Cleaner Production Opportunities in Precured Tire Retreading Industry

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ABSTRACT

Re-treading is the manufacturing process which extends the life of a used tire. In Sri Lanka, market demand for retreaded tires showed a significant drop of approximately 20% from year 2012 to 2013. The main reasons for this drop are the availability of cheap, new imported tires and the use of radial tires which can be used for a longer period before retreading. The purpose of this study was to identify CP opportunities in a leading Sri Lankan tire retreading plant and to investigate the impact of CP implementation on resource efficiency and environment. Production process starting from unloading raw materials to the end product was assessed using UNEP/UNIDO standard CP methodology. Material and energy consumption of each process step and water usage were evaluated. The calculations revealed substantial wastes in all three forms where material accounted for the highest. The results of the study indicate that numerous CP opportunities exist in the production process. Some of the selected options were implemented during the period of study and there was a monetary-alone saving of four million rupees per month. Inability to implement all the feasible CP options limited the observation of actual impact of CP implementation. The study helped to identify plentiful options that can be implemented in the tire retreading industry in general. Finally, the attitude and commitment of the entire organization do have a strong effect on CP implementation. To implement CP successfully, time, continuous involvement and capital investments are needed too.

KEYWORDS: Cleaner Production (CP), Retreading, Tire, UNEP/ UNIDO

INTRODUCTION

With the increasing demand for vehicles, supported by improved economic conditions worldwide, the world tire market continued to grow rapidly (Dallas, 2014).

The main raw materials used to manufacture a tire are the natural and synthetic rubber, carbon black and oil. The share of rubber compounds of the total weight of a tire is more than 80% and approximately, half of the rubber is produced from the rubber tree.

Tires are among the industrial products which generate the largest solid waste (Ferrer, 1996).

Disposing used tires poses a substantial environmental issue due to their durability nature (Lutsey et al, 2006). Approximately 60% of the value-added in the tire is in the casing, which hardly deteriorates during its first life. Therefore, reusing old tires not only saves resources needed to manufacture new tires but also protects the environment in several ways.

LITREATURE REVIEW

Tire Re-treading

Tire re-treading is a manufacturing process used to extend the life of a used tire by replacing the worn-out tread. The re-treaded tire is brought back into the same service conditions without sacrificing tire road performances. More importantly, re-treading can save up to 80% of the raw materials and energy required to produce a

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new tire (Ferrer, 1996). Re-treaded tires are much cheaper and generate less waste comparing to the production of a new tire.

Sri Lankan tire re-treading industry has grown from a handful of factories in 1992 to 45 factories by the end of 2013. In the current market there are four industry giants who dominate around 75% of the market consists of 13 factories.

The availability of cheap, imported Chinese and long-lasting radial tires imposes a significant threat to the local re-treaders since the customers always prefer cheaper yet lasting tires. To survive in the market, re-treaders have to sell their tires with good quality but at a lower price comparing to cheap brand new tires. The best way to offer the products with the required quality and a cheaper price is to reduce the cost of production while maintaining the quality.

In order to maintain the quality of their products, re-treaders use expensive materials and the re-treading process requires a huge amount of energy in terms of steam and electricity. Therefore, any kind of waste has not only an environmental impact but also a huge monetary concern.

Cleaner Production (CP)

Cleaner production is quite similar to pollution prevention. Both cleaner production and pollution prevention emphasize environmental management through source reduction, rather than pollution control methods. Cleaner production should not be considered in an absolute state, but rather a process that continually evolves with the introduction of improved technology and innovative ideas.

According to the definition of the United Nations Environment Programme (UNEP), cleaner production is the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment.

Cleaner production helps to reduce environmental impact of a product through its entire life cycle from raw material extraction to disposal by conserving raw materials and energy, eliminating toxic materials, reducing quantity and toxicity of all emissions and other waste. More importantly, cleaner production helps reducing cost of production since it addresses the sources of waste generation.

Cleaner production was first introduced in Sri Lanka in the year 1993 through UNEP and United Nations Industrial Development Organization (UNIDO) program in association with the Central Environmental Authority. Under the UNIDO integrated industrial development support program for the government of Sri Lanka, National Cleaner Production Centre (NCPC) was set up in May 2002 to streamline and drive the CP activities dynamically in the country. Since then, the progress of CP in Sri Lanka has been far significant and today many enterprises make use of CP as a tool to enhance their resource productivity and environmental performance.

