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STRATEGIC SUPPLY CHAIN MANAGEMENT IN INDIAN PLASTIC PROCESSING INDUSTRIES

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Abstract: Plastic is undoubtedly to reign among the variety of materials for its varied applications; engineering machinery parts to domestic appliances to packaging's. Warning bells are now sounding aloud against the deterioration of the eco-system; witnessed by the over use of plastics. From environmental sustainability perspective, literature survey suggests, efforts are focused mainly on formulating methods to achieve maximum plastic waste recycling targets. Still, all plastic waste collection and even whole recycling of collected plastic can't be ensured. However, plastic recycling does not prove economical due to collection and sorting difficulties. Moreover, Single use plastic waste remains at large from collection and hence recycling. It is dumped in the landfill sites along with solid food waste. Plastic industries have a potential to adapt strategic changes. The research paper follows the approach of current/baseline scenario study. It proposes a renewed scope in achieving; resource, economic and environment sustainability in plastic supply chain through various strategic alternatives.

Keywords: Supply chain management, LCA, Plastics

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INTRODUCTION

Over the past 25 years, environmental issues have gained greater public recognition. Production, use and disposal of virtually all goods present potential health and environmental impacts. These effects occur at all stages of the Life Cycle of a product, beginning with raw material acquisition and continuing through material manufacture and product fabrication. At each of these steps, pollutants may be released into the environment with ecological consequences [6].

In this case, plastics are a thoroughly investigated material because plastic waste is one of the components in municipal solid waste management. Plastics are predominantly employed in packaging, construction and consumer products. The first commercial plastics were developed over one hundred years ago. Now plastics have not only replaced many wood, leather, paper, metal, glass and natural fiber products in many applications, but also have facilitated the development of entirely new types of products. Plastic products are durable, which although having functional benefits, can cause problems at the end of products' lives. As plastics have found more markets, the amount of plastic produced becomes increases [1]. This phenomenal growth was caused by the desirable properties of plastics and their adaptability to low-cost manufacturing techniques. The life cycle of plastic products includes production, transportation, use and disposal which have contributed to the release of waste emissions [3]. This results in toxins existing in the water, air and food chain, bringing the people around the polluted area severe health problems. Recently, environmental groups are voicing serious concern about the possible damaging impact of plastics on the environment. Plastics end products and materials eventually contribute to the solid waste stream [15]. The plastic fraction in municipal solid waste consists mainly of polyethylene (PE), polyethylene terephthalate (PET), polyvinyl chloride (PVC) and polypropylene (PP) and polystyrene (PS). Different types of plastics will perform differently in the environment, e.g. polyvinyl chloride (PVC) has caused concern because of their potential to cause environmental harms [11].

By improving either products or end-of-life schemes, impacts and risks could thus be mitigated and investigated. Life cycle assessment (LCA) intends to aid decision-makers in this respect. The aim of the study is to take the overview of environmental performance of three polymer-based plastics which are polyethylene terephthalate (PET), polyvinyl chloride (PVC) and polypropylene (PP) in different disposal treatments. Scope of the study covers the entire life cycle of the plastic product encompassing raw material processing, manufacturing, transportation, use, recycling and disposal. This study concentrates only on air emissions released within the life

cycle of plastic which contributes to the impact of global warming. Therefore, this paper focuses on the plastic from the LCA perspective.

