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Liquid Waste Management Practices and the Role of Communal Treatment Plant in the Eastern Industrial Park of Dukem town, Ethiopia

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Abstract

There was pollution of effluents from some of the industries inside Eastern industrial park. Consequently, the paper intended to assess the liquid waste management practices and the role of communal treatment plant. The researcher used mixed approach. Accordingly, the existing liquid waste management practices were not sufficient. The perception of employees of industries also revealed, there was no effective liquid waste communal treatment plant and the existing equipments and facilities was not sufficient. Based on multinomial logistic regression model, formulation and enforcement of legislation and training and motivation of personnel were the factors that determine the existence of effective liquid waste management practices. While financing and investment in equipment and facilities, training and motivation of personnel and public education and involvement are the factors that determine the existence of sufficient facilities and equipment for liquid waste management practices. Each company was recommended to have efficient primary treatment plant and sufficient facilities.

Keywords: Liquid waste; Management practices; Role of communal treatment plant; Eastern industrial park

Introduction

Background of the study

In the last period of time environmental issues were overlooked in the industrial design, manufacturing use, and disposal of industrial wastes [1]. Beside this, hazardous and toxic wastes used to be handled in unsustainable way. As a result, severe environmental effects were caused from material production, manufacturing, distribution, usage and disposal of wastes.

Conversely, according to Despeisse M, et al. [2], increasing environmental problems resulting from natural resource depletion and pollution need to be addressed. One approach to these issues is sustainable development. Principally, it is the idea that social, economic and environmental issues should be addressed at once and holistically in the development process [3].

In other way, sustainable manufacturing has been expressed as the generation of manufactured products employing processes that minimize wastes, conserve natural resources, which are safe for communities, employees and consumers [4,5]. In contrast, it seems that the issues of environment in the industries neglected part [2]. Currently, following the development of society and anthropogenic activities such as industrialization, environmental protection gradually has become a focus area [6].

Nevertheless, rapid population increase and unsustainable industrial development are extremely degrading the urban and semi-urban environment in Ethiopia [7]. They are causing enormous damage on natural resources, and hindering sustainable development because of inadequate waste management and pollution control and resource depletion.

Regarding this, the Ethiopian government has considered the Eastern Industrial Park as an integral part of Sustainable Development and Poverty Reduction Program [8].

However, the effluents discharged from the Industries in the park are degrading the environment such as water and soil [8]. The local community nearby the industrial park is also affected by the activities in the industrial park.

On the other hand, the national environmental pollution control proclamation No. 300/2002 primarily intends to safeguard the right of citizens to a healthy environment and to enforce law to protect the environment of the nation. In relation to this, the proclamation offers a basis from which the appropriate environmental standards relevant to Ethiopia can be established, while endorsing violation of these standards as illegally punishable offenses.

Besides, regulation 159/2008a which was established by the Federal Environmental Protection Authority, aimed to avoid industrial pollution and promote compatibility of industrial development with

environmental conservation. A factory subject to the regulations is obliged to avoid or reduce the generation and discharge of pollutants to a level not beyond the environmental standards.

Although the country formulated different regulatory frameworks that prevent or minimize environmental pollution, even the industrial park which the government considered the model of sustainable development has been polluting the environment through its liquid waste discharges.

Hence, this study aims to investigate the liquid waste management practices and the contribution of Communal treatment plant in the Eastern Industrial Park of Dukem town.

Statement of the problem

The impact of human activities on the environment has been increasing since the beginning of the industrial revolution and at current it extends to a much bigger level, at continental and global scale. Emission levels have reached the point where environment related physical effects are witnessed on a large proportion [9].

In addition, according to McMichael AJ, et al. [10], the environmental effects that are related with industrialization in least developed countries remain crucial as they encroach typically on the poor and vulnerable communities. Chemical and heavy metals remains contaminate local foods, urban air pollution brings premature deaths, and waterborne internal organ pathogens cause for the death of children.

In Ethiopia due to population growth and urbanization, industries are hurriedly evolving in different parts of the country. Although, these industries have social and economic importance still they have environmental influence on local communities. As study conducted by Demewoz B, et al. [11], revealed, human beings have been polluting the environment with their industrial activities. Other study conducted in Addis Ababa by Menbere MP, et al. [12] indicated, the liquid wastes from poorly handled industries such as textile and garment, beverage industries and industrial parks were contributing to the pollution of both water bodies and different parts of the city. On the other hand, according to Mekonnen FH, et al. [13], there was a poor level of knowledge about the current regulations on liquid waste management among the experts as well as the community.

Dukem is one of small sized town found in Oromia regional state, which hosts the Eastern industrial park reveals this problem (Dukem town Environmental protection, Forest and Climate Change Authority, 2021).

The Eastern Industrial Park was constructed for social and economic development, though some of the industries inside the park are polluting the surrounding environment as they are not properly treated. For example, the Oromia Environmental protection Bureau, (2020) investigated that concentration of Phosphorous (P) in the sample treated waste water from Dongfang textile industry was 35.8 mg/l which is greater than the national limit that is <5 mg/l.

In addition, from the outlet of the communal treatment plant of Eastern industrial park, dark color wastewaters and offensive odor were observed showing the discharge of inadequately treated waste water from the industries. Furthermore, the local communities have been repeatedly complaining of liquid waste pollution from the industries. It was also observed that, this waste water has been used as source of irrigation water utilized by local farmers to grow vegetables. This might have considerable health impacts on the local community.

Various scholars conducted a research in the area of industrial liquid waste pollution dealing with different parameters and they found out that large concentration of Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TTS), and PH found in the observed industries [14-16]. On the other hand, Itanna F, et al. [17] conducted a research on the Metal concentration of some vegetables irrigated with industrial liquid waste at Akaki, and the research found out that some metals such as Cd, Cr, Cu, Hg, Ni and Zn in potato and Cr in onion and red beet was above the maximum limit with less considering liquid waste management practices and the contribution of communal treatment plant. Therefore, this study focuses on filling some of these gaps.

Objective

General objectives

To assess liquid waste management practices and the role of Communal treatment plant in the Eastern Industrial park of Dukem town.

Specific objectives

1. To assess the liquid waste management practices in the selected industries of industrial park.

2. To examine the attitude of employees of industries on the contribution of the communal treatment plants.

3. To assess the factors that affects the effectiveness of the liquid waste management practices.

Material and Methods

Study area

The study is located in Dukem town Eastern Industry Park, where it is surrounded in the North West by Galan town, in the South East by Bishoftu, in the South West by a peasant association, Akaki. The town is located at a distance of 37 Km from the capital city, Addis Ababa. The total area is 9,630.3 ha. The GPS location of Dukem ranges 8°45'25" N to 8°50'30"N and 38°51'55"E to 38°56'5"E (Figure 1).

