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Clarion University of Pennsylvania, Clarion, Pennsylvania

EFFECTIVENESS OF ISO 14001 ENVIRONMENTAL MANAGEMENT SYSTEMS IN ENHANCING CORPORATE ENVIRONMENTAL SUSTAINABILITY AT UNILEVER SOUTH EAST AFRICA IN HARARE, ZIMBABWE

By

Thomas Marambanyika and Timothy Mutekwa

Department of Geography and Environmental Studies, Midlands State University

ABSTRACT

ISO 14001 environmental management system remained one tool widely implemented to mitigate industry's negative impacts on both aquatic and terrestrial life. However, skepticism still surrounds the worthiness of this tool in environmental management, as it merely sets a framework without stringent measures. The paper seeks to explore the effectiveness of the standard at Unilever South East Africa in improving corporate environmental performance and ultimately addressing the goals of sustainable development. Evaluation of the tool was accomplished with the aid of ISO 14031 environmental performance evaluation guidelines. Notwithstanding, the fact that the company has been improving its environmental performance, this in most cases lingered outside permitted legislative limits at the expense of recipient environment. In order for the standard to attain meaningful achievements in the realm of environmental management, there must be harmonization of local authority and central government's environmental regulations and coordination of industrial inspectorate activities to avoid conflicts.

INTRODUCTION

One of the major consumers of environmental resources and producers of environmental damage and pollution is the manufacturing industry. Traditionally, manufacturing industries are the bedrock of economic activity (Fisher and Schot, 1993). Many goods and services are provided only through the sector's industrial activities. As a result, the world has witnessed a rapid increase in the manufacturing sector after World War II. Industrial production grew most rapidly between 1950 and 1973 with an annual growth rate of 7%, recorded in the manufacturing sector (WCED, 1987). Despite its importance, the manufacturing industry and its products have had varied negative impacts on the natural resource base through the entire cycle of raw material exploration, extraction, and transformation into finished products, energy consumption, waste generation, and disposal of products (WCED, 1987; North, 1997).

Major industrial pollution challenges were experienced in the developed world mainly during the industrial revolution period in the late 18th and early 19th centuries (http://en.wikipedia.org/wiki/Pollution and http://en.wikipedia.org/wiki/Industrial_Revolution). This challenge has now shifted to the developing countries, such as Zimbabwe, that are currently mainly preoccupied with industrialization to create employment and improve their economic wellbeing. Moyo (1998) noted that the quality of water in major rivers and lakes near industrial areas in both developed and developing countries has been declining over the years mainly due to the disposal of industrial effluent. In Zimbabwe, industrial pollution of the environment, particularly water bodies in the vicinity of major cities, has been of major concern in recent years. Lake Chivero, Manyame and Mukuvisi rivers near Harare bear testimony to this industrial pollution scourge as evidenced by the 1996 fish deaths and the luxuriant growth of the water hyacinth weed that is threatening the demise of these water bodies.

In Zimbabwe, the current industrial pollution problems continue to take place against the background of weak and poorly coordinated industrial inspectorate activities coupled with ridiculously low gazetted penalties for environmentally related crimes. This scenario has, therefore, failed to deter the current and would be perpetrators of environmentally related crimes from constantly breaking the law (Herald, 2006). A case in point was the pathetic fine of Z$5 million (US$167) for each manufacturing company that was dumping toxic waste in major sources of drinking water for the city of Harare that killed aquatic species in 2006.

Growing environmental awareness and public concern in recent years has led to action by governments and industry in both developed and developing countries. It was realized that in order to achieve sustainable development, resources and environmental considerations must be integrated into industrial planning and decision making process, (WCED, 1987). This prompted most industries to shift from being reactive to environmental problems that they instigate towards proactivity, whereby environmental management is now an essential element integrated into a company strategy. This enabled the measurement of companies' good faith efforts to achieve reliable and consistent environmental protection (Wever, 1996).

ISO 14001 environmental management system (EMS) standard emerged, as a result of the Uruguay round of General Agreement on Tariffs and Trade (GATT) negotiations and the Earth summit in Rio de Janeiro in 1992, as one of the tools that can be used to achieve sustainable development. Standards Association of Zimbabwe (SAZ, 1996:2) defined ISO 14001 EMS as "the part of the overall management system that includes organizational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy."