Review of Literature

Qinghua Zhua et al.[1] evaluates the general relationships between specific GSCM practices and performance using hierarchical regression analysis. Influence of GSCM on environmental and operational economic performance is only considered while organizational performance as a whole is not investigated. Jose M. Cruz [2] developed a dynamic framework for the modeling and analysis of supply chain networks with corporate social responsibility through integrated environmental decision making. Paper proposed the dynamics associated with the continuous–time adjustment processes and constructed the projected dynamical system formulation. The developed GSCM network did not consider supplier and logistics in decision making. Chun-Jen Chung et al.[3] investigates the efforts towards green product designs and remanufacturing while developing an integrated production inventory model with short life-cycles. Study is restricted to green product design while multi-objective optimization is not considered. Stephan Vachona et al.[4] examines the impact of environmental collaborative activities on manufacturing performance. Evidence emerged that upstream practices were more closely linked with process based performance while downstream collaboration was associated with product-based performance. Design of this study is based on only one respondent. David J. Robba et al.[5] addresses the study of practices and performance (operational and financial) relating to supply chain and operations management among furniture manufacturers located throughout China. Performance and perspectives of wood processors and furniture distributors is not considered in the supply chain. Nitin H. Mutha et al.[6] Forecasting material flows is essential for sound policy making on issues relating to waste management. This paper presents the results of the plastics materials flow analysis (MFA) for India. Riccardo Accorsi et al.[7] proposed an original conceptual framework for the integrated design of a food packaging and distribution network. Frost & Sullivan [8] states that there is an increasing interest being generated in the bio-plastics in India. Factors like lack of environmental concern, price and regulation are said to be affecting the implementation of GSCM practices in the plastic processing segment. Balan Sundarakani et al.[9] applied the long-range lanrangian and the Eulerian transport methods. The model helps to understand the heat flux and carbon wastage at each node of the supply chain and allows to calculate the total heat (and hence the carbon) transferred from one stage of the supply chain to another. Model did not take cost of carbon emissions into account. Chun-Jen Chung et al.[10] developed an integrated deteriorating inventory model with green-component life-cycle value design and remanufacturing. Issue of controlling the defects in the production process, multi-objective optimization and revenue

sharing mechanism in view of integrated model is not considered. Ashish Kumar Bhateja et al. [11] highlights successful implementation of green practices in tools, industrial equipments and machinery manufacturing enterprises in India. Brand building is considered by the paper as one of the highlights successful implementation of green practices in tools, industrial equipments and machinery manufacturing enterprises in India. Brand building is considered by the paper as one of the top incentives for implementing green practices. A quantitative technique to measure the performance and calculate the carbon emission of any particular process, product or organization is not given. Sikhar Barari et al.[12] proposed a two player game has been developed to stand synonymous to the situation considered. Evolutionary dynamics has been adopted extensively to locate the optimal and the most stable point offering the best economic gains. Paper established the aspect of economic welfare in a three agent supply chain with an eye for observing the greenness associated in a market which is neutralized by the forces of demand, governed by the aspect of price and marketing. Paper did not address the detailed processes involved in the manufacturing sector. Ezutah Udoncy Olugu et al.[13] used visual basic Net because of its object oriented programming features. The fuzzy rules and arithmetic used are described. The resulting performance measurement system was evaluated using a case study company from the automotive industry. Methodology did not facilitate a real-time assessment capability. Paper did not create client-server system in which manufacturers and their various suppliers and customers can conduct their evaluations independently at different times and locations. Xiaojun Wang et al.[14] paper blends fuzzy logic, which is a popular method of incorporating uncertain parameters into the decision-making process, with analytic hierarchy process to form a selection (decision-making) model for different green initiatives in the fashion industry. The rationale behind the model is to analyze the associated risk of different alternatives, subject to different factors, be they deterministic or not. Study is developed from theoretical research perspective. It does not address practical real-life application. Corinthias Pamatang Morgana Sianipara et al.[15] proposes to give an understanding on how to predict incoming issues before developing any prevention plans as regards to monitoring of supply chains. Research did not extend this study in practical area. Usha Ramanathan et al.[16] uncovers the impact of collaborative planning, collaborative decision making of supply chain partners and collaborative execution of all supply chain processes in the success of collaboration. This will help supply chain partners to make investment decisions particular to collaborations. Research is limited to one particular company with many supply chain partners. It can't be extended to many companies involved in supply chain collaborations. Inda Sukati et al.[17] explored the relationship between supply chain management strategy and chain management practices of supply chain performance. The analysis involved statistical methods. The study seems indicative rather than definitive because