The topography of the town is mainly rugged terrain landform features with ridge and plain in all its land area cover the town.

The climatic condition of Dukem is, dominantly, semi temperate. The highest temperature of it is 29.3°C in the month of March, April and May while the lowest is 7.1°C in the month of August which is the temperature of Semi temperate or 'Weinadega'. The highest mean annual rainfall is 95 mm and the lowest mean annual rain fall is 48 mm.

The population of Dukem is 58,017 (49.12%) males and 56,010 (50.88%) females which is totally 114,027 (Dukem town municipality, 2021).

Data collection method

Both quantitative and qualitative data from primary and secondary data source employing mixed approach were used in the study. Secondary data was collected from different sources such as the town annual report, different journal articles and documented data in the industries, audit report and management plan of industries. On the other hand, the primary data was collected from experts of selected companies using survey questionnaires and key informants of selected government sectors of the town using interview guide. Similarly, primary data also collected from key informants of sampled industries of Industrial Park using interview guide.

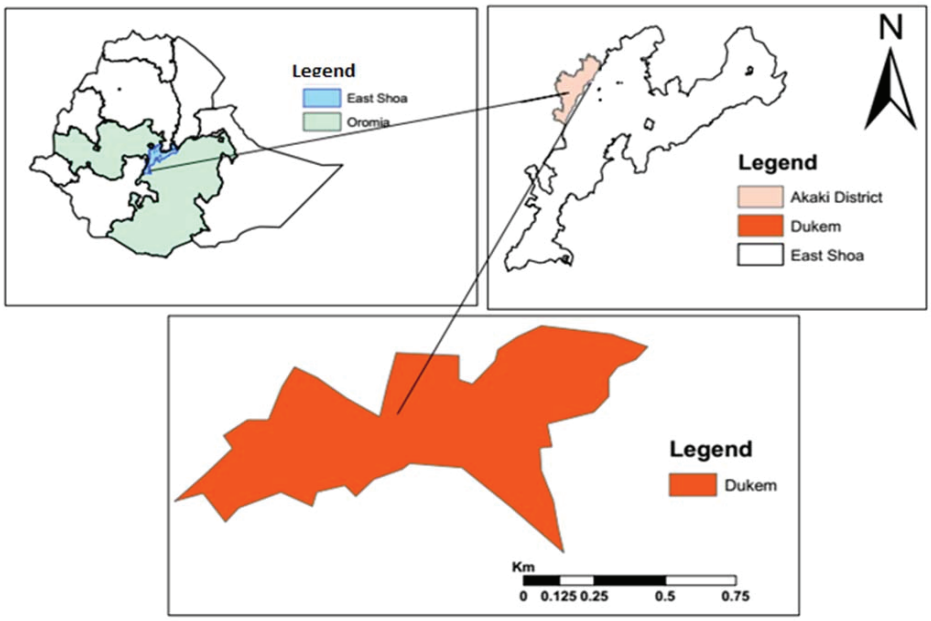

Figure 1: Study area. Source: Adopted from Dagne (2020).

Sampling method and size

In this study, cluster, purposive and systematic sampling were used to select the required sample.

Cluster sampling: According to Acharya, et al. (2013) a cluster sampling is a two-step process in which the whole population is separated into clusters or groups. It is very valuable when the population is extensively dispersed and it is impossible to sample and choose a representative sample of all the components. In this study, it was used to categorize industries in the industrial park based on their product types. Accordingly, industries in the park categorized as Construction material product manufacturing, textile and garment product manufacturing, wood and others product manufacturing. Out of 62 industries that were operational 31 were textile and garment, 15 were construction materials, 16 were wood and other product manufacturing industries.

Purposive Sampling: According to Etikan, et al. (2016) purposive Sampling is the deliberate choice of a member because of the qualities the participant holds. For this study purpose, out of 62 manufacturing industries seven of them were purposively selected i.e. Dong fang spinning, printing and dyeing textile manufacturing, Di Yuan ceramics manufacturing, Zhongshun Cement Manufacturing, East Steal metal manufacturing, Lida textile manufacturing, Linde Garment and TY Wood manufacturing. This was due to the problem aggravate more in the selected industries.

Besides, purposive sampling was employed to select key informants from government sectors and selected industries from Eastern industrial park. This was done by taking sectors and departments that were working closely with industries, considering, that employees that were working in these sectors and departments and head of the government sector offices including the vice know well about environmental management practices in the industries of the park. Hence, experts and heads of the office from government sector such as Dukem town Land administration, Investment, Environmental protection and Labor and Social affairs office were purposively selected as key informant.

Systematic Sampling: According to Bellhouse (2014) systematic sampling is a sampling method that is employed for its easiness and convenience. In this study, it was used to select the sample experts from purposively selected industries. This was so, through arranging the target experts according to some ordering scheme and then selecting elements at regular intervals through that ordered list. The systematic sampling involved a random start and then proceeds with the selection of every kth element from then on wards. In this case, k=(population size/sample size). The starting point was not automatically the first in the list, but was instead it was chosen randomly from within the first to the kth element in the list.

Questionnaire was administrated to experts of selected industries. On the other hand, structured interview was prepared to key informants from the selected government offices and Industries.

Sampling frame

The target population of this study was key informants from the selected government sector, selected industries of the park and employees of selected industries of industrial park. Therefore, the sampling frame of the study was the list containing all employees from the selected industries of Industrial park.

Sample size determination

The total number of focal person, department heads and heads of selected office and industries were 51 in number. This was by taking four (4) key informants from 4 (four) selected government sectors which is 16. On the other hand, by taking 5 (five) key informants from selected 7 (seven) industries of Industrial Park which is 35.

Conversely, the total employees in selected seven companies were 2,000 in numbers. However, the total experts in the selected companies were 995 from where the sample size is determined. The sample size

of the population was determined using Yamane's (1967) formula. According to him for a 95% confidence level and P=0.5, size of the sample should be using equation 1 formula.

$$n = \frac{N}{1 + N(e^2)} \quad \text{.....Equation (1)}$$

Where, N is population size and e is the level of precision. Let this formula be used for our population, in which N= 995 with+5% precision assuming 95% confidence level and P=0.5, we get the sample size as n=995/(1+995 (0.052))=285. By adding 5% contingency plan 285+(285)* 5/100=285+14=299.

Therefore, the total simple size of the study was 299. However, 285 collected from respondents while 14 questionnaires lost.

