

A CASE STUDY ON THE WASTE MANAGEMENT PRACTICES OF A GREEN PRODUCTION FACILITY IN THE APPAREL INDUSTRY OF SRI LANKA

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Abstract

This paper reports on a case study of the waste management practices of a Green Production Facility in the Apparel Industry of Sri Lanka. The purpose of this study is to explore the waste management practices carried out and understanding the efforts of waste management practices to achieve the key performance indicators and annual sustainability targets that have been employed by a Green Production Facility. Through this study the gap that exists in the Sri Lankan context regarding waste management practices in green factories of the apparel industry of Sri Lanka would be addressed. This issue is of great significance since sustainable management practices are of greater demand in the present due to the requirements of the worldwide customers in the apparel industry and the number of suppliers who cater this requirement is limited in the Sri Lankan context. We have selected Brandix Eco Center, a renowned apparel manufacturer based in Sri Lanka catering to worldwide apparel markets to conduct our study. By employing an explanatory approach as the research design, this study would explore the said objectives. As per the observations and information obtained several waste management practices are carried out to measure and reduce waste in different stages in the production line of Brandix Eco Centre.

Introduction

Background of the Study

With the inception of international trade, a connected global economy was created among the countries leading towards redefined boundaries among countries hence; a shift in the out sourcing and offshore manufacturing paving the way towards global supply chains (Gereffi & Memedovic, 2003 cited in Chi 2011). Sri Lanka's apparel and textile industry is Asia's fashion and logistics hub and a forerunner in global apparel visionary and identified as a producer of "Garments without guilt" with the high values of reliability, quality and social and environmental accountability (Sri Lanka Export Development Board, 2016). The ethical brands and Sri Lankan apparel go hand in hand and becoming a sustainable apparel export nation. (Sri Lanka business n. d. Sustainability- and ethical-practices, 20th April 2017, <http://www.srilankabusiness.com/apparel/sustainability-and-ethical-practices.html>). Being among top in apparel manufactures, the "Made in Sri Lanka" label is now synonymous with quality, reliability, social & environmental accountability. Sri Lanka is the first amongst seven apparel manufacturing facilities in the world to be awarded the LEED platinum rating, setting a global benchmark for Green Apparel factories.

With the increase trend in practice of sustainability to build complete advantage among the world economies, this has resulted the apparel manufacturing companies to play a major role in ensuring that the companies are adhering to best practices in order to achieve long term sustainable manufacturing practices which has paved the path towards breaking leaps and bounds to achieve higher returns in the industry they operate through the distinct competitive advantage they occupied through Sustainability practices as Sustainability incorporates in fields of entire production, human resource and supply chain process is leaving the minimum chances for unfavorable practices there by leading to assuring high quality in garments and competitiveness.

Apparel and textile industry has increasing concerns in regards to sustainability practices due to fact that lot of waste is generated to the environment at each stage of manufacturing and with consumers raising their concerns over environmentally friendly products, the manufactures are taking attempts to meet sustainable manufacturing requirements while ensuring that the company bottom line is met (Gam and Banning 2011). In the context of ensuring sustainable manufacturing

practices, one measure is establishment of “Green Factories” (GF) which will be a focus in our case study carried out as GF ensures more inclination to sustainable practices by companies. (Kibert, 2007 cited in Thilakarathne & De Silva, 2015).

Several studies, mostly qualitative oriented research studies have been carried out in assessing the waste management practices in terms of overall apparel industry and specific apparel companies worldwide. Further in the context of Sri Lanka, projects and assignments are conducted that provides related knowledge but no prior research is conducted in the respective field.

It is our belief that this study contributes to the knowledge by comprehensively analyzing the waste management practices performed by a Green Apparel factory in Sri Lanka. Hence, this study would fill the research gap related to the literature which is researched way forward by the below mentioned objectives.

Problem Statement & Research Question

Overview

In the present corporate giants in the apparel sector such as M&S, GAP, VS, H&M go by the golden rule; “Customer is the King”. Hence, whatever requirement the customer demands, they aim to fulfill it to gain customer loyalty and ultimately market share growth. As a modern trend of sustainability management practices has effected customer buying behavior accordingly. Hence even in the apparel sector, consumers prefer clothing suppliers who practice sustainability to those who do not. This has driven the fashion industry as well to practice sustainability. The customers of apparel manufacturing companies require sustainability in the entire value chain. Sustainable management practices are a broad area under which waste management is a core practice. However, in Sri Lanka there are only a few numbers of companies in the apparel sector who carry out sustainable waste management practices to meet their customer requirements. The first three green factories identified are owned by MAS Holdings, Brandix Lanka and Hirdramani Group (Thilakarathne & De Silva, 2015)

The main research issue addressed in this study is the gap, that to best knowledge of the researcher no prior studies has been published in the Sri Lankan context regarding waste management practices in green factories of the apparel industry of Sri Lanka.

The study is conducted to examine the waste management practices followed by a Green Production Facility to identify the different solid waste collected during the production process. Under this broad issue, several sub-issues will be addressed as follows: (1) exploring how the waste management practices are carried out on an ongoing basis based on the company practices. (2) Understanding the efforts of waste management practices to achieve the key performance indicators and annual sustainability targets that have been employed by the green factory.

By the term “Green Plant” what we mean is a production facility that has the primary focus in sustainability management practices. Green production leads to significant values for better efficiency, quality and productivity, as well as cost saving, new market opportunities and increased product price, sales and market share (Hami et al. 2015). Even though the concept “Green Plant” is an up roaring term in the international world, it is only at inception when it comes to Sri Lanka. There are only a few Green production facilities in the country as of now since sustainability has become a key area of stakeholder interest since of late.

The Green Production Facility which we have selected for the case study is the Brandix Eco Centre, Seeduwa. Brandix is not strange or new to sustainable development and the due recognition it brings. In August 2008, Brandix Eco Centre Seeduwa was awarded the Platinum Certificate in the Leadership in Energy and Environmental Design rating system of the US Green Building Council. This is commonly known as the “LEEDS” certification. Nevertheless, the vision of this company is to achieve zero material wastage, while they pledge to achieve zero waste to landfill by 2020 and increase the Earth Index by 20% from the baseline by 2020.

Research Questions

The study explores the waste management practices used in a green production facility in the apparel sector company in Sri Lanka. This study is carried out as a case study. Thus, this study contributes to the extant knowledge by bridging the above-mentioned gap in the problem statement.

In exploring the waste management practices used in green production facility the study aims at identifying;

1. How the waste management practices are carried out on an on-going basis based on the company practices.
2. What are the key performance indicators and annual sustainability targets that have been employed by the green factory.

Research Objectives

Overall Objective

The overall objective of this study is to examine the waste management practices used in a Green Production Facility of a company in the apparel industry of Sri Lanka using Brandix Eco Centre, Seeduwa as a case study.

Specific Objectives

As part of the study it is intended to understand the what sort of waste management activities are carried out by Brandix Lanka at their Green plant and adding further insights amounts of each selected waste type that is released by the end of production to obtain a more holistic picture of the types/categories of wastage of an apparel manufacturing line and enhanced with a depth analysis of quantified waste items,

Accordingly, the research issues which we have converted into objectives of this research study are as follows.

