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OPPORTUNITIES IN GREEN SUPPLY CHAIN MANAGEMENT

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ABSTRACT

The supply chain consists of those activities associated with manufacturing from raw material acquisition to final product delivery. Because of the recently changed environmental requirements that affect manufacturing operations and transportation systems, growing attention is given to the development of environment management strategies for supply chains. A green supply chain aims at confining the wastes within the industrial system so as to conserve energy and prevent the dissipation of harmful materials into the environment. In this paper, we compare and contrast the traditional and green supply chains. Moreover, we discuss several important opportunities in green supply chain management in depth, including those in manufacturing, bio-waste, construction, and packaging.

INTRODUCTION

Today, environmental pollution is the main problem which has the potential to lead to the extinction of mankind on earth if not addressed at this moment. Of the various kinds of pollution, air pollution is the one which needs immediate attention. Global warming, an effect due to the increase in amounts of the green house gases present in air is the most severe problem mankind is facing at the moment. The amount of carbon dioxide which was found to be roughly around 280 parts per million before industrial revolution has reached to a proportion of 380 parts per million, and its rise has accelerated. At present we have been adding 2 parts per million annually. It was found that a rise in carbon dioxide proportions to more than 450 parts per million would lead to an increase in temperature up to 2 degrees centigrade which would result in faster and irrevocable melting of Greenland and Antarctic ice. Melting of Greenland ice itself is expected to increase the sea level by 23 feet, which means that the face of earth will be changed beyond recognition [McKibben, p.38-39]. Without proper action, it will be merely impossible to stop at 450 ppm. For that to happen, large scale technological and social changes instigated by financial and political inputs are necessary.

Accordingly, international negotiations took place and Kyoto Protocol came into effect on February 16, 2005 under which the developed countries are required to reduce their collective emissions by 5.2% compared to 1990 levels. This treaty gives exemption to the developing countries to help them catch up with the industrialized world. However, with the U.S. opting out where 5% of world population produces 25% of carbon dioxide emissions, the treaty is not expected to have the desired effect [Vedantam, p.A04]. With democrats taking over the government in the recent elections, it is expected that strict laws will be in place to curtail the emissions. It is evident from the fact that dozens of states are making laws requiring industries to use renewable energy. For example, Ohio and Iowa requires utilities to buy some of its power from renewable sources and New Hampshire will require its state to buy fuel that contains at least some biodiesel [Koch, p.03a]. The international recession is likely to influence the usage of green technology, as entrepreneurs are more likely to focus on profit making than on the environment. However, recently made innovations which are both cost saving and green are likely to drive the embracing green technology.

The traditional supply chain comprises five parts: raw material, industry, distribution, consumer, and waste. Each of the links in the supply chain can be a reason for pollution, waste, and other hazards to the environment. Regarding raw materials, a company may use environmentally harmful materials such as lead. However, organizations can put pressures on suppliers to use more environmentally friendly materials and processes.

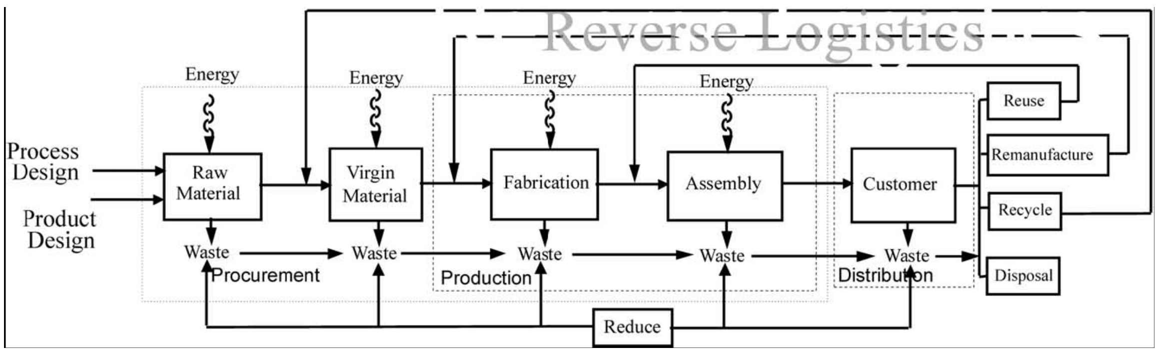
Oil is one of the chief raw materials used by both industries and consumers at various stages of supply chain. Oil is used as a raw material in many processes varying from power generation to petro products and as fuel to run engines that are used in agriculture, automobiles, etc. As the combustion of oil leads to the emission of green house gases, its usage needs to be curtailed and if possible is to be eliminated completely. With the industrialization of world's populous countries like China and India, oil usage is expected to reach new highs in near future with most of it imported. Even European resilience on oil is expected to reach 90% by 2030 [Billon and Khatib, p.114]. With the increased demand for oil, the availability of which is limited, countries are forced to embrace alternative technologies or see their economies falling apart. Moreover, much of the oil is imported from countries that promote terrorism [Meyer]. This factor too forces the world to adopt alternative technologies.

