, urban agriculture and many domestic purposes, making the impact so complex. This gives rise not only to environmental problems but also public health concerns.

Many pollutants such as pesticides, oil, hydrocarbons, heavy metals as well as thermal and radioactive pollutants can get into the environment through direct or indirect release from industries, agriculture and households. These have contributed to the high concentrations of Cadmium, Chromium, Copper, Mercury, Nickel and Zinc in some crops traced in Ethiopia around Addis Ababa[10, 12]. The excessive levels of these pollutants in the environment are causing a lot of damage to human and animal health, plants and trees (see [13]).

Of the two main types of effluent (pollution) sources that exist i.e. point source and non-point source (see [14]), it the non-point source pollution that is common to many industries where standard enforcement is weak and as a result neither the source nor the size of specific emissions can be observed or identified with sufficient accuracy.

Various countries have put in place different mechanisms of dealing with effluent standard enforcement and compliance. Despite the well-articulated measures, it remains a challenge to ensure complete enforcement and compliance as several factors hamper the efforts of government agencies in balancing between economic development and the environment. For instance, in the case of United States, Heyes and Rickman [15] note that despite the fact that when the EPA observes regulatory violations it rarely pursues the violator and the underlying factor may be that the expected penalty faced by a violator who is pursued is small compared to the cost of compliance. In the case of developing countries like Ethiopia where priority is eradicating absolute poverty through limited capital resources financial resource skilled manpower and well-established institutions and coordination among them affect enforcement and compliance. Therefore, critical to the issues of enforcement and compliance is the formulation and implementation of operational environmental legislations.

In this study, the presence of adequate monitoring and enforcement systems, the level of industry compliance practices and institutional coordination are assessed in order to identify the key weaknesses in the current industrial effluent implementation process and recommend appropriate solutions.

2. Study Area Description

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The study was conducted in Addis Ababa city. Addis Ababa is one of the 9 states in federal nation of Ethiopia, located between $8^{\circ}55' - 9^{\circ}05'$ N latitude and $38^{\circ}05' - 39^{\circ}05'$ E longitude, covering a total area of 540 km^2 [16]. According to the CIA, the population of the city is estimated to be 4.794 million in 2020 [17]. The city is of great political and economic significance, being a base for African Union and many other international organizations. It is also considered as the hub of country's industrialization in which is located more than half of the nation's industries.

Geferssa, Legedadi and Dire dams (having a combined daily production of $173,000 \text{ m}^3$) and Akaki well system ($\sim 30,000 \text{ m}^3 \text{ day}^{-1}$) are the main water sources [18]. Furthermore, two major rivers which are tributaries of country's longest river Awash, flow through the city and used for various purposes notably irrigation, industrial consumption, washing of materials, bathing, cattle filching and waste disposal. The city of Addis Ababa has two public sewage treatment plants, given the scope of the sewage disposal only 7.5% of wastewater is handled by the plants. On the other hand, wastewater from agglomerations is estimated at $398,985 \text{ m}^3/\text{day}$, whereas the capacity for disposal of such waste is estimated to be $1,727 \text{ m}^3/\text{day}$ [19].

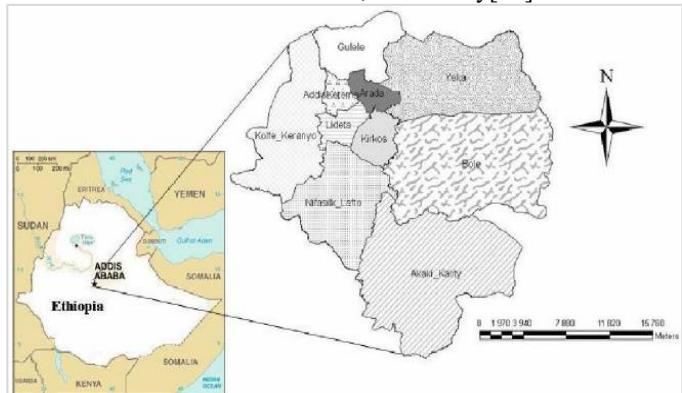


Figure 1: Map of Addis Ababa city

Source: Desta Ab. Et

3. Material and Methods

3.1 Sampling, industry selection and data collection

This survey was carried out through questionnaires and interviews to investigate (1) standards and effectiveness of the implementation and/or enforcement of Industrial Effluent (2) trends of wastewater discharge from industries and treatment practices, and (3) effectiveness of monitoring and enforcement system. Section chiefs and staff specifically assigned to monitor effluent-related processes at the industries were targeted. Similarly, government agencies responsible for the enforcement of standards were targeted. Key informant interviews were conducted with Environmental Protection Authority (EPA), Federal Chemical and Construction Inputs Industry Development Institute and Industry Bureau of City administration Occupational safety and energy directorate experts.

