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DYNAMIC ROLE OF REVERSE LOGISTIC CYCLE WITH IN LIFE CYCLE ANALYSIS FOR SUSTAINABLILITY

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ABSTRACT In our Capitalistic System of Economy the main focus of every business activity is to monitor the profitability and enhance productivity through lean manufacturing system to produce low cost durable products for capturing new markets for the satisfaction of the quest of getting maximum benefit out of this whole process. In the context of Life Cycle Engineering, The flow of all inputs and out puts should be in such a systematic order that besides achieving the company‟s goals and targets all participating stakeholders requirement and needs must be met up to the ultimate limit available. With this respect Life Cycle Analysis and Reverse Logistic analysis are considered sine quo none for establishing a closed loop recycling System; As by means of this ideation a top down design approach will obviously result in producing a sustainable green product. A firm based upon this thinking supports the sustainable manufacturing system which makes possible to reuse the low cost resource while considering for re-manufacturing. This in turn increases the assets and also enables the manufacturer to produce high quality low cost products without using the virgin materials. Apart from that if the assets which are generated by the company due to life cycle thinking if follow the cradle to grave policy ; then the products will end up in the land fill or in incinerator by producing a negative impact on the environment, besides that more virgin resources will be utilized for the new product design. Similarly, when it comes to house hold waste and disposal then the most dominating factor in our refuse of daily life becomes questionable. Which infact is made of papers and plastic materials and is therefore needs attention from sustainability stand points. This is an alarming fact that our cities have millions of shopping bags to dispose which has so far caused a huge problem. A case study has been conducted in this regard which shows the significance of the reverse Logistic and life cycle assessment of the product like single use Carrier plastic (Sacs) bags. The result of the study provides the measure which has been made by different stakeholders in order to satisfy the golden principles of the sustainability by means of regulation, shaping customer behavior and manufacturer preferences for making a best possible alternative for the decision making.

Keywords: Plastic bags, LCA, Sustainable Product Design, Plastic Reverse Logistic.

INTRODUCTION

The concept of the reverse logistic considered as quite old however the term in precision is used for terms like Reverse Channels or Reverse Flow which first appeared in scientific literature of the seventies, but it has been reportedly mentioned with respect to the concept related with recycling as described by Ginter and Starling (1978) . One similar definition is being described by Stock (1992) in the Council of Logistics Management (CLM) published the first known definition of Reverse Logistics in the early nineties; According to which the this term refers to the role of logistics in recycling, waste disposal and management of hazardous materials, A broader perspective encompasses the areas of activities which are concerned for source reduction, recycling, substitution, reuse of materials and disposal. Therefore, the entire strategic planning is to make a successful cost effective system implementation for the flow of material inventory processing, finishing goods and related controlling the efficient related information from the point of origin to the point of destination where it will be consumed or disposed off; just for the purpose to determine the value. Besides that practice Melissen and De Ronet al (1999) has so far described that there are some intermittent terms described by practice the behaviour of reverse Logistics, like reversed logistics, return logistics and retro logistics or reverse distribution.

BACK GROUND

It is the dictate of the Welfare economic that the consumer utility preference in the design idea should must be given vital importance as it is HE who will be willing to pay a price for a fair choice whose attributes includes the consequences as well. In this context, as mentioned by De Brito et al. (2004) and is explained here as that the term Reverse Logistics, one is tempted to introduce the term forward logistics, to indicate all logistic activities on “virgin” materials and products. The difference however, is difficult to make as forward and reverse logistics melt in each other. New glass can well be made using a percentage of old glass. As a result the term “Closed-Loop Supply Chain” (CLSC) has been introduced, which received popularity. It puts recovery practices in the frame of Supply Chain Management. It also stresses an encircling process, either

1) Physical (closed-loop): original user; or
2) Functional (closed-loop): original functionality.