RESEARCH OBJECTIVE

The main purpose of this study is to investigate the applicability of cleaner production activities in tire re-treading industry in order to reduce the cost of production and to promote a more environmentally friendly industry.

METHODOLOGY

One of a leading Sri Lankan tire re-treading plant was selected for this study. Initial walk through assessment revealed that there is a potential to implement cleaner production in tire re-treading process. Further, it was found that a comprehensive CP assessment needs to be employed in order to identify all the possibilities of applying CP techniques into the industry and their benefits. For this purpose, the UNEP/UNIDO standard cleaner production assessment methodology was used. The steps followed in achieving key objectives of the study are given in a sequential manner in Figure 1.

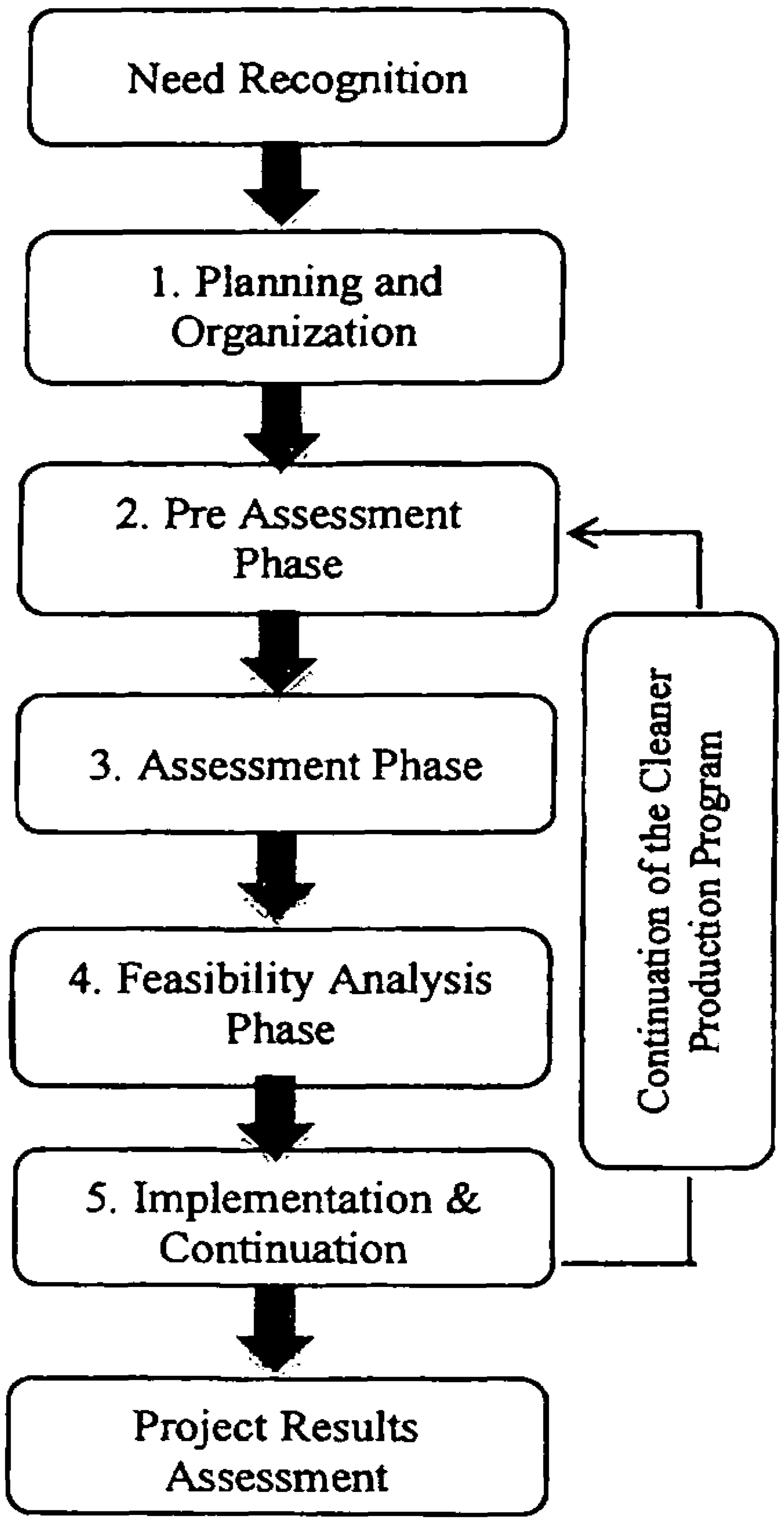

Figure 1: UNEP/UNIDO Standard CP Methodology

First, the CP team was selected in a way that it represents all the key sections across the entire tire re-treading process. All the main processes were identified including unloading and storing of raw materials, mixing, milling, extruding of compounds, pressing of treads, flash removal, buffing, tread finishing, tire rebuilding, chambering and finishing, steam generation and in-house electricity utilization. A standard process flow chart was prepared based on the arrangement of processes and material and energy flows into and out of the processes.