1. To identify the waste management practices that are followed by the production facility concerned.
2. To identify the efforts of waste management practices to achieve the set KPIs and annual sustainability targets of company considered in the case study analysis.

Significance of the Study

Significance of the study can be discussed in terms of its both practical contribution and theoretical contribution as elaborated below.

Practical contribution

This research is concentrated mainly on sustainability practices focusing waste management practices conducted by an apparel sector Green Factory based in Sri Lanka. Though studies have been conducted addressing this research issue in different contextual backgrounds, only a limited number of published studies have been conducted in fields related to sustainability waste management practices in Sri Lanka. Therefore firstly, this study contributes to the extant knowledge by bridging the above-mentioned gap by studying the waste management practices in the specific factory and to add more value to the literature by quantifying the waste created in different stages of production process. Secondly, an apparel company can realize its goals and objectives via implementing the waste management practices that are properly documented, recognized and observable. Thirdly, the research study attempts to identify what stages of the production process create waste in what quantities, and thereby give an insight on to what are the segments that contribute most and least to the waste count. Fourthly, identifying sustainable waste management practices is essential in the context of Sri Lanka as the country is identified to be among the top in apparel sector.

Theoretical contribution

As result of extensive literature survey which we have done regarding the sustainable waste management practices in apparel sector in Sri Lanka, it is evident the that there are only limited number of published studies related to the underlying area, where the solid waste generation in production flow is addressed very rarely. This study will assist to identify the main categories of solid waste that is generated in the production process. Furthermore, we intend to apply a monetary value for each unit of waste to demonstrate the impact of solid waste to the bottom-line of the plant. With that, we strongly believe this approach will assist to light up the significance of managing solid waste as an essential component of sustainability practices in apparel sector.

Scope & Limitations of the Study

Firstly, the scope of the study is limited to one plant of Brandix Lanka Ltd in the Apparel sector. Hence, this study covers only the practices used to manage material wastage produced in production flow of one plant of Brandix group. Secondly, this study involves the problem of generalizability across other organizations due to possible organizational mismatches. Direct observations, qualitative interviews with a small number of individuals in one plant of one company cannot be generalized to other organizations.

1 Literature Review

Overview

This section discusses the extant literature in relation to waste management and analyses the waste management practices and techniques that have been employed by green factories as a step towards sustainability.

Waste management system

A waste management system can be described as the management of responsibilities and procedures for establishing a system that manages waste and complies with environmental regulations. Waste management may also entail the ways in which waste generation is avoided and reduced (Elsaid & Aghezzaf, 2015). Waste management strategies with minimization and diversion efforts can save significant amount of resources and energy. Integrating waste management objectively and directly into sustainability will increase the utilization of resources (Owen & Davidson, 2011). The theoretical background is laid by concepts such as 7R's (Reduce Reuse Recycle Research Refuse Regenerate and Rethink), triple bottom line, design for environment, product life cycle analysis and zero waste principle.

Concepts

This section discusses the concepts of waste management practices and techniques that have been employed by green factories as a step towards sustainability.

Waste Management Practices

Waste Management Practices implies the activities carried out to ensure waste management or waste disposal from the point of occurrence to final disposal. These practices will ensure that waste is monitored and regulated accordingly. Waste management Practices are intended to reduce adverse effects of waste on health, the environment or aesthetics. These differ among countries, industries and entities in a particular industry. (Apparel Industry- according to this case study).

Green factories

A basic requirement for a “green factory” is energy-efficient and sustainable production that balances environmental and business interests. The holistic approach does not start with machinery, but much further back down the line with building planning. As a result, companies

can achieve cost savings over the long term while making an active contribution to environmental protection. For new constructions or existing factory structures, a comprehensive energy demand analysis can help to achieve the aim of creating a green factory where production is efficient and ecological, and costs are optimized. Such an analysis ranges from the building structure and the materials used and the amount of power required for each unit of production. Based on the information collected, appropriate optimization measures are defined for existing structures or integrated as part of the planning for new buildings.

Approach towards Green Factories in Sri Lanka

With decades of project experience in production planning, Brandix Eco Center is able to provide especially strong support in this area with a practical approach to the topic of sustainability. Green factories are built using ecological based principles in a resource efficient manner, which could provide a healthy facility for people to work (Kibert, 2007).

Sri Lanka as a developing country is becoming a key player in the global apparel market by producing and exporting leading global markets (Thilakaratne & De Silva, 2015). Even though there exists a growing concern of going green which is expected by their world class customers, there are only a few factories that is considered as green factories. They are owned by pronounced garment producers like MAS Holding, Brandix Lanka and Hirdaramani Group. This study would explore the green practices adopted by garment manufacturers limiting the scope into a single case. This study would add more insights and value to the existing knowledge of green factories as there is a gap in the present literature in the Sri Lankan context.

Theoretical Models

The theoretical background is laid by concepts such as triple bottom line, five-R, product life cycle analysis, and zero waste principle.

Triple Bottom Line

Sustainable development is the view that **social, economic and environmental** concerns should be addressed simultaneously and holistically in the development process. (Rosen and Kishawy, 2012), Sustainability involves stabilizing the currently disruptive relationship between humanity and our planet. (Hawken, 2007).

An important facet of measuring and assessing sustainability and efforts to enhance it are sustainability indicators. Indicators for a sustainable community identify where the links between economics, environmental stewardship and society are inadequate, and suggest and prioritize approaches to address the problems. (Rosen and Kishawy, 2012).

While economic viability is necessary for an organization to survive, it is not sufficient to sustain the organization in the long run if it causes irreversible damages to the ecosystem by emitting greenhouse gases (GHG) and toxic wastes and depleting non-renewable resources or it fails to ensure safety, security, dignity, healthcare, minimum wage, indiscrimination and better working conditions for its employees, the community and the society in general. Therefore, it has become imperative for any organization to behave in a socially and environmentally responsible manner while trying to achieve its economic goals. (Gupta, Dangayach & Singh, 2015).

Five-R Principle

Traditionally, the pollution prevention hierarchy is formed by the three-Rs: reduce, reuse and recycle. The primary difference between these processes is the extent to which the characteristics of the product are changed (Ho et al., 2009). While the physical characteristics of a material are maintained in reuse, recycling may change the characteristics of the material completely including chemical and physical traits. Sarkis (2003) points out further that an organization has to decide which methods to employ depending on the product characteristics. This Three-R model has been extended to a Five-R model, as introduced by Etsy and Winston (2009). The additional segments of “re-design” and “re-imagine” serve to complete the Five-R pyramid of five-level analysis framework. Moreover, the Five-R can be extended into a Six- or even Seven-R model as a result of the findings and data gathered. (Ho & Choi, 2012).

Recycling is the process by which materials are collected, processed into reusable forms and subsequently used as raw materials for new products. (HKTDC, 2009b). Shedroff (2009) emphasizes that recycling is an important tenet of sustainability, but in order for it to be effective; products need to be easily disassembled into component parts and separated by material.

