Life cycle assessment

ASSIGN BUSTER

Executive Summary

This report assessed the ‘ wholistic’ environmental impact of fast food packaging over the packaging life cycle, using a case study of a McDonald’s Big Mac hamburger. The four packaging options were the current packaging option of paper wrap and cardboard collar with unsorted waste trucked to landfill, the current packaging option with increased recycled content and on-site composting of biodegradable waste, a biodegradable starch hamburger clam with on-site composting of biodegradable waste, and reusable porcelain dinnerware with a dishwashing system.

Life Cycle Assessment (LCA) methodology was employed to quantify and describe the total inputs of raw materials and energy, and total outputs of solid waste and air and waterborne emissions for the life cycle of each packaging option. The results showed that, of the four tested options, the current paper and cardboard option uses the most environmentally-harmful raw materials and creates the most solid waste, yet creates the least hydrocarbons and particulates. The paper and cardboard option with recycled content and composting creates the most Chemical Oxygen Demand and the least carbon dioxide. Starch clams produce the most carbon dioxide, sulfur dioxide and Biological Oxygen Demand, but consume the least environmentally-harmful raw materials and produce the least solid waste. Washable dinnerware uses the most environmentally-benign raw materials and creates the most hydrocarbon and particulate emissions, yet creates the least greenhouse gas emissions and causes the least biodiversity loss and damage to aquatic ecosystem health. Hence, no packaging option performed the best in all of the impact categories that could be quantified.

Key environmental impacts are often not considered in quantitative LCA studies because they cannot be quantified, but ‘ descriptive’ LCA can be used to identify environmental impacts that are not included in quantitative assessments, and for identifying areas for environmental improvement. This report made such recommendations, including sourcing pulp for paper and cardboard from post consumer recycled paper, using ‘ totally chlorine free’ paper, purchasing energy from renewable sources, filtering air and water emissions before discharging, composting biodegradable waste in an on-site composter, and ensuring the mining of clay and feldspar for porcelain does not have adverse effects on biodiversity or groundwater.

Industry

Industry is the overall application of technology and other resources to the generation of economic output by producing goods and services. An industry is any grouping of businesses that share a common method of generating profits, such as the “ construction industry”. The term is also often used to refer to heavy industry.

The following outline is provided as an overview of and topical guide to industry:

Essence of industry

* Business

* Cottage industry

* Heavy industry

* Light industry

There are four key industrial economic sectors: the primary sector, largely raw material extraction industries such as mining and farming; the secondary sector, involving refining, construction, and manufacturing; the tertiary sector, which deals with services (such as law and medicine) and distribution of manufactured goods; and the quaternary sector, a relatively new type of knowledge industry focusing on technological research, design and development such as computer programming, and biochemistry. A fifth quinary sector has been proposed encompassing nonprofit activities. The economy is also broadly separated into public sector and private sector, with industry generally categorized as private. Industries are also any business or manufacturing.

Industry in the sense of manufacturing became a key sector of production and labour in European and North American countries during the Industrial Revolution, which upset previous mercantile and feudal economies through many successive rapid advances in technology, such as the steel and coal production. It is aided by technological advances, and has continued to develop into new types and sectors to this day. Industrial countries then assumed a capitalist economic policy. Railroads and steam-powered ships began speedily establishing links with previously unreachable world markets, enabling private companies to develop to then-unheard of size and wealth. Following the Industrial Revolution, perhaps a third of the world’s economic output is derived from manufacturing industries—more than agriculture’s share.

Many developed countries (for example the UK, the U. S., and Canada) and many developing/semi-developed countries (People’s Republic of China,

India etc.) depend significantly on industry. Industries, the countries they reside in, and the economies of those countries are interlinked in a complex web of interdependence.