The standard takes a process and performance approach to environmental management and is meant to complement national regulatory regimes and not replace or adopt them. This paper, therefore, seeks to assess the effectiveness of ISO 14001 EMS in influencing environmental sustainability in industry with specific reference to Unilever South East Africa (USEA) in Zimbabwe. The assessment was done in light of the view that the standard has become a means of operationalizing self-regulation that companies prefer compared to government regulations (North, 1997).

Regardless of the fact that ISO 14001 EMS has been widely accepted and implemented by most companies the world over, the standard's inherent weaknesses has generated debate within environmental circles concerning its usefulness in sustainable environmental management. Firstly, the standard does not establish absolute requirements for environmental performance measurement, thus making it difficult to determine its efficiency and effectiveness. Moreover, an organization can set environmental objectives and targets which are not environmentally friendly. They can be set within a framework of the company's desire to improve its access to the international markets due to increased public environmental awareness (Cascio and Schideler, 1998; Riveira-Camino, 2001).

Secondly, the standard's lack of guidelines on ensuring that companies comply with regulatory and legal requirements prompted Lloyd Register Quality Assurance Limited (2006) to observe that there is, therefore, room for companies to discontinue effective legal compliance with time. Thirdly, the standard's high degree of flexibility and lack of many restrictions gives room for varied interpretations of its requirements (Allenby and Graedel, 1995). In light of these views, one can conclude that the standard does not guarantee good environmental performance (Connaughton, 2002).

However, Howes *et al* (2006) argues that an ISO certified company delivers real environmental improvements, usually as a byproduct of the attention that it focuses on material use and waste management. In order to contribute and clarify on skepticism surrounding the effectiveness of the standard as a tool to enhance sustainable environmental management, research was carried out at USEA in Zimbabwe. Moreover, Yarnell (1993) argued that employee training and awareness were key strategies in the implementation of an integrated EMS and ultimately an improved corporate environmental performance. Research craves to verify on the significance of the role played by employees at USEA.

MATERIALS AND METHODS

Description of the Study Area

USEA is a manufacturing company based in Workington industrial site along Lyton road to the west of Harare City Centre. It has a total of 587 employees. The company's main products are laundry soaps, bath soaps, powder detergents, personal products, edible oils, margarine, and savory soups that can be categorized into personal care and food products. Manufacturing of these products consumes significant amounts of raw materials and generates both liquid and solid waste into the City of Harare's dumpsites. The effluent disposed through City of Harare's sewage network ducts eventually finds its way into Lake Chivero, currently heavily polluted and is the main source of water for the greater Harare metropolitan region. USEA was certified to ISO 14001:1996 EMS in year 2003 and to date the organization is committed to implementation of this environmental standard.

Data Collection

Primary data was collected mainly through questionnaires, informal interviews, observational surveys, and laboratory analysis of industrial effluent samples. This was complimented with desk study of company records, pamphlets, and other documents that provided information on the company's environmental activities and performance. Data collection and analysis focused on the following critical areas of ISO 14001 EMS at USEA: environmental objectives and targets, environmental management programmes, legal and regulatory requirements, employees training, awareness and competence.–These areas were selected on the basis that they constitute important determinants of the company's overall environmental performance.

Desk study of company records and other documents enabled the researchers to identify the company's significant environmental aspects and subsequently the formulation of its operational performance indicators (OPIs) (Table 1). SAZ ISO 14031 (2000: 2) defined OPIs as "indicators that provide information about the environmental performance of the organization".

Table 1: Operational Performance Indicators for Unilever South East Africa

1. Concentration of contaminants in effluent; namely potential Hydrogen (pH), Chemical Oxygen Demand (COD) and Total Fatty Matter (TFM).
2. Consumption of water in cubic meters per year
3. Consumption of energy in giga-joules per year
4. Total amount of hazardous waste discharged per year

The above indicators were instrumental in the scrutinization of the company's environmental performance for the years 2001, 2002, 2004, and 2005. The first two years represented the pre-EMS phase and the last two years represent the post-EMS period. The selected years have complete annual documentation. The two contrasting periods were selected in order to establish the magnitude of change in environmental performance that had occurred towards environmental sustainability. Effectiveness of the company's EMS was determined by its aptitude to meet environmental objectives and targets, legal and regulatory requirements.