The study considered about 40 factories categorised in Table1. The selection of industries was based on the industries (plants) that dispose of the effluents.

Table 1: category of industry surveyed

| Category of factory | Number surveyed |
|---------------------|-----------------|
|---------------------|-----------------|

| | |
|----------|----|
| Chemical | 16 |
| Food | 16 |
| Medical | 2 |
| Tannery | 6 |

3.2. Data processing and statistical analysis

Processing of raw data was performed using IBM SPSS 20 (SPSS Inc., Chicago, Ill., USA). Data including industry's attitude, monitoring and enforcement mechanism, institutional coordination and adequacy of legislation, wastewater disposal methods were presented as a relative percentage. Average values of Wastewater generation ($m^3 \text{ day}^{-1}$) per category of factory were presented. A linear regression model was developed to assess the relationship between the Effective implementation of standards (EI) and four independent variables as showed in Equation 1 as follow:

$$EI = \alpha + \beta_1 IP + \beta_2 ME + \beta_3 IC + \beta_4 AL + \epsilon \quad (\text{Eq.1})$$

Where;

EI = Effective Implementation of standards (dependent variable),
IP = Industry's attitude on standards, PMaE= proper monitoring and enforcement, IC= institutional coordination, AL= adequacy of legislation, ϵ = error term, α = constant term, β = coefficient of independent variable ($\beta > 0$ means the predictor has positive effect on EI).

4. Results and Discussion

4.1 Awareness and attitude of the industries

Managers and employees of manufacturing firms' awareness and attitude of pollution control and environmental management are basic tools to implement environmental standards in a sustainable development[20, 21]. The selected factories were assessed of their awareness of the existence of effluent standards and responsiveness (attitude) towards them. It was found that 60% acknowledged awareness and importance of standards compliance, 15 % were aware but had negative sentiments towards standard compliance while 25% claimed they were not aware of the existence of effluent standards hence were not compelled in any way to protect the environment (Figure 2).

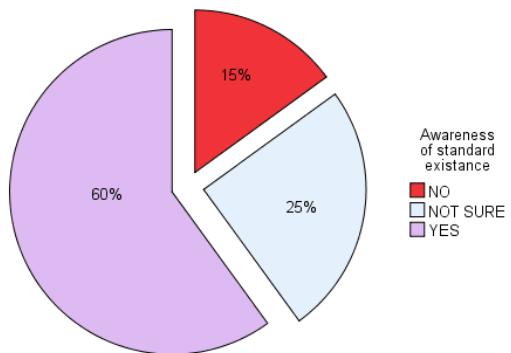


Figure 2: Respondents attitude towards the importance of industrial effluent standards.

This is justified by the finding that out of 40 selected industries only 18 have proper treatment plants. Other 22 industries have no at least primary treatment facilities. Whilst some treatment plants at some industries as shown in Figure3 were not functional as observed during the survey.



Figure 3: non-operational treatment facility

High operational cost and lack of skilled man power were found to be affect compliance. As such, despite industries being aware of standards they failed to install and/or effectively use treatment plants. Generally, there is a lack of knowledge on the standards as well as reluctance to construct treatment plants. The result being partially treated or untreated wastewater discharge into nearby ditches and rivers.

4.2 Industrial effluent discharge practices in Addis Ababa

The study found that 10% of discharging industries were public and 90% private owned. Further, assessment revealed that the industries could be categorized based on activity type. Thus, found chemical, food, Medical and tannery industry related activities accounting for 40%, 40%, 5% and 15%, respectively as shown in table 2.