Major industries

* Aerospace industry

* Agriculture

o Fishing industry

o Timber industry

o Tobacco industry

* Chemical industry

o Pharmaceutical industry

* Computer industry

o Software industry

* Construction industry

* Defense industry

* Energy industry

o Electrical power industry

o Petroleum industry

* Entertainment industry

* Food industry

* Health care industry

* Hospitality industry

* Information industry

* Insurance industry

* Manufacturing

o Arms industry

o Automotive industry

o Pulp and paper industry

o Steel industry

o Toy industry

* Mass media

o Broadcasting

o Film industry

o Internet

o Music industry

o News media

o Publishing

* Telecommunications industry

* Water industry

McDonald’s

Amoung food industry fast food sector is chosen for this assignment. Furthermore, McDonalds is chosen as an fast food organization for the pupose of this project. McDonald’s Corporation is the world’s largest chain of hamburger fast food restaurants, serving nearly 47 million customers daily. At one time it was the largest global restaurant chain, but it has since been surpassed by multi-brand operator Yum! Brands (KFC, Taco Bell and others) and sandwich chain Subway.

In addition to its signature restaurant chain, McDonald’s Corporation held a minority interest in Pret A Manger until 2008, and owned the Chipotle Mexican Grill until 2006 and the restaurant chain Boston Market until 2007.

A McDonald’s restaurant is operated by either a franchisee, an affiliate, or the corporation itself. The corporation’s revenues come from the rent, royalties and fees paid by the franchisees, as well as sales in company-operated restaurants. McDonald’s revenues grew 27% over the three years ending in 2007 to $22. 8 billion, and 9% growth in operating income to $3. 9 billion.

McDonald’s primarily sells hamburgers, cheeseburgers, chicken products, french fries, breakfast items, soft drinks, milkshakes, and desserts. In response to obesity trends in Western nations and in the face of criticism over the healthiness of its products, the company has modified its menu to include healthier alternatives such as salads, wraps and fruit.

Rationale for Selection of McDonald’s for the Report

Australia boasts 17, 000 fast food outlets. Of these, McDonald’s claims 50 percent of the market, followed by the Pizza Hut, Taco Bell and KFC (Ban ham, 1999), and generates a turnover of $1. 4 billion per year (Buchhorn and Kent, 1999). This dominance in the market places McDonald’s in a highly influential position in the fast food industry, especially regarding environmental initiatives. For these reasons, this study will examine packaging options for a McDonald’s Big Mac hamburger as a case study.

Internationally, McDonald’s was the focus of a two-and-a-half year legal challenge in London by environmental activists who claimed that McDonald’s had damaged the environment through rainforest clearance, unnecessary packaging and methane emissions from cattle, in addition to promoting unhealthy food, exploiting youth labour and trying to censor criticism. The Royal Courts of Justice, London, ruled that McDonald’s falsely advertised its food as nutritious, risked the health of regular, long-term customers, were responsible for cruelty to animals, were ‘ antipathetic’ to unions, and paid their workers low wages. However, the defendants failed to prove their environmental claims (McSpotlight, 2000, story. html)

In a public document outlining their environmental commitments, McDonald’s states that ‘ cost-effective, environmentally-sensitive, responsible business practices . . . reflect . . . an environmental conscience’. McDonald’s stated goal is to use the ‘ best and most environmentally conscious products on the market’, and that packaging is a focus for waste minimization (McDonald’s Australia, 1997, p3). To this end, McDonald’s reduced their solid waste generation by 33 percent in 1991 by shifting from foam to paper wrap and cardboard collars (Greenhouse Challenge, 1998c), and is currently the largest user of recycled paper in the Australian restaurant industry (McDonald’s, 1997c).

In several countries, McDonald’s restaurants have responded to customer pressure to implement environmental initiatives. In Nuremburg, Germany, the local city council introduced legislation preventing the disposal of recyclable or avoidable waste. In response, nine McDonald’s outlets implemented a ‘ biowaste’ collection system to use biodegradable and returnable packaging (Buchhorn and Kent, 1999). Operations in Germany and Austria use biodegradable starch hamburger clams and biodegradable corn starch cutlery (Buchhorn and Kent, 1999; Biocorp, 1999). In Thailand and Malaysia, burgers are often served on porcelain plates, and in Indonesia some drinks are served in washable glasses (Summit, J. 2000, pers. comm., UNSW, 21 Feb.). In the United States, there are plans to introduce biodegradable starch hamburger clams to McDonald’s outlets (Earth Shell, 1999, earthshell. com/html).