It is argued that this puts Reverse Logistics in the wide scope of supply chain management and stresses that not only the reverse streams should be considered but also the integration with the forward streams as well. The drawback of the term CLSC is that quite often the streams/loops are not closed, but open. Such as the Reverse Logistics is different from Waste Management as the latter mainly refers to collecting and processing waste (products for which there is no new use) efficiently and effectively. The crux of the issue in this regard is the definition of waste. This encompasses some severe legal consequences, e.g. it is often forbidden to import waste.

Reverse Logistics concentrates on those streams where there is some value to be recovered and the outcomes enter a (new) supply chain. Reverse Logistics also differs from Green Logistics in a sense that the former considers environmental aspects to all logistics activities, channels and concentrates specifically on forward logistics. Further more, in this context, Gungor and Gupta, et al (1999) has so far performed some important work related to environmentally conscious manufacturing which infact is a step further than just manufacturing for forward logistics. Long-run environmental impact is taken into account until the end of-life of the product. There are four main reverse logistic processes. First there is collection, next there is the combined inspection / selection /sorting process, thirdly there is re-processing or direct recovery and finally there is redistribution. Collection refers to bringing the products from the customer to a point of recovery. At this point the products are inspected, i.e. their quality is assessed and a decision is made on the type of recovery. Direct recovery embraces re-use, re-sale and re-distribution. Reprocessing includes the following options: repair, refurbishing, remanufacturing, retrieval, recycling and incineration. Finally, redistribution is the process of bringing the recovered goods to new users describes the Thierry et al. (1995).

METHODOLOGY

The LCA includes the production of raw materials, manufacture of plastic bags, transport of the bags to the retailers and disposal at the bags' eng of life. One of the most widely used items in the world today is plastic bags. Highly convenient, strong and inexpensive, plastic bags are appealing to both customers and businesses as a reliable way to deliver goods. However, there are several issues associated with the production, use, and disposal of plastic bags which may not be initially apparent to most users, but which are extremely important from LCA analysis with respect to product systems and associated sub systems analysis to find out the potential risk to sustainability. It is the Dynamic and systematic development of the product which provides the clear cut picture in LCA to identify the week areas of sustainable risk. This report deals with the immediate impacts associated with their manufacturing, followed by impacts created by their use and disposal, and further towards waste management and recycling.

SCOPING ANALYSIS OF PLASTIC BAGS LCA PERSPECTIVE

Life Cycle Assessment (LCA) is not only provides the major account of the product resource consumption from cradle to grave after having been used by the user. The dynamic role of the life cycle begins from the cradle where as the raw material for a product say a plastic bag is being extracted. During the birth of the raw material for a product all input and output studied and the analysis is referred as the product premanufacturing analysis. Modeling of the each step in put and its consequential output data provides the relevant impact on a particular area provides a holistic view of systems analysis under focus.

Advantages of the Plastic bags from re-usability stand point:

1. Reusability of the plastic bags for the next batch of groceries.
2. We can put them in a bag recycling bin at the grocery story.
3. Portable for reusability.
4. We can donate the plastic bags to others to use the same when they want.
5. We can donate that to library to use these bags for people who forgot their carry over bags.
6. We can wrap plastic bags around each shoe to keep your entryway mud-free when coming inside home on a rainy day or if you are living in tropical area where the rain is expected every now and then.
7. Sealed bagged are good source of protection as well as avoids the spill of the content also.

Dis-advantages:

If stretched the LDPE brand bag can be elongated and makes it week in performance.