Table 2: Percentage of Type of company and Ownership

| Type of company | Ownership | | Total (%) |
|-----------------|-----------|--------|-----------|
| | Private | Public | |
| Chemicals | 40 | - | 40 |
| Food | 35 | 5 | 40 |
| Medical | 5 | - | 5 |
| Tannery | 10 | 5 | 15 |
| Total (%) | 90 | 10 | 100 |

4.3 Wastewater generation

The average daily waste water generation by chemical, food, medical and tannery industries investigated was about $17.98 \pm 10.01 m^3$, $179.69 \pm 146.96 m^3$, $18 \pm 0.0 m^3$ and $230 \pm 120.02 m^3$ (Figure 4). The high volumes of effluent coupled with low compliance levels entails high levels of pollution. Noting the fact of inadequacies and/or gaps in monitoring polluters are at large with the law. The polluter pays principle as one of the most prevalently applied penalty in the case of this study could be said to be weak. This is not only because the industries pollute at will but are not also paying for polluting especially due to the fact that they are characterized by non-point source pollution.

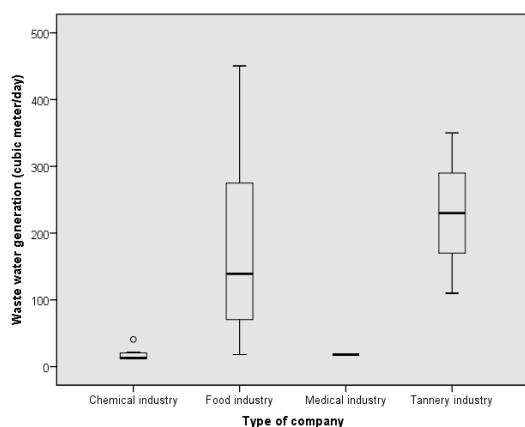


Figure 4: Amount of wastewater discharged

4.4 Treatment plant existence

An inquiry into the existence of treatment plants within the industries' premises revealed that only 33.33% of chemical industry, 47.37% of food industry, and 100% of tannery industry had treatment plant whilst the medical industry had no treatment plant available on site.

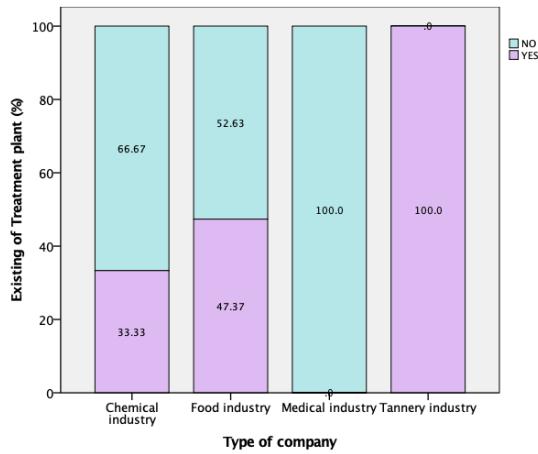


Figure 5: Existence of treatment plant

The industries are expected to have the necessary facilities like waste treatment plants as all of them are established earlier than the period specified. The absence of treatment facilities implies that the effluent discharged by the affected industries may not meet the standards.

4.5 Discharge methods

The levels of treatment and methods of disposal create high levels of uncertainty in terms of adherence to set standards on acceptable pollution levels and final disposal destination. The disposal is highly characterized by non-point source pollution as depicted in figure 6, most discharge source cannot be traced to original sources.

Figure 6 shows that medical facilities discharge wastewater exclusively into the river by truck. However, chemical industries and tanneries use two different discharge methods. Chemical facilities mainly used to treat and discharge to a nearby ditch (65.63%) while tannery industries mostly treated partially and discharged to the river (60%). For the food industries, wastewater effluent was discharged in four main ways: treated and discharged to nearby ditch (35.77%), untreated and

discharged to nearby ditch 19.51, treated and discharged to the river by truck or pipe (26.83%) and treated and discharged to the river (17.89%).

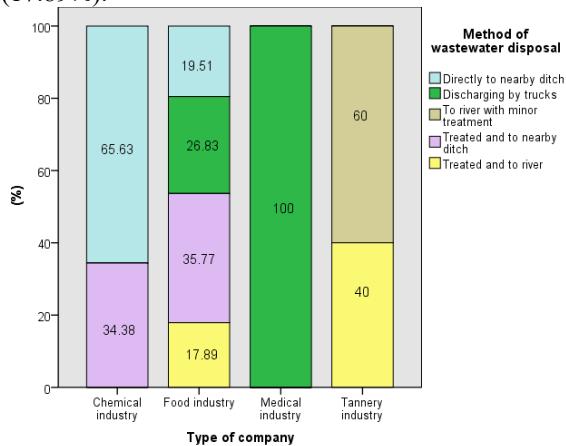


Figure 6: Industries-used wastewater discharge practices

4.6 Precautionary principle implementation tools

Ethiopia implements environmental regulations based on Precautionary Principle and polluter pays principle. But the principle has not been fully operationalized. Furthermore, ideally based on the precautionary principle industries are expected to prepare several documents and establish basement for complying with the standard [22, 23].