Data collection instruments

Interview: Interview was made with key informants from selected government sector that incorporated heads, department heads and experts. Besides, key informants from industries of industrial park were engaged in the interview. This was made through preparing structured interview questions.

In the interview, issues such as the liquid waste management practices and the role of communal treatment plant were raised. On the other hand, the key informant interview was administered using structured interviews.

Questionnaires: For experts' survey, a self-administered survey was distributed to the experts of selected industries. A random sample style approach was used to ensure that the whole experts of selected industries have the opportunity to participate in the study.

The survey examined the perception of employees on the communal treatment plant and the factors affecting liquid waste management practices. The participant age, gender, level of education and position were included in the survey. The purpose of the open-ended questions in the survey was for methodological triangulation.

Open-ended questions: The open-ended questions within the self-administered survey related to the liquid waste management practices. The responses were examined and coded to represent a thematic interpretation of responses. The narrative was provided by the participants were used for triangulation purposes to explain and provide meaning. The narrative also allowed participants to express views that they considered weren't adequately covered within the confines of the survey.

Data analysis and presentation

Both the qualitative and quantitative data were analyzed. The qualitative data was examined first, and then quantitative, finally the open-ended questions, for methodological triangulation and to further information and explain the quantitative findings. The qualitative data was analyzed using thematic analysis through classifying the interview transcript in to different themes. On the other hand, the quantitative data was analyzed using the Statistical Package for Social Science (SPSS) using descriptive statics and multinomial logistic regression model while Tables, figures, charts and graph were employed for data presentation.

Ethical consideration

The research conducted with officials at different levels was aided by supporting letters from Addis Ababa University. The researcher collected data carefully in order to ensure confidentiality of information, privacy and personal safety of the respondents. Verbal consent was obtained from the respondents. The participants were informed about the objective of the research before conducting each interview. Those who were willing to participate were interviewed. The collected data was checked for completeness, clarity and accuracy.

Results and Discussion

The liquid waste management practices in the selected industries of industrial park

In the following section, based on interview with key informants of selected government sectors and industries, and secondary data, liquid waste management practices in the selected industries were discussed. Accordingly, the volume of liquid waste generated from selected company and the method and technology that were practiced in the selected company such as reusing, ponding system, primary and the communal treatment plant stated as in the following.

The liquid waste management practices in the Dong Fang and Lida textile factory: As interview and secondary data result revealed, liquid waste was the major environmental and human health impacts of selected textile factories. The main source of liquid waste was dyeing process. The liquid waste from dyeing operation was characterized with several dies, mordant and reducing agent such as sulphides, hydrosulphides, acetic acid and soap were strongly colored, fairly high BOD [5].

The other liquid waste sources were floor washing, domestic use and drainage line leakages. In the Dong Fang textile factory, there were around 35,880 M3 liquid wastes produced annually. Out of the total annual production, 52% of them reused while the rest 48% of them discharged to the communal treatment plant. On the other hand, in the Linda textile factory, there were around 36,145 M3 liquid wastes produced annually. Out of the total annual production, 40.5% of them reused while the remaining 59.5% of them discharged to the communal treatment plant [5].

This implies that the majority of liquid wastes from sampled textile factories have been draining to the communal treatment plant of Eastern Industrial park after passing the company's primary treatment plant which was not efficient.

The liquid waste management practices in the Linde garment factory: As far as liquid waste management practices in the Linda Garment factory were concerned, there was no considerable amount of liquid waste that has been generating from the factory. As interview made with key informants of the factory revealed, there was little amount of liquid waste that has generated from the factory. Some of this liquid waste was washed water which was stored in the septic tank. In the Linde Garment factory, there were around 51 M3 liquid wastes produced annually. The total annual production of liquid waste was disposed. This revealed, there were no reusing and recycling practices of liquid wastes in the Linde Garment as less volume of waste produced in the garment factory as compare to the rest selected industries of Industrial Park.

The liquid waste management practice in the Steel factory: The East Steel factory consumed large volumes of water as high as 150-200 tons/ton of steel production. The major source of waste water was from cooling water. In the East Steel factory, there were around 899,100 M3 liquid wastes produced annually. Out of the total annual production, 40.5% of them reused while the rest 59.5% of them discharged to the communal treatment plant (East Steel Environmental Audit report, 2021) [18].

In the East Steel factory, in certain sections waste water was isolated and treated separately. However, all waste water coming from the East Steel plant was treated in communal treatment plant found in the Eastern Industry Zone. Besides, reusing of water was adopted in several units. In other hand, the ponding system was used to treat the cooling water through adding powder chemicals (East Steel Environmental Audit report, 2021) [18].

The liquid waste management practice in the Di Yuan Ceramics factory: In the Di Yuan Ceramics company, tremendous volume of water was used for ceramics manufacturing processing, particularly, in cooling section. The ceramic industry also used and consumed large volume of water in its production in the process such as glazing, polishing, molds washing and ball grinder preparation.

On the other hand, the liquid wastes from Ceramics Company were washed water of raw materials, oil, greases and water removed or liquid waste from toilet. Some of this waste was reused while others drained to the communal treatment plant.

There were 1,000 litters waste water reused on average per day for cooling reason. The company consumed large amounts of water from molds washing and raw material through reusing process of waste water. On the other hand, the ponding system used to treat the cooling waste water through adding the powder chemicals (Di Yuan Ceramic Environmental Audit report, 2021) [19].

In the Di Yuan Ceramics factory, there were around 633,100 M3 liquid wastes produced annually. Out of the total annual production, 46% of them reused while the rest 54% of them was discharged to the communal treatment plant.

The liquid waste or mud generated from this ceramic process contained mostly fine particles and clay minerals like kaolin, mica and silt. Some coarse particles and chemicals containing suspended and dissolved heavy metals such as zinc and lead. This waste water not only contained high suspended and total solids but also significant volume of dissolved organics causing in high BOD or COD loads (Di Yuan Ceramic Environmental Audit report, 2021) [19].

However, in solving the issues of liquid waste pollution, Di Yuan ceramics PLC established a liquid waste primary treatment plant with liquid waste collection pond. On the other hand, from polishing of end products that produced large volumes of waste water were generated throughout the process. The liquid waste that incorporated harmful chemicals with negative effect on human health was polluting the environment. To mitigate the impacts, the company has added powder chemical which treated the pounding system (Di Yuan Ceramic Environmental Audit report, 2021) [19].

However, the primary treatment plant of the company was not that much efficient in treating the liquid wastes (Di Yuan Ceramic Environmental Audit report, 2021) [19].