1. Cannot sustain the design load over the design strength and causes to tear apart.
2. It is made from a non-renewable resource. Its recycling is not easy

REVERSE LOGISTICS CYCLE OF PLASTIC SACS

Plastic bags and plastic based products are distributed to retailers through numerous channels including distributors and direct supply. The environmental impacts of product delivery are factored into several of the environmental indicators: non-renewable energy consumption, greenhouse gas emission, water consumption, atmospheric acidification and photo-oxidant formation. There are four main reverse logistic processes. First there is collection, next there is the combined inspection / selection /sorting process, thirdly there is re-processing or direct recovery and finally there is redistribution. Collection refers to bringing the products from the customer to a point of recovery. At this point the products are inspected, i.e. their quality is assessed and a decision is made on the type of recovery. Direct recovery embraces re-use, re-sale and re-distribution. Reprocessing includes the following options: repair, refurbishing, remanufacturing, retrieval, recycling and incineration. Finally, redistribution is the process of bringing the recovered goods to new users describes the Thierry et al. (1995). In the inspection / selection and sorting phase products are being sorted according to the planned recovery option and within each option, products are sorted according to their quality state and recovery route. As a last phase in the recovery products undergo some kind of processing. This can consist of dismantling and/or grinding, again a sorting, a testing and possibly a (re)manufacturing. In dismantling the product is split up into parts or components, which may undergo a separate recovery. In grinding the product structure is destroyed and its materials may be recycled after sorting. These actions may be combined, e.g. one may first remove batteries from a monitor and then grind it. The condition of returned products may be derived from the return reason. They determine very much whether the product can be re-used or remanufactured. If that is not the case then only recycling or disposal are left over as recovery options. For example, supply chain returns normally refer to products in good condition (unless damaged in transport and or if they are recalls). They can often be re-used, but not always be sold as new. Yet they may be sold at a discount or at a secondary market. Warranty returns may often be repaired, but sometimes the needed effort for testing and repair does not pay (economically) off. End-of-use returns are often deteriorated, but they may contain valuable components that can be re-used. This is e.g. the case with photocopiers. It is very important to figure out the fact that recycling cycle may be different for many of plastic family of products but the Reverse logistic scenario depicted by the steps involved in this regard are principally based upon collection, handling and transportation facility to return the recyclable stuff to a recovery facility as discussed by Fleischmann (2001). Moreover, in this context De Brito and Dekker et al (2004) so far has explained that sine quo none for the establishment of the logistic network are as such:

1) That, the all of the mismatches in demand and supply in terms of timing, amounts and quality of the product.
2) That, financially all Economies of scale must be sufficient to make reverse logistics environmentally and economically viable.

3) That, while from the operational management perspective, a cost–benefit analysis must be made of collection, transport, freight, MRF, etc.