a) Environmental impact assessment/ environment management plan

Under these provisions the authorities classified the industries into two, new and old established after and before 2008, respectively. As of 2008 new industries are mandated to conduct environmental impact assessments (EIA) and comply with the Effluent Standards. Old (existing industries) on the other hand have to submit environmental management plans which targeted to comply with the standard within five years.

It was found that 13 of the 40 assessed factories were established before 2008 and 27 after 2008. Hence, the 13 were by law expected to prepare and wholly implement environmental management plans, however, 4 of the factories had not prepared the plans. Similarly, out of the 27 new industries only nine 9 had environmental management plans.



Figure 7: Industries' Compliance practices.

b) Environmental performance report (EPR)

The industrial pollution prevention regulation of Ethiopia has a provision that regulates the operating industries to have a complete record of their waste management activities and annually submit report to AAEPA. However, the survey discovered that 70% of the selected industries are not submitting annual environmental performance report. Figure 8 shows that only six factories submitted the report but not regularly. It is clear that preparation of environmental report related to the presence of skilled environmental professions as the survey found that out of the selected 40 factories only 22 have appointed professionally related skilled man power. This indicates that there is a problem of follow up by the Addis Ababa Environmental protection Agency. Also, it is common behavior among the industries to not expose their environmental damage while they don't have any treatment facilities.

c) Internal Environmental audit (IEA)

The IEA is another compliance tool required to be conducted by the industries. The industries are expected to conduct by themselves annual environmental audits. 55% (Figure 7) do not audit their environmental management activities while 45% who claimed they have performed internal environmental audit. The reason that the firms hesitate to reveal might be an attempt to create a positive firm image or fear of government repercussion as most of them do not properly treat the wastewater.

d) Environment professional skilled manpower (SM)

Appointing environmental skilled manpower is very important and the basic indicator of the industries willingness to do something on reducing environmental damage. SM is a requirement set out by the AAEPA. As indicated in figure 7 Out of the assessed 40 industries had only 55% had appointed professionally related skilled man power and environmental experts. It was learnt that most professionals working in the industries were chemists with other professions working on other production units in place of environment professionals. This culture contributed to industries' failure to report their environmental management activities.

4.7 Factors affecting effective implementation of industrial effluent standards on factories in Addis Ababa,

The most parsimonious linear model using 4 predictors as explanatory variables was significant ($F=27.98$; $p<0.001$). Table 3 depicts that Industry's attitude on standards (IP) and industry's attitude (IC) positively influence the implementation process and effectiveness. IP and IC are the most significant factor among others ($p<0.05$). That is to say, increase in one unit of industry's attitude would result in an increase the effectiveness of standard implementation of standard by 0.501. This tell us that most imperative to the implementation is the institutional coordination, this is because it is as a result of coordination that communication that good relationship and information exchange can be born and consequently attitudes changed.

Table 3: Effectiveness and factor of standard implementation

| Implementation factors | Coefficient | Std. Error | t-value | Pr(> t) |
|------------------------|-------------|------------|---------|----------|
| (Constant) | 0.706 | 0.304 | 2.322 | .022 |
| IP | 0.501 | 0.052 | 9.576 | 0.001** |
| PMaE | -0.018 | 0.052 | -0.349 | 0.728 |
| IC | 0.149 | 0.062 | -2.386 | 0.019* |
| AL | -0.071 | 0.040 | -1.774 | 0.079 |

Note: independent variables were compared dependent one using t-test and the levels of significance are shown with ** $p<0.01$ and * $p<0.05$

Among the identified factors adequacy of legislation correlated negatively due to the perception of selected industries. This shows the kind of legislation is not a source of problem for the industries because they do not have any idea about the specific pollutant limit described in the standards. They only focused on the cost that incurs them to treat wastewater even at very minimum level not mention the required level.

From the result the implementation of standards by improving institutional coordination among relevant institutions improves effectiveness in implementing the standards. Similarly, the more efforts on monitoring and enforcement mechanism and changing of industry's perception exerted the more effectiveness can be achieve among industries in Addis Ababa.