Reuse refers to repeating the usage of items in their original format. Instead of discarding the items, they can be reused and thus have their usage life extended. (Ho & Choi, 2012)

Reduce means source reduction and waste prevention. In a fashion and textiles industry context, this could equate to buyers reflecting more carefully on their fabric procurement; perhaps sourcing locally would be less environmentally taxing and if purchasing globally, they should minimize the safety stock ordered to prevent fabric wastage. (Ho & Choi, 2012)

Re-design. Prior to the process of reducing, companies should contemplate and explore ways to re-design what they do and how they do it (Etsy and Winston, 2009).

Re-imagine. Even before the process of re-designing, companies can also consider the re-imagination of their products or processes, since innovation is critical to twenty-first century competitive advantage. These two R's aim to drive and direct environmentally creative thinking into companies, encouraging them to seek new opportunities to add value to what they do and realize that re-designing and re-imaging precludes the former Three-R's in generating greater profit and long-lasting company value and vision.

Product Life-Cycle

Clothing lifecycle presents how the clothing was made, used and recycled. In this lifecycle, many people are involved, and the lifespan can be changed by apparel designs. Clothing can be a communication medium created by designers, which is an observable medium that can encourage wearers and viewers to consider sustainability (Hethorn & Ulasewicz 2008 cited in Min & Koo 2017). Most designers and manufacturers consider the types of materials and manufacturing aspects when considering sustainability but not the consumer phase and the end of life for the apparel (Dombek-Keith & Loker 2011 cited in Min & Koo 2017). Apparel companies make many decisions when designing and each decision can impact the whole clothing lifecycle and its level of sustainability. Therefore, apparel companies have the responsibility to make sustainable decisions and make the clothing lifecycle more sustainable (Black, 2008; Fletcher, 2008; Gwilt, 2011).

According to Appadurai (1988), creators should consider all stages of an object's life journey. Min and Koo (2017) stated that a garment lifecycle could be developed based on the following lifecycle models focusing on garment design: Allwood *et al.*'s (2006) lifecycle: material, production, transportation, use and disposal; World Watch Institute's (2003) lifecycle: raw materials, processing manufacturing, packaging transport, use and disposal; Fletcher's (2008) product

lifecycle: cultivation, production manufacturing, distribution, consumer laundering, and reuse/final disposal; Rosselot and Allen's (2002) product lifecycle: raw material acquisition, material and product manufacture, transport, use and disposal; and Loker's (2008) lifecycle: materials, garment design and production, distribution and transport, consumer use, disposal, recycling and reuse.

Zero Waste Principle

Waste occurs due to inefficiency or non-essential activities of a manufacturing process. An integrated approach need to be occupied by considering the entirety of the waste to find an optimum solution to manage waste using all feasible technologies (Jourdain & Zwolinski, 2015). Waste management may also entail the ways in which waste generation is avoided and reduced (Elsaid & Aghezzaf, 2015).

A Zero waste strategy leads us to look for inefficiencies in the use of materials, energy and human resources. To achieve a sustainable future, extreme efficiency in the use of all resource will be required in order to meet the needs of all of the earth's inhabitants. A Zero waste strategy will leads to faster innovation and movement far beyond incremental approaches that do not include an end point goal (Velmurugan & Ramaraj, 2014).

Zero waste strategies have been adopted by large and small business and by both foreign and domestic governments. The result have includes **increased profits resulting from significant cost saving, improved environmental performance, and stronger local economies**. The result will be economically healthy organisations, healthy communities, and healthy environment for future generations. Thus includes, save money, faster progress, Economic well-being, Supports sustainability, Environmental protection, Social well-being, improved material flows. (Velmurugan & Ramaraj, 2014).

Empirical Association of Studies Connected with the Research Objectives

Sustainability

Apparel manufacturing consumes a huge amount of material and resources, emit a significant amount of pollutants and greenhouse gases to the environment thus creating a growing concern about sustainable practices of organizations (Thilakaratne & De Silva, 2015). The apparel industry is considered as the second largest industrial polluter since it accounts for 10% of global carbon

emission. <https://rctom.hbs.org/submission/sustainability-in-the-apparel-industry-just-do-it/>

Sustainability represents a state where a good quality of life is achieved through a just and healthy society, without jeopardizing the environmental system which enables our survival (Lewis, 2008). The transition towards sustainable development requires bringing together social, economic and environmental concerns to the production process. People need to feel a sense of responsibilities and ownership towards the environmental and social factors. Sustainable development is therefore concerned with finding a better and more efficient way of delivering what is needed within the finite environmental limits ensuring the survival of all the species (Lewis, 2008). It is also defined as a mean of meeting the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987).

The need for sustainable practices in the apparel industry has become an emerging requirement from the world-class customers. Adherence to sustainable practices not only has an impact on the profitability but also on the reputation because this could lead to loss of key customers (Jin-Gam and Banning, 2011). Key drivers of compliance, community expectations and market competition will ensure those who do not adapt will be left behind (Manufacturing Skills Australia, 2008). On the other hand, since sustainability has received an enormous attention in the recent years, it can be conceptualized as a strategy or solution to support continues growth and expansion of the manufacturing organizations. From a resource based view of the firm, sustainability may constitute a valuable, innovative and hard to imitate capability that leads to competitive advantage (Fadzlin et al., 2012). Thus, an apparel manufacturer should be more responsible for sustainability and should take initiatives to abide by ethics and laws of environmental conservation (Thilakaratne & De Silva, 2015).

Manufacturing and Sustainability

Sustainable manufacturing has evolved from the concept of sustainable development and has been introduced at the 1992 UNCED conference in Rio de Janeiro as a guide to help organizational transition towards sustainable development. Minimizing or eliminating production and process waste by incorporating eco efficient practices and encouraging adoption of new environmental friendly technologies are promoted by sustainable manufacturing (Gupta, Dangayach & Singh, 2015). Manufacturing organization have developed and applied numerous approaches to integrate sustainability into industrial operations. As an example, triple bottom line, ecological

sustainability, the use of environmentally friendly and renewable material, safe production process and recycling (Rosen and Kishawy, 2012), (Jin-Gum and Banning, 2011). Sustainable product design and manufacturing is playing a crucial role in industrial growth and quality of the product provided to customers. Economic and environmental impacts are examined in the total life cycle of a product. Environmental issues must be considered in the early stage of product development process and tools, design principles and standards must be applied effectively to create a sustainable product (Gupta, Dangayach & Singh, 2015). Nonetheless organizations have occupied sustainable techniques to come up with garment designs such as using organic fabric, renewable fabrics, postconsumer clothing, reuse non-garment materials, natural and sustainable dyes with innovative pattern changes (Jin-Gam and Banning, 2011).

One way of assessing sustainability performance is incorporating key performance indicators into the reviewing and controlling systems. Since the sustainability goals are often broad, organization should adopt specific issues or areas of priority. One way of doing so is focusing on environmental performance parameters such as, chemical oxygen demand, hazardous and non-hazardous waste, energy consumption and waste consumption (Epstein and Roy, 2001). Hence, this shows the importance of waste management as a sustainable practice.

Waste Management

Per Jourdain and Zwolinski (2015, p.1) rarefaction of raw material and growing awareness of preserving environment have led to a new vision of waste. At present, waste has turned out to be a new resource for material or energetic use. Waste as the terminology suggest is unwanted or undesirable material or substances. Waste occurs due to inefficiency or non-essential activities of a manufacturing process. An integrated approach need to be occupied by considering the entirety of the waste to find an optimum solution to manage waste using all feasible technologies (Jourdain & Zwolinski, 2015).