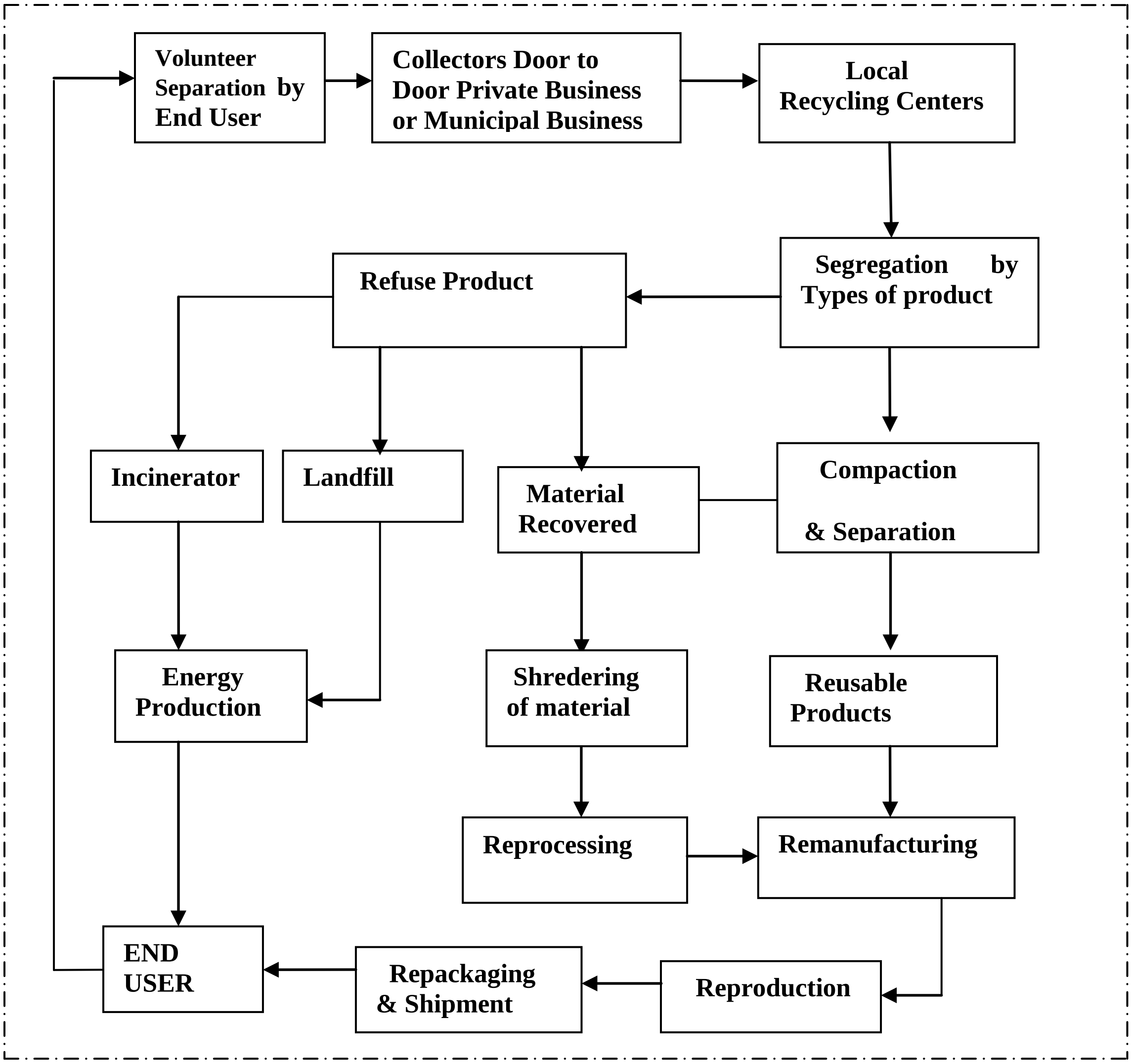

Figure 1: Flow Diagram Showing the Closed loops Reverse Logistic Cycle of Plastic

In order to establish an efficient reverse logistics network for plastics recovery and then couple it with the existing technologies, the current situation must first be analysed. This means analysing the cities that are already applying sorted collection for plastics, the industries that usually discharge plastic wastes in their processes, the existing technologies for plastics recycling in the area, etc. Subsequently, the main factors affecting the collection system should be determined. These factors include collection areas and frequencies, collection efficiency, transport modes as well as the Materials Recovery Facilities (MRF), which are usually the first destination of the collected waste plastics. These recycling methods, insofar as they are currently recognised under the Japanese plastics containers and packaging recycling legislation as described in PWMI (2004) include material, chemical and thermal recycling .Material recovery technologies include the transformation of waste plastics into flakes for further product making (open loop) and the chemical transformation of polymers into their original monomers (closed loop). Reverse supply chain analysis takes into account all the steps in the waste plastics flow from the time the plastic wastes are discarded until their final recovery or disposal.

Most collection analyses are based on assumptions of transport distances without considering important factors such as population densities, different collection systems for urban and rural areas, collection types, collection frequencies, truck capacities, distance to transfer stations, etc. But shredder can be utilized to obtain the productivity and crushed plastic is supplied back to the manufacturers of the same type of the plastic.

