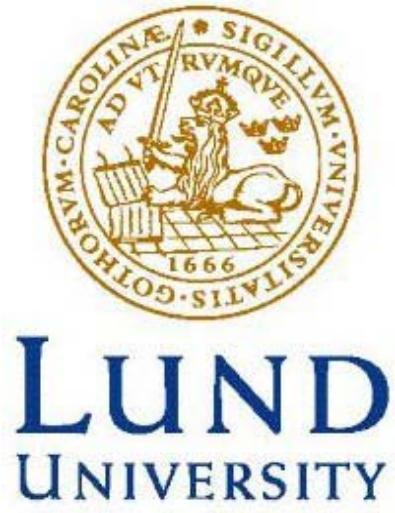
On Measuring the Environmental Performance of the Service Sector

A Case Study of A Service Sector Organisation in Cambridge, UK.



A thesis presented in partial fulfilment of the requirements of the Lund University Master's Programme in Environmental Science, Lund University, Sweden - 22nd November, 2004.

Abstract: *With corporate environmental impacts making headlines with increasing frequency it has become important for companies to monitor these aspects and impacts for their own value (share price; risk mitigation; etc…) The indicators used form an important element of this monitoring and their choice, application and auditing currently vary in many different ways. A large proportion of companies in the UK can be described as service-sector and they have historically been considered 'environmentally benign'. But with the manufacturing sector being encouraged to monitor their impacts through governmental legislation and, given the dominant size of the service sector in the UK, it has become important for services to be held accountable for their financial, social and environmental performance. Many initiatives have been established (such as the Global Reporting Initiative) to recommend a best practice method for all companies to report but this can often be resource intensive (especially important for smaller firms) and often clouds the real issues underlying the problems.*

This paper examines one company in detail, Arthur D. Little, an Environment & Technology consultancy, and takes data collected during a series of interviews and observations made on their premises. As a leader in Environmental consulting it seems hypocritical to have no internal efforts towards bettering environmental performance and so, examining the literature available and current best practice, this paper aims to make recommendations for the most effective way of minimising the environmental impacts in this particular case. This is then synthesised into general conclusion for environmental performance metrics to be used under similar circumstances and to answer the question as to whether a standardised set of metrics is really applicable across the whole of a sector, let alone an individual economy.

Alistair Blackmore, Britta Holmström's Gata 4:304, Lund 222 20, Sverige, tel: +46 (0) 730 21 31 55, email: ali@blackmore.com

Thesis Advisor: **Bjørn Stefan Anderberg**, Associate Profesor, Geografisk Institut, University of Copenhagen, Øster Voldgade 10, 1350 København K, tel: +45 (0) 353 22 524, email: sa@geogr.ku.dk

1 Introduction

There are many wider questions in the field of environmental science and ethical issues in connection with the economy. For example, is it ethical to make any environmental impact? This paper seeks to address a small aspect within a greater question like this. How can we reduce the impacts of our organisations to within the limits set by nature within which we must live? And in specific: how can a small to medium enterprise achieve this ambitious target? A streamlined life cycle assessment will be used as the analytical framework to discuss the data presented in the results.

1.1 Statement of Purpose

Once the most relevant environmental aspects of the company's activities are established the task is to evaluate indicators to measure these activities over time in an appropriate way. If the data is already available this will allow a retrospective look at the environmental performance of ADL over the last few years and to establish areas for improvement and if not it will highlight changes that need to be made in order to generate these figures. Other, maybe more practical, obstacles to accurate measurement will also be illuminated as a test-study will show any barriers to effective use of indicators. The interviews also enabled a broad overview of the company's activities and allowed a more qualitative approach to environmental impacts. If a more formulaic approach had been taken then many of the nuances connected with the individuality of the company would have been missed.

1.2 Scope & Limitations

Research into the measurement of environmental performance and the metrics employed for this aim have grown in complexity. Previously isolated problems are now understood to be interrelated and subsequently there is a need for more complex models than have previously been utilised. SMEs are the main focus of the study which is a limitation in itself. But these are understood to be one sub-group in the wider context of the business world. The study is then further narrowed to concentrate on one caveat of the service sector (gamma-services), itself a sub division of industry. The SLCA tool is very specifically tailored to this sub-group but the results and analyses have wider implications for an economy's aspect to the environment.

1.3 Methods & Materials

The methodology specifies a single case-study to aid in the explanation of the phenomenon under investigation. The case-study was chosen as Arthur D. Little as they had a concurrent project to establish indicators to measure their major impacts. The SLCA tool can be presented as an interim method of establish where the indicators need to be developed.

This does limit the study as there is no scope for comparison across different cases. A multi-case approach may highlight differences and possible symbiosis effects of the cases' activities but the single case-study approach allows for a more detailed insight and subsequent explanation of the results presented.

1.4 Disposition

This paper is presented in a chronological order with a logic model structure as provided by the SLCA. The following gives a guide to the work presented in the chapters within this study.

Chapter 2
This section of the thesis deals with the background to the problem under investigation. By establishing context for the study of small-medium enterprises, and, in particular, those in the service-sector and highlighting the need to measure their environmental performance, the paper gains relevance.

This paper aims not to dwell too much on the negative impacts of our current activities but rather seeks to explore ways in which we can strive to reduce these impacts. Resultantly, this section will cover why we, as a society, have allowed these problems to persist and what attempts are being made to rectify the gap between our intentions as ethical citizens and out activities as economic actors.

Chapter 3
The methodology is outlined, giving the academic lineage of the format of the study. Justifications as to why decisions were made during the data collection phase are presented here in an attempt to produce a transparent report of the work undertaken.

Chapter 4
The results are presented here grouped into the stages of the life-cycle assessment. Interview data is not reproduced verbatim but rather the relevant sections are recreated and a more complete interview breakdown is available in the appendices. The interviews are augmented here and in the next chapter with other data from observations made during the course of the data collection and from archival information made available for the research.

Chapter 5
The analysis is presented to increase understanding and derive meaningful conclusions from the results. The wider applications of the SLCA are presented and potential methods for reducing the case-study's impacts are suggested, but only as an example of how the SLCA can be implemented. The issue of propagating wider use of these types of environmental management tools in small-medium enterprises is addressed; benefits of doing so are also presented.

Chapter 6
The conclusion draws upon the previous chapters to summarise the main findings and reflect upon the effective of the study in answering the questions posed at the outset.

2. Background

It has been said that with the advent of Christianity, pagan animism was destroyed resulting in the establishment of the duality between nature and culture, insisting that it is God's will that man exploit nature for his own means (White: 1967). Saint Francis of Assisi (1181-1226) is widely acknowledged as the first person who tried to "depose man from [this] monarchy over creation and set up a democracy of all God's creatures" (*ibid.*). However his efforts were stamped out by other religious figures of the era as heretical.