A waste management system can be described as the management of responsibilities and procedures for establishing a system that manages waste and complies with environmental regulations. Waste management may also entail the ways in which waste generation is avoided and reduced (Elsaid & Aghezzaf, 2015). Waste management strategies with minimization and diversion efforts can save significant amount of resources and energy. Integrating waste

management objectively and directly into sustainability will increase the utilization of resources (Owen & Davidson, 2011).

Wastage of resources occurs at numerous stages of production process, as raw materials in different combinations undergo processes and are converted to finished goods. One of the main ways of waste creation is that pattern pieces of apparel items have irregular shapes, which do not perfectly join like puzzle pieces (Min & Koo, 2017 p.8). The compositions of different wastes have varied overtime and per location, with industrial development and innovation being directly linked to waste materials. The prevention of waste at the source, that is eliminating waste before it is created, should be the future way of managing waste (Velmurugan & Ramaraj, 2014). Most of the manufacturers are concentrating on diverting apparel waste from landfills to their own sites of recycling. This concept is referred to as reverse logistics (Kozlowski, Searcy & Bardecki, 2015).

Manufacturing organizations have linked their operations with natural environment and the manufacturing strategy for products often involves a design for environment and lifecycle analysis. Environmental improvement related to manufacturing processes are linked to 4R (reduction, reuse, recycling, redesign and remanufacturing), zero emission manufacturing. This requires the reuse of wastes or by-product within the manufacturing systems. An important practice that has an environmentally based influence is ISO 14000 certification. These factors being overlapped and interdependent, would yield a synergistic impact on waste management practices (Rosen & Kishawy, 2012). Going green or green factories is one way of going beyond all these conventional models.

Green Factories

Green factories are built using ecological based principles in a resource efficient manner, which could provide a healthy facility for people to work (Kibert, 2007). Green factories adopt a new paradigm of manufacturing which implements various green principles and technologies to become more efficient in resource utilization. Green manufacturing tries to generate processes which utilizes inputs with low environmental impact as well as productive in relation to zero waste and contamination. Green factories try to maintain production efficiency, low raw material cost due to reduced environmental and occupational safety expenses and improved corporate image (Ghazilla et al. 2015). To assume a green policy by a manufacturing company, it should ideally

work upstream with its suppliers and downstream with their customers to ensure all the parties are aligned with the green principle (Ho & Choi, 2012). Going green not only covers green manufacturing processes and techniques, it covers the impacts it has on employees and economy of firm as well (Thilakaratne & De Silva, 2015).

Sri Lanka as a developing country is becoming a key player in the global apparel market by producing and exporting leading global markets (Thilakaratne & De Silva, 2015). Even though there exists a growing concern of going green which is expected by their world class customers, there are only a few factories that is considered as green factories. They are owned by pronounced garment producers like MAS Holding, Brandix Lanka and Hirdaramani Group. This study would explore the green practices adopted by garment manufacturers limiting the scope into a single case. This study would add more insights and value to the existing knowledge of green factories as there is a gap in the present literature in the Sri Lankan context.

Theoretical Gap

Going green as a business concept is gaining much popularity day by day and hence has spread its application to a variety of industries including manufacturing mainly.

Apparel manufacturers have also embraced this concept to a greater extent recently and it can be easily evidenced in Sri Lanka as well, especially since the edge we have over the apparel makers of other countries are these ethical practices. Many studies and researches have been carried out in this respect that have enormously contributed toward the development of the subject matter; “Waste management practices of green factories in apparel sector”.

It was identified that despite the number of studies that have been conducted on the subject area, only a very limited number of studies have been carried in the context of Sri Lankan apparel manufacturing industry.

Therefore, through this attempt we wish to further strengthen the academic base beneath these practices in Sri Lanka to contribute towards filling in of the gap observed in the Sri Lankan extant literature regarding green apparel factories and their waste management.

In summary, we first of all identify the two main concepts; green factories and sustainability and moving forward, we look deep into the concepts that form the theoretical background of this study,

namely; triple bottom line, five R's, product life cycle analysis and zero waste to succeed in the attempt of building up our study upon this basis. Because we believe that a stronger theoretical basis will facilitate a stronger contribution to the extant literature through our study.

Thirdly, some selected empirical studies connected to our study are analyzed. Those studies also are categorized under three sub-areas; sustainability.

Accordingly, it is realized that the need for sustainable practices in the apparel sector has become an evolving requirement from the world-class customers such as M&S, Victoria's Secrets, Nike and etc.

However, several reasons have also been identified why it is hard to implant sustainability in the apparel industry. First, sustainability has no specific definition within the industry.

Also, there is no "one size fits all" solution for a sustainable apparel industry due to the numerous sub divisions (retail market segments) it has within for example sportswear, casual wear, swim wear and etc.

However, when we analyze sustainability and manufacturing, it is noted that manufacturing organizations have developed and applied various tactics to incorporate sustainability into their operations. (Rosen and Kishawy, 2012)

When it comes to measurement of these approaches, integrating of sustainability related key performance indicators (KPIs) into the reviewing and controlling system can be deemed a prominent and a more pragmatic method.

Coming to Wastage, third sub-area of analysis, waste is an unavoidable factor in production and without waste an organization would not be able to run even. So, the goal here is to effectively minimize waste not to eliminate waste completely. Apparel manufacturers can have various types of waste of which the main type being material (fabric) waste due to the fact that pattern pieces of apparel items have irregular shapes, which do not perfectly join like puzzle pieces. (Min & Koo, 2017 p.8)

According to **Environment Wise Governance Guide** also, “Waste minimization aims to eliminate waste before it is produced and reduce its quantity and toxicity. Prevention is the primary goal, followed by reuse, recycling, treatment and appropriate disposal”. (Rosen & Kishawy, 2012)

Under the fourth and the last sub heading Green factories, Green factories are built using ecological based principles in a resource efficient manner, which could provide a healthy facility for people to work (Kibert, 2007).

With the rapidly increasing position of Sri Lanka’s apparel manufacturers in the global market, there have been a few green manufacturing facilities opened up in Sri Lankan domicile as well, owned by the renowned apparel makers of Lanka; MAS Holdings, Brandix Lanka and Hirdaramani Group.

After analyzing the empirical studies connected, then the theoretical gap addressed in this study is explained in brief, which is to enrich the extant literature on the study area.

Research Methodology

The research design which we have selected is in the form of a case study where we aimed to study the waste management practices which are being practiced in the Brandix Eco Centre, Seeduwa. The study was conducted for a period of 8 weeks where we actively engaged in observing and studying the waste management practices of the plant with the relevant support from the key management personnel in the Sustainability and Engineering divisions of the plant who have been generous to extend a helping hand to us. Mainly the Plant Engineer, Plant Administration Officer and the Engineer – Sustainability are the key personnel whom we have identified and from whom we have obtained support.