Sixteen samples that were collected over a period of four months at the rate of four samples per month for randomly selected days were analyzed in the laboratory to determine the levels of potential Hydrogen (pH), chemical oxygen demand (COD), and total fatty matter (TFM) in the wastewater. This was done in order for the researchers to establish the partiality of the company's documented results as well as those that it was generating during its on-going monitoring processes. Sample analysis was also meant to assess the effectiveness of environmental management programmes in the company's main effluent generating departments, such as edibles and soap. Effluent samples from the Dissolved Air Floatation (DAF) plant were also collected and analyzed to check on treated discharged effluent's conformity to legal limits before its subsequent disposal to the environment.

Questionnaires were self-administered to 58 randomly-selected employees who constituted 10% of the company's workforce. This conformed to Walford's (1995) assertion that sampling techniques require at least 10% of observations or sampling fraction for them to be considered representative of the total population. Questionnaires, solicited among other things, gave information on employees' training, awareness, and competence. Both open-ended and closed-ended questions were used to allow for employees flexibility in answering questions and to enable results comparability, respectively. Departmental employee representativeness was ensured through proportional allocation of samples according to number of employees in each department.

Informal interviews were done with selected key informants from the Safety Health and Environment (SHE) department and City of Harare's Inspectorate Department for Industrial Pollution. Interviewees were selected on the basis that they are custodians of standard's implementation and measures compliance to regulations, respectively. The researchers also made on-site observations on standard implementation, including adherence to best practices, such as induction and employees' awareness of the company policy and competence to execute set procedures.

RESULTS AND DISCUSSION

Environmental Management Programmes

The research established that environmental management programmes (EMPs) for selected OPIs were developed with defined objectives and targets. Environmental objectives and targets were set based on prevailing levels of environmental performance, regulatory requirements, existing Unilever Framework

Standards (UFS), financial capability, and technical options. SHE department exists to oversee the implementation of the standard through various EMPs. Its main targets include percentage legal compliance of total fatty matter loads, potential Hydrogen, and chemical oxygen demand from departmental effluents, as well as monitoring and regulating levels of specified water contaminants from the Dissolved Air Floatation (DAF) plant.

The companies' EMPs specify the actions to be taken for each environmental aspect, the responsible person who represents each department in the ISO 14001 steering committee which meets on a monthly basis for reviews, the dates for starting, ending and reviewing action being taken for each significant environmental aspect, as well as the information on progress to date and future plans. This ensures that compliance with set environmental objectives and targets in each EMP is effectively monitored and adhered to.

Top management sets and agrees on performance targets for OPIs annually. Bi-annual management meetings were conducted to review progress and implement necessary changes to ensure progress towards achieving set environmental objectives and targets. The management review addresses the possible need for changes to policy, objectives and targets, and other elements of EMS in light of EMS audit results, changes in circumstances and commitment to continual improvement. It is imperative to note that the company monitors, measures, and evaluates its progress on environmental performance in both regulated and non-regulated areas. Regulated areas include industrial wastewater and waste disposal and non-regulated are electricity and water consumption.

Legal Compliance

The company is well conversant with the legal instruments obtaining at local, national, and international levels that govern its activities, products, and services. This knowledge became a pre-requisite for the company to establish its acquiescence process as legal conformity was measured for all selected significant environmental aspects with legal obligations. However, Cascio and Schideler (1998) maintained that compliance with all laws may be difficult or elusive. The following sections of the paper will discuss in detail how the company is performing against existing pieces of legislation.

Industrial Wastewater Constituents' Performance

According to the Statutory Instrument 274 of 2000 on waste and effluent disposal, USEA's industrial wastewater is highly hazardous to the environment since it is classified in the red category (Appendix 1). However, the red permit was given on the basis that both COD and TFM parameters in discharged effluent were always out of specified limits set by Zimbabwe National Water Authority (ZINWA).

Potential Hydrogen (pH) Performance

Wilcoxon Signed Rank test at 95% confidence interval was used to compare the company's pre and post EMS pH performance. The results showed that there was a significant difference ($p < 0.05$) between pH levels of the two phases (Appendix 3). In the pre-EMS period, disposed waste's pH levels, despite the fact that they were within the City of Harare prescribed range, was quite high ranging from 8 to 9. This exceeded the 6–7.5 ZINWA limit. The inception of EMS led to improved management of the pH challenge to the prescribed ZINWA range since it dropped to and oscillated around the neutral point of 7. Therefore, the adoption of EMS led to a -1 change in pH.