It was not until Thomas Malthus' essay on '*The Principles of Population; or a View of its Past and Present Effects on Human Happiness: with an inquiry into prospects respecting the future removal or mitigation of the evils which it occasions*' first published in 1798 that our dominance over the environment began to be questioned in earnest. The basic premise of Malthus being that human population growth is exponential and food productivity growth is additive creating a graph similar to the following:

Malthus' predictions were made from his bedroom and did not take into account the increased productivity of the land due to increased labour and capital intensification but the principles were laid for many years of research into the restraints that our natural environment may impose upon us as we continue to look to exploit it. The technological changes brought about by the agricultural and industrial revolutions changed the world in which we lived in, introducing technological change that Malthus had not needed to consider.

The next important research in the story of our 'ecological enlightenment' is Meadows' publication *The Limits to Growth* (1972). It is "undoubtedly the most influential work of perhaps the last two decades" (Nielssen et al. 1997). All previous works had been based on one causal factor leading to environmental problems (population growth, resource depletion etc…) but this was the first attempt to link all of these factors together in a coherent model. It utilised new computer techniques to analyse the relationships. The club of Rome, for whom the report was prepared, was then able to see for the first time, and publish to the wider academic community, the complicated relationships between the factors and how there will be many limits and unless we look at the system as a whole we will not be able to "test the possible consequences of new technology that aim to raise the limits to growth" (Meadows: 1972).

2.1 Progress vs. Sustainability

As Hermann von Helmholz (1995) observed, as one paradigm becomes accepted it reaches saturation and becomes axiomatic. The paradigm of "progress" has been taken forward to the extreme as capitalism and globalisation have pushed the nation state to the side and economics takes over politics in our incessant need to "develop", a direct result of the rise of our present paradigm (*ibid.)*. But whilst one paradigm rises there is always an opposite movement where ideas incubate. Once these ideas have incubated there is a period of illumination where the "new" knowledge starts to be accepted in society followed by a period of trepidation as our safe worlds are changed leading to the eventual saturation of the new ideas amongst society creating new axioms (Polanyi: 2002).

We are in an interesting time, as the paradigm of progress has reached saturation. Since the elucidation of quantum physics and chaos theory we have begun to accept that we can only know approximations of how nature works through the eyes of science and that numbers do not fully explain the world (Kwiatkowska: 2001). These two new and interrelated disciplines have shown that the world doesn't behave according to the empirical certainties that we have been searching for. Through post-modernity and chaos theory we have begun to accept that quite frequently some concepts can be ontologically indeterminate as opposed to epistemologically ignorant. This has enabled us to see the "world as being of complex and flexible character whose processes are open to the future," as our fallacious dominance over nature is slowly eroded by the rise of a new paradigm, the global civil society as envisioned by Matti Wuori, former head of Greenpeace (*op. cit.*).

The basic propositions of economics and the paradigm of development that it has spurred can be related to matters of human psychology such as values attached to selling (supply) and buying (demand). Many eminent economists including Galbraith (1987) have criticised the rôle economics plays in our society. Firstly, as Keynes glumly theorised "in the long run we are all dead" (Harris, 2002), relating to the short-term nature of economics resulting in an absence of long-term decision making and secondly, economic definitions of cost exclude all 'free goods', i.e. the natural environment that has not been privately appropriated. Therefore "it is inherent in the methodology of economics to ignore man's dependence on the natural world" (Schumacher, 1973). It is out of this critique of economics that the concept of Sustainable Development has formed.

Sustainable development can be defined as 'development which meets the needs of the present generation without compromising the ability of future generations to meet their own needs' (WCED, 1987). It is a concept which has been growing in importance since the 1970s as a historically growth-driven economy had led to a growing number of poor as this form of growth was reinforcing inequality. After this period social objectives were recognised as being as important as economic growth. In India, for example, this new insight has led to improvements in economic and social conditions in rural areas. Increased expenditure was reducing the short-term economic problems but achieved little in the long-run as low agricultural productivity per capita due to population pressure was causing long-term poverty problems. Research into agriculture suggested the answer as it helps in the long run by increasing agricultural yields enabling the poor to support themselves without continuous investment from the government (IFPRI, 1999). But this solution, bereft of environmental considerations, cannot produce growth *ad infinitum,* as it fails to consider the 'limits to growth' highlighted by Meadows'. As, again, E.F. Schumacher (1973) said "An attitude to life which seeks fulfilment in the single minded pursuit of wealth – in short materialism – does not fit into the world because it contains no limiting principle, while the environment in which it is placed is strictly limited". "The concept of sustainable development has, therefore, evolved to encompass three major points of view: economic, social and ecological" (Munasinghe, 1992).

2.2 Industry's impact

For many years society's aspect to the environment has been gaining increasing press coverage. The negative impacts of our activities have also been increasing in media prevalence with natural disasters constantly cited as a negative effect of global warming; itself brought about by increased emissions-to-air of a basket of greenhouse gases as a by-product of human activities. The relevance and real importance of these issues have been debated for many years with some academics claiming there is no

need to worry (the most notable of which being Björn Lomborg and his publication *The Skeptical Environmentalist*) whereas other camps take a more catastrophic view (possible reference to cerebral cortex negative information handling). Whether either of these two are right or wrong is appearing increasingly irrelevant as there are only two broad courses of action; we can take heed of the potential damage being done and work towards eliminating the aspects causing the damage or carry on regardless until we reach the limits to growth. It may seem extremely plain and simple written in abstract terms but when it comes to making a difference on a day-to-day basis it is not as simple as there are people involved sentient beings who make decisions for themselves.

That these 'limits to growth' exist is irrefutable as the only incoming energy to the planet upon which we exist is in the form of solar radiation from the sun. From this all life stems through the photosynthetic cycle: the plants convert the sun light and carbon dioxide in the air around us into simple sugars, starch and the vital oxygen molecules which are the very building blocks of all living matter on the planet. If we use more energy than the sun gives us in any one given time-period we are eating into the planet's 'bank' of energy created during its formation in the maelstrom of the big bang over 1 x 10^{10} (ten billion) years ago. This expenditure of capital includes the use of oil, formed over millions of years from the slow decomposition of biomass under heat and pressure. If we continue to use the oil reserves unchecked, we have the potential to run out of oil: it is not a question of 'if' as opposed to 'when' as the rate of replenishment is slower than our extraction and has a period of millions of years.

2.3 Human Consequences of Environmental Degradation

It is not only a case of natural resource depletion as a means to economic growth but as hindrance to our welfare. Many of the public goods that we as biological organisms depend upon, such as clean air and fresh water may be threatened by our activities. So it has become increasingly important that we monitor and check our own activities. Rachel Carson is widely regarded as the first academic to highlight the limits of nature on our own welfare with her publication *The Silent Spring* (1962). It examines the effects of insecticides and pesticides on the songbird population throughout the United States. The songbirds declining numbers yielded the silence, to which the title refers. She analyses the complex nature of ecological systems noting that "where spraying destroys not only the insects but also their principle enemy, the birds. When later there is a resurgence of the insect population, as almost always happens, the birds are not there to keep their numbers in check." The Toxic Release Inventory (TRI) is one of the most significant and widespread metrics in use today and can be said to stem directly from Carson' and her contemporaries' work.