At the second stage, industry or manufacturing, Bluemhof-Ruwaard et al. [Bluemhof-Ruwaard, Beek, Hordijk, Wassenhove, p.230] describe that both the processes and product design present many opportunities to implement environmentally friendly procedures. For example, these procedures entail reducing waste, minimizing pollution, and utilizing resources efficiently.

In the distribution process, organizations minimize packaging materials and stress "reverse distribution." An organization may encourage its end consumers to efficiently use the products by including instructions and suggestions in product manuals. In the waste disposal process, a company must comply with regulations regarding collection and disposal of hazardous materials.

As illustrated by Figure 1, the green supply chain model shows the various points where wastes occur and opportunities exist to limit waste by reuse, recycling, and remanufacturing. In a green manufacturing environment, the supply chain decisions include the possibility that a process can use certain renewable materials, the ability to utilize reusable or remanufactured materials, and the reduction of wastes. Sarkis [Sarkis, p.399] states that environmentally friendly innovations may best be utilized during the manufacturing stage of the supply chain, as this part is the most internally focused and the organization can more directly see the benefits of implementing environmentally friendly processes.

FIGURE 1
FUNCTIONAL MODEL OF AN ORGANIZATIONAL SUPPLY CHAIN WITH ENVIRONMENTALLY INFLUENTIAL PRACTICES (SARKIS, p.400)



Green supply chain management (GSCM) involves traditional supply chain management practices, which integrate environmental criteria, or concerns, into organizational purchasing decision and long term relationships with suppliers [Gilbert, p.6]. A green supply chains aims at confining the wastes within the industrial system in order to conserve energy and prevent the dissipation of dangerous materials into the environment. It recognizes the disproportionate environmental impact of supply chain processes within an organization.

Conventional and green chains differ in several ways. First, conventional chains often concentrate on economic objectives and values, while green chains give significant considerations to ecological causes also. When a conventional chain does take ecological standards into account, it is often limited in its optimization scope. For example, conventional chains merely take into consideration human toxicological effects, leaving out the effects on environment. Furthermore, they often concentrate more on controlling the final product, while allowing negative effects to occur during the production process.

On the other hand, green, integrated, ecologically-optimized supply chains extend the scope not only to human toxicological effects, but also to ecologically negative effects on the natural environment, as well as the entire value-adding process, resulting in low ecological impacts during production. Ecological requirements are considered as key criteria for products and productions, and at the same time the company must assure its economic sustainability by staying competitive and profitable.

The buyer and supplier selection criteria are fundamentally different in conventional and green chains. In conventional chains, the predominant standard is price. In green chains, ecological objective is a part of the supplier selection criteria. Putting these ecological criteria into practice requires careful supplier evaluation, based on long-term oriented relationships. The development of suppliers usually takes a long time and only a very limited number of suppliers meet the defined criteria. Hence, any change of supplier selection cannot be implemented in a green chain as quickly as in a conventional chain.