Consequently, several approaches for managing the waste water have been designed, particularly; minimize the production of waste water instead of treating liquid wastes. In addition, actions in which the waste water can be reduced directly subject to the guide lines of Environmental Protection Authority (EPA) have also been implemented (Di Yuan Ceramic Environmental Audit report, 2021) [19].

This reveals considerable amount of liquid waste discharged to the communal treatment plant of Eastern Industrial Park instead of reusing in the company.

The liquid waste management practices in the Zhongshun Cement Manufacturing: As far as liquid waste management practices in the Zhongshun Cement Manufacturing were concerned, there was no substantial amount of liquid waste that generate from the factory. As the secondary data and interview made with key informants of the factory revealed, there was little amount of liquid waste that generated from the factory. Some of this liquid waste was washed water which was stored in the septic tank of the company. In the Zhongshun Cement factory, there were around 499,100 M3 liquid wastes produced annually. Out of the total annual production, 44% of them reused while the rest 56% of them was discharged to the communal treatment plant. Besides, the company had no primary treatment plant which intended to treat liquid waste as there was no considerable amount of liquid waste from the company (Zhongshun Cement Manufacturing ESMP, 2019). This indicates that almost half of the liquid waste discharged to the communal treatment plant instead serving as water consumption through reusing.

The liquid waste management practice in the TY Wood Company: On the other hand, concerning liquid waste management in the Wood Company, there were large volumes of liquid wastes from TY Wood Company. In the Company, there were around 443,100 M3 liquid wastes produced annually. Out of the total annual production, 43.5% of them reused while the rest 56.5% of them discharged to the communal treatment plant. The primary waste water treatment plant in the TY Wood Company treated the liquid wastes in the company which finally drained to the common wastewater treatment plant of Eastern industry Park. Besides, there were liquid waste reusing practices to fulfill their water consumption in one hand and reduce environmental pollution in the other hand (TY Wood ESMP, 2019) [20].

In general, there were limitations in liquid waste management in the companies. Among others, lack of quarterly effluent monitoring and sending results to EPA and Dukem town administration Environment, Forest and Climate Change Authority, inadequate implementation of monitoring and follows up in the management of liquid waste, inadequate safety equipment provision, lack of awareness and training for staff, absence of quarterly inspection, lack of establishing quality assurance unit to guarantee timely repairs to leaking oil and waste water pipes (DEFCCA, 2021).

In general, there were large volume of liquid wastes that were generated from selected textile companies such as Dong Fang, Linda textile and construction product companies such as Di Yuan ceramics, East steel, Zhongshun cement; and wood company such as Ty Wood. Though considerable volume of liquid waste reused, however, the majority of liquid wastes generated from the sampled companies discharged to the communal treatment plant without efficient treatment with primary treatment plant in each company. On the other hand, the communal treatment plant itself was not efficient and adequate in treating the liquid wastes discharged to it. This might due to poor treatment plant technology and inadequate facilities such as powder chemicals that were used in the communal treatment plant to treat the liquid wastes as per the national standard. Hence, the liquid wastes in the communal treatment plant discharged to the environment without efficient treatment which in turn pollutes the environment.

The attitude of the employees of selected industries on the contribution of the communal treatment plants

Under this section, descriptive analysis was employed to explain

the socioeconomic and demographic profile of the respondents. These play a great role in determining their attitude in the analysis. Likewise, descriptive analysis was made on the attitude of the employees of selected industries on the contribution of the communal treatment plants. This can easily determine the attitude of the respondents that they have about the contribution of communal treatment plant.

Description of respondents' socioeconomic and demographic characteristics of residents: In this section, different respondents' socioeconomic and demographic characteristics which included gender, age, educational background, and position of the employees of selected companies were described.

As table 1 shows, out of 285 respondents 138 (48.4%) of them were males and the remaining 147 (51.6%) were females. This implies that there was gender proportion among respondents.

Table 2 depicts, out of 285 respondents 140 (49.1%) of them their age range between 18 to 25 years. The other, 120 (42.1%) of the respondents their age range between 26-34 years. The remaining, 25 (8.8%) of the respondents their age range between 35-54 years. This indicates that, the majority of the respondents were employees of selected industries who's their age ranges 18-25 and who were youngsters.

Table 3 reveals, out of 285 respondents 120 (42.1%) were employees of selected industries whose their educational background was below high school. The other 95 (33.3%) of the respondents were high school completed. The remaining 25 (8.8%) and 45 (15.8%) of respondents were employees of selected industries who's were their educational background were diploma and degree respectively. This indicates; the majority of employees who participated in the survey were people with low educational background.

As table 4 shows, out of 285 respondents the majority 245 (86%) of them their position was expert. The remaining 35 (12.3%) and 5 (1.8%) of the participants were team leaders and coordinators respectively. This indicates that the majority of the respondents were experts.

The attitude of the employees of selected industries on the contribution of the communal treatment plants: As figure 2 presents, out of 285 respondents 136 (47.7%) of them strongly disagreed in the existence of effective communal treatment plant in the Eastern Industry Park. The other 123 (43.2%) of the participants disagreed in the existence of effective communal treatment plant. The rest 26 (9.1%) of the respondents have agreed in the existence of effective communal treatment plant in the Eastern Industry Park.

The above stated data indicates, the majority of employees of industries strongly disagreed in the existence of effective liquid waste communal treatment plant in the Eastern Industry Park. This shows that there was no effective liquid waste communal treatment plant which in turn affected the liquid waste that discharged to the environment. However, according to Environmental Protection Authority of Ethiopia (1997), stated Industry required to have good treatment technology and waste disposal method.

Figure 3 depicts out of 285 respondents 148 (51.9%) of them strongly disagreed in the treatment of liquid waste in the communal treatment plant as per the national standard. On the other hand, 121 (42.5%) of the candidates disagreed the treatment of liquid waste as per the national standard. The rest 16 (5.6%) of respondents agreed the treatment of liquid waste as per the national standard.

This implies the majority 148 (51.9%) of employees of industries strongly disagreed in the treatment of liquid waste in the communal treatment plant as per the national standard. This shows that there was liquid waste pollution as the communal treatment plant was not treating the liquid waste as per the recommended standards. This was degrading the environment in general and affecting the human health in particular. However, the role of Industrial Park is to improve sustainable development through using clean technology (Haileslasie, 2018).

According to figure 4 demonstrates, out of 285 respondents 138 (48.4%) of them strongly disagreed that the communal treatment plant was benefiting the environment in general and the health of local people in particular. The other 125 (43.9%) of the respondents disagreed that the communal treatment plant was benefiting the environment in general and the health of local people in particular.