2.4 Service Sector

Services play a vital role within post-industrial modern society. They represent the progression from subsistence through agricultural abundance to the peak of our technological expertise. The traditional sectoral division of the economy comprises of three main areas: primary, secondary and tertiary with an additional quaternary frequently mentioned. The primary sector covers agriculture and extractive industries such as mining and oil prospecting and is the most basic form of industry and is increasingly being concentrated in the less economically developed countries (LEDCs) and their products imported into the more economically developed countries (MEDCs). The secondary sector can be defined as the stage that comes after the primary sector and incorporates the industries which manipulate and produce goods from the raw materials extracted in the primary stage. The Industrial Revolution encouraged a

large number of people to move into this sector for employment purposes but as economies progress further it becomes more efficient to purchase these products from a different market so in many developed countries the labour force has witnessed a shift, again.

The tertiary sector (the stage where this paper turns most of its attention) encompasses the industries who utilise the output of the two previous stages. For example, a bank may use computers and other office equipment, as well as labour to provide a service (i.e. borrowing and saving of assets), without the two previous industrial stages this would not be possible. As an economy grows it is a natural progression to the tertiary sector as more and more people can afford to eat out, go to the theatre etc… and this employs more people in the tertiary sector. Oftentimes a fourth distinct sector, the Quaternary, is described. This sector encompasses all research and development of new technologies and innovations including Universities and Information Technology (I.T.) firms. It has been posited that one reason for Japan's success during the 1980s was the investment in this quaternary sector leading to better quality products. However, for the purposes of this paper and as many other people contend (see…) the quaternary sector will be considered as a special sub-section of the tertiary sector as the environmental impacts of the two are fairly similar (both require offices, energy, computers and do not produce tangible products).

The agricultural revolution saw the beginning of a development as we now call it. In 1750 the population of England stood at about 5.7 million. It had probably reached this level before, in the Roman period, then around 1300, and again in 1650. But at each of these periods the population ceased to grow, essentially because agriculture could not respond to the pressure of feeding extra people. Contrary to expectation, however, population grew to unprecedented levels after 1750, reaching 16.6 million in 1850, and agricultural output expanded with it (BBC online). From this moment increases in efficiency of resource allocation have been on the rise, freeing up manpower to be used as labour. It was this excess labour, employed in the primary sector which enabled the beginnings of economic growth and as technological breakthroughs continued apace the industrial revolution stared (year). From here on increased agricultural and industrial efficiency led to growth in the manufacturing (secondary) sector and the rise of the tertiary sector. The tertiary sector accounted for 70% (national statistics) of all value added in the UK during 1995 as compared with only 2% for agriculture, which used to account for all of value-added as well as labour force allocation.

2.5 Sub-groups of services

The service sector itself can be subdivided into three separate divisions – type alpha (α), beta (β) and gamma (γ). α-type services are the most common service provision type and encompass all services provided in a fixed location and require the customer to travel to that location. A good example might be a university who provide the services of research, education and dissemination of knowledge. As Graedel (1998) states a design for the environment (DfE) assessment standpoint would attribute responsibility for the building in which the service is provided and the provision of the rented equipment itself to the owner of the organisation. The onus of responsibility for transport would often fall to the customer as the service provider cannot determine the methods used, e.g. foot, bike or motor transport.

β-type service provision are services where the provider performs the service at the customers' location and may include cleaners, grounds-care and insitu-repairs. From a design for the Environment stand-

point the environmental responsibility of any logistics involved will fall to the provider. Any responsibility referring to the 'facility' would be referring to the facility or headquarters of the provider, the maintenance of vehicles at the office and the functions provided by the facility, such as telephones, toilets and desk-space for employees etc…

γ-type service provisioning is the newest addition of phenotype to the phylum of services and has been brought about by the advent of the telecommunications and wider innovations of the information technology age. These services could be described as 'virtual' as neither the provider nor the customer travel to each other and may never even communicate by telephone. Often, this type of services has been heralded as the saviour of modern society (quote?) due to the concept of decoupling (DEFRA) from the natural laws that govern the world and possibly universe that we inhabit. Although it is true that they create economic wealth and could therefore be said to be productive with a minimum of natural or physical capital they are not completely decoupled and this has led to many believing gamma-service provisioning is environmentally benign. But all of the computers require power as do the routers providing the back-bone of the internet and the offices where the employees perform the services utilise water, cleaning fluids, air conditioning, energy etc… A design for the environment perspective would therefore focus all attention upon the facility and the functions it provides to the business.

With respect to the different categorisations of service types, frequently there are companies – this paper deals with one such example as its core case-study – who do not fit entirely in to one 'pigeon-hole'. With our example, a consultancy, the employees are frequently required to travel to customers, customers often travel to the company for training, briefings etc… and provisioning of data products over the internet (such as non-gratis research papers) can see their activities spread across all three types.

Service Sector Reliance on Logistics of both people and goods – therefore driving environmental degradation. Astrid Kander.

2.6 What is a Metric?

Characklis & Richards (1999) define environmental performance metrics as "measuring sticks against which companies can gauge their progress toward environmental goals and related business strategies". It is a concise definition in the context of the business world but it is possible to see how it might also apply to the non-business world as well and metrics therefore be defined in a wider context as being 'a means of identifying trends and assessing performance with respect to any given goal'. Many metrics exist including societal, governmental and industrial performance related measures. This study concentrates on the industrial, arguably the most common and well researched form of metric, and in particular the service sector: an area traditionally considered to be environmentally benign.

"In both government and industrial operations, what gets measured gets managed." (Graedel and Allenby: 2002). Indicators can be used to ensure transparency of activities and provide driving forces to achieve goals in complex and subjective area like the environment. Some form of structured evaluation must be relied upon to validate and guide any attempt at environmental governance, and metrics and indicators provide the tools for this evaluation. Graedel and Allenby (2002) separate an indicator from a metric defining a metric as a quantitative measure of performance towards a goal whereas an

indicator is a non-quantitative snapshot of an environmental state, such as the existence of a specific endangered species (*ibid.*).

There are many methods of metric categorisation that exist in the literature including product-centred; site-centred and sustainability metrics. Product-centred metrics such as tail-pipe emissions and fuel efficiency have existed for a while as regulatory standards require them. One common example is the efficiency of cars measured in miles per gallon of petrol used (in the UK and US) and litres per one hundred kilometres distance travelled. This is an example of a metric used within the usage phase of a product's so-called life cycle. The proportion of recyclable content in a product can be used an example of end-of-life measures. This has particular significance in the manufacturing of electronic goods where the take-back policy of the supplier is becoming increasingly important. This is largely to do with the legislation imposed in Sweden regarding the safe disposal of consumer electronics. As a result all retailers must offer a point of return for the goods they sell so that the manufacturers can deal with their disposal effectively. Production phases at the beginning of a product's life are also important and subsequently taken into account during a life-cycle assessment. Figure 2 shows the whole stage of a product's life cycle from raw materials to end-of-life.