it is based on a self-reported questionnaire. M.S. Pishvaee et al.[18] proposed a robust possibilistic programming model which addresses the problem of socially responsible supply chain network design under uncertain conditions. To this aim, first a bio-objective mathematical programming model is developed wherein its objective functions include minimizing the total cost and maximizing the supply chain responsibility. Paper did not integrate the economical and social aspects into a single objective function like life cycle costing procedure. Jiang Ying et al.[19] analyzed the difference between green supply chain and traditional supply chain and elaborated the content of green supply chain management. Paper highlights, for comparatively low per capita income of resources in one particular country, the implementation of green supply chain management shall bring long-term economic and social benefits. Business process re-engineering or re-designing and encouraging green technological innovation is not addressed. S.M.J. Mirzapour Al-e-hashem et al.[20] developed a stochastic programming approach to solve a multi period multi product multisite aggregate production planning problem in a green supply chain for a medium term planning horizon under the assumption of demand uncertainty. The model is first a non-linear mixed integer programming which is converted into a linear one by applying some theoretical and numerical techniques. Paper does not justify the relationship between price and end customer demand. Seyed Mostafa Mirhedayatian et al.[21] proposed an evaluation technique that can be used for evaluating GSCM is Data Envelopment Analysis in the presence of undesirable outputs and fuzzy data. Evaluation model did not consider the closed loop green supply chain management.

Plastic Manufacturing

Plastics are made from oil, natural gas, coal and salt. The major feedstock is oil; the petrochemicals industry supplies the monomers for plastics production and manufactures a wide range of additives to modify their behavior [7]. Plastics are produced by polymerization, the chemical bonding of monomers into polymers. The size and structure of the polymer molecule determines the properties of the plastic material. In their form, plastics are produced as powders, granules, liquids and solutions. The application of heat and pressure to these raw materials produces the final plastic product [13].

Plastics are classified as thermoplastic or thermosetting resins. When thermoplastic resins are heated, it soften and flow as viscous liquid; when cooled they solidify. The heating and cooling cycle can be repeated any times without the loss of specific properties. Thermosetting resins liquefy when heated and solidify with continued heating [18]. The polymer undergoes permanent cross-linking and retains its shape during subsequent cooling and heating cycles.

Thermoset plastics cannot be reheated and remoulded; however, thermoplastics can be reprocessed by melting and hence readily recycled[9].

Almost 85% of all resins produced are thermoplastics and over 70% of the total volume of thermoplastics is accounted for by the resins: polyethylene, polypropylene, polystyrene and polyvinyl chloride (PVC) [6]. They are made in a variety of grades and because of their low cost is the first choice for a large number of applications [5]. A variety of processing and shaping methods are available to form the desired product of these processes extrusion and injection moulding are the most common.

Method

To carry out a life cycle analysis requires that, the boundaries of the global system e.g. a set of subsystems must be defined precisely. The energy requirements for the hierarchy of alternatives are based upon the following global boundaries [6]:

Input: One (1) kg of plastic fraction in a waste stream that can be either source separated, sorted, landfilled or combusted. Additional energy as required for each option considered.

Output: Identical finish plastic parts.

Figure 3.1 shows the simplified life cycle of plastics which covers from their manufacture to their use and to their disposal.

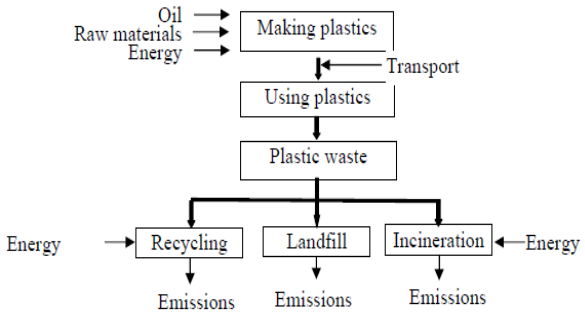

Figure 1 Simplified life cycle of plastics (Environmental Agency, 2001)

Plastic Production

This section gives an overview of the complex and varied processes involved in making plastic. We also look at 'additives', which enhance the performance of plastic or aid it's processing. These chemicals often have a greater potential impact on the environment than the polymer

itself. Finally, we consider information on the impact of making plastics on the environment and human health.