Table 1: Respondents' gender profile.

Sex					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	138	48.4	48.4	48.4
	Female	147	51.6	51.6	100.0
	Total	285	100.0	100.0	

Source: Field survey (2021).

Table 2: Respondents' age profile.

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-25	140	49.1	49.1	49.1
	26-34	120	42.1	42.1	91.2
	35-54	25	8.8	8.8	100.0
	Total	285	100.0	100.0	

Source: Field survey (2021).

Table 3: Respondents' educational background profile.

Educational back ground					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than high school	120	42.1	42.1	42.1
	High school	95	33.3	33.3	75.4
	Diploma	25	8.8	8.8	84.2
	Degree	45	15.8	15.8	100.0
	Total	285	100.0	100.0	

Source: Field survey (2021).

Table 4: Respondents' position profile.

Position					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Expert	245	86.0	86.0	86.0
	Team leader	35	12.3	12.3	98.2
	Coordinator	5	1.8	1.8	100.0
	Total	285	100.0	100.0	

Source: Field survey (2021).

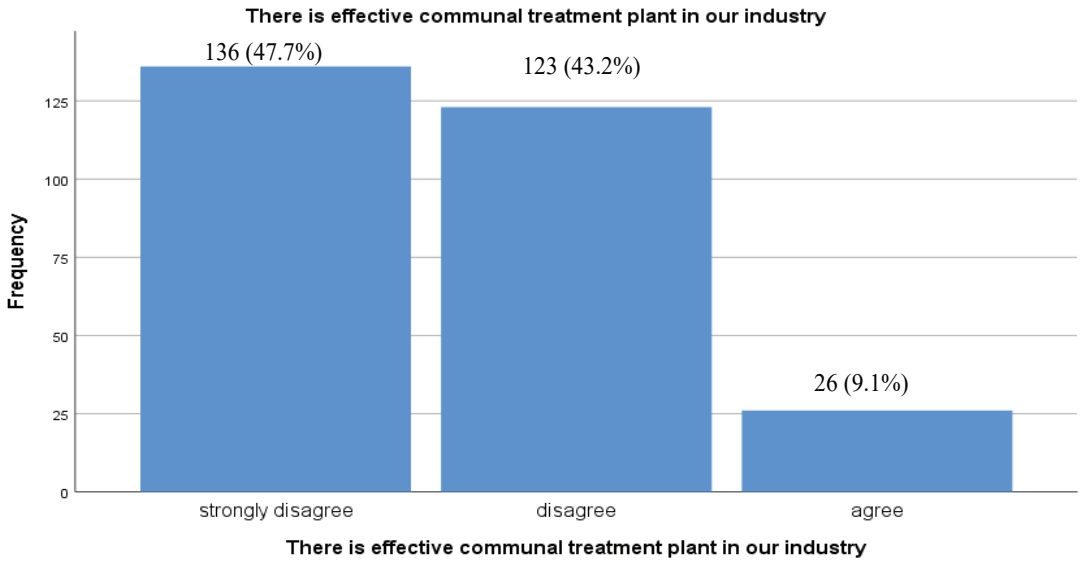

Figure 2: The perception of employees' on the effectiveness of communal treatment plant. Source: Computed using SPSS software by the author.

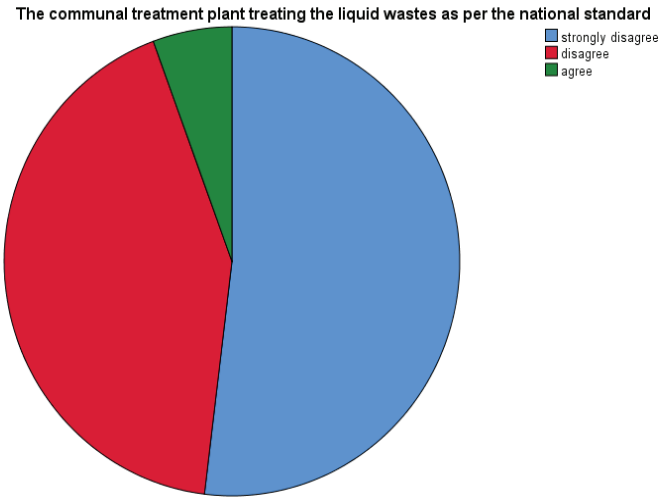

Figure 3: The perception of employees' on the treatment of liquid waste in the treatment plant. Source: Computed using SPSS software by the author.

The rest 17 (6.0%) and 5 (1.8%) of the respondents agreed and strongly agreed respectively that the communal treatment plant was benefiting the environment in general and the health of local people in particular.

This indicates that the majority of employees of selected industries strongly disagreed in the benefit of communal treatment plant for the environment in general and the health of local people in particular. The communal treatment plant was simply for the name which means it didn't meet what was intended to meet.

As table 5 presents out of 285 respondents the majority 161 (56.5%) of them strongly disagreed in the existence of sufficient equipment and facilities in the communal treatment plant of Industrial Park. The remaining 103 (36.1%) and 21 (7.4%) of the participants disagreed and agreed the existence of sufficient equipment and facilities in the communal treatment plant of Industrial Park respectively.

This implies that the majority of employees of selected industries of industrial park strongly disagreed in the existence of sufficient equipment and facilities in the communal treatment plant of Industrial Park. Hence, the communal liquid waste treatment plant in the industry park had no sufficient equipment and facilities which made the treatment plant capable in treating the liquid wastes in order to protect our environment from deterioration. Beside, since there were no sufficient facilities and equipment such as chemicals used for treatment and safety materials not only the environment but also the human health harmed.

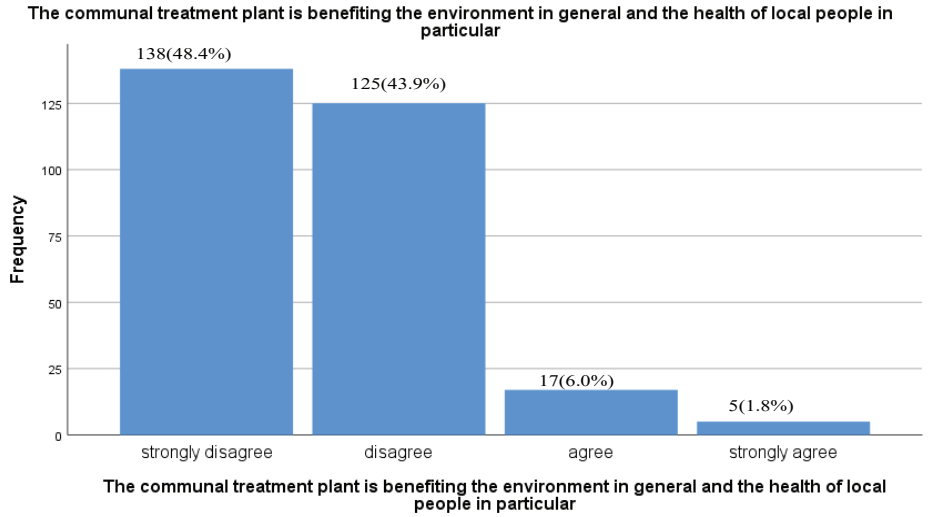

Figure 4: The perception of employees on the environmental and health benefit of communal treatment plant. Source: Computed using SPSS software by the author.