As the official restaurant and a sponsor of the Sydney 2000 Olympic Games, McDonald’s stated that it was ‘ happy . . . to help make these Games

environmentally friendly’ (Hipsley, A., McDonald’s Australia, letter to author, 2 Sept, 1998). McDonald’s was required to develop an integrated waste management program, however a report one year prior to the Olympics by the environmental ‘ watchdog’, Green Games Watch 2000, claimed that McDonald’s activities did not demonstrate an ‘ integrated approach’ to waste minimization. Rather, they chose ‘ isolated initiatives which have [Public Relations] value’ (Buchhorn and Kent, 1999, p34). This report asserted that McDonald’s did not commit to initiatives that had been suggested by Australian consumers, including the installation of a composting facility for biodegradable packaging and food waste, and the phasing out of chlorine-bleached paper products from supplier contracts (Buchhorn and Kent, 1999).

Of particular relevance to this research, in early 1998 Newcastle City Council (NSW) informed a local McDonald’s outlet that, in order to reduce waste, consent for local site redevelopment would only be granted if a washable dinnerware system were installed for eat-in customers (James, P. and Angel, J. 1998, Letter to Newcastle City Councillors, Green Games Watch 2000 and Total Environment Centre, 30 Apr). The general public, environment groups and, initially, councillors supported this move. In a letter to the Council, two environmental groups described the extant one-way litter stream as a ‘ massive waste of natural resources’. The authors supported Extended Producer Responsibility (see Section 5. 2. 4) as an effective method for achieving the NSW legislated target of a 60 percent reduction in waste. They stated that McDonald’s and its consumers should bear the cost of waste collection instead of the community bearing the cost through rates.

McDonald’s threatened legal action in the NSW Land and Environment Court if the council rejected its redevelopment application (Reiner, 1998). McDonald’s stated that a ‘ wholistic approach’ to addressing environmental issues would be far more effective than a single condition involving the implementation of reusable food packaging. This opinion was based on the findings of a literature review of reusable and disposable packaging, published by the Waste Policy Centre, USA and per chards, UK (Dent, R., McDonald’s Australia, letter to Lord Mayor of Newcastle City Council, 27 Apr, 1998). However, this report clearly states that packaging re-used several hundred times consumes less energy and generates less solid waste and air pollution than disposables. Disposable packaging is only favourable in terms of reduced water usage and wastewater generation (Waste Policy Centre and Perchards, 1996).

To end this dispute, Newcastle City Council and McDonald’s signed a Memorandum of Understanding in late 1999 to develop and trial environmental initiatives at Newcastle McDonald’s outlets. This plan involves implementing environmental initiatives into the outlets, including new systems to reduce energy and water consumption and waste, and to focus on recycling (McDonald’s Australia, 2000, mcdonalds. com. au). Although these initiatives will reduce the environmental impact of the environmental impact of these outlets, no changes were proposed to the existing packaging options (McDonald’s Australia and City of Newcastle, 1999).

Technology Management

Technology Management is set of management disciplines that allows organizations to manage its technological fundamentals to create

competitive advantage. Typical concepts used in technology management are technology strategy (a logic or role of technology in organization), technology mapping (identification of possible relevant technologies for the organization), technology roadmapping (a limited set of technologies suitable for business), technology project portfolio (a set of projects under development) and technology portfolio (a set of technologies in use).

The role of the technology management function in an organization is understand the value of certain technology for the organization. Continuous development of technology is valuable as long as there is a value for the customer and therefore the technology management function in an organization should be able to argue when to invest on technology development and when to withdraw.

Technology Management can also be defined as the integrated planning, design, optimization, operation and control of technological products, processes and services, a better definition would be the management of the use of technology for human advantage.