One of the initial perceptions about introducing green products in the market is that they lead to higher cost of manufacturing compared to conventional ones. However, recent findings showed that innovations and optimal planning can dramatically reduce the costs in most cases. For the cost problems to be managed effectively, the efficiency of the entire supply chain must be evaluated. Compared to conventional chains, which have a large number of conventional materials and suppliers, green chains are relatively inferior in terms of speed and flexibility. Table 1 summarizes the major differences between the conventional and green supply chain management.

TABLE 1
DIFFERENCES BETWEEN THE CONVENTIONAL AND GREEN SCM

Characteristics	Conventional SCM	Green SCM
Objectives and values	Economic	Economic and ecological
Ecological optimization	High ecological impacts	Integrated approach Low ecological impacts
Supplier selection criteria	Price switching suppliers quickly Short-term relationships	Ecological aspects (and price) Long-term relationships
Cost pressure and prices	High cost pressure Low prices	High cost pressure High prices
Speed and flexibility	High	Low

Though in some cases the costs involved in a green SCM are high compared to conventional supply chains, consumer conscience on environment helped organizations create a brand image and in turn gain a unique competitive edge. Beamon [Beamon, p.334] showed that an estimated 75% of the consumers claimed that their purchase power was influenced by the company's environmental reputation and that 80% would be willing to pay more for environmentally friendly goods. By practicing just a fraction of green concepts in supply chain management, many commercial firms have achieved success. In the next four sections, we discuss green supply chain management opportunities in the areas of manufacturing, bio-waste, construction, and packaging.

MANUFACTURING

To create real environmental change, firms must develop innovations that consume fewer resources, produce less waste, and create less environmental harm [Hervani, Helms and Sarkis, p.338]. An environmentally beneficial innovation needs new combinations of knowledge about product characteristics, process and material characteristics, and technologies. The change must come from within the firm's aims. The key to developing innovations that will be beneficial and profitable is an effective exchange of knowledge between the individual links within the supply chain. An organization requires structures that enable the firm to critically analyze and review the changes implemented. There is also a need for the capacity to accept change and modify operations at various levels when needed.

The literature points out a few common methods for making the manufacturing stage "green": reusing, remanufacturing, and recycling. The primary difference between these processes is the extent to which the characteristics of the product are changed. While the physical characteristics of a material are maintained in reuse, remanufacturing includes some changing of parts or disassembly. Recycling may change the characteristics of the material completely including chemical and physical traits. An organization has to decide which methods to employ depending on the product characteristics [Sarkis, p.400].

Literature present many findings regarding how significant an influence the suppliers could have on the "greening" of the manufacturing stage in a supply chain. Manufacturers are liable for purchasing products and services that violate environmental standards, but they may not be legally responsible for their suppliers' environmental activities. Currently there are few incentives for manufacturers to be concerned with the environmental procedures of their suppliers; moreover, there is new research pertaining to the connection between supplier's environmental practices and competitive advantages in the supply chain.

Recent environmental management literature has suggested that an informed relationship between supplier and manufacturer can lead to innovative and cost effective end-products. A recent study found that Japanese automakers were operating on a productivity twice as that of their American counterparts. The main difference in productivity was attributed to the Japanese organizations' lean manufacturing systems, reducing lead-time while at the same time increasing quality [Lewis, p.960]. However, suppliers are generally concerned with cost, quality, and delivery, while environmental safety has been taken with a lower priority. In contrast, manufacturers may list environmental safety and improvement as a major priority. Manufacturing firms may need to consider their own environmental goals, social responsibilities, and reputation to consumers [Simpson and Power, p.61]. For instance, a recent survey of 212 U.S. manufacturing firms found that over 75% of respondents identified pollution prevention as a key component to their overall company performance. Over 49% of these firms also reported that suppliers were key components to the reduction of pollution [Rao and Holt, p.902].