4.8 Allocation of required skilled manpower

The manpower requirements for sound environmental management are quite enormous in terms of both numbers and proficiency[24]. Thus, the institution should be staffed with well-trained professionals who have adequate knowledge about environmental pollution prevention and control system. Environmental pollution prevention and control process

involves many activities such as, monitoring the availability of waste disposal facilities and take the necessary measures to ensure that their availability is satisfactory, take samples of any material and carry out laboratory check-ups to determine whether or not it passes the limit, inspecting and ensuring compliance with the law requires not only adequate number of staffs but qualified experts trained in different disciplines. However, as it is observed in Figure 8, the environment protection inspection department is lacking in terms of both the quantity and quality of staff compared to the enormous and complicatedness of the department's task. Under the AAEPA, from the required number of 8 experts in the department only 6 experts are available to perform all the required duties.

However, it was mentioned that the position at sub city and woreda taken as unnecessary and assigned unqualified who is evaluated low performer at sub city and woreda level. The identified reason was low payment which forced the experts to be attracted by NGO's and private institutions in search of better salary.

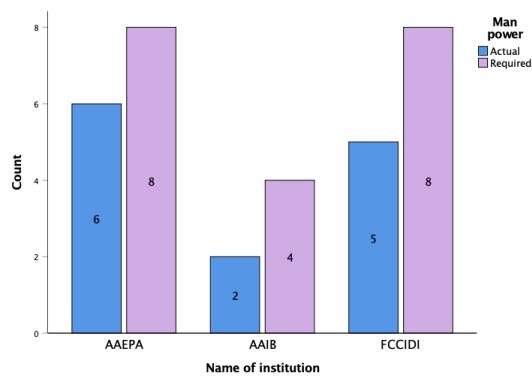


Figure 8: Number of experts assigned for Environment activities in three environment related institutions.

4.9 Regularity of the inspection

Unless the inspections are conducted on a regular basis it would be difficult to monitor industries to comply with the effluent standard(s). Table 4 depicts that 60% of respondent indicated that that AAEPA and other institutions had not visited their industries to check the wastewater discharge during the course of the year. Visited industries on the other hand claimed that the inspections were irregular.

Table 4 : response for inspection and response for violation of standard

| Level of agreement (%) | Yes | Never |
|--|-----|-------|
| -Inspected once | 40 | 60 |
| -Agreement on regularity of inspection | - | 100 |
| -Fined for violation | - | 100 |
| Discharging above the standard limit (%) | 75 | 25 |

The environmental protection and inspection team claimed otherwise. They expressed that in addition to the regular inspection, the authority conduct inspection on community appeal when there are an environmental and human health problems around factories due to discharge of wastewater, or licensing issue. An examination of information from FCCIDI environmental protection directorate revealed there is no strong monitoring system regarding environmental issues on chemical industries. Thus, a huge gap has been observed between level of compliance practices and enforcement. This does not show absence of monitoring system but rather exposes irregularity of inspection and very weak enforcement through lack of leaders' commitment towards pollution control and implementation of strong environmental management system as their priority is to maximize industrial economic productivity.

5. Conclusion

Overall, the level of industries perception and awareness of the effluent standards, proper monitoring and enforcement and the institutional coordination among the relevant institution is the determinant factor for effectiveness in implementation of the effluent standards. The stronger these factors are the better implementation status of industrial effluent standards.

It is also possible to conclude that the industry level of perception and the precautionary principle implementation tools were seen low. This is because of the financial constraints as described by the industries owners and experts in government institutions.

The scenario becomes more difficult due to poor monitoring and enforcement mechanism. The results highlighted that there is unpredictable monitoring and very loose approaches for violators of set limits. Lack of commitment among AAEPA's higher officials was seen as the major problem in this regard.

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Abbreviations

| | |
|--------|--|
| AAEP | Addis Ababa Environmental protection agency |
| AAIB | Addis Ababa industry bureau |
| AAWSA | Addis Ababa water and sanitation Agency |
| CSA | Central statistics Agency |
| EIA | Environmental impact Assessment |
| EPR | Environment performance report |
| ES | Effluent standards |
| FDRE | Federal democratic republic of Ethiopia |
| FCCIDI | Federal chemical and construction input industry development institute |
| IEA | Internal environmental audit |
| MoFC | Ministry of forest and climate change |
| SMP | Skilled man power |

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