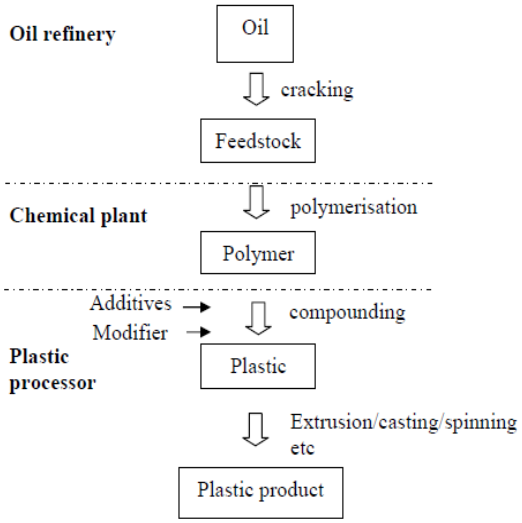

Figure 2 Generalised process for making plastics

Strategic fit for sustainable plastic supply chain management

Plastics make a valuable contribution to the way we live, but as a society we need to find ways of using plastics more wisely. The way we make, use and dispose of plastics should have a minimal impact on the environment. Some of the methods to reduce the impacts on the environment are:

- **A greener plastics industry.** The manufacture of plastic materials is one of the major industries with potential for serious pollution to the surrounding environment. Different types of plastics manufacturing processes and disposal methods will contribute to different effects on the environment. Therefore, government agency must ensure that industry operates in a way that minimises adverse effects on people and the environment, and contributes to the achievement of sustainable development.

- **The potential impact of chemicals leaching from plastics on human health and the environment**

The use of plastics in food packaging and toys aimed at young children increases the risk of exposure. Risk assessments have been carried out for some, but not all chemicals used in plastics. Where information exists, it suggests that the quantities released during the

manufacture and disposal stages of the life cycle are much greater than those lost during the use phase, when humans are likely to be most exposed. This information gap needs to be addressed.

- **Reducing the waste generation.** As a society, we are generating an increasing amount of waste. As with other materials, more must be done to reduce the amount of plastic waste we produce. There has been a shift towards a 'disposable' culture, and the lower cost of plastics may have contributed to this and the associated growth in waste.

- **Practicing recycling habit.** The attitude of the public in recycling practices should be improved. The public should be well informed of the importance to recycle. Environmental influences appear particularly effective among members of the public who have a "strong belief in personal responsibility and influence, as well as the power of self-determination". The public would recycle more if they had a greater understanding of the environmental benefits of recycling.

- **Charging for waste.** Although this practice is still not common in our country, but several recycling centers in Malaysia are already implementing this concept, as a way to encourage more people to recycle. This concept is mainly targeting specifically at those who don't recycle, and in turn supports those who do. By charging for the waste sent to the recycling centers, this can help to encourage more recycling practices among the public.

- **Introducing more recyclable products.** By replacing the plastic shopping bags used in supermarkets and food stalls, with recyclable shopping bags; this can initially encourage more people to recycle. By displaying the international standard 'Recycling Logo' on recyclable products, the consumer will be fully informed whether the items can be recycled or not. When the consumer is aware that the items can be recycled, they will automatically categorize the items as recyclable products and will not dump them together with non-recyclable wastes. With such measures, it is hoped that the public will be more aware of the recyclable items available in the market.

CONCLUSIONS

The aim of the study was to take the overview of life cycle assessment approach to determine whether which options will substantially reduce the environmental burdens. Several important observations are:

- Recycling of plastic products can significantly reduce the energy required across the life cycle because the high energy inputs needed to process the requisite virgin materials greatly exceeds the energy needs of the recycling process steps.
- Greenhouse gases can be reduced by conducting recycling option rather than landfilling option.
- Quantity of waste emissions released from different disposal options was identified.
- Recycling is the environmental preferable disposal method while polypropylene (PP) is the most desirable plastic product.

REFERENCES

1. Qinghua Zhua, Joseph Sarkis, "Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises", Journal of Operations Management 22 (2004) 265–289, Science Direct.

2. Jose M. Cruz, "Dynamics of supply chain networks with corporate social responsibility through integrated environmental decision-making", European Journal of Operational Research 184 (2008) 1005–1031, Science Direct.

3. Chun-Jen Chung, Hui-Ming Wee, "Green-component life-cycle value on design and reverse manufacturing in semi-closed supply chain", Int. J. Production Economics 113 (2008) 528–545, Science Direct.