The improved management of pH in USEA's industrial wastewater provides life protection for fresh water fish and bottom dwelling invertebrates as it has less synergistic effects to the aquatic environment. The fluctuation of pH around the neutral value of 7 in the post-EMS period implies that water drawn from recipient rivers, lakes, and dams has minimal public health risks. Highly alkaline waters as in the pre-EMS period are unpalatable and can cause gastrointestinal discomfort (http://www.gaepd.org/Files_PDF/techguide/wpb/devwtrplan_b.pdf). Therefore, the company managed to meet its objectives and targets by remaining inclined to legislative limits and dispose safe water.

Chemical Oxygen Demand (COD) Performance

COD is a useful measure of water quality as it determines the amount of organic pollutants found in surface water, such as rivers and lakes. Notwithstanding the fact that there was continual improvement on environmental performance of COD in disposed industrial effluent, its overall performance has remained outside ZIMWA's permissible limits of less than 60 milligrammes per litre (mg/l) and 200 mg/l for blue and red permits requirements, respectively. However, statistical tests using Wilcoxon Signed Ranks test at 95% confidence interval indicated that there was a significant difference ($p < 0.05$)

between COD performance in both the pre- and post-EMS phases (Appendix 4). COD levels in the pre-EMS were higher than of the post-EMS phase. In the pre-EMS period, COD performance ranged between 1,500 and 2,700 mg/l compared to fluctuation around 1,000 mg/l in the post-EMS era.

Paradoxically, in both phases the company was complying with local authority's limit of 3,000 mg/l. This means that legally without environmental consideration, the company can use conflict between these pieces of legislation as a scapegoat to justify its COD performance. In the environmental realm, high COD as discharged from USEA is associated with increased depletion of oxygen to lethal levels for most aquatic organisms (http://en.wikipedia.org/wiki/Chemical_oxygen_demand). High COD accelerate bacterial growth, leading to the depletion of dissolved oxygen in water bodies, such as rivers, dams, and lakes.

In order for the company to comply with ZINWA's scientifically acceptable limits, USEA set targets at both COD sources and DAF plants. Edible departments contribute most to high COD due to margarine sterilization. Usefulness of this intervention measure was proved through confirmatory data analysis done with a parametric t-test at 95% confidence interval. The statistical test results indicated that there was a significant difference ($p < 0.05$) on COD levels discharged from the foods and DAF plant (Appendix 5). This could be attributed to differences in target limits at these two sections. For example, the food factory target was 3,000 mg/l compared to 1,500 mg/l for DAF in year 2005. Sample test results in year 2006 showed that COD average was 1,360mg/l from the food factory and 364.4 mg/l from DAF. The results showed that DAF plant disposal to environment was outside the company's ZINWA red permit limit of 200 mg/l. Interestingly, sample results and pre- and post-EMS COD trend analysis indicated that DAF plant is capable of reducing COD levels to permissible limits if the edible department reduces its COD load to the plant. Therefore, improved environmental targets will eventually signal the discharge of environmentally friendly COD levels.

Total Fatty Matter (TFM) Performance

TFM in discharged effluent is composed of oils, fat, and soap. Statistical analysis, using Wilcoxon Signed Ranks test at 95% confidence interval, confirmed that there was a significant difference ($p < 0.05$) in TFM levels for the pre- and post-EMS phases (Appendix 6). TFM levels in industrial wastewater drastically decreased in the post-EMS stage. This was in line with the objective of the company to reduce TFM amounts to legislative limit of 50 mg/l set by the local authority. High TFM concentrations averaging 313 mg/l before EMS implementation were responsible for blockages in city drainage lines and Crowborough workstation. This situation prompted the city authority to apply the polluter pays principle, whereby the company was compelled to cover all expenses accrued during the remediation process.

In the post-EMS era, the company reduced its TFM load to the environment to levels less than 50 mg/l. This could be attributed to establishment of intervention measures at the soap and edible departments that constitute the primary sources of oils, soap, and fat. Soap factory reduced TFM load to DAF plant by 20% from an average of 1,500 mg/l to an average of 1,200 mg/l in year 2005. During the same period, food factory reduced its load to drain water from 1,000mg/l to 600mg/l.

Mann Whitney U statistical tests confirmed that there was no significant difference ($p > 0.05$) in TFM concentration discharged from soap and food factories, as well as from DAF plant (Appendix 7). It implies that intervention measures at the sources, as a result of EMS integration, were effective tools in reducing TFM loads to legal limits into the environment. This means that the company was complying with Section 59 of Chapter 20:27 of the Environmental Management Act of 2002 on water pollution in Zimbabwe which states that all effluent and pollutants from industries should be discharged into an existing sewerage system in terms of the licence issued by the responsible authority.