The Association of Technology, Management, and Applied Engineering defines Technology Management as the field concerned with the supervision of personnel across the technical spectrum and a wide variety of complex technological systems. Technology Management programs typically include instruction in production and operations management, project management, computer applications, quality control, safety and health issues, statistics, and general management principles.

Perhaps the most authoritative input to our understanding of technology is the diffusion of innovations theory developed in the first half of the twentieth century. It suggests that all innovations follow a similar diffusion pattern – best known today in the form of an “ s” curve though originally based upon the concept of a standard distribution of adopters. In broad terms the “ s” curve suggests four phases of a technology life cycle – emerging, growth, mature and aging.

These four phases are coupled to increasing levels of acceptance of an innovation or, in our case a new technology. In recent times for many technologies an inverse curve – which corresponds to a declining cost per unit – has been postulated. This may not prove to be universally true though for information technology where much of the cost is in the initial phase it has been a reasonable expectation.

The second major contribution to this area is the Carnegie Mellon Capability Maturity Model. This model proposes that a series of progressive capabilities can be quantified through a set of threshold tests. These tests determine repeatability, definition, management and optimization. The model suggests that any organization has to master one level before being able to proceed to the next.

The third significant contribution comes from Gartner – the research service, it is the hype cycle, this suggests that our modern approach to marketing technology results in the technology being over hyped in the early stages of growth.

Taken together these concepts provide a foundation for formalizing the approach to managing technology.

Life Cycle Assessment Approach

Life Cycle Assessment (LCA) is a technique that assesses the environmental impacts created throughout a product's life cycle. LCA is also known as ' cradle-to-grave' analysis, to emphasize its wholistic scope. LCA incorporates all stages of the product's life, from the ' cradle' (raw material extraction, husbandry, planting and feeding), through fabrication, manufacturing, packaging, transportation, consumption, and recycling, to the ' grave' (disposal) (Environment Canada, 1999, whatislcm. cfm). 2 demonstrates the full life cycle approach of LCA to a service or product, involving extraction, production and use, to disposal, reuse and recycling. More recently, the term ' cradle-to-cradle' has been used to emphasize the continued reuse and recycling of a resource (Hawkins, 1993). LCA is also an ideology intended to change the way people think about products. Cradle-to-cradle thinking assists consumers in making a better ethical purchase on environmental grounds, by raising their awareness of ' the world behind the product' (Hall, M. 1999, pers. comm., NSW DPWS, 14 Sept.).

Life Cycle Assessment evolved mainly during the 1990s. The origins of LCA were in pollution prevention, involving a shift away from ' end-of-pipe' controls, towards avoiding the creation of pollution at the ' start-of-pipe' (see Glossary). This focus was then broadened to include issues and opportunities in a life cycle context (Environment Canada, 1999, whatislcm. cfm). With the advent of ' Ecologically Sustainable Development' (ESD), LCA has been used as a tool to help achieve sustainable resource use and development. ESD

encourages development that meets the needs of the current generation without jeopardizing resources for future generations (Environment Canada, 1999, whatislcm. cfm).

LCA practitioners have developed database software packages to assist with Life Cycle Assessment, including Semipro 3. 1 (The Netherlands), the Boustead Model (Britain), and Gabi (Germany) (Duncan, 1998). These databases are commercially available for a license fee.

The International Organization of Standardization (ISO) has produced a series of international voluntary standards for Environmental Management Systems, collectively known as ISO 14, 000. Standards 14, 040 to 14, 049 list guiding principles and practices, inventory analysis, impact assessment, and improvement assessment (Duncan, 1998). Standard 14, 040 states that LCA was developed in response to the ‘ heightened awareness’ of the importance of environmental protection, and the possible impacts associated with manufacturing and consuming products (ISO 14040, 1998). This standard identifies key uses of LCA, including:

* identifying opportunities to improve the environmental aspects of products at various points in their life cycle;

* assisting decision-making in industry, governmental or non-governmental organisations; and

* providing relevant indicators of environmental performance for environmental claims and eco-labelling schemes (ISO 14040, 1998).