4. Stephan Vachona, Robert D. Klassen, "Environmental management and manufacturing performance:The role of collaboration in the supply chain", Int. J. Production Economics 111 (2008) 299–315, Science Direct.

5. David J. Robba, Bin Xiea, Tiru Arthanari, "Supply chain and operations practice and performance in Chinese furniture manufacturing", Int. J. Production Economics 112 (2008) 683–699, Science Direct.

6. Nitin H. Mutha, Martin Patel, V. Premnath, "Plastics materials flow analysis for India". (2006), Science Direct.

7. Riccardo Accorsi, Alessandro Cascini, Susan Cholette, Riccardo Manzini, Cristina Mora, "Economic and environmental assessment of reusable plastic containers: A food catering supply chain case study", (2014), Science Direct.

8. Frost & Sullivan, "Introduction to Bioplastics Market in India", (2009) www.frost.com

9. Balan Sundarakani, RobertdeSouza, MarkGoh, StephanM.Wagner, Sushmera Manikandan, "Modeling carbon footprints across the supply chain", Int. J. Production Economics 128 (2010) 43–50, Science Direct.

10. Chun-Jen Chung, Hui-MingWee, "Short life-cycle deteriorating product remanufacturing in a green supply chain inventory control system", Int. J. Production Economics, (2010), Science Direct.

11. Ashish Kumar Bhateja, Rajesh Babbar, Sarbjit Singh, Anish Sachdeva, "Study of Green Supply Chain Management in the Indian Manufacturing Industries: A Literature Review cum an Analytical Approach for the measurement of performance", IJCEM International Journal of Computational Engineering & Management, Vol. 13, July 2011.

12. Sikhar Barari, Gaurav Agarwal, W.J.(Chris) Zhang, Biswajit Mahanty, M.K. Tiwari, "A decision framework for the analysis of green supply chain contracts: An evolutionary game approach", Expert Systems with Applications 39 (2012) 2965–2976, Science Direct.

13. Ezutah Udoncy Olugu, Kuan Yew Wong, "An expert fuzzy rule-based system for closed-loop supply chain performance assessment in the automotive industry", Expert Systems with Applications 39 (2012) 375–384, Science Direct.

14. Xiaojun Wanga, Hing Kai Chan, Rachel W.Y.Yee, IvanDiaz-Rainey, "A two-stage fuzzy-AHP model for risk assessment of implementing green initiatives in the fashion supply chain", Int. J. Production Economics 135 (2012) 595–606, Science Direct.

15. Corinthias Pamatang Morgana Sianipara, Gatot Yudokoa, "Predicting issue dissemination and arrival pattern on supply-chain using network analysis", Procedia - Social and Behavioral Sciences 57 (2012) 175 – 182, Science Direct.

16. Usha Ramanathan, Angappa Gunasekaran, "Supply chain collaboration: Impact of success in long-term partnerships", Int. J. Production Economics (2012), Science Direct.

17. Inda Sukati, Abu Bakar Hamid, Rohaizat Baharun, Rosman Md Yusoff, "The Study of Supply Chain Management Strategy and Practices on Supply Chain Performance", Procedia - Social and Behavioral Sciences 40 (2012) 225 – 233, Science Direct.

18. M.S. Pishvaee, J. Razmi, S.A. Torabi, "Robust possibilistic programming for socially responsible supply chain network design: A new approach", Fuzzy Sets and Systems 206 (2012) 1–20, Science Direct.

19. Jiang Yinga, Zhou Li-junb, "Study on Green Supply Chain Management Based on Circular Economy", Physics Procedia 25 (2012) 1682 – 1688, Science Direct.

20. S.M.J. Mirzapour Al-e-hashem, A. Baboli, Z. Sazvar, "A stochastic aggregate production planning model in a green supply chain: considering flexible lead times, nonlinear purchase and shortage cost functions", European Journal of Operational Research (2013), Science Direct.

21. Seyed Mostafa Mirhedayatian, MajidAzadi, RezaFarzipoorSaen, "A novel network data envelopment analysis model for evaluating green supply chain management", Int. J.Production Economics (2013), Science Direct.