Figure 2
Raw Materials
Production & Design
Assembly
Transport
Usage Phase
End of Life

As a result of examining the early stages of the life of a product many site-related metrics have been established and utilised as they establish the aspects and impacts of the production site. For example, although we may know the fuel-efficiency of car A & B and let us say that car A is more efficient than car B. But if the environmental impacts of the production phase of car A outweigh the benefits of its increased fuel efficiency the overall environmental impact may be greater than with car B, which may have a more environmentally benign production process. The concept of the supply-chain becomes important here as many companies out-source and purchase raw materials from another company. With very few measures of upstream accountability it is a complex area and has received less coverage than site specific measures. A notable exception is the paper and pulp industry where many firms stipulate that their pulp comes from a renewable stock grown to what the industry itself defines as Sustainable Forestry Principles (Characklis & Richards: 1999).

2.7 Environmental Management Systems

Many metrics that are in common use today form part of total environmental management system (Brorson & Larsson: 1999). Often these systems are integrated with other control systems, such as health and safety, particularly with the advent of the concepts of sustainable development which closely links the environment with societal issues. These environmental management systems have many advantages over ad hoc measures including comparability and standardised audits. This allows external auditors to evaluate the validity of a company's progress increasing general public confidence.

Standardisation of these systems is becoming increasingly prevalent with more and more initiatives being developed.

The first example of a standardised EMS can be found in 1992 with the British Standards Institution introducing BS7750 in June of that year. The methods used are similar to the International Standards Organisation (ISO) 9000 certification of product/service quality, with methods to be used open to definition by the company (quality.co.uk). BS7750 requires an Environmental Policy to be in existence within the organisation and fully supported by senior managers, outlining the policies of the company to all relevant stakeholders. The European alternative initially established in 1993, the Eco-Management and Audit Scheme (EMAS), created with a view to allow companies to voluntarily participate in an environmental management scheme, opened to industrial sector companies operation in the European Union and the European Economic Area (EEA) in 1995.

The next major environmental management system to appear is now the most widely used. The International Standards Organisation developed the 14000 series of standards to make it easier for businesses and organisations to conduct environmental work efficiently and systematically by providing generally accepted methods. These include product-oriented criteria such as ISO 14040 (Life-cycle assessment) and ISO 14020 for labelling standards, as well as site-oriented such as management and auditing (ISO 14001 and ISO 14010, respectively). The EMAS scheme is currently used in 3072 organisations across 4050 sites (EMAS: 2004) and ISO 14000 is used by 49,462 organisations in 118 countries. EMAS is a lot more demanding than ISO 14000 and frequently ISO 14000 is used as a sub-section to fulfil one of the 8 main requirements of EMAS (as shown in box…) This may give one indication of the increased uptake of ISO 14000 subscriptions as well as the obvious geographical limitations, although ISO 14000 outstrips EMAS subscriptions even in Europe with 23,316 organisations on its books. The differences between the two systems do not stop there as there requirements for continuous improvement differ slightly as well as a organisational approach taken by ISO 14000 as opposed to a site-specific approach taken by EMAS (Dalhammer).

But there is one fundamental problem with these systems and their actual effectiveness in reducing environmental impacts of organisations; none of these systems say anything explicitly about a company's environmental performance. An organisation may have ISO 14000 and EMAS certification but still be performing extremely poorly as these accreditation bodies only require that steps towards improvement are being made. Companies with weak performance may try to use these accreditations as masks to appear stronger and delay any ramifications of poor environmental performance until later.

Beyond the fundamental flaw with the EMS' connection to actual improvement, implementation itself can create quite a few obstacles in itself. Both systems are very complex and time consuming as a result. In all three above examples a large 'manual' must be produced outlining very detailed policies which is not only costly but may be irrelevant in a very small ad hoc workplace. Unfortunately both EMAS and ISO 14000 have 'refused for various reasons to develop a light and adapted version of their respective tools with respect to [small to medium sized enterprises].'' (Engel: 2004).

Other methods

Resultantly there has been a proliferation of techniques and methods developed by academics and organisations, as well as the Associated body of Chartered Certified Accountants and other such boards. As Engel puts it; "why should very small companies invest in full blown environmental management tools like ISO 14001 and EMAS when small innovative management tools could be sufficient for them? After all what matters is the result – improved environmental performance." (2004 p.1)

Many of these measurements (such as amount of packaging used per production unit) double as cost-saving measures as well as demonstrating environmental performance (Charaklis & Richards: 1999). This has led to a growth in commercial organisations taking on the gauntlet of reducing the environmental impact without costing an organisation too much in the long run or by even making it a selling point of the company. One such example is The Natural Step…

2.8 What makes a good indicator?

So what can knowledge can be gleaned from this array of differing techniques with regard to the metrics we now seek? Of the literature already attempting to do just that, the most notable example is by the US National Research Council/National Academy of Engineering. *Challenges and Opportunities in Environmental Performance Metrics* (2001) examines the indicators and metrics used in four industries: automotive, chemical, electronics and pulp & paper within the United States and resultantly defines three categories of metrics; Operational, Management and Conditional.

2.9 Why not the service sector?

It must be noted though, that this paper refers mainly to tertiary sector firms and recommendations for their improvement and that all previous work tends to refer to primary and secondary sector industries. Most of the literature tends to refer to the manufacturing sector as these areas, as already illustrated, are believed to have more impact on the Environment. This may not be true, however, as the effects of the service sector are harder to see for a few reasons. Firstly, manufacturing firms benefit from increased size due to increased returns to scale and employ over four and a half million people in 145,000 registered business entities (meaning on average there are 32 employees per business).Services tend to be organised into smaller and medium sized enterprises with the sector as a whole within the UK employing 21 million people in 1.3 million separate business entities (giving 21 employees as the average size). This makes it much easier to see the effects of manufacturing firms on the environment as they are larger thereby producing more effects per individual enterprise. A second reason is also the nature of risk in our mind as will be described below. The risks of the manufacturing sector are far more visible and apparent and contain more obvious linkages to the environment.

2.10 Risk

The movement to monitor our environmental performance stems directly from the first of our basic needs as human beings (according to Manfred Max-Neef): survival. If we are polluting into our own streams the connection with our drinking water creates a very obvious health risk. As John Adams' theory published in Risk (1995) establishes, there are three major categories of risk. These are: risk, which is directly perceptible (such as the chance of being run over by a car); risk perceived through science (e.g. the risk of contracting lung cancer from polluted air) and virtual risk (e.g. the risk of consequential effects that have not yet been considered or discovered). In the case of corporate

responsibility, direct risk would include the risk of being killed whilst performing some of the activities such as being electrocuted whilst changing the printer cartridge etc...