Research Approach and Justification

The research approach that we have chosen is of qualitative nature where we have used participative observation. The reason for selecting this approach could be elaborated by the fact that as this is a case study. Thus, the use of more than one data analysis methods would facilitate and provide a more justifying meaning to the data collected. We used methods of participative observation with interviews and document analysis. Through this approach we could familiarize with the personnel, who are directly involved in the waste management practices in the facility by

understanding their culture, norms and values. And this was of an overt nature where the interviewees were aware of our intentions and research objectives. Which built up the confidence in the team at Brandix Eco Centre of our true intentions and for them to render us support in whatever way needed.

Sources of Data and Data Collection Methods

The main document sources and the data which we have collected are as follows.

Table 1: Sources of data

Sources of Data	Collected Data
Solid Waste Management Handbook of Brandix Lanka Ltd	The guidelines of Brandix Lanka Ltd on the waste management across the group.
Waste Management Manual of Brandix Eco Centre, Seeduwa	The guidelines of Brandix Eco Centre, Seeduwa within the production facility.
Occupant Waste Recycling Reports	The methods of waste recycling and past records.
Training and Awareness Records	Data about training and awareness sessions for the staff on waste management.
Certifications Awarded for Sustainability Practices	Data about the recognitions of the facility for sustainability practices.

Source: Author constructed

The data collection methods which we would use would be semi structured interviews, participative observations and documentary analysis. Plant Engineer, Plant Administration Officer and the Engineer – Sustainability are the key personnel whom we have interviewed. We prepared and used an interview guide to support our semi structured interview (Refer Annexure 01) Through semi structured interviews and participative observations we have collected information about the waste management practices that are currently in place in the production facility. Through documentary analysis we have obtained information about the annual sustainability goals of the company. We have collected these data via email from the personnel of the Brandix Eco Centre,

Seeduwa as well as the Brandix corporate division where all the documentation will be sent out to and by making plant visits. Tools such as voice recording and taking down field notes were done throughout the study with the Brandix personnel's consent.

Data Analysis Strategies with Justification

The data analysis strategies which we carried out were documentary analysis and data triangulation. These strategies were used in alignment of our stated objectives. Documentary analysis as a part of data triangulation was used to achieve our first objective. Our first objective was to identify the waste management practices that are followed by the production facility. This was also used to identify the efforts of the Waste Management Practices to achieve sustainability targets stated in the second objective of the study.

We analyzed the documents which we received from the sustainability division of Brandix as well as the Eco Centre itself. This was to cross refer on the waste management practices which we identified from the semi structured interviews. From the Eco Centre sustainability records, we obtained the actual sustainability data which is being recorded namely, Energy Consumption, Electricity Consumption and Water Consumption. Then we developed a trend analysis to understand the efforts of the Waste Management Practices to achieve sustainability targets.

We performed documentary analysis as a basis for cross reference with the data which we collected through interviews and participative observation. By incorporating data triangulation into our study, our intention was to increase the reliability and confidence in our findings.

Discussion

Waste Management Practices of Brandix Group

Brandix Lanka Ltd has managed to take great efforts in maintaining appropriate waste management practices within the group as a whole. The main indicator that justifies this fact is the Handbook prepared by the Environment and Energy Management Division (BEED) of Brandix Lanka Ltd to develop awareness of the best practices in waste management for all staff working at Brandix facilities. This provides a framework for the Brandix Group to thrive for success in terms of sustainability which is a balance between economy, environment and societal prospects. The vision of this company is to achieve zero material wastage, while they pledge to achieve zero waste

to landfill by 2020 and increase the Earth Index by 20% from the baseline by 2020. These waste management practices of the group have set a foundation for Brandix echo centre. These act as a common platform on a group basis and are expected to be executed in all corners of sub units of the group. The Brandix echo center stands out to prove environmental friendliness of the Brandix group.

Waste Management Strategy

The Waste Management Practices pertaining to sustainability is based on the following waste management strategy that indicates the most favorable options at the top and the least favorable at the bottom.

Table 2: Waste management strategies – Brandix group

Strategy	Practices
Prevention and Minimization	• Prevention of waste at the source • Review purchasing policy for goods with minimal packaging • Choose products made from recycled materials to support the industry • Choose products that are life-long and durable • Avoid disposable items • Buy in bulk and use refillable containers
Reuse	• Discuss with suppliers for the possibility of using delivery trays, return certain packaging and/or change to a more environmentally friendly alternative. • Refrigerators, ink cartridges and computer printers, for example, can be refurbished for re-use. • Switch to reusable and high-quality batteries.
Recycle	• Working with Waste Service Providers to ensure the recycling of waste material, especially Hazardous Waste. • Composting of food waste, garden waste and other organic waste.

Source: Author constructed

Energy Recovery	• Using organic waste for the production of biogas or thermal energy. • Wood waste is used as fuel for the boilers.
Disposal	• Opposed to the disposal of waste to landfill and it is not part of their accepted waste management strategy.

Responsibility Centers based on Waste Management

The responsibility centers are expected to control waste in their respective unit which gives more clarity to waste management. These include divisions and personnel who are responsibility to monitor and control waste.

Energy & Environment Division oversees all waste management processes throughout the Brandix Group. They engage in the implementation of the measures and practices explained in the Waste Management Handbook and monitors compliance with said practices. They ensure that the steering committee of all facilities receives professional development to assist them with the implementation of measures and practices given in the Waste Management Handbook.

Green Ambassador uploads the waste data in to the Eco-Caliper before 5th of each month. Each facility should appoint a “Green Ambassador” (preferably from the administration division). They Submit Waste Data Form to relevant person at BEED. This is a informal position developed to facilitate green initiatives.

Administrative Staff communicates all measures and practices in Waste Management Handbook to contract parties working on behalf of facility. They provide approved coloured containers/bins for placement within respective facilities and office buildings and an in-house location for storing the separated waste.

Facility Engineers communicates all measures and practices in Waste Management Handbook to contract parties working on behalf of facility and ensure all waste is stored and disposed of properly to ensure it will not cause environmental pollution or a health and safety risk.

Operation Managers and Supervisors promote waste segregation at generation points at all production units and office buildings and identify ways of waste generation reduction.

Housekeeping Staff separates waste and collects waste in designated bins. Ensures clear access and inspecting interior and exterior solid waste containers regularly and ensures that they are maintained in a clean accessible condition, reporting any deficiencies to the supervisor.

Sourcing and Procurement Division introduce green criteria in selection of suppliers, incorporating environmentally friendly options in purchasing of products. Green Purchasing is the procurement of products and services that have a reduced effect on human health and the environment when compared with competing products and services that serve the same purpose. The Brandix policy on purchasing includes a statement on the protection of the environment and sustainability.