Furthermore, TFM waste removed at the DAF plant was recycled for soap production. This also signifies that the company was minimizing waste at the same time recovering costs. Ironically, despite continual improvement, TFM levels remained outside ZINWA limits of less than 2.5 mg/l and 10 mg/l for safe disposal and red permit requirements, respectively. This again exhibits contradiction in regulating legal limits between local authority and the national board.

3.7: Hazardous Waste Disposal

In the post-EMS era, hazardous waste was classified into liquid and solid wastes. This is different from the pre-EMS phase, whereby it was not separated and documentation on waste generation and disposal was poor. Classification was done to achieve continual environmental performance improvement.

Targets were set differently for the two subsets. Only Unilever Framework Standards (UFS) were used as targets.

USEA met its UFS for liquid waste in the post-EMS period. In year 2005, the company released less than 50 tons per month, compared to the set target of 230 tonnes. Environmental performance improvement was attributed to a reduction in the amount of spent earth disposed from the soap factory through landfill. The company had found an alternative use of spent earth from the factory. Reduced amounts of spent earth meant reduced underground water pollution from landfill leachates.

Main sources of solid waste at USEA include cardboard boxes, plastics, cartridges, and rubbles from construction. In the year 2004, when EMS was still in its infancy stage with employees still unable to effectively curb solid waste generation, the company contributed significantly to land pollution as it released solid waste surpassing target limit of 50 tons. Improved targets in year 2005 were accompanied by drastic reductions in solid waste generation to levels less than 25 tons, compared to the monthly target limit of 130 tons. This was attributed to the intensive induction carried out within contracted companies, such as construction, accounts, and marketing in line with the expectations of the company's environmental policy. The aim of the induction process was to ensure that contracted institutions minimizes on site waste generation from their daily activities.

Water Consumption

In Zimbabwe, the only legislated instrument governing water consumption is water pricing. Individuals and institutions are charged for volumes of water used over a specified time frame. Since water consumption has no strict deterrent measures, in the pre-EMS time, there were recorded high levels of consumption. Despite the fact that UFS targets were not met in the post-EMS period, there was a marked decline in water consumption. Failure by the company to meet UFS could be attributed to absence of stiff regulatory measures. This means that without backing strict environmental legislation, effectiveness of the EMS in non-regulated areas remains questionable as companies have no worry to evade harsh fines. The only incentive for improvements in non-regulated areas therefore remains the company's will to maintain good environmental reputation.

Energy Consumption

Just like on water consumption, targets for energy consumption were set after implementation of the EMS. This marks a paradigm shift towards monitoring of energy consumption through UFS. UFS target for years 2004 and 2005 was 4.394 giga-joules/year. Actual energy consumption was 4.882 giga-joules and 4.204 giga-joules for years 2004 and 2005, respectively. This signifies a marked reduction in energy consumption. However, the improvement has coincided with scaled down production due to economic meltdown in the country. Since information on waste produce per quantity of materials consumed was not available, it become very difficult to make an objective conclusion. However, the mere fact that this trend emerged after EMS implementation leaves room for credit to be given to the inception of the standard. Interestingly, reduced energy consumption meant that there was an indirect reduction in emissions of carbon dioxide, sulfur dioxide, and other air pollutants released from coal combustion during electricity production. Economically, the diminution means reduced electricity production and transmission costs.

Employees Training, Awareness, and Competence

In order for employees to be aware of EMS requirements, they were trained on the expectation of the standard in relation to environmental policy, environmental management programs, environmental objectives, and targets. Chi-square was used at 95% confidence interval to determine whether a relationship exist between training and awareness. Results of the statistical test show that there was a significant association ($p < 0.05$) between the two variables (Appendix 8). This explains why the questionnaire survey results indicated that 87% of employees were trained and 82% were aware of the requirements of the company’s environmental policy. Higher percentages in both training and awareness show that the company was committed to effective implementation of the standard. Only 13% of the employees indicated that they were not trained. This group is composed of temporary contract workers hired periodically and employees from sub-contracted companies, such as in accounts department.

The obvious focus of EMS training is technical competence of the employees as it determines the way in which employees follow set procedures required to achieve environmental sustainability of the company. Statistical analysis using chi-square at 95% confidence interval indicated that there was little association between training ($p = 0.000$) and competence ($p = 0.016$). Of the 87% trained employees, only 66% indicated that they were able to follow set operating procedures, identify and control environmental problems in their working areas. The difference in training and competence was attributed to training of employees only when there is an environmental audit and change in operating procedures instead of periodical refresher courses becoming an integral part of the implementation process. The menace of employees training when an environmental audit is impending remains employees' reluctance to effectively utilize acquired skills after the exercise.