The inputs and wastes are shown with arrows heading in and out at each process step. Material and energy balance was applied to each and every unit operation in the flow chart to quantitatively express the flow streams into and out of the processes.

Both direct and indirect methods were employed for the quantification of inflows and outflows and the data sources were on-site measurements and secondary data such as purchase and sales records, steam generation, electricity consumption and dispatch data and other recorded data.

Next, material and energy quantities were converted into financial terms so that the magnitude of the losses could easily be comprehended by all the stakeholders. In converting waste stream to costs, both internal and external cost components and cumulative cost due to flow material and energy through different operations were taken into consideration.

Root cause analysis was conducted to determine the root causes for the identified waste streams. CP options (solutions), addressing the causes of waste streams were generated through a brainstorming session. Initial screening of these options categorized them into three groups: obviously feasible options, obviously infeasible options and options requiring further analysis. Options in the third group were screened in terms of technical, financial and environment feasibility.

Technical feasibility would be assessed based on the availability and reliability of the equipment, requirements for utilities, process monitoring and control, space, maintenance requirements, required technical skills (operators, technicians, etc.). Technically infeasible CP options were rejected and not being subjected to further analysis. The remaining options would be assessed against financial and environmental soundness.

Financial viability assessment required the data on pre and post implementation scenario. Depending on the organization's accounting practices and financial policies and other economic instruments such as simple payback period, net present value employed to determine financial viability of the CP option. Options with no positive environmental impacts would not be considered as implementable CP options.

Weighted average matrix method was used to prioritize the best CP options giving 25 weightage to technical feasibility, 50 weightage to economic viability and 25 weightage to environmental feasibility. Company's concerns, expectations and capabilities determined the weightages given to three areas. Top ranked CP options would be selected for implementation.

Prior to implementation, detailed preparations are required especially for technical and technological changes. In case of technology changes detailed technical equipment specifications need to be written for procurement, detailed construction plans should be prepared for installation of equipment, comparative evaluation of equipment from different suppliers and final selection should be made and planning to reduce installation downtime need to be ensured. Adequate advanced preparation would reduce disruption to current processes and ensure a smooth transition to the new conditions.

The implemented CP options need to be monitored together with data for evaluation. Measurements and monitoring should be for changes in waste quantities, changes in resource consumption or changes in profitability. The measurements should be recorded together with the CP team with changes in total production output and changes in products. Any negative changes should be reviewed immediately and should make appropriate corrective actions.

DATA COLLECTION AND ANALYSIS

Based on the study focus, which begins with weighing raw materials to manufacturing the finished product, the major steps of tire re-treading process were identified together with the inputs and outputs at each process step.

Apart from the main process, there are other auxiliary processes such as boiler operation, tire carcass preparation, ventilation, compressed air system, water cooling system, gardening and cleaning process, maintenance operations, and use of water for sanitary and drinking.

Material balance which was conducted throughout each of the process steps revealed that approximately 10% of the total input material is lost as either waste or unaccounted losses. This is approximately 5% more than what the organization considers as waste in which the concern is limited to material wastes and scrap of rubber compounds only.

Tire re-treading uses energy in two forms; as steam and as electricity. Quantification of energy data showed significant losses in four parameters namely energy consumption for lighting, equipment, boiler flue gas and steam losses. During the study period, electricity was exclusively used for lighting the entire production floor and one magnetic ballast was used for several bulbs. Calculation of power factor for several important machines in the production floor revealed that the equipment were inefficient resulting a higher electricity consumption and cost (power factor is the ratio between real power to apparent power quantities the portion of power consumed by an equipment. If it properly works it should be equal to one).

O_2 (%) and CO_2 (%), CO (%), NOX (mg/m3), SOX (mg/m3), flue gas temperature, excess air, heat transfer efficiency parameters were reviewed in flue gas analysis of the boiler. Comparing to the standard emission parameter values emissions from the boiler is significantly high.