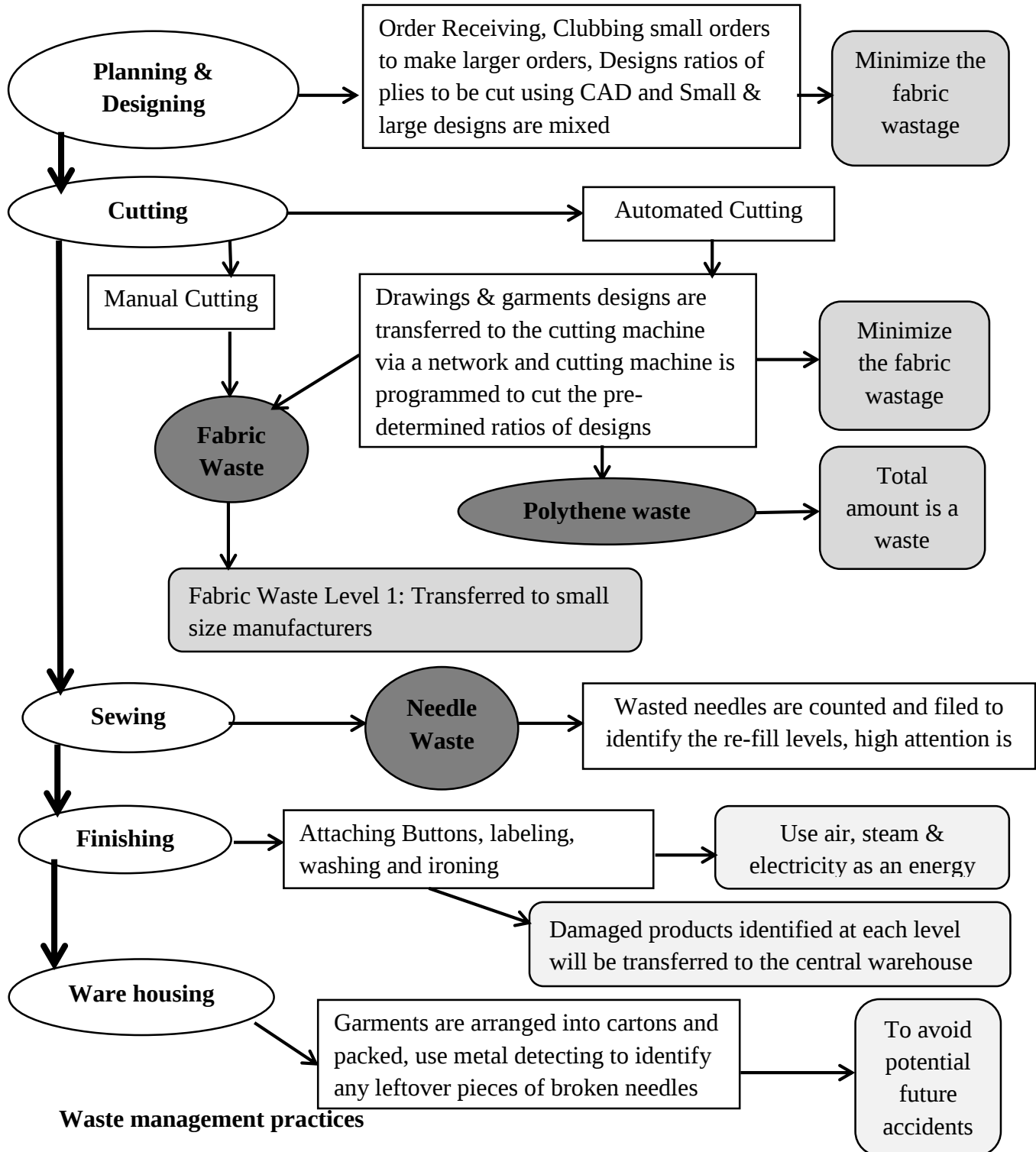
The organization follows the following tools and methods under its Green Purchasing Policy;

- Preventing pollution from the start of a process or procedure, reducing or eliminating toxicity, air and water emissions.
- Lifecycle perspective is aimed at looking beyond purchase price. Consider costs and environmental impacts over the lifetime of a product or service (manufacturing, packaging, transport, energy consumption, maintenance, and disposal).
- Natural resource protection gives preference to sustainable, reusable content, and recycled materials over virgin materials, as well as to conserving water and energy.

Guidelines for Green Purchasing include review purchase specifications and contracts to determine if they meet environmental performance standards or requirements. Check with existing suppliers about environmentally friendly alternatives and give them a try. Consider how to make the product or service "green" and what it'll need to purchase differently to make it happen. Request vendors to provide supplies in reusable packaging that can be reused or returned to the supplier. Purchase appropriately sized lots to minimize waste. Purchase bulk where feasible but in small quantities for shelf life/dated materials. Implement office purchasing policies: buy recycled office consumable products, Energy Star certified office equipment, and reusable utensils, plates and cups for meetings. These do not form a part of these guidelines rather acts as a supportive set of guidelines.

Waste Management Practices of Brandix Eco Centre, Seeduwa

Production line of Brandix Eco Centre, Seeduwa has mainly several stages of processing such as order planning, order designing, cutting, sewing, washing, finishing, and finally warehousing.



Company has identified six types of solid waste and the following strategies are used to manage these waste:

Table 3: Waste management strategies – Brandix Eco-Center (Seeduwa)

Solid waste type	Strategy
Fabric waste	Industrial solid waste material management program to divert fabric waste generated to reuse in another industry for example production of local mattresses.
Cardboard, Mixed paper, Polythene and Plastics	Segregated waste is collected by local recyclers at regular intervals for recycling
Kitchen and food waste	Kitchen and food waste collected in the factory welfare center bins are diverted to animal feed utilized at the farm house.
Garden waste	Used to produce compost (organic fertilizer) and will be used to meet the garden fertilizing requirements.
Fused fluorescent light bulbs	A local recycler will dispatch the bulbs periodically from the factory to India to recover mercury and recycling of glass.
Used batteries	Discarded batteries will be given to a local recycler to recover the metal and plastic parts which will be recycled and reused.

Source: Author constructed

Also, apart from these, company follows the following strategies of minimizing waste at the point of generation.

Table 4: Waste management strategies at the point of generation

Waste type	Strategy followed
Polythene	It is prohibited to bring meals wrapped in polythene and instead company will provide reusable containers made of long lasting plastic for the employees who bring meals from outside.
Mercury added light bulbs	All sewing machines are provided with a LED task light and other factory interior will be illuminated with special sky lights and Metal Halide bay lights which are operated on duty.
Printing and copying practices	Practices such as both side printing and copying, half page or adjusted printing, reuse of single side printed paper are adopted.
Toners and cartridge reuse	Toner/cartridge refilling and reuse program is in place. Used cartridges are re-submitted to the supplier and the supplier will return them refilled, at a lower cost.
Green meetings	Use of laptops and widescreen projector so that many attendees no longer need meeting materials, use of porcelain mugs rather than Styrofoam or plastic cups.
Metal free zone	No metal or metal containing material is used on site.

Source: Author constructed

For the purpose of collecting numerous types of waste, company has kept waste bins accordingly and details of those are as follows.

Table 5: Details of waste bins

Type	Capacity (liters)	Shape	Material of construction	Total no. of bins
S – Wall Litter Bin	7.5	Semi cylindrical/cubical	Fiber glass	50
M – Medium	20	Cylindrical	Plastic	5
L – Large	175	Cubical	Fiber glass	44

Source: Author constructed

Colors of these bins vary according to the waste type and other waste will be collected in hanging waste bins reserved collection of small pieces of papers, tapes, discarded paper serviettes etc.