Involvement of suppliers in manufacturer's plant and manufacturers in supplier's plant helps them to communicate better, build trust, plan effectively and concentrate on each individual process and part to achieve a desired environmental rating for a product. Geffen and Rothenberg [Geffen and Rothenberg, p.184] conclude that the greatest success between supplier and manufacturer was found in firms where suppliers were physically involved in the manufacturer's plant and where manufacturers were actively involved in the supplier's plant. Moreover, the study found that manufacturing firms in Taiwan had successfully implemented highly innovative and effective environmental management practice between suppliers and manufacturers. The success is attributed to the relationships developed between the manufacturing firms and their suppliers.

Benefits can be generated for both supplier and manufacturer. Firms can work together to improve product design and product efficiency, which can lead to improved overall waste reduction. The manufacturing system is where the greatest amount of pollution may be generated by firms, and where the highest volume of resources is consumed [Simpson and Power, p.61]. This means that the supply-manufacture relationship has the ability to make significant strides towards a greener, leaner supply chain.

Simpson and Power [Simpson and Power, p.61] indicate that recent research finds that higher pollution prevention is found in companies that utilize lean manufacturing practice. Lean manufacturing is a philosophy derived from Toyota Production System. Lean means responsible manufacturing processes that reduce consumption and waste. This reduction in consumption of resources and production of waste is achieved by sorting out the problems in the supply chain immediately by making the worker who is producing the part responsible for the quality of it. It also includes that manufacturers and suppliers must maintain a high level of communication and trust unlike in conventional supply chains as it is not easy to shift from one supplier to other. A lean manufacturer has to maintain strong relation with supplier to build an effective supply chain that meets all the quality, environmental and time requirements. Therefore, a lean manufacturer is more likely to be a green manufacturer. Recently there has been some research proving the link between adopting lean practices and achieving advanced pollution prevention in some industries. The likelihood of success for lean manufacturing depends on the how well the supply chain is integrated between the supplier and the manufacturer.

In conclusion, many large U.S. companies have realized the significance of green supply chain management to long-term success, and are positioning themselves to develop green methods in their technologies and products. A company can employ environmentally beneficial strategies selectively to become more competitive over the long run. Putting these strategies into practice will require fundamental changes in core business processes, including product development, manufacturing, and supply chain management.

BIO-WASTE

Waste, defined as anything that adds adverse effects to the environment without adding value [Hicks, Heidrich, McGovern and Donnelly, p.3], is a byproduct in almost every type of industry. With growth in world population expected to increase by 50% from 5.7 billion (circa 1996) to 8.5 billion by the year 2030, the world's garbage is certain to increase at an unprecedented rate [Gotschall, p.105]. Some companies, especially small businesses in underdeveloped countries, have limited choices on how to handle their wastes. These businesses are often plagued by the spreading of disease due to unhealthy conditions from improper waste disposal. Eventually, these conditions lead to their closure. However, with waste management and waste prevention, companies may turn waste into profit through green supply chain management.

Waste management is an effect-directed approach that is reactive in nature and tries to reduce landfill and incinerator supporters. The reactive pressures are usually attributed to governmental and legal regulations and preservation of a status quo among corporate competitors. Europe leads the path by making the manufacturers responsible for the waste generated thought out and at the end of the product life cycle. On the other hand, waste prevention or reduction is a “catch it at the source” approach that is proactive in nature and attempts to restrict waste generation from the outset. Proactive pressures are connected with building and maintaining favorable reputations among customers and communities in order to gain a sustainable competitive advantage in various markets [Sarkis, p.159].

Solid waste in the United States has grown in the last 30 years and it is expected to continue to grow. According to the United States Environmental Protection Agency (EPA), approximately 12 billion tons of industrial waste and 208 million tons of municipal waste are generated in the U.S. each year. Industrial development has generated complex waste not only in terms of quantity but also in terms of their composition. Industrial waste encompasses food waste, rubbish, ashes, construction and demolition wastes, special wastes, and hazardous waste [Casares, Ulierte, Mataran, Ramos, Zamarano, p.1075 and Wei, Huang, p.93]. Health care waste is the total waste stream from a healthcare establishment, research facilities, laboratories, and emergency relief donations [Johannessen and Dijkman, p.3]. Proper management of health care waste is a vital process that can help ensure proper hospital hygiene and safety of health care workers and communities. Typically, waste is disposed of in landfills and despite the intense efforts that are directed to the recycling and recovery of solid wastes, landfills still remain and will remain as part of most solid waste management plans [Al-Jarrah and Abu-Qdais, p.299]. However, health care waste needs special attention as it includes different kinds of wastes such as infections, radioactive, chemical, heavy metals and regular municipal wastes. Land filling of such wastes causes soil and ground water pollution resulting in health hazards. The impacts of direct and indirect exposure to health-care wastes include carcinogenic effects, damage to reproductive, respiratory and central nervous systems [Alagoz, Kocasoy, p.1227-1228].