We do not need an advanced scientific education to evaluate the outcome of being electrocuted or falling into a river (*op. cit.*) as a result, some of the risk created by organisations will be direct. It is these direct risks of industrial smog that have led to health and safety issues being paramount in the corporate world today.

Guidelines for these areas are not totally ineffectual as the management structure, stakeholder responsibility and reporting principles by which they are trying to adhere are similar across all types of industry.

DEFRA & 'Decoupling'

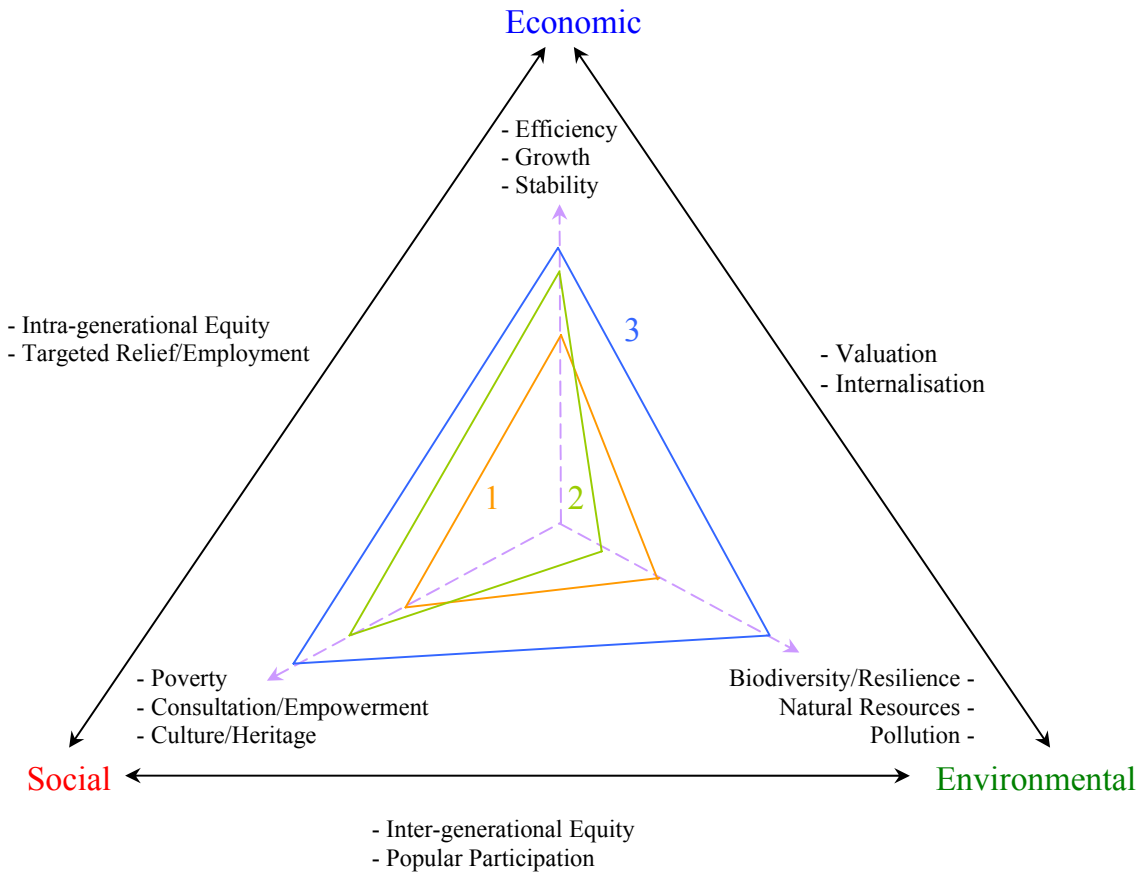
The Department for Environment, Food and Rural Affairs in the United Kingdom set out the government's initial ideas for a 'basket' of twelve indicators to measure how effectively UK firms are progressing towards sustainable production (DEFRA: 2003). The framework for sustainable consumption and production developed during the World Summit on Sustainable Development (WSSD) outlines three key objectives:

1) To 'decouple' economic growth from environmental degradation;
2) To focus policy on the most important environmental impacts associated with the use of particular resources, rather than on the total level of resource use;
3) To increase the productivity of material and energy use. As part of the broader Government commitment to increase the productivity of the nation.

Decoupling is a concept normally viewed as a 'breaking of the link between an economic good and an environmental bad' (DEFRA: 2003, p2). With the advances in computer technology the concept of decoupling has been heralded as the way towards sustainable development without even having to change our consumption patterns. Although this is contested ground, measuring environmental performance against economic performance is in accordance with the concepts of sustainable development. Sustainable development, as previously defined, has grown since its original conception to a much more 'hard-edged, uncompromising, quantifiable and scientifically rigorous' concept (Porritt: 2000). "The rules are set by nature not by man." (*Ibid.*)

"The concept of sustainable development has, therefore, evolved to encompass three major points of view: economic, social and ecological" (Munasinghe, 1992). Munasinghe (1995) also provides a useful triangular matrix containing the elements of sustainable development which can be used to evaluate whether a strategic decision will result in trade-offs or complementarities (see figure 1).

Figure 3



(Adapted from – Munasinghe: 1995, pp. 3a & 10)

If we look at the two triangles within the matrix this will help to exemplify the concepts of complementarities and trade-offs. The orange triangle (1) represents our current situation with the loci of the three vertices relating to economic, social and environmental benefits. If we envisage a change in policy resulting in our triangle changing to the green position (2) we can see the social and economic factors are complimentary as both have improved but we also see a trade-off as the environment is not benefiting from the policy decision. The blue triangle (3) shows a situation where a policy decision has resulted in an increase in economic, social and environmental benefits. With the case of the environment this may be a reduction in pollution as opposed to an increase in positive environment (Harris, 2002). This can be termed a win-win situation as all three of the main factors considered in sustainable development are benefiting from the actions (Munasinghe, 1995). Decoupling can subsequently be described as a measure of the win-win situations as defined by Munasinghe.

4 core principles of sustainability – in order to avoid an element of subjectivity in choosing metrics.

1) We must be careful not to extract more from the Earth than there is capacity to absorb and contain the elements which are resultantly increasing in prevalence.
2) We must not release man made materials such as persistent volatile organic compounds that the natural system within which we live is able to deal with and process.

3) We must not diminish the natural life-support systems that our planet provides, such as biodiversity, forestry cover for O_2 production etc…
4) We must ensure that equity of natural capital is maintained as all humans have equal rights to the natural capital out planet provides.