FUNCTIONAL UNIT

Any comparison of life cycle environmental impacts must be based on a comparable function. For the purpose of this study, the 'functional unit' for this is the study of single use carrier sacs for house hold use and assumption is that similar size of the bag considerably HDPE, LDPE, and PP Green bag single use. It has been learned that a household carrying approximately 70 grocery items home from a supermarket each week for 52 weeks. The functional unit of the LCA of plastic bags is the amount of product or material for which the environmental loadings are quantified.

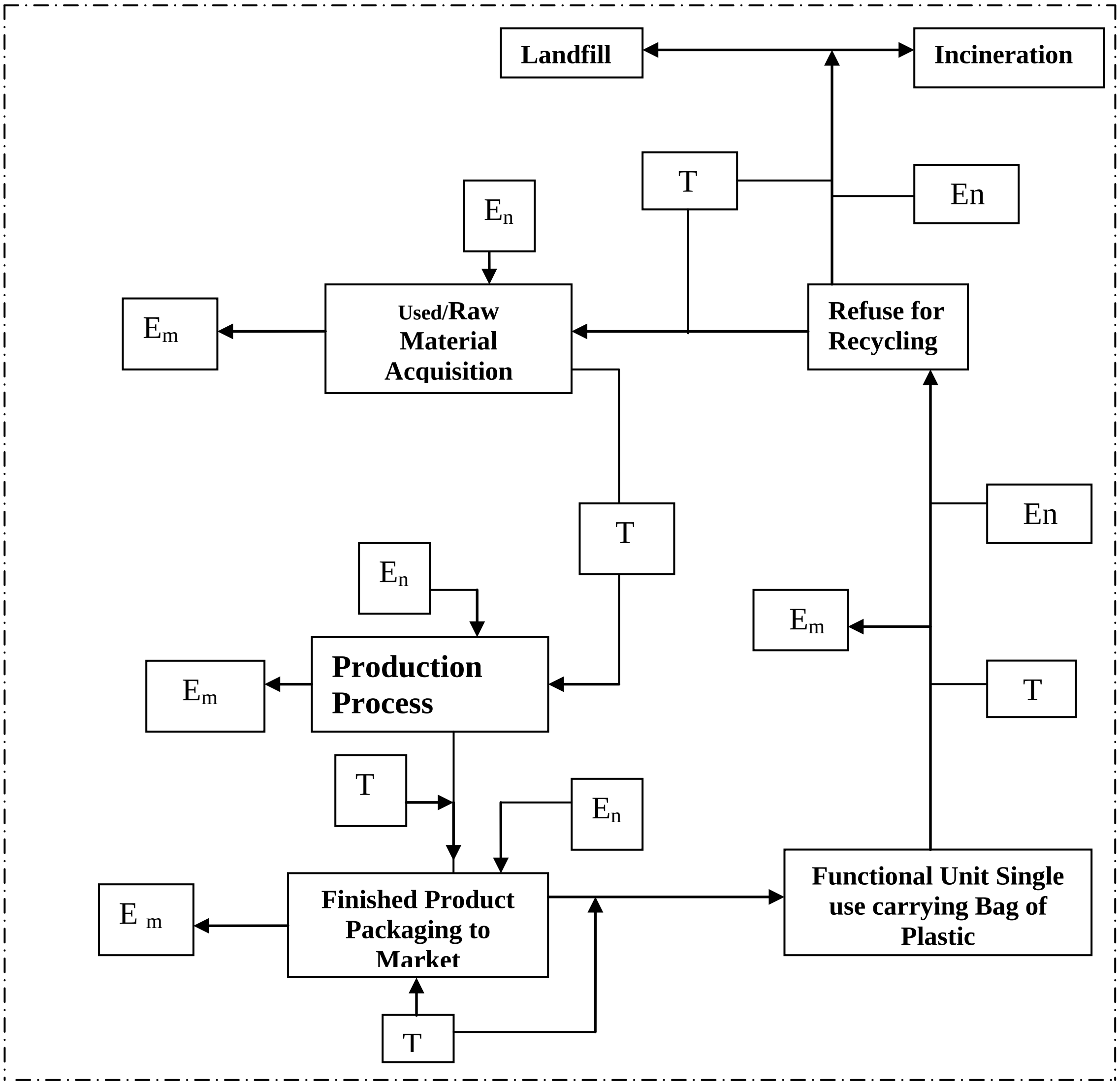

Figure 2 Flow diagram Showing Boundary of the system and Functional Unite of Single use plastic Bag. Where Em= Emissions, En= Energy, T= Transportation