Table 5: The perception of employees' on the sufficient equipment and facilities in the communal treatment plant.

There is sufficient equipment and facilities in the communal treatment plant of industrial park					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	161	56.5	56.5	56.5
	Disagree	103	36.1	36.1	92.6
	Agree	21	7.4	7.4	100.0
	Total	285	100.0	100.0	

Source: Computed using SPSS software by the author.

Table 6: The perception of employees' on the existence of good treatment system design.

There is good treatment system design					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly disagree	108	37.9	37.9	37.9
	Disagree	146	51.2	51.2	89.1
	Agree	31	10.9	10.9	100.0
	Total	285	100.0	100.0	

Source: Computed using SPSS software by the author.

Figure 5 depicts out of 285 respondents 162 (56.8%) of them strongly disagreed in the existence of best selection of treatment process in the communal treatment plant. The other 98 (34.4%) of the respondents disagreed in the existence of best selection of treatment process in the communal treatment plant. The rest 25 (8.8%) of the participants agreed the existence of best selection of treatment process.

This implies that the majority of employees in the selected industries of Industrial park strongly disagreed in the existence of best selection of treatment process in the communal treatment plant. There was no best selection of treatment process. The treatment process didn't filter the liquid waste from industries instead; it released the effluents without proper treatment.

As table 6 reveals, out of 285 respondents 108 (37.9%) of them strongly disagreed in the existence of good treatment system design. However, the majority 146 (51.2%) of the participants disagreed in the existence of good treatment system design. The rest 31 (10.9%) of the respondents agreed the existence of good treatment system design in the Eastern Industrial Park.

This implies that the majority of employees of selected industries of Industrial Park disagreed in the existence of good treatment system design in the Eastern Industrial Park. Hence, there was no good treatment system design in the Eastern Industrial Park which in turn affected the quality of treatment process of liquid wastes.

Generally, as the perception of employees of industries revealed, there was no effective liquid waste communal treatment plant in the Eastern Industry Park. The treatment of liquid waste in the communal treatment plant was not as per the national standard. Besides, there was no benefit of communal treatment plant for the environment in general and the health of local people in particular. Furthermore, there was no sufficient equipment and facilities, best selection of treatment process and good treatment system design in the communal treatment plant of Industrial Park.

The factors that affects the effectiveness of liquid waste management practices: Under this section, multinomial logistic regression analyses were conducted to see the influence of independent variables on the dependent variables. To assess the likelihood that the respondents identify the existence of effective liquid waste management practices and the existence of sufficient facilities and equipment determined with four explanatory variables such as formulation and enforcement of legislation, training and motivation of personnel financing and investment in equipment and facilities of liquid waste management, and public education and involvement in the liquid waste management practices. The choice of independent variables

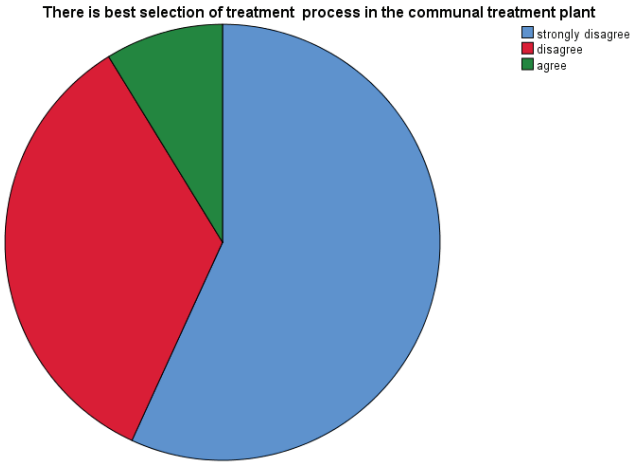

Figure 5: The perception of employees on the environmental and health benefit of communal treatment plant. Source: Computed using SPSS software by the author.

was relied on common sense and literature. For the constituents of the questionnaire reliability analyses were made and the computed Cronbach's Alpha value is 0.864 which is considered as good reliability.

Analysis of multinomial logistic regression model: Table 7 presents out of 285 respondents 22 (7.7%) of them accepted the existence of effective liquid waste management practices. On the other hand, the majority 232 (81.4%) of the selected respondents rejected the existence of effective liquid waste management practices. The rest 31 (10.9%) of the respondents were uncertain the existence of effective liquid waste management practices.

This indicates that the majority of employees rejected the existence of effective liquid waste management practices. Hence, there were no effective liquid waste management practices which in turn lead to environmental pollution and contamination.

On the other hand, to get the entire measure of the model, considering the statistics demonstrated in the Model Fitting Information table is important. Accordingly, the model fitting information was presented in the following table 8.

As it can be seen from the "Sig." column that p=0.000, which means that the full model statistically significantly predicts the dependent variable better than the intercept-only model alone.

In this multinomial logistic regression dependent variable is the existence of effective liquid waste management practices. On the other hand, the independent variables are formulation and enforcement of legislation, training and motivation of personnel, financing and investment in equipment and facilities of liquid waste management, and the public education and involvement in the liquid waste management practices this is a model which we call it the final model.

Here the significance value is .000. Since the significance difference is <0.05 the null hypothesis is rejected. This means the final model fits. Hence, since the value of p=0.000 which is <0.05 we reject the null hypothesis which mean the final model more significant than the null value or model.

As we see from the table 9 above that the p-value is 0.792 (from the "Sig." column) which is >0.05. Hence, it is not statistically significant. According to this criterion, the model fits the data well. Goodness of fit has also null hypothesis. The null hypothesis is the model adequately fits. If the significance value is <0.05 it is rejected. If it is above 0.05 it is accepted. Since Pearson value is 0.792 which is >0.05 the data adequately fit the model. In general, from these two tables the model that is developing is good.

The other important elements in the model are the results presented in the Likelihood Ratio Tests, as presented in the following table 10.