(Porritt, 2000)

3: Methodology

This chapter provides a brief overview of the methodological approach used in this research. The purpose of the research is examined to establish the most appropriate research methods. Subsequently, both case-study and qualitative research methods are validated with respect to their use within the project. The framework for the analysis is then presented with how the results from the interviews are to be integrated. Validity and reliability of the research will be discussed at the end of the chapter.

3.1: Research Design

As previously mentioned, the majority of research into environmental performance metrics has been in the primary (extraction) and secondary (manufacturing) sectors with scarce attention being paid to tertiary (service) sector organisations. In order to fully explore, describe and explain this phenomenon a research design with a case-study and qualitative research method was chosen as it is preferable for studying such contemporary events (Yin, 2003: 7-8).

The project is aimed at conceptualising the phenomenon within its context to aid understanding. Conceptualisation of the core problems identified by the case-study is most accurately achieved with the use of logic models. The explanation of the phenomenon should be aided by the use of such models facilitating greater understanding of the context within which the case is situated.

3.2: The Case-study as a research method

In many ways the case study utilises the same techniques as a history but it allows for the addition of direct observations of the phenomenon itself and interviews with the actors connected to that phenomenon. The ability of case-studies to incorporate multiple methodologies enables an investigator to "retain the holistic and meaningful characteristics of real life events – such as life cycles, organisational and managerial processes, neighbourhood change, international relations and the maturation of industries" (Yin, 2003). The use of this research method concentrates and crystallises thought on a specific phenomenon and allows the investigator to cover the real-life contextual conditions that are pertinent to the phenomenon of study.

As Yin (*Ibid.*) states; "case studies are the preferred strategy when 'how' or 'why' questions are being posed and the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context." The case study can be used as a research method in many situations to contribute to our knowledge of individual, group, organizational, social, political and related phenomenon. As a result it has been often employed in fields as diverse as political science, sociology and business (Ghauri & Grønhaug; 2002).

As the phenomenon under investigation has not been studied in this context before, a single revelatory case study of a gamma-type service provision organisation is used. Observations and insights into the case-study are important as these types of services are increasingly commonplace. The case-study will investigate a single organisation but the analyses include outcomes about individual units within the whole. This embedded case-study design prevents any 'slippage' in the research goals maintaining a focus on measuring environmental performance. A holistic study may have reflected one orientation at

the beginning but as the case study proceeds, a different orientation may emerge and the evidence is directed towards other research questions.

3.3 Research Methods

3.3.1 Qualitative Research Methods

The research presented here predominantly utilises qualitative methods of research, i.e. interviews and participant observations. By interpreting what is being said during an interview it is possible to gain understanding of a subject and its relation to the phenomenon under investigation. One approach is through the use of hermeneutics.

During the Reformation hermeneutics came into being as a special discipline concerned with biblical criticism. The Protestant theologian Friedrich Schleiermacher expanded the discipline from one concerned with *removing obstacles* preventing readers from gaining understanding of a document to one concerned with *analyzing the conditions* for a reader to gain such understanding. Wilhelm Dilthey expanded the discipline still further by conceiving of the entire human and social sciences as hermeneutical enterprises and trying to construct a method uniquely for them (Hoy, 1978). The implementation of such an analysis is achieved in this project with a literature review and the empirical results developed from the gathering of information from interviews.

Semi-structured interviews were conducted with members of staff. The interim goal of the interview method was to determine the feasibility of measuring environmental performance in-line with the global reporting initiative. However, the flexible nature of the semi-structured interview also allowed an informal setting to pose questions. Resultantly, it was possible to establish knowledge about the interviewee and the organisation in order to understand the context of the relevant phenomena within the case study. In order to augment the data from these interviews, archival information from expense sheets and other accounting information is also presented. It became apparent early on in the interview process that efforts to measure performance in line with a large-scale environmental management system or with the 35 indicators developed by the global reporting initiative were inappropriate in small to medium-sized enterprises. They do not have the resources to expend on such activities when the potential for financial gain is so small, either through better public image or eco-efficiency savings. This exemplifies the advantages of a flexible design approach as a study into applying an EMS would have been irrelevant as it the resources to apply it do not exist. Instead questions were structured to gather information to complete the streamlined life cycle approach (SLCA) as outlined by Graedel (2003). The SLCA is relevant to small to medium-sized enterprises and is particularly applicable to services as opposed to manufacturing sector firms. The concepts and implementation of this logic-model are explained in the proceeding sections.

3.3.2 Quantitative Data

Quantitative archival data is used as an extra descriptive element to this multi-method approach case-study. These add significant opportunities for extensive analysis, enhancing the insights into the single case. However, it is important not to concentrate solely on these individual subunits: “if the larger, holistic aspects of the case begin to be ignored, the case study itself will have shifted its orientation and changed its nature.” (Yin, 2003: 46)

3.3.3 System Boundaries

System boundaries dominated the interview discussions for the most part. Initially the boundaries had been established as an individual office. At the outset it was posited that any metrics employed would have to include only activities on the one site as any other locations should have their own measures and this would invoke 'double-accounting'. For example, if the metric of CO_2 emissions per employee were to be utilised, the energy supplier would be measuring the CO_2 emissions per kilowatt hour of electricity produced for their own facility and then made relative to the number of staff. If these emissions were to be included in the case-studies own environmental assessment it would be counted twice, once at the power plant and once in the case study organisation. On a national statistical level CO_2 is measured from the point of emission, i.e. the power plants and cars etc…, but this does not explain the driving factors behind CO_2 emissions. If we were to measure the CO_2 emissions of the case study it was predicted that any emissions that are measured will be slight, but it is undeniable that there will be CO_2 emitted to allow the organisation to continue their activities due to the energy use and transport requirement of gamma-type services. All the activities within offices themselves are relatively benign when looking at the 16 aspect areas identified by Brorson and Larsson but, when using the SLCA approach it becomes apparent that the more important aspects are within the supply-chain; e.g. purchasing of electricity from companies that operate non-renewable generators. In order to use the SLCA to describe the holistic image of the phenomenon the systems boundaries extend to include elements outside of the offices including CO_2 emissions from transport & energy generation etc…

3.4 Logic models

The logic model deliberately stipulates a complex chain of events over time; the complexity arising from the fact that multiple stages may exist over an extended period of time. The processes under examination here are not linear however. They subsequently call for 'systemic models' to be used in order to understand the complexity within the system. Changes may reverse course and not just progress in one direction and the completed transformation that will be described is not necessarily an end point, as a linear logic model would imply, rather processes may be continuing and the reformation itself may be altering over the long run.

3.4.1 Life Cycle Assessment (LCA)

The life-cycle assessment can be performed on products, services and sites, unlike many of the other indicators, which tend to be specific. Recently streamlined life-cycle assessments have been used with increasing frequency as full-scale life-cycle assessments are inappropriate. Below is a description of the five different stages of a service-sector organisation's life.