The manufacturing assessment of each shopping bag included the extraction of raw materials and the processing of them into the final product is shown as under with the logical reverse because after the collection the process of separation and segregation is performed and recyclable goes to re processing while the refuse of any kind is treated as per requirement i.e. Land fill etc. In this regard see the flow diagram and boundary of the system with the functional unit in Figure- 2 above.

RAW MATERIAL ACQUISITION AND MANUFACTURING

The lifecycle of a plastic bag begins with the extraction and processing of raw materials. The key ingredients in plastic bags are petroleum and natural gas, and the manufacturing of plastic bags accounts for 4 per cent of the world's total oil production describes the Sara Ellis et al (2005) as such that the Polyethylene is a non-renewable resource made from ethylene, which takes hundreds of years to break down LDPE, HDPE, PP, is commonly used as raw materials to make plastic bags. HDPE is manufactured from ethylene, a by-product of gas or oil refining which is extracted from natural gas or naptha (from oil) by high temperature cracking. LDPE is manufactured from ethylene, a by product of gas or oil refining. They offer a thin, lightweight, high strength, waterproof and reliable means of transporting shopping goods. 'Green Bags' are manufactured from polypropylene gas, a by-product of oil refining. They are strong and durable, and can hold more than a conventional single use HDPE shopping bag. The process of manufacturing plastic bags requires significant quantities of both energy and raw materials. Polyethylene is appealing to manufacturers because it can be manipulated into any shape, size, form or color. Significant impacts of this stage mainly result from photochemical oxidant emissions linked to the use of solvent-based ink. Air pollution caused by the emission of toxic chemicals and CO2 during the manufacturing of plastic bags is a significant part of the environmental impact of this product.

According to the Institute for Lifecycle Environmental Assessment, the manufacturing of two plastic bags produces 1.1 kg of atmospheric pollution, which contributes to acid rain and smog. Most energy is used in material manufacture, not in bag production or transport. A reusable plastic bag requires more energy to manufacture, but as it is used several times, there is an overall reduction in the impact compared with lightweight plastic bags. These include effects on human health, sensitive ecosystems, soiling and deterioration of building facades, forest decline and acidification of lakes. These acidic gases are released mainly when fossil fuels are burnt mentioned by the Sara et al (2005). After collection, the waste is sorted and depending on quality and condition, it is either disposed of by incineration or dumped in a landfill or recycled. Disposal of bags (landfill or incineration) contributes to the specific impacts of environmental risks from discarding used plastic bags, producing solid waste and creating greenhouse gas emissions. Polyethylene releases 2.75 times more energy upon incineration than unbleached paper. The energy within a plastic bag can be used in the production of electricity or steam for heating in an energy-from-waste (EFW) facility reducing the need for coal for producing energy, by virtue of being a cleaner burning fuel. Energy from Waste (EFW) is combustion of municipal solid waste for energy. Combusting plastic bags is not burning garbage, it is the same as burning natural gas for energy. The end-of-life step (incineration or disposal) contributes mainly to three indicators (littering probability, residual solid waste, GHG emissions).