To provide uniformity in LCAs, the ISO standards require all LCAs to spell out the goal and scope of the study, and provide an inventory analysis, an impact assessment and an interpretation of results (ISO 14040, 1998). The ISO standards discuss limitations inherent to LCA, namely the assumptions made to confine the study to a specific length, and the restrictions of data accessibility, availability and quality (ISO 14040, 1998). LCA is also restricted by value-judgements and available scientific knowledge (ISO14042-3, 1999).

Implementation of Life Cycle Assessment

Stages 1 and 2: Aim and Descriptive Assessment

All LCAs begin by developing a clear aim. The next stage of the LCA descriptively assesses the boundaries and parameters that limit the study. The most common method used for this assessment is ‘ purposive sampling’, using several case studies to advance the research. These case studies are chosen for their appropriateness, rather than randomly (Minichiello et al.., 1995), and are those cases anticipated to be ‘ information-rich’ (Baxter and Eyles, 1997, p513). These case studies represent specific aspects of the product or service being studied, and enable the researcher to determine what can and cannot be quantified. Impacts that cannot be easily quantified numerically, such as loss of biodiversity, are addressed in the final results through narrative descriptions (American Institute of Architects, 1998).

To descriptively determine the type of impacts that a product is expected to create, it is easiest to develop a table to clearly display the information (American Institute of Architects, 1998). The example shown in Table 1 is adapted from a table of the impacts of mining materials for porcelain manufacture. The environmental ‘ stressor’, such as fuel combustion, results

ultimately in an ‘ impact’, such as respiratory tract infections. The final column describes whether quantification of the stressor is difficult or not possible, thus leading into the next step that develops a quantitative LCA.

Table 1: Descriptive Assessment of Tile Materials Acquisition

Activity	Stressor	Impact/ Stressor	Impact/ Stressor	Impact/ Stressor	Quantifiable?
Mining of clay, silica, talc, kaolin, feldspar, glass sand, limestone, soda ash, gypsum, and iron ore, and various other minerals	Tailings waste	Runoff	Increased turbidity	Increased benthic deposition	
		Increased BOD	Deoxygenation	Loss of faunal diversity	

Possible Fishkill

Yes

Difficult

Yes

Land disturbance

Soil erosion

Runoff (see impacts above)

Habitat alteration

Loss of habitat

Species extinction

Loss of biodiversity

Difficult

Difficult

Runoff

(see impacts above)

Fuel combustion emissions

VOCs

Ground-level ozone (smog)

Respiratory tract problems

Decreased visibility

Eye irritation

Difficult

Yes

Difficult

Sulfur dioxide

Respiratory tract

Problems, and lung

Damage

Acid precipitation

Surface water

acidification

Reduced reproduction

Fishkill

Yes

Difficult

Yes

Tree/crop damage

Materials corrosion

Difficult

Yes

Carbon dioxide

Greenhouse effect

Global warming

Yes

Carbon monoxide

Human health hazards (cardiovascular,

nervous, and

pulmonary systems)

Difficult

Nitrogen oxides

Ground-level ozone (smog)

Respiratory tract problems

Decreased visibility

Eye irritation

Difficult

Yes

Difficult

Acid precipitation

Surface water

acidification

Reduced reproduction

Fishkill

Yes

Difficult

Yes

Tree/crop damage

Materials corrosion

Difficult

Yes

Particulates

Eye and throat irritation

Bronchitis

Lung damage

Impaired visibility

Difficult

Difficult

Difficult

Yes

(Adapted from the American Institute of Architects, 1998)

Stages 3 and 4: Quantitative Assessment and Life Cycle Inventory

The next stage of LCA is to quantitatively examine the product or service. This initially requires the scope and issues to be defined, and the assumptions, considerations and data sources used to be listed. Data are collected from primary industrial sources, which are the most accurate and specific, or from publicly-available LCA documents. Raw, unweighted LCA data are displayed in a Life Cycle Inventory.