Figure 01: Colored Bins for waste collection



Figure 02: Storage of waste for disposal

The other best practices followed in reuse of waste in the facility are as follows:

1. Use of durable stainless-steel plates and cups for the canteen.
2. Using cloth napkins or towels.
3. Use of water dispensers instead of disposable plastic bottles.
4. Donating old or surplus furniture or building material for reuse.
5. Reusing cardboard boxes wherever possible.
6. Purchasing refillable pens and pencils.

The efforts of Waste Management Practices to achieve sustainability targets

During our study, we aimed to obtain the Sustainability KPI's and the annual Sustainability targets of Brandix Eco Centre. However due to confidentiality, the key personnel were not willing to

disclose the Sustainability KPI's for 2020. Hence, the below area discusses the efforts of Brandix Eco Centre's Waste Management Practices to achieve the annual sustainability targets.

The company records and monitors its sustainability data under 3 categories.

1. Energy Consumption
2. Electricity Consumption
3. Water Consumption

We have analyzed the actual data for the above categories and developed a trend analysis to evaluate the efforts of the waste management practices which were discussed earlier. The purpose for developing this analysis is to understand the progress of the waste management processes towards achieving the annual sustainability targets of the company.

The annual sustainability targets of the company are as below.

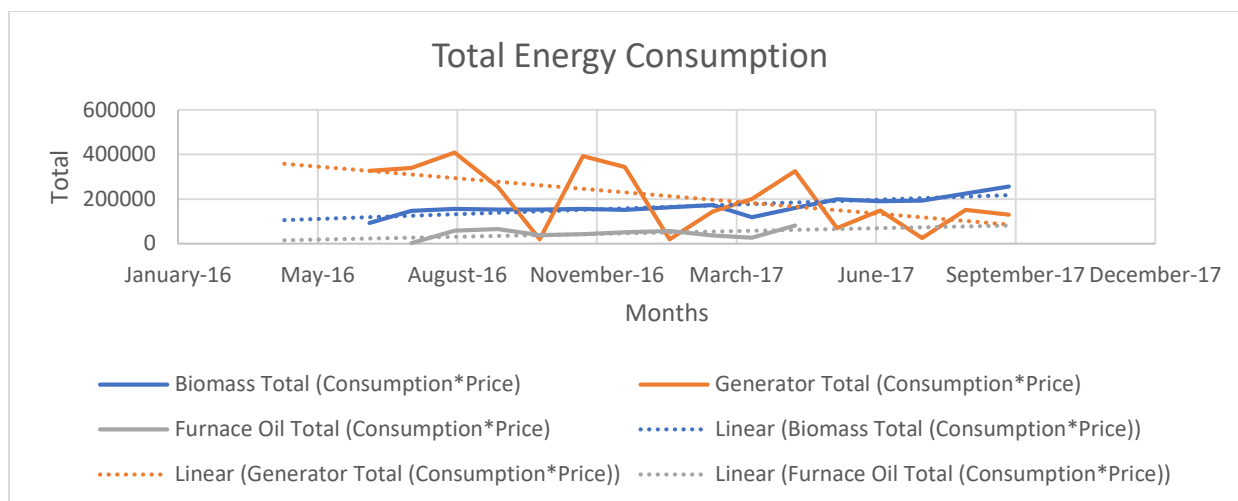
1. To reduce water consumption by 3%, every year.
2. To reduce energy and electricity consumption by 5%, every year.
3. To reduce food waste per meal by 50g, every year.

Brandix Eco Centre records data of its monthly energy consumption, which is generated from 2 sources; Furnace Oil/ Bio Mass Boiler and Generator.

Company uses its organic waste material to generate energy through its Bio Mass Boiler which also requires the insertion of Furnace Oil. This energy is produced and consumed in addition to the power supply as a substitute to the electricity and energy produced by the Generator. Generator is used for constant power supply in case of a power failure.

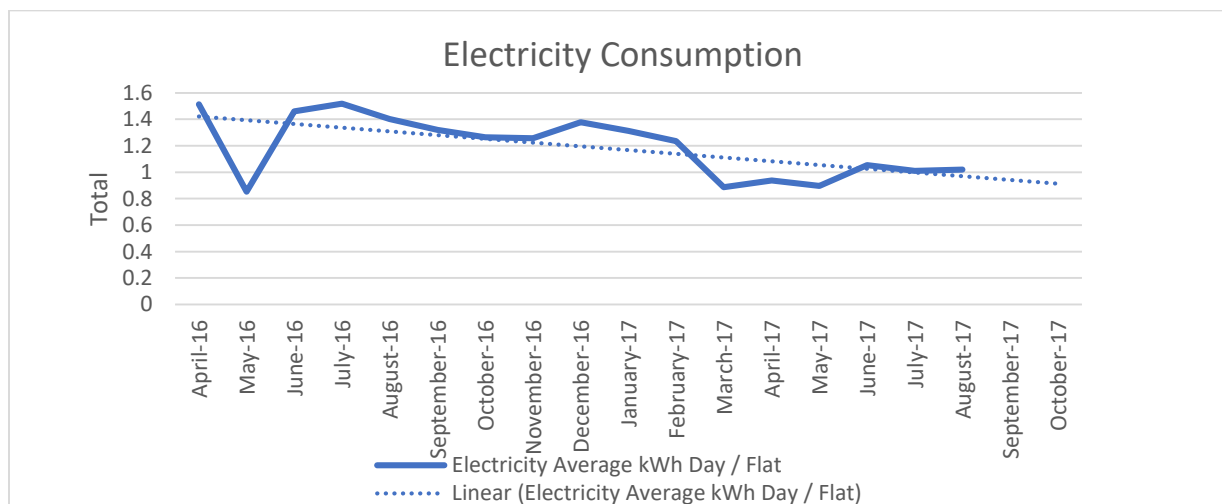
By observing Graph 01 – Total Energy Consumption (Refer Annexure 02 for source data); which are plotted by using the actual data for the last 9 months, a decreasing trend can be observed in the energy consumed through the generator. Whereas an increasing trend can be observed in the energy consumed from Furnace Oil/ Bio Mass Boiler.

The reasons which the key personnel provided for this during our second-round interviews was that in aid of achieving the sustainability target of reducing energy and electricity consumption by 5%, the plant is substituting the Boiler energy as an alternative to the normal power supply.



