Waste Handling Optimization: Operation Cost and Environmental Impact Minimization

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Abstract *— The company Eli Lilly established environmental goals to reduce waste and manage resources more effectively. From this, the pharmaceutical site in PR underwent a waste generation evaluation of its current operations, to determine the course of action towards the zero emissions and waste to landfill, product sustainability and material re-use goals set for 2030. The project objectives were to minimize waste generation from site processes, minimize environmental footprint from generated waste to landfill, maximize the possible recycled materials and the hazardous waste reduction on site. From design to implementation, objective results yielded a 20.9% cost reduction and a 60% generated waste to landfill reduction. These results were within the range of acceptance in both profitability and ecological impact. The long-term execution of these actions will significantly enforce site compliance with regulatory aspects to a higher degree, will help identify any new material which could impact the waste metric and enforce continuous improvement on site processes.*

Key Terms *— landfill, pollution, recycling, e-waste*

INTRODUCTION

Lilly is a pharmaceutical company founded in 1876. Since its beginnings, it has focused on creating high-quality medicine to those in need [1].

Waste generation is a common problem seen in the company's site processes. Agencies enforce environmental compliance via regulations and permits, among other methods, to mitigate the impact it may have on the environment. Eli Lilly requested that all sites to run an assessment of their processes and the waste generated, either direct or indirectly, to find ways to eliminate, substitute and/or mitigate the handling of waste in an eco-friendlier way, if possible, per the established 2030 environmental goals. Although Lilly del Caribe complies with these regulatory factors, to meet company goals it was required to evaluate all of the site processes to identify any potential material which could impact this metric in order to reduce waste and manage resources more effectively throughout the PR site processes.

Objectives

The objectives of this project were to:

- Minimize waste generation to landfill, reducing overall environmental footprint.
- Maximize the amount of recyclable material, from site consumption.
- Reduce hazardous waste inventory on site.

LITERATURE REVIEW

Waste and Pollution

Pollution via emissions, landfill waste, energy generation, transportation and even agriculture aspects are leading precursors that directly affect the environment around us and our health. Even more, it can be seen in correlation to the increase of climate changes, throughout the years, occurring worldwide [2].

A direct result of the rapid increase in consumption that leads to waste generation, of all the cradle to grave processes that are within the business nowadays. This has brough concern to the current society, such that a more circular approach when handling materials is being overseen for many of the processes and activities previously mentioned, to promote a more efficient and conscious usage of materials in general [3, 4].

Environmental Footprint

Climate change is a variable that may fluctuate between positive and negative impact, based on the influencing factors affecting the environment, depending on these factors' correlations and/or trend can be develop in order to assess situations around the world, it can be seen as extreme droughts to increase in sea level, due to global warming, etc. [5]. The environmental impact caused by industrial pollution is one of the top contributors which directly affects the ecosystem, leaving significant traces and impact on the earth's climate and our health [2]. Initiatives that may promote environmental awareness as well as developing and enforcing environmental regulations have been implemented worldwide [4]. Industries movement and initiatives toward more enforced recycling actions to comply with regulations and appeal to the society, serves as an indication that they recognize the impact they have on the environment and its implication in our eco-system [6]. Nowadays companies are researching for more cost-efficient ways to mitigate environmental footprint, within their processes, and to try and integrate cradle to cradle processing in their overall operations [6].

E-Waste and Implications

Out of the growing offenders, the E-waste has direct impact to both humans and the environment, and it has been growing throughout the decades as a byproduct of the fast technological changes within society and industries [3]. Although this and many other types of waste have challenges, in terms of its handling and storage processes as well as recycling or refurbishing methodologies due to technological aspects or availability of a process to handle them, it is possible to pass them via a cradle-to-cradle cycle uprising depending on factors such as integrity, possible toxic compound parts present within the device, etc.

Landfill Waste, Recycling and Refurbishing

The degree of environmental compliance could vary and its crucial on the mitigation or aggravation factor of the current environmental status, it could drastically reduce the overall environmental footprint or even worsen it. While regulations enforce standard required to conduct operations, the compliance degree may fluctuate based on certain factors such as: company initiative to go above the minimum required by regulations, business planning, production, and process development, etc. that a company may conduct.

METHODOLOGY

The project consisted of conducting a waste profile evaluation from all site areas, to identify any potential materials within the scope of being recycled and determine a course of action to handle them. The project was divided into five phases that covered from the waste identification step to the full site implementation of the actions, based on the waste analysis.