Investigations show that appropriate management can reduce the generation of infectious wastes by 15%. To achieve this hospital staff needs to be trained on the guidelines for separation of infectious wastes at the generation point itself resulting in lesser burden and better management at later stages [Sabour, p.587]. To design an effective waste management supply chain, current practices, types of wastes produced in the place for which the system is being developed, types of disposal available and quality improvement procedures that can be implemented are to be studied. Alagoz et al., presents a similar study done in Istanbul, Turkey. It also states that source reduction, segregation and reuse should be the initial alternatives depending on the type of waste before the final disposal. Sterilization, incineration and land filling are to be considered as the final disposal methods [Alagoz, Kocasoy, p.1233].

The World Health Organization (WHO) estimates that 20% of the waste generated by medical facilities and practices can be classified as hazardous materials that may be infectious, toxic or radioactive [Birchard, p.56]. We believe that health care professionals, who wish to improve their facilities’ environmental profiles, must implement waste disposal procedures and develop criteria for the environmental screening of products.

CONSTRUCTION

A wide array of negative impacts on the environment and human beings is attributed to the astounding amount of debris generated by the United States construction industry. These include Sick Building Syndrome (SBS), non-renewable energy consumption, wasteful land use through abundant landfills, and ozone formation.

Sick Building Syndrome is a term used to describe a situation in which building occupants experience acute health and comfort effects that may somehow be linked to the occupancy of a building. Oftentimes, these adverse effects stem from the same construction materials used on the facility proper. The adhesives, paints, and other finish materials produce a condition referred to as off-gassing. These often contain toxins whereby regular exposure to such results in numerous health conditions such as: coughing, chills, fever, chest tightness, muscle aches, and a plethora of respiratory diseases.

Another detrimental condition is the sheer disregard for the creation of landfill after landfill sites. Statistics indicate that approximately 3.7 trillion pounds of construction debris is created by Americans on a yearly basis. U.S. landfills accept 136 million tons of construction and demolition waste in 1996 [U.S. Environmental Protection Agency, p.7]. The net result is a direct contribution to methane gas production among other by-products, which is a major "greenhouse" gas.

Current practices in construction material production and disposal consume vast amounts of non-renewable energy resources. An example is the production of steel, a common material in modern building construction. Coal is readily used in the production of this material. However, the manufacturing process is not the only stage where this non-renewable fossil fuel is utilized. A quick analysis of the life-cycle of this building product reveals that material extraction and recycling also use this fuel source that induces vast amounts of air pollution and its depletion as well.

Commercial buildings add significantly to energy consumption, air pollution, and solid waste creation. About 68% of total U.S. energy consumption, more than one-third of municipal solid waste streams, and 30% of greenhouse gas emissions comes from commercial buildings [U.S. Green Building Council, p.3 and p.5]. In addition, commercial structures use nearly 12% of the nation's potable water consumption and use approximately 3 billion tons of raw materials globally each year [U.S. Green Building Council, p.5]. Green design practices strive to significantly reduce or eliminate the negative impact of buildings, and offer many benefits for, for examples, environment – reducing the impact of natural resource consumption; economic – reducing the operating costs through a significant reduction of utility costs and liability costs; health and safety – enhancing the occupant's comfort and health; and community – minimizing the strains put on local infrastructures.