Approximately 21 liters of fuel is lost per day due to un-insulated transmitting pipes and a significant amount of steam is lost due to leaks. Apart from electricity and steam other identified waste streams are powdered raw material, rubber processing oil, mixed compounds, flash & rejects, compressed air, shrink poly & wrapping polythene and water.

RESUTLS AND DISCUSSION

Ample CP options were brainstormed for each identified waste stream and screened them for identifying feasibility in implementation.

Use of transparent sheets instead of opaque roof is one obvious solution for high electricity consumption for lighting. According to the findings and calculations, there is a savings of 143.64 kWh of electricity per day if solar power can be obtained approximately for 10 hrs. Use of LED, CFL bulbs, separate switches, natural lights, on off time schedules are some of the other options addressing electricity consumption for lighting. Insulating the bare heat transmission/ distribution lines, repairing leaks flanges and properly fitting the flanges are obviously feasible options reducing the heat emissions and leaks.

Few CP options were rejected directly due to the difficulties in implementation. The proposed CP option for the power factor inefficiency of the currently used equipment was rejected since it required replacing old with new/ modern equipment which is not affordable to the organization at present.

Remaining options required a feasibility study before implementation. Reusing the polythene which is used to wrap the tread in the chambering process results a reduction in polythene consumption by half and saves nearly one million rupees per month. However, it should be investigated whether the heating-standing and other properties of the wrapping polythene is similar to the polythene used in chambering. Implementation of the fire wood boiler will meet the standard emission parameter values however, supply of firewood and its environmental impact should be further considered.

Feasibility analysis was conducted according to the identified three aspects and prioritized giving the pre-determined weightages. Selected CP options were categorized as material, water and energy in par with CP standards. There are 37 CP options for material savings, 23 options for energy saving and 7 options for water savings.

CONCLUSION

This study attempts to investigate the applicability of CP activities in tire re-treading industry to reduce the cost of production in an environmental friendly way. As it was discussed earlier, the industry needs to find cost effective ways to manufacture their products in order to survive in the stiff competition arising from low price brand new and durable radial tires.

It was revealed that by implementing the identified CP options, the organization could save more than four million rupees per month and accordingly every manufacturer in the industry could be benefited by applying the suggestions customizing to their problem areas.

Implementation of firewood boilers for steam generation was a proposed CP option as a low cost as well as environmentally friendly mechanism compared to furnace oil boilers. This option was implemented and proven to be a huge cost saving for the organization. This would make the organization eligible for 'carbon credit' as well. Further considering the environmental aspects, the organization always attempts to use firewood fuels such as gliricidia, saw dust, straw, wood chips and removed rubber plantations due age.

Based on standard data, by using wood chips for the boiler, there is a CO_2 emission reduction of 81kg per gigajoule of energy produced. This is based on the life cycle emissions of furnace oil and wood chips. In sourcing biomass for the firewood boiler, its effect on the environment was considered too.

However, it could be identified that fuels such as gliricidia, and wastes such as saw dust, straw, wood chips and removed rubber plantations due to age are available to be sourced to the factory easily. This minimizes any negative impact on the forestation and environment due to use of firewood for the boiler operation.

According to the study generated flash and rejects can be used as a fuel. This could be a good opportunity to satisfy the energy needs of the industry in a different way. However, a comparison between reusing the flash after grinding and using it as a fuel should be compared while considering the environmental aspects as well. National Science Foundation of Sri Lanka says "while uncontrolled fires cause substantial air and ground pollution, the incineration of whole tires or tire chips in a controlled furnace is environmentally safe."

Further Study

A complete and a comprehensive energy balance which includes electricity and steam could be carried out in order to find the CP options to reduce the energy consumption in the tire re-treading industry. Further a rubber technology based research could be carried out in order to change the composition of raw rubber compounds which would yield less flash and waste when pressed.

More importantly a study could be conducted to check the feasibility of newly developed concepts to utilize the scrap tires and cured rubber waste in Sri Lanka. Some options are chemical, mechanical and wave methods of tire recycling, the tire recovery process, new rubber de-vulcanization process, scrap tires yield fuel, tire derived fuel, pyrolysis of waste rubber, production of rubber pavements, activated carbon produced from waste tire rubber, granulated rubber slabs and other civil engineering applications. Sri Lanka's rapid infrastructure development paves the ways for many applications to adopted using waste tire and rubber. This would be a good opportunity to gain financial and sustainable benefits from a material which is considered to be an environmental burden.

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