Moreover, employees were not fully equipped with information on possible departure from operating procedures. 18% indicated dismissal from work, 5% increased injuries, 34% increased waste, 23% indicated all, and 20% did not know. Varied opinions clearly show that employees were not totally sure of the ultimate goal of the EMS standard in their company. Therefore, training, awareness, and competence need to be closely coordinated so that employees acquire relevant knowledge and skills. This will result in employees performing their daily tasks in a way that is less harmful to the environment.

CONCLUSION

The environmental management system contributed to improved environmental performance of the Unilever South East Africa Company. However, it was established that conflicting pieces of environmental legislation set by local authority and central government remains a stumbling block in measuring the company's good faith towards environmental protection. This has resulted in the corporate institution under study justifying its environmental performance leaning on favourable legislative limit sometimes at the expense of the environment, as in the disposal of COD. It, therefore, means that there is need for harmonization of environmental legislation from various institutions responsible for environmental protection and coordination of industrial inspectorate activities if sustainable management is to be achieved. More so, ISO 14001 EMS standard must establish absolute criteria requirements in order to assure that companies adhere to environmentally protective regulations.

Environmental performance in non-regulated areas is not strictly monitored and complied with, as marked by no change in targets for energy and high water consumption in the post EMS period. This means that deterrent fines must be put in place even in non-hazardous areas, such as water consumption, in order to achieve sustainable use of the precious resources. Whilst the company has an upper edge in employees' training on environmental policy, a huge gap between training and competence need to be closed through frequent periodical workshops. This will enable the company to have 100% compliance as employees will be able to at least adequately follow the required set operating procedures. Finally, the research found that the standard remains a potential tool towards improved corporate environmental performance if relevant institutional support is given as it entices and improves even performance of non-regulated areas.

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Appendices

Appendix 1a: Reasons for classification of effluent discharged into surface waters

Classification	Risk	Penalty
Blue	safe	Nil
Green	low hazard	Z$ 30,00
Yellow	medium hazard	Z$67,00
Red	high hazard	Z$120,00

Source: Water (Waste and Effluent Disposal) Regulations, 2000

Appendix 1b: Classification table using effluent standards for discharge

Parameter	Blue		Green	Yellow	Red
	Sensitive	Normal			
Chemical oxygen demand	≤ 30	≤ 60	≤ 90	≤ 150	≤ 200
Total fatty matter	Nil	≤ 2.9	≤ 5	≤ 7.5	≤ 10
pH (pH units)	≤ 6.0 – 7.5	≤ 6 – 9	≤ 5 - 6	≤ 4 - 5	≤ 0 - 4

Measurements in mg/l unless otherwise stated

Source: Water (Waste and Effluent Disposal) Regulations, 2000

Appendix 2: City of Harare effluent contaminants concentration

Item	Concentration
Chemical oxygen demand	3 000
Soap, oils and fat	50
pH	6.8 – 9

Appendix 3: Wilcoxon Signed Rank test for pre- and post- EMS pH at 95% confidence interval

	post-EMS-pre-EMS
Z	-4.485
Asymp. Sig. (2-tailed)	.000

Appendix 4: Wilcoxon Signed Rank test for pre- and post- EMS COD at 95% confidence interval

	post-EMS-pre-EMS
Z	-4.200
Asymp. Sig. (2-tailed)	.000

Appendix 5: T-test COD differences at 95% confidence interval

	t	Df	Sig. (2-tailed)
Soap and edible samples	8.652	9	.000
DAF plant samples	11.195	9	.000

Appendix 6: Wilcoxon Signed Rank test for pre- and post- EMS TFM at 95% confidence interval

	post-EMS-pre-EMS
Z	-4.287
Asymp. Sig. (2-tailed)	.000

Appendix 7: Mann-Whitney U test for TFM differences at 95% confidence interval

	Soap and edibles TFM	Daf TFM
Mann-Whitney U test	.000	.000
Asymp. Sig. (2-tailed)	.317	.317

Appendix 8: Chi – square test for employees training and awareness at 95% confidence interval

	training	awareness
Chi-square	31.500	23.143
Df	1	1
Asymp. Sig	.000	.000