To compare products or systems, LCA requires each product to have the same ‘ functional unit’. The functional unit in this study is the consumption of

8575 Big Macs, with a total weight of 165. 36 kg, by eat-in customers. This is equivalent to approximately one week of operations for an average McDonald’s outlet at an Olympic site.

A Life Cycle Inventory comprehensively includes all the inputs and outputs of material and energy, as well as environmental releases. 3 describes how all relevant aspects of the life cycle of a product or service are arranged into a Life Cycle Inventory.

Life Cycle includes

· raw materials acquisition;

· manufacturing, processing and formulation;

· distribution and transportation;

· use/reuse/maintenance;

· waste management

(Frame represents a closed

Systems boundary)

Inputs Outputs

Energy Main Product

Raw Materials Solid Waste

Airborne Emissions Waterborne Emissions

(Adapted from Environment Canada, 1999, whatislcm. cfm).

In order to better analyse the environmental impact of a product, the input and output data are presented in the ‘ impact categories’. Eco Indicator 95 (see Section 5. 2. 2) is one method by which impacts are sorted into impact categories, then normalised or weighted to allow for easy comparison between the severity of impacts (Goedkoop, 1995).

This study will use the Eco Indicator 95 impact categories, but will not normalize or weight the results. This is because there are insufficient data in specific categories, and because additional impact categories have been used that are not included in the Eco Indicator 95’s weighting regime. Both these limitations prevent comprehensive normalized and weighted results.

The following Eco Indicator impact categories and sub-categories will be used in this study:

* Greenhouse Gas Emissions (Carbon dioxide, Carbon monoxide, and Hydrocarbons (including methane));

* Acidification (Sulfur dioxide and Nitrogen oxide); and

* Smog (Sulfur dioxide, Nitrogen oxide and Particulates) (Goedkoop, 1995).

In addition, these impact categories and sub-categories will also be used:

* Biodiversity Loss (Potentially Harmful and Benign Raw Material Consumption, Water consumption, and Waste to Landfill);

* Fossil Fuel Depletion (Energy Consumption); and

Aquatic Ecosystem Health (Biological Oxygen Demand, Chemical Oxygen Demand, Suspended Solids, Sulfur-based.

LCA and MacDonald's Performance

This report demonstrated LCA as a tool for quantifying and describing environmental impacts to enhance environmentally-concerned decision-making. LCA was employed with professional rigour; following international guidelines outlined by ISO 14040, and consulting experts in the Australian LCA field. These experts included Tim Grant of the Royal Melbourne Institute of Technology's Centre for Design (28 Oct., 1999), Murray Hall of Energy and Environmental Services, NSW Department of Public Works and Services (14 Sept. and 24 Nov, 1999; 8 Feb., 2000), and Karli James of the Cooperative Research Centre for Food and Packaging (16 Sept., 1999). The packaging options were examined within the industry and government's current framework of the National Packaging Covenant. Additionally, the applicability of LCA to complementary strategies was explored, such as Extended Producer Responsibility and Cleaner Production. Due to bearing the limitations of a university study, the shortcomings of the data were critically described and the assumptions listed.

The assessment revealed that the washable porcelain dinnerware, the packaging option disputed by McDonald's, had a lower environmental impact than the other options in many categories. However, this option also had serious environmental impacts, thus demonstrating that none of the tested options were ultimately the ' best', but that ' trade-offs' must often be made, depending on the environmental impacts that are considered important in the local area, regionally, or globally.

Role of Manager to Support the Management of Technology

* Follow the operational & procedural guidelines related to manage a technology

* Work with sincerity & honesty to learn the technology

* Get proper training to manage the new technology in the organization Role of Organization to Support the Management of Technology

* Provide necessary financial & human resources to manage new technology

* Arrange necessary training for employees about the management of new technology

* Hire consultants & experts to manage a new technology in the organization

* Provide operational support to employees for managing the technology

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