Currently there are three major methods utilized to assess the environmental impact of buildings. Eco-labeling is the practice of branding the environmental qualities of a product or system so that consumers can make environmentally-based decisions. Life Cycle Assessment, on the other hand, is a comprehensive methodology for evaluating the environmental impact of a system or product. Finally, Leadership in Energy and Environmental Design (LEED) represents a national, voluntary standard for developing high-performance, sustainable buildings and structures, and is based on accepted energy and environmental principles, practices, and emerging concepts in the construction industry.

The Leadership in Energy and Environmental Design (LEED) Green building rating system is a point-based system for certifying the level of a building's sustainability. Sustainable buildings are achieved through integrated building design. For example, in an integrated design approach, mechanical engineer will analyze the energy use and its cost implications. Similarly, a structural engineer will choose the structural system, whether steel, wood or concrete and analyze the chances of using recycled-content materials into the building project, thus creating opportunities for green design strategies [Alsamsam, Lemay and VanGeem, p.1]. LEED-NC is the latest and updated version that is used for giving ratings to the buildings based on the following six categories: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality and innovation & design process. LEED has four award levels: Certified (26-32 points), Silver (33-38 points), Gold (39-51 points) and Platinum (52-69 points). A LEED-Gold building and a LEED-Platinum building have 50% and 70% less impact on environment respectively [Lockwood, p.2-3].

To acquire LEED certification, we should plan the usage of raw materials, choose proper design, select proper site etc. For example, use of concrete helps building earn 18 points as concrete can reduce urban heat islands, reduce water runoff, help meet minimum energy requirements and increase the life of the building [Marceau and VanGeem, p.1]. Similarly, usage of FSC certified wood helps in gaining one point [Hansen, Fletcher, Cashore and McDermott, p.9]. Usage of wind generator and solar panels over roofs will reduce the consumption of power from non-renewable sources and helps in gaining ratings for innovative designs.

Sustainable architecture will continue to grow throughout the U.S. with LEED playing an important role. Not only will it play a major role in its growth but will also transform itself to raise the standards of green building as dictated by the market demands, technical standards and research findings. Although LEEDs is perceived as a national standard, it can perhaps be customized for regions of the U.S. in order to that region. This will provide an impetus towards green construction being the standard of design.

PACKAGING

Packaging performs various functions in today's society. It can be seen differently from either the producer or consumer's standpoint. For producers, it is a way to promote and differentiate products, as well as safely transport finished goods to the market. For consumers, packaging is a way to identify the maker of the product, its usage, and important features. It should ultimately get the consumers' attention and make them want to buy that particular product.

There are five basic objectives of the packaging process. The first objective is to physically protect the product from any damage that might occur during storage or shipping. The second objective is agglomeration of products. Smaller items can generally be packaged and shipped together for efficiency. The third objective is information transmission. This gives the important information of how to use the product, how to dispose of it properly, or even how to transport it. For example, the food industry in the U.S. is required to put nutrition information labels on food packaging. The fourth objective is about marketing. This includes the design of the packaging that attracts consumers to buy the product. The final objective is to reduce the theft associated with particular products. Some companies make packages larger than they need to be in order to deter people from stealing it. For example, many software companies often put small compact discs into large boxes. To think of supply chains without thinking of the packaging that goes into the chain would create a "blind-spot" in the firm. This "blind-spot" is the lack of vision of adopting 'green' packaging materials or creating alliances with suppliers that use "green" packaging materials. Forty-six percent of supply chain executives cited resistance to process change as the major factor that will impede their supply chain performance [Carlson, p.15].

Packaging can exist in endless formats, designs, and chemical components. Most lay people do not consider packaging to be important or a dynamic constituent in product's life cycle. But according to Sarkis [Sarkis, p.399], "Packaging has a strong relationship with other components of the operational life cycle." Packaging characteristics such as size, shape, and materials have an impact on distribution because of their affect on the transport characteristics of the product. Better packaging, along with rearranged loading patterns, can reduce materials usage, increase space utilization in the warehouse and in the trailer, and reduce the amount of handling required [Wu and Dunn, p.29]. Systems that encourage and adopt returnable packaging methods will require a strong customer supplier relationship as well as an effective reverse logistics channel.