3.4.1.1 Stage 1: Site and Service Development

In order to provide a service an operations or office facility is required. The majority of environmental impacts of service industries could be said to be derived from here (reference). The site selection, the way it is developed, construction materials used and transportation needs are all key factors. Gamma-type services can be situated anywhere where the infrastructure is present to support their activities. In the example of Sealand, an internet service provider, this happens to be on a disused oil rig in the middle of the Thames estuary (ref). Often, however, and in this case, the service provider is leasing the office space. Resultantly, the selection and contract phase is the only opportunity for the lessee to influence the facilities inherent environmental impact. In the optimal case where a service provider is building their own facility they can influence the design and planning stage (where 80% of all

environmental impacts are determined – ref). As this is not so in our case, stage one of the streamlined life-cycle assessment is no longer relevant and will be disregarded in the adapted version.

3.4.1.2 Stage 2: Service Provisioning.

For the development and provisioning of a service it is generally necessary to buy or rent office equipment such as computers, photocopiers, desks, chairs etc… The environmental impacts of these are the responsibility of the manufacturer to provide but it is the responsibility of the service provider to purchase or lease the equipment which most closely matches the specifications of their environmental characteristics. Considerations may include maintainability, energy use and design for recycling.

One example is the use of laptop computers as many companies now issue them to employees. The use of semi-conductors has received some academic scrutiny. A recent study by Williams *et al* (2002) estimates that a typical 2 gram silicon chip requires 1.6 kilograms of fossil fuel, 72 grams of chemicals and 32 kilograms of water to manufacture. This needs to be taken into account when considering the materials use of a firm, product, service or site.

3.4.1.3 Stage 3a: Performing the Service

As the service industry covers such a wide-range of activities it becomes hard to generalise and synthesise recommendations across the whole sector for this stage of the life-cycle. For example, gardeners need to consider the chemicals they use to facilitate their work as emissions to ground and hair dressers need to consider the chemicals in shampoos and conditioners as well as the amount of water and energy they use. In a gamma-type service provider the impacts of performing the service are mainly energy use for computers and lights and waste generated (solid residues) as a result of printing.

3.4.1.4 Stage 3b: Facility Operations

It is this section where transport plays a major role as it is defined as an operative function of the facility where work is performed. This may include travelling to and from a client's location but could also be increased to include employees' commuting habits; however, not within the scope of this thesis. The corporations facilitating delivery of transport services bear the responsibility for emissions (as with purchasing of all products and services from suppliers) but it is the responsibility of the purchaser (ie our case-study) to pick the supplier which is most aligned with a companies' own policy, economically, socially and environmentally speaking. It may be possible to reduce environmental impacts of transport with clever scheduling and coordination of deliveries maybe through cooperation with other industries nearby or during stage one of the LCA; selecting the most appropriate facility based on the later reliance on transport.

Facilities 'receive and disperse much non-product material' (Graedel: 1998). This may include food for employees, surfactants used to clean the toilets, fertiliser for maintaining the land around the facility. An environmentally responsible facility should be aware of all of these and have policies in place to reduce their use as much as possible. Paper purchasing should have a high-recycled content and toners for printers should be refilled from previously used toner cartridges.

Energy use within facilities is also to be carefully examined as it is an easily rectifiable environmental bad. With the de-regulation of the UK electricity boards it is possible to buy your electricity from any supplier within the country, this allows for greater consumer power to decide what generation methods

are used. The U.S. office of technology assessment estimated that lighting for businesses generated 5-10% of overall emissions in 1991 (USTA: 1991). Air-conditioning and heating are also major users of energy and the air-conditioning systems have the additional problem of the CFCs used in their operation. These can be switched to the more environmentally benign HCFCs to reduce their environmental impact but with regards to reducing energy use it can be quite hard to isolate the individual areas that take most.

As printing technology continues apace it has become inexpensive to enable printing on both sides of a document. As a result, duplex printing has been a recent revelation in the office environment and has the ability to halve paper use.

3.4.1.5 Stage 4: Site and Service Closure

Again, this varies from type of service to type of service. Large A-type services where the customer goes to the facility will likely have a large impact when the service ends. There may be a large non-design for the environment facility which needs to be demolished as well as tools such as custom-built office furniture which may not work in another location and therefore has to be disposed of. Increasingly products are being designed for a longer-life span to reduce their overall environmental impacts in the long run

Many services, in particular office-based gamma-type, are located in an office-block sub let from another service provider and if they were to terminate service provision the space could be occupied by another firm with little alteration to the site. The telecommunications, water and power infrastructure are already in place and the building would be equipped with all the accoutrements of a modern office space allowing an incoming firm to have a relatively high rating during the initial phase (stage 1) of a life-cycle assessment.

3.4.2 SLCA Matrix

The use of metrics can appear to be a complex and initially daunting prospect. Complicated metrics such as GRI are both unattainable and inappropriate at this early stage of assessment of the service industry. They can take years to implement and can also prove costly to implement. This is not feasible for the small to medium-sized enterprise in a comprehensive way. A semi-quantifiable streamlined life-cycle assessment was employed to gauge the overall picture of the environmental impacts through the five life-cycle stage, as described. Resultantly an adapted version of the Streamlined Life-cycle assessment employed by Graedel was used to gaufe our case-study's environmental impacts.

The proposed scale for the matrix assessment differs from that proposed by Graedel. The basis of Graedel's matrix is an intervallic scale where the surveyor would estimate the amount of impact from a particular aspect on a scale of 0-4. The slightly altered version proposed in this thesis uses an ordinal scale instead to indicate the management, operational and conditional state of an organisation with respect to the environment. Using the following scale:

Scale	Graedel (Interval)	Adapted (Ordinal)
0	Highest Impact	Unabated
1		Concerned

2		Effective
3		Progressive
4	Lowest Impact	No impact

Individual indicators can then be established between stages 1 and 2 of the progression from unabated polluting to a no impact organisation. For example, if energy use was highlighted as an issue that an organisation are concerned about they may then implement indicators to monitor the progress of any policy to improve their performance. It is intended for this ordinal scale to overcome the problems of environmental attitudes not matching environmental behaviour (Tilley: 1999).

The Matrix can also be placed on a chart of revenue, profit or maybe expenditure on environmental issues. Many of the concerns raised during the interviews regarded the communication of results and the possible ramifications of any negative discoveries. Placing the matrix on a performance graph allows the communication to accurately reflect any increases in productivity over time that may explain a regression in environmental progress. Social indicators can also be used to create an index of progress towards sustainability. A graph of the aggregate score of the matrix plotted against revenue or profit would also show decoupling of the organisation; if economic value creation is rising above environmental degradation then decoupling can be said to appear to be occurring.

3.5 Choosing the Case

The effective application of the methodology requires the selection of a specific case-study. The previous literature covers primary and secondary sectors extensively and alpha-type service provision has been touched upon. As a result, to make the case-study as revelatory as possible it should cover a gamma-type service-sector firm. This is at the opposite end of the 'decoupled' firms' spectrum and is subsequently where the least research has been conducted. On top of the already existing criteria for a gamma-type service it is preferable to look for an organisation that operates concepts of flexi-time and working from home as these could prove to be used as further techniques to decouple economic activity from its environmental impact.