The above table 10 shows which independent variables are statistically significant. As it can be seen in the "Sig." column, level of satisfaction with the financing and investment in equipment and facilities and level of agreement on the public education and involvement in the liquid waste management practices are not statistically significant since p=0.134 and 0.383 respectively which is greater than 0.05.

On the other hand, the level of formulation and enforcement of legislation for liquid waste management and level of training and motivation of personnel working in the industrial liquid waste management are statistically significant since p=0.000 and 0.007 respectively which is less than 0.05. Both variables have significant impact on the dependent variable. Hence, the level of formulation and enforcement of legislation for liquid waste management and level of training and motivation of personnel working in the industrial liquid waste management are the key factors that affect the existence of effective liquid waste management practices.

As table 11 presents, out of 285 respondents 22 (7.7%) of them accepted the existence of sufficient facilities and equipment for liquid waste management. However, 233 (81.8%) of the respondents rejected the existence of sufficient facilities and equipment for liquid waste management. The rest 30 (10.5%) of the participants was uncertain the existence of sufficient facilities and equipment for liquid waste management.

The above stated data revealed that the majority of employees rejected the existence of sufficient facilities and equipment for liquid waste management. This makes the liquid waste management difficult in the industries.

On the other hand, to get the entire measure of the model, considering the statistics demonstrated in the Model Fitting Information table is

important. Accordingly, the model fitting information was presented in the following table 12.

In the table 12, it can be seen from the "Sig." column that p=0.000, which means that the full model statistically significantly predicts the dependent variable better than the intercept-only model alone.

In this multinomial logistic regression dependent variable is the existence of sufficient facilities and equipment for liquid waste management. On the other hand, the independent variables are

Table 7: Summary of the existence of effectiveness of liquid waste management practices and its factors.

Case Processing Summary			
		N	Marginal Percentage
The existence of effective liquid waste management practices	Yes	22	7.7%
	No	232	81.4%
	Uncertain	31	10.9%
Evaluating the level of formulation and enforcement of legislation for liquid waste management	Very poor	53	18.6%
	Poor	208	73.0%
	Good	24	8.4%
Ranking the level of training and motivation of personnel working in the industrial liquid waste management	High	34	11.9%
	Low	229	80.4%
	Medium	22	7.7%
Level of satisfaction with the financing and investment in equipment and facilities of liquid waste management	Very dissatisfied	46	16.1%
	Dissatisfied	210	73.7%
	Satisfied	29	10.2%
Level of agreement on the public education and involvement in the liquid waste management practices	Strongly disagree	36	12.6%
	Disagree	227	79.6%
	Agree	22	7.7%
Valid		285	100.0%
Missing		0	
Total		285	
Subpopulation		15[a]	

Source: Computed using SPSS software by the author.

Table 8: Model Fitting Information in the effectiveness of liquid waste management practices and its factors.

Model Fitting Information				
Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	264.494			
Final	17.815	246.679	16	0.000

Source: Computed using SPSS software by the author.

Table 9: Goodness-of-Fit in the effectiveness of liquid waste management practices and it factors.

Goodness-of-Fit			
	Chi-Square	Df	Sig.
Pearson	7.913	12	0.792
Deviance	8.782	12	0.721

Source: Computed using SPSS software by the author.

Table 10: Likelihood Ratio Tests in the effectiveness of liquid waste management practices.

Likelihood Ratio Tests				
Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	17.815[a]	0.000	0	
Level of formulation and enforcement of legislation for liquid waste management	38.943	21.128	4	0.000
Level of training and motivation of personnel working in the industrial liquid waste management	31.839[b]	14.024	4	0.007
Level of satisfaction with the financing and investment in equipment and facilities of liquid waste management	24.849	7.034	4	0.134
Level of agreement on the public education and involvement in the liquid waste management practices	21.986[b]	4.171	4	0.383

Source: Computed using SPSS software by the author.

Table 11: Summary of the existence of sufficient facilities and equipment for liquid waste management and its factors.

Case Processing Summary			
		N	Marginal Percentage
The existence of sufficient facilities and equipment for liquid waste management	Yes	22	7.7%
	No	233	81.8%
	Uncertain	30	10.5%
Evaluating the level of formulation and enforcement of legislation for liquid waste management	Very poor	53	18.6%
	Poor	208	73.0%
	Good	24	8.4%
Ranking the level of training and motivation of personnel working in the industrial liquid waste management	High	34	11.9%
	Low	229	80.4%
	Medium	22	7.7%
Level of satisfaction with the financing and investment in equipment and facilities of liquid waste management	Very dissatisfied	46	16.1%
	dissatisfied	210	73.7%
	Satisfied	29	10.2%
Level of agreement on the public education and involvement in the liquid waste management practices	Strongly disagree	36	12.6%
	Disagree	227	79.6%
	Agree	22	7.7%
Valid		285	100.0%
Missing		0	
Total		285	
Subpopulation		15[a]	
a. The dependent variable has only one value observed in 13 (86.7%) subpopulations.			

Source: Computed using SPSS software by the author.

Table 12: Model Fitting Information in the existence of sufficient facilities and equipment for liquid waste management practices.

Model Fitting Information				
Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	Df	Sig.
Intercept Only	264.015			
Final	12.342	251.673	16	0.000

Source: Computed using SPSS software by the author.

Table 13: Goodness-of-Fit in the existence of sufficient facilities and equipment for liquid waste management practices.

Goodness-of-Fit			
	Chi-Square	**Df**	**Sig.**
Pearson	3.615	12	0.989
Deviance	5.132	12	0.953

Source: Computed using SPSS software by the author.

formulation and enforcement of legislation, training and motivation of personnel working in the industrial liquid waste management, the financing and investment in equipment and facilities of liquid waste management, and the public education and involvement in the liquid waste management practices this is a model which we call it the final model.

Here the significance value is 0.000. Since the significance difference is <0.05 it is said that the null hypothesis is rejected. This means the final model fits. Hence, since the value of p=0.000 which is <0.05 we reject the null hypothesis which mean the final model more significant than the null value or model.

A statistically significant result (i.e., p<.05) reveals that the model does not fit the data well.

However, as we see from the table 13 above, the p-value is 0.989 (from the "Sig." column) which is >0.05. Hence, it is not statistically significant. According to this criterion, the model fits the data well. Goodness of fit has also null hypothesis. The null hypothesis is the model adequately fits. If the significance value is <0.05 it is rejected. If it is above 0.05 it is accepted. Since Pearson value is 0.989 which is >0.05 the data adequately fit the model. In general, from these two tables the model that is developing is good.

The other important components in the model are the results presented in the Likelihood Ratio Tests, which was presented in the following table 14.