ENVIRONMENTAL IMPACT ASESSMENT

The Environmental Impact analysis produces the following results: Primary energy consumption calculation including energy utilization in the production of the raw material (i.e. crude oil and wood) is very important to be estimated. This is the fact that due to the use of fossil raw material and energy used in production of plastic bags. Next, the depletion of a biotic resource such as metal ores and fossil fuels is problematic since it results in a situation where future generations will be required to resort to use other resources. Global warming is caused by increases in the atmospheric concentration of chemical substances that absorb infrared radiation. Global warming is measured in CO2 equivalents. It is to find that which that the LDPE and HDPE bags which one gives the highest potential contribution to global warming. Moreover, as the Eutrophication disturbance of nutritional balance of soil in aquatic systems this leads to increased production of biomass, which may lead to oxygen deficiency on decomposition. The paper bag gave the highest contribution to Eutrophication due to the high levels of COD from paper production that nature of the impact. Further, human toxicity caused by air emission; it is the LDPE bag that gives the highest contribution. The emissions of NOx and SO2 associated with the use of fossil fuels at the production of LDPE were found to dominate thereby giving the LDPE sack a greater contribution to air emissions. The positive contribution from the recycling of LDPE arises due to the creation of NOx and SO2 at electricity generation. For human toxicity caused by water emissions, it is the bleached paper sack, landfill scenario that gives the highest contribution. The negative contributions from the system expansions for recycling were found to be higher for the plastic bags than for the paper bags. The main sources of greenhouse gases in the bag LCA are carbon dioxide (CO2) from the combustion of fossil fuels. Most greenhouse gas emissions are associated with material manufacture. This indicator takes into account fossil CO2 and N2O emissions (created for instance by combustion of fuel and natural gas). On The greenhouse effect is expressed in CO2 eq. /bag. The solid waste and green house gas related impacts are shown in figure-3 below. Where the relatively lowest percentage amount is evident for PP green bag in compare with other for similar use.

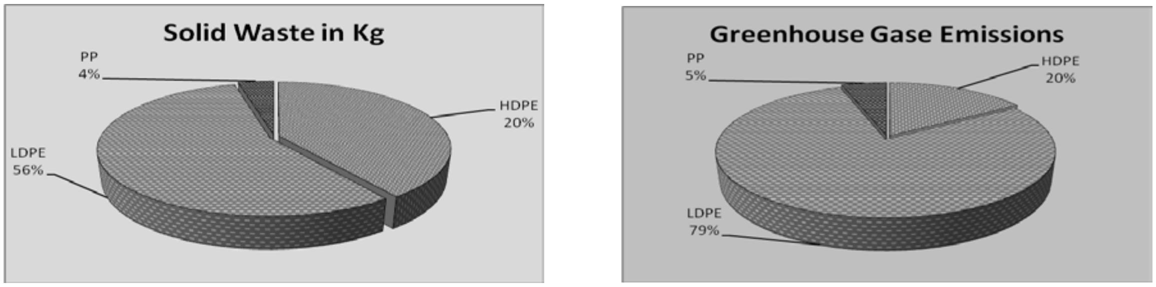

Figure -3 Solid waste and green house gas related impacts.

ATMOSPHERIC ACIDIFICATION

From NOx, SOx and HCl emissions in particular, this indicator characterises increase in the quantity of acid substances in the lower atmosphere, producing "acid rains" and in particular bringing about the depletion of certain forests. Atmospheric acidification is expressed in kg H+ eq./bag. Key life cycle stages for atmospheric acidification are material manufacture for all bag types.

PHOTOCHEMICAL OXIDANT CREATION

In certain climatic conditions, atmospheric emissions from industries and transport can react in a complex way as a result of sunlight and lead to the formation of a photochemical "smog". A succession of reactions involving volatile organic compounds and NOx leads to the formation of ozone, a super oxidising compound. The potential for creating photochemical oxidants is expressed in ethylene equivalent.

EUTROPHICATION OF WATER

Eutrophication which leads to proliferation of algae and asphyxiation of the aquatic environment is characterised by the introduction of nutrients, for example in the form of nitrogen and phosphate compounds. Eutrophication is expressed in phosphate equivalent. results shows that PP green has minimum impact in this regard. However water used is significantly higher among others as shown in figure-4.