The most common form of packaging materials that can be seen daily are the classic peanuts, bubble-wrap, Styrofoam, air bladders, and the numerous paperboard formats. Even though most products compose of either petroleum based materials, such as plastics, or paper based materials, such as cardboard and other paperboard items, a continuous effort has been made on finding new reusable materials. The key with respect to a greener supply chain is the implementation of the use of green packaging materials.

Green packaging materials are those that are used for making a sustainable packing with least or no impact on environment. Bioplastics that are completely biodegradable in a composting cycle belong to this category. Bioplastics from renewable sources are a new generation of plastics that are being used in specific applications where biodegradability is required. Bioplastics resemble plastics in functionality and are completely degradable in a composting cycle. Various applications where bioplastics are used are composting bags and sacks, fast food service ware, packaging, agriculture and hygiene. Bioplastics that are available in the market are mainly derived from starch. Polylactic acid (PLA) is obtained by fermentation and polymerization of starch. Bioplastics that are directly derived from starch are used extensively whereas the use of PLA is less due to the high cost in the market. Novamont, National starch, Enpac and Biotec are some of the major players in the bioplastics industry. Italian paper mill Cartiera Lucchese started to use Mater-Bi, a bioplastic from Novamont Company for packing the recycled tissue paper in 1999. PLA thermoformed pots are being used by Danone for yogurt containers [Bastioli, p.351, 352,353]. Other biodegradable materials that can be used for packaging applications are bio-nano composites that are prepared with natural biopolymers, such as starch and protein. Though the usage of nanocomposites at present is low due to the high cost involved in their production, research is underway to produce low cost nanocomposites that can be used especially in short life-time applications where recycling is difficult and/or not economical [Zhao, Torley and Halley, p.3058, 3069]. Ricca [Ricca, p.1] refers the eco-friendly packaging as "by eliminating chlorine bleaching of virgin or recycled fiber, or by eliminating hydrochloride compounds from the converting process." The removal of various chemical compounds from ordinary packaging products can add tremendous value to the environment, customers, and shareholders.

The power of free market at times will likely determine the pace of going green. Influential corporations, such as IKEA, Starbucks, and Ben & Jerry's, set requirements for all their suppliers to comply with stricter environmental regulations including bleach-free processes [Ricca, p.1]. Wal-Mart Stores recently announced a five-year program with its suppliers to help reduce overall packaging by 5 percent, hoping to keep trash out of landfills and global-warming gases out of the atmosphere [D'Innocenzio]. This is a win-win initiative for the world's largest retailer, because Wal-Mart would improve not only its corporate image, but it also would save $3.4 billion in its own costs. In the five-year plan, Wal-Mart will require its 600,000 global suppliers to use more efficient packaging methods with estimated total supplier savings of $11 billion [D'Innocenzio].

In short, the expected future trend is for more and more companies to establish Environmental Management Systems. The goal for these companies will be to gain ISO environmental certification. Consequently, our landfills will last longer and the environment will be the big winner. In addition, the most important factor for companies to look at when considering whether or not to implement a greener chain is cost. Although cost is a main consideration, there are many examples of companies that have reduced operating costs by implementing greener packaging products. Before green supply chain management can be successfully adopted, there needs to be coordination between all involved members of the chain in addition to industry leaders, governments, and consumers.

CONCLUSIONS

In recent decades, businesses have created and adopted strategies that are in better alignment with the best interests of the environment. Although EPA and other agencies have not given specific guidelines for many businesses, some operations have discovered the cost saving benefits after adopting more environmentally friendly practices. These new operations have altered the traditional supply chain that most organizations have grown accustomed to. These innovations are expected to drive the embracement of green technology even in the recession period. Methods for determining a successful green supply chain management are new and are not fully developed. However, organizations can effectively and efficiently "green" the supply chain by integrating existing environmental standards and innovation uses of new materials and new manufacturing processes. In this paper, we discuss four important areas – manufacturing, bio-waste, construction, and packaging – of green improvement opportunities.

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