The above table 14 shows which independent variables are statistically significant. As it can be seen in the "Sig." column, level of formulation and enforcement of legislation for liquid waste management is not statistically significant since p=0.801 which is greater than 0.05.

On the other hand, the level of satisfaction with the financing and investment in equipment and facilities, level of training and motivation of personnel working in the industrial liquid waste management and level of agreement on the public education and involvement in the liquid waste management practices are statistically significant since p=0.047, 0.000 and 0.009 respectively which is less than 0.05. All the three variables have significant impact on the dependent variable.

Table 14: Likelihood Ratio Tests in the existence of sufficient facilities and equipment for liquid waste management practices.

Likelihood Ratio Tests				
Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	12.342[a]	0.000	0	
Evaluating the level of formulation and enforcement of legislation for liquid waste management	13.988[b]	1.646	4	0.801
Ranking the level of training and motivation of personnel working in the industrial liquid waste management	40.880[b]	28.538	4	0.000
Level of satisfaction with the financing and investment in equipment and facilities of liquid waste management	21.986[b]	9.644	4	0.047
Level of agreement on the public education and involvement in the liquid waste management practices	25.930[b]	13.588	4	0.009

Source: Computed using SPSS software by the author.

Hence, the level of satisfaction with the financing and investment in equipment and facilities, level of training and motivation of personnel working in the industrial liquid waste management and level of agreement on the public education and involvement in the liquid waste management practices are the key factors that affect the existence of sufficient facilities and equipment for liquid waste management practices.

In general, the level of formulation and enforcement of legislation for liquid waste management and level of training and motivation of personnel working in the industrial liquid waste management are the key factors that affect the existence of effective liquid waste management practices. On the other hand, the level of satisfaction with the financing and investment in equipment and facilities, level of training and motivation of personnel working in the industrial liquid waste management and level of agreement on the public education and involvement in the liquid waste management practices are the key factors that affect the existence of sufficient facilities and equipment for liquid waste management practices.

Therefore, to facilitate the effective liquid waste management practices the companies required to fulfill and implement rule and regulation, strategies and policies that are important to liquid waste management in the companies. Besides, there has to be sufficient skilled man power, efficient facilities such as treatment plant, powder chemical for treatment of liquid waste and other waste water technology. Moreover, public awareness and involvement in the liquid waste management of the companies significantly contribute in the effective liquid waste management of the companies.

Conclusion and Recommendation

Under this section, the conclusion and recommendation of the paper were also presented.

Conclusion

In general, based on interview with employees of sampled industries and secondary data results, the liquid waste management practices in the selected Textile and Garment product factories and Construction companies and other wood product industry were assessed. Accordingly, there were large volumes of liquid wastes production in the selected textile companies such as Dong Fang and Lida textiles [21], and construction companies such as Di Yuan Ceramic, East Steel Metal Production and Zhongshun Cement Manufacturing, and other wood product industry such as TY Wood company.

With the exception of Linda garment and Zhongshun Cement Manufacturing, the rest sampled companies had their own primary treatment plant which was not efficient in treating the liquid wastes from the companies. Eventually, the liquid wastes from the companies discharged to the communal treatment plant of Eastern Industry Park for further treatment. However, the communal treatment plant itself was not efficient in treating the liquid wastes from the companies as sample test of pollution level with selected parameters from effluents of communal treatment plant and its outlet exceeds the national standards.

This in turn might affect the environment in general and the health of people in particular as the local communities have been using liquid waste for irrigation purposes and producing tomatoes, green paper and cabbages for local market consumption.

On the other hand, based on the perception of employees of industries there was no effective liquid waste communal treatment plant in the Eastern Industry Park. The treatment of liquid waste in the communal treatment plant was not as per the national standard. Besides, there was no benefit of communal treatment plant for the environment in general and the health of local people in particular. Furthermore, there was no sufficient equipment and facilities, best selection of treatment process and good treatment system design in the communal treatment plant of Industrial Park.

Based on multinomial logistic regression likelihood ratio test result, out of the four independent variables which are formulation and enforcement of legislation for liquid waste management and training and motivation of personnel working in the industrial liquid waste management are statistically significant since p=0.000 and 0.007 respectively that is less than 0.05. Both variables have significant impact on the dependent variable 'the existence of effective liquid waste management practices.' Hence, the two independent variables formulation and enforcement of legislation for liquid waste management and training and motivation of personnel working in the industrial liquid waste management are the factors that highly determine the existence of effective liquid waste management practices.

On the other hand, out of the four independent variables, three of them such as financing and investment in equipment and facilities, training and motivation of personnel working in the industrial liquid waste management and public education and involvement in the liquid waste management practices are statistically significant since p=0.047, 0.000 and 0.009 respectively which is less than 0.05. All three variables have significant impact on the dependent variable 'the existence of sufficient facilities and equipment for liquid waste management practices.' Therefore, the independent variables such as financing and investment in equipment and facilities, training and motivation of personnel working in the industrial liquid waste management and public education and involvement in the liquid waste management practices are the factors that highly determine the dependent variable the existence of sufficient facilities and equipment for liquid waste management practices.

Recommendation

- There were large volumes of liquid wastes production from sampled industries of Eastern Industrial park. Hence, each company recommended having their own primary efficient treatment plant that helps them treat the liquid wastes that discharged to the communal treatment plant.
- Each company recommended making sample test regularly from the effluents discharged to the communal treatment plant and its outlet.
- The existing communal treatment plant of Eastern Industrial park was no efficient in treating liquid wastes discharged from industries of Industrial park, therefore, the industry park recommended to plant efficient treatment plant with sufficient facilities in order to avoid environmental degradation due to pollution of liquid wastes.
- The sampled industries recommended using modern and efficient technologies that reduce liquid waste pollution.
- Some of the chemicals that have been used in the treatment plant was not labeled either in English or local language rather labeled with Chinese language which was difficult to read and identify the expire date by local experts, hence, the chemicals that have been used in the treatment plant should be written either in English or local language so that appropriate evaluation and monitoring will be made by local experts.
- The existing regulatory framework that are related with liquid waste management in the Industrial Park need to be implemented in the sampled industries and the communal treatment plants.

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Authors' Contributions

Bekele Girma conducted the study including data gathering, analysis, interpretation and other research activities.

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Availability of Data and Materials

The interview result and secondary data used in the current study are available from the corresponding author.

Competing Interests

The author declares that he has no competing interests.

Ethics Approval and Consent to Participate

This study has been commented and approved by Environment and Sustainable development, College of Development studies.

Consent for Publication

Not applicable.

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