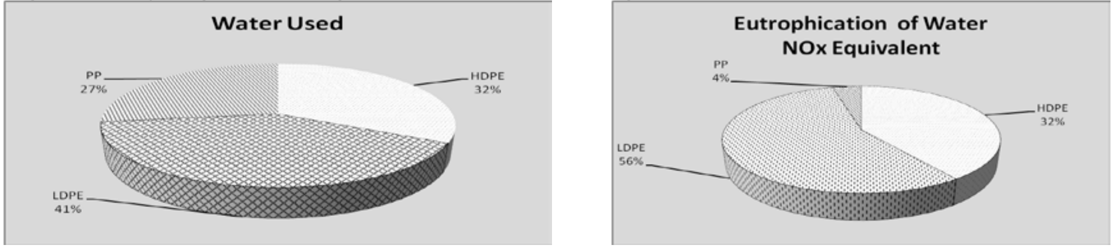

Figure-4 Water effluents and Eutrophication effects of the product.

PRIMARY ENERGY CONSUMPTION

Most energy is used in material manufacture, not in bag production or transport. A reusable plastic bag requires more energy to manufacture, but as it is used several times, there is an overall reduction in the impact compared with lightweight plastic bags. The LDPE bags are found to give a higher contribution to the depletion of non renewable resources. This is due to the use of fossil raw material and energy in the production of LDPE. Lowest Primary energy and the material consumption relate to PP green bags only as shown in the figure-5. Where the Primary Energy for the PP green bag is much lower as well as the Material Consumption in compare to what is invested in other types for a similar nature of use.

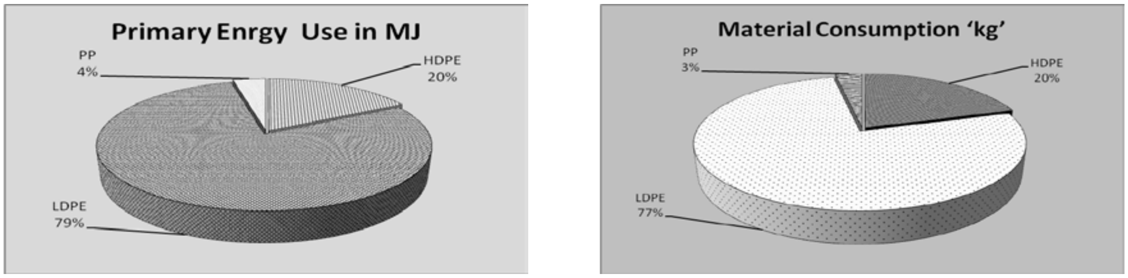

Figure -5 Primary energy and material consumption of the products

LAND POLLUTION

Due to many factors, not the least of which is their ready availability, 96 per cent of all bags are thrown into landfills. However, plastic bags decompose very slowly, if at all. In fact, a bag can last up to 1000 years, inhibiting the breakdown of biodegradable materials around or in it. Lightweight plastic bags are additionally harmful due to their propensity to be carried away on a breeze and become attached to tree branches, fill roadside ditches or end up in public waterways, rivers or oceans. (Sara Ellis et al (2005)

CONCLUSIONS

It has been found that the PP green bags are one of the greenest and most energy-efficient bag materials produced today for the users. Moreover, other plastic carrier sacs have been found to significantly contribute to litter and have other negative impacts on marine wildlife safety and environment if not handled properly for disposal. Reusable bags contribute towards environmental sustainability over plastic and paper carryout bags. Accelerating the widespread use of reusable bags will diminish plastic bag litter and redirect environmental preservation efforts and resources towards "greener" practices. Reusable bags consume least energy during production when compared to other plastic bags. After one use, reusable plastic bags are superior to all types of disposable bags across all significant environmental indicators.

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