In Phase 1, the potential material or materials to be recycled were identified, in addition to the ones currently within the recycling loop, assessing the major offenders from site waste. For Phase 2, negotiations were conducted with the recycling companies for cost estimates and material handling limitation aspect acceptance. In Phase 3, the site waste management plan was improved or modified, at which the e-waste was incorporated and specifications in terms of handling, storage, dispatch, and material limitations were added. Phase 4 consisted on the pilot run implementation and evaluation of the modified site waste management plan on the material handling center area. Finally, after evaluating possible areas of opportunities identified within the pilot run, Phase 5 consisted of the full site implementation.

PROJECT STEP IMPLEMENTATION

Phase 1: Site Evaluation

Phase 1 consisted of the waste generation analysis per site area, which was conducted and the scope of potential materials to be recycled was identified and narrowed down to the e-waste, as one

of the major offenders on site that was not being recycled.

Phase 2: Company Assessment

The list of materials identified from the e-waste category was filtered throughout the recycling companies' capabilities and handling aspects to determine the possibility of it being recycled, in a way to mitigate the landfill impact it was retaining because of the site processes, and they were deemed manageable under certain conditions. The companies selected, during the second phase of the project, were RDN, JQ Recycling and E-Cycling since they had the handling capabilities within their facilities and processes to manage this waste. It is important to denote that one of the limitations identified during the discussions was the integrity of the waste, which if compromised the material could not be accepted.

Phase 3: Waste Management Plan

It is important to denote that the site waste management plan contemplated aspects regarding hazardous and non-hazardous waste handling, storage, and disposition. E-waste was identified as a material which could be recycled, based on the recycling companies' capabilities, and added to the list joining compost and other materials such as metals and plastics currently being recycled.

Modifications to the waste management plan were conducted, as part of phase three of the project, resulting in a quick adaptation, due to the similarity of the current vs the proposed handling process regarding e-waste handling, with the slight difference on the designated storage area that was prepared based on the recycling company specification. The scope of the modifications to the waste management plan contemplated the following additions:

- Storage area modification, per company specifications to attend possible integrity issues.
- Spill prevention and personal protection equipment addition, to the new designated area, as per assessment overview integrity issues and EHS requirements.
- Designated specific handling equipment for the transport in site of the e-waste, to avoid cross contamination issues.
- Dispatch inspection checklist and transaction procedure.

Phase 4: Pilot Run

Pilot run area was narrowed down to the Material Handling Center since it was the last checkpoint before dispatch to either disposal or recycling facility. After the modification on the area was implemented, the pilot run started and evaluated throughout a period to identify any potential opportunities regarding handling and storage aspects. After the period was completed, a qualitative assessment was performed and identified opportunities were added to the plan to start the full site implementation.

Phase 5: Full Site Implementation

Hence pilot run was reviewed during the assessment period and approved for full site implementation, the areas adapted quickly to the modifications performed, effectively executing all activities regarding classification of waste, handling and storage.

Assessing and complying with the procedure requirements to meet the project goals. Future assessment will be conducted to evaluate any potential changes to the scope of the processes, management plan and/or materials used on site.

COST AND ENVIRONMENTAL IMPACT ANALYSIS

In Figure 1, information regarding to the current average annual waste disposal cost in comparison to the established waste recycling process costs can be seen in detail. This projection was based on a three-year average consumption, from which the recycling cost was calculated based on recycling company rate per pound of recyclable material. The projected cost reduction, as showed in

Figure 1, would result in free capital which could be distributed to other areas or processes, based on the site necessities. It is important to denote that the projected costs presented in Figure 1 are subjected to possible changes caused by multiple variables.

Figure 1
Cost Comparison for Disposal and Recycling of Waste

Material consumption, material acceptance due to integrity issues, recycling cost rising or declining when renewing contracts, finding more cost-efficient contracted companies and/or processes, etc. are some of these key indicators. These factors affect cost reduction and sites' environmental footprint at a long-term perspective. To maintain the positive impact, periodic assessment was determined to be needed and KPI's were stablished for this process oversight to sustain the positive environmental impact throughout the years, identify and mitigate potential detrimental factors within the sites' processes.

CONCLUSION

Approximately a 21% cost reduction resulted from the final contract settlement, with the recycling companies. Translating to a 60% waste to landfill reduction and a significant reduction in term of ecological footprint will be achieved, if sustained at a long term. Current site operations will increase material re-use metrics and lower the amounts of hazardous waste disposal and storage from site, due to the recycling implementation.

Overall objectives were met successfully, periodic revision of the waste management plan will cover any potential changes to the scope of the materials involve on site processes and/or any other related to a new process incorporation on site. Any potential material which could be processed via new and/or innovative recycling technology or processes will also be identified within the revision. This is to enhance any possible environmental compliance aspect, within site, and/or possible regulation developed in the future that may affect site operations.

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