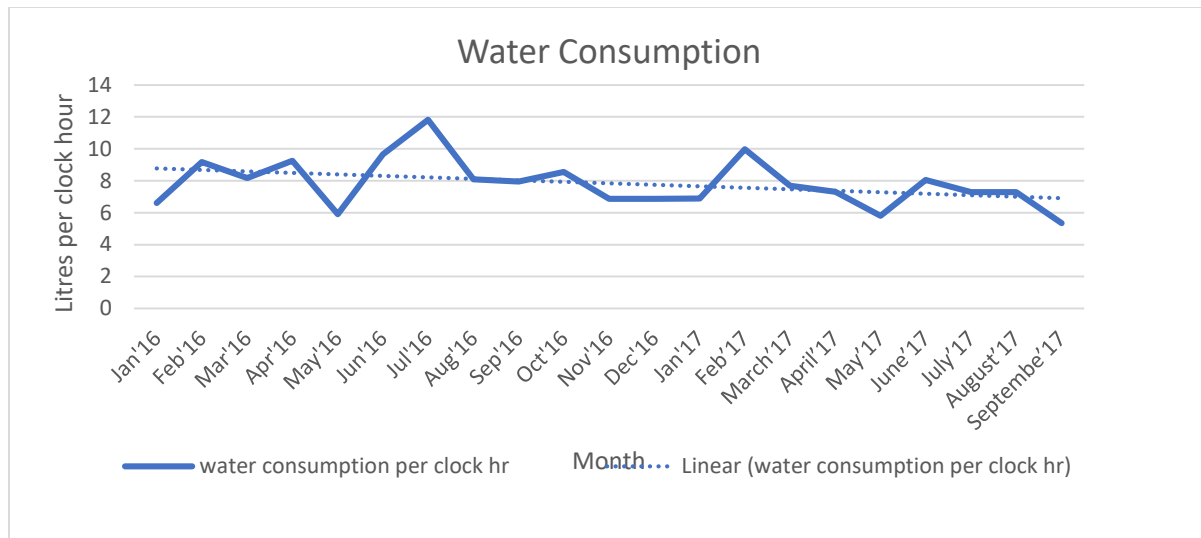
Graph 01

This can be further elaborated by observing Graph 02 – Electricity Consumption (Refer Annexure 02 for source data), which shows the decreasing trend in the electricity consumption of the plant for the last 1 year. The electricity consumption also shows a decreasing trend.



Graph 02

Graph 3 – Water Consumption (Refer Annexure 02 for source data) explains the gradual, decreasing trend in the water consumption per clock hour, which also shows that the company's waste management practices are gradually moving towards the achievement of the annual target of decreasing the water consumption by 3%, every year.



Graph 03

5 Conclusion

Waste is occurred as result of inefficient resources consumption and unwanted materials left over from production process including distribution and consumption until the end of apparel product lifecycle. The study is conducted to examine the waste management practices followed by a Green Production Facility to identify the different solid waste collected during the production process. Under this broad issue, several sub-issues addressed are as follows: to explore how the waste management practices are carried out on an ongoing basis and quantify the wastages based on the company practices, to understand the key performance indicators that have been employed by the green factory and the benefits drawn to the company by practicing waste management practices and to understand what sort of support it requires from the corporate level in-order-to maintain its commitment to sustainability.

The research design is in the form of a case study where we studied the waste management practices which are being practiced in the Brandix Eco Centre, Seeduwa. The research is of qualitative nature which we used participant observation and measured the quantitative nature of the solid waste produced at different production stages. Data was obtained through semi-structured interviews, participative observations and documentary analysis. The data analysis strategies which we carried out were documentary analysis and data triangulation. We have analyzed the actual data for the above categories and developed a trend analysis to evaluate the efforts of the

waste management practices. Brandix Lanka Ltd has managed to take maintain appropriate waste management practices within the group as a whole. Prevention and minimization, reuse, recycle, energy recovery and disposal are the waste management strategies used. There are responsibility centers to control waste in respective units and waste audits are carried out regularly. As per the observations and information obtained several waste management practices are carried out to measure and reduce waste in different stages in the production line of Brandix Eco Centre.

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Annexures

Annexure 01 – Interview Guide

The semi structured interviews were conducted based on the following key areas.

Section 1 : Waste Management Practices of Brandix Group

Interviewee : Engineer – Sustainability, Brandix Lanka Ltd

1. What is the importance of Sustainability to Brandix Group?

2. What is the waste management strategy of the Brandix Group?

Section 2 : Waste Management Practices of Brandix Eco Centre, Seeduwa

Interviewee : Plant Engineer, Brandix Eco Centre, Seeduwa

1. What is the importance of Sustainability to Brandix Eco Centre
2. What are the different stages of the production process in the manufacturing facility?
3. What are the waste management processes that are practised in each stage?
4. How are the employees motivated in following these practises?

Section 3 : The efforts of Waste Management Practices to achieve sustainability targets

Interviewee : Plant Administrations Officer, Brandix Eco Centre, Seeduwa

1. What are the Sustainability KPI's and annual Sustainability targets of Brandix Eco Centre, Seeduwa?
2. What are the recognitions that have been achieved by Brandix Eco Centre Seeduwa for its efforts to achieve sustainability?

Annexure 02 – Source Data for Graphs 01, 02 and 03

Table 01: Energy Consumption Data

Month	Furnace Oil Total (Consumption*Price)	Biomass Total (Consumption*Price)	Generator Total (Consumption*Price)
16-Apr	2,460.00	92,736.00	326,230.00
16-May	58,630.00	146,544.00	338,865.00
16-Jun	65,108.00	156,192.00	408,785.00
16-Jul	37,638.00	152,928.00	254,885.00
16-Aug	42,558.00	152,928.00	19,285.00
16-Sep	50,430.00	155,064.00	392,920.00
16-Oct	57,154.00	151,584.00	343,140.00
16-Nov	35,916.00	162,432.00	18,525.00
16-Dec	26,404.00	173,030.00	144,685.00
17-Jan	81,508.00	118,415.00	200,640.00
17-Feb		159,945.50	324,900.00
17-Mar		198,660.00	68,875.00
17-Apr		189,420.00	148,770.00
17-May		192,500.00	24,795.00
17-Jun		224,840.00	151,525.00
17-Jul		256,320.00	129,485.00
17-Aug		225,420.00	190,095.00
17-Sep		225,000.00	16,530.00

Table 02 – Electricity Consumption Data

Month	Total kWh Consumption	Clock Hours	Average kWh
16-Apr	124,543	82,316	1.512987
16-May	166,845	195,580	0.853078
16-Jun	190,274	130,265	1.460669
16-Jul	117,335	77,244	1.519018
16-Aug	187,461	133,818	1.400865
16-Sep	180,968	137,018	1.320761
16-Oct	167,479	132,605	1.262992
16-Nov	175,996	139,921	1.257824
16-Dec	159,757	116,043	1.376705
17-Jan	156,784	119,372	1.313407
17-Feb	161,868	131,114	1.234559
17-Mar	199,877	225,597	0.885991
17-Apr	137,768	146,896	0.937861
17-May	171,306	191,109	0.896379
17-Jun	187,360	177,845	1.053502
17-Jul	174,737	172,965	1.010245
17-Aug	186,502	182,726	1.020665

Table 03 Water Consumption Data

Month	Clock Hrs	Water consumption per clock hr
Jan'16	117,810	6.609456
Feb'16	113,076	9.16534
Mar'16	129,866	8.175889
Apr'16	82,316	9.257277
May'16	195,580	5.909321
Jun'16	130,265	9.655825
Jul'16	77,244	11.82401
Aug'16	133,818	8.097715
Sep'16	137,018	7.941541
Oct'16	132,605	8.54869
Nov'16	139,921	6.861443
Dec'16	116,043	6.873056
Jan'17	119,372	6.889606
Feb'17	131,114	9.983068
March'17	225,597	7.684632
April'17	146,896	7.306189
May'17	191,109	5.814483
June'17	177,845	8.053355
July'17	172,965	7.283202
August'17	182,726	7.295678
Septembe'	186,069	5.348016