By focusing on Arthur D. Little, a consultancy firm based in Cambridge, UK, it is possible to examine a firm that matches all of the above criteria. By using interviews conducted there it is possible to investigate the phenomenon in its real-life context and to use archival information to further describe the problem at hand. Arthur D. Little was also chosen as they are a company to which I have personal connections. They issue a list of projects every year to which Masters Students can apply to work in co-operation with staff at the organisation. Being selected to help with a project on measuring the environmental impact of the firm presented the opportunity to collect data as a revelatory case-study and pose recommendations to the firm based on the results of any analysis.

3.6 Choosing the Interviewees

Prior to visiting the organisation the only knowledge was from reading company reports and through discussions with two members of staff. It was through these connections that interviews were established with other directors and key stakeholders within the firm. They suggested members of staff who have either played a part in environmental measurement in the past or who would be involved if it were implemented. Decision makers in the organisational hierarchy were also selected to help explain

the driving forces for change. The interviews were held over a period of three months (August – October 2004) either by telephone or in person at the Arthur D. Little offices in Cambridge. The interviewees are listed as follows:

Alan Marples	-	Established Environmental Policy at ADL
Greg Saunderson	-	IT Purchaser
Stephen Watson	-	Health & Safety Officer
Rick Eager	-	Marketing Director
Justin Keeble	-	Environmental Consultant
Helen Pearce	-	Environmental Consultant
Martin Scutt	-	Accountant
Gareth Oxlade	-	Accountant

3.7 Dealing with Data

The interviews were later used to determine the organisations' attitude towards the environment across the 25 areas of the SLCA. The interviews were not interpreted verbatim, rather a deeper meaning (as described in the hermeneutical process above) was obtained by considering the greater context of the interview and the interviewees. Due to constraints on space, the full transcripts of all of the interviews are not reproduced here, rather the key interviews are presented in Appendix I and quotes from the interviews are used as and when needed during the presentation of the case-study.

Aggregating Interviews

Although no explicit indicators were employed during the SLCA, quantitative data derived from archival information is presented to justify and cross-reference the results presented in the SLCA. It is the intention of the SLCA to develop metrics which can be implemented at a later date. Where possible, data is used to justify the rating given in a specific category of the SLCA.

3.8 On the Quality of Research Methods Used

A research design represents a logical set of statements and, subsequently, the quality of any given design can be judged according to certain logical tests. Validity and reliability are oft used measures of quality within a research methodology.

Figure of types of validity

These four 'tests' are commonly used to establish the quality of any empirical social research. For a case-study to be exemplary it is necessary to ensure that all four are secured to stand up to academic scrutiny (Yin, 2003: 35). The following section describes the way in this was achieved.

3.8.1 Validity

Validity concerns the ability of any design to study what it sets out to study. There are three types of validity. Construct validity ensures the correct operational metrics are used for the concepts being studied. Internal validity establishes whether the causal relationships where one set of conditions leads to another are genuine as opposed to spurious. The final validity, external, establishes the context to which the project's findings can be generalised and synthesised.

3.8.1.1 Construct Validity

By using multiple sources of evidence construct validity has been strengthened. By varying not only the interviewee and type of data, interview or archival, in a manner creating converging lines of inquiry any biases that may occur within the staff or attempts to mask the truth is hopefully by-passed. By using a systemic model that has been pre-established and employed, in theory, a priori it ensures that subjectivity is minimised. Subjectivity may also occur during the interpretation of any interviews, by including the quantitative data, although it may not be analysed in any mathematical way, it adds validity and ensures that any personal bias is highlighted.

3.8.1.2 Internal Validity

Predominantly internal validity is a problem for case-study research that establishes a causal relationship, where x causes y. As this case study is more exploratory and descriptive in nature the main threat to internal validity is when inferences are made. It is necessary to ensure that all possible rival explanations have been considered to ensure the inference is correct. Again, converging sources of evidence can be used to establish this validity as well the use of the life-cycle assessment model, a form of logic that can be ascribed to other case studies.

3.8.1.3 External Validity

This form of validity helps us to establish whether the findings can be generalised beyond the immediate case study into the greater context of society. Is the study of one gamma-type service applicable to another gamma-type service? The traditional critique poses case-studies findings against those of surveys. A survey of all the firms in the sector would enable statistical generalisations and would find the mean, mode or median of the findings. However, a case-study relies on analytical generalisations where the investigator strives to generalise the results to a broader theory.

By including many different techniques of performing the same analysis in the background and by using multiple sources to give an accurate overall picture of the phenomena under investigation the external validity is increased. The conclusions are therefore more convincing as analytical generalisation undertaken can be from the results towards the theories forming the frame of references for this project.

3.8.2 Reliability

Reliability concerns the repetition of study; if it is possible to perform the same research with the same data set and produce the same results then it can be said to be reliable. “The goal of reliability is to minimise the errors and biases in a study.” (Yin, 2003: 37) One necessary step to allow any study to be repeated involves the accurate documentation of the procedures undertaken during the research. Without documenting the work undertaken it wouldn’t be near impossible, even for the original investigator, to repeat the study. By dividing the research into operational steps as outlined in the above sections it is possible for an auditor to produce the same results by following the same procedures.

Another principle employed to increase the reliability of the research method is to maintain a chain of evidence. This, again, allows an external observer to follow the derivation of any evidence from initial research conception through to the conclusion and in reverse. This has the added advantage of also ensure construct validity

3.9 Summary

This chapter has charted the development of the research method used and justified the decisions taken in establishing this method. The case study method is used to gain an explanation in to the phenomenon under study as it is a useful method to gain a holistic view. A single-case study with a multi-method approach was chosen to augment the explanatory nature of the case-study with some descriptive statistics of the factors under investigation. The use of both qualitative and quantitative data sets will also increase the validity of the research undertaken and the chain of evidence can be followed from design stage through to the data collected to increase reliability.

The application of a logic-model has been outlined to explain the reporting and subsequent analysis of the results which follows. The model is useful for the theoretical conceptualisation of the problems at hand and as a comparative tool to be used by subsequent investigators who wish to investigate similar phenomena and could replicate the study with a different case.

4: Results

This section of the thesis will present the case-study to position the collected data within its broader business environment and context. The results are then presented in-line with the streamlined life-cycle assessment subdivided into its five constituent stages. These five stages are: site & service development, service provisioning, performing the service, facility operations and site & service closure. These five stages are then analysed in line with the five areas of environmental aspects to create 25 subgroups. The case study will be rated as explained in the methodology, on a scale of 0-4 for each of the 25 individual sub groups creating a maximum aggregate score of 100 points. The limitations of analysing the data in this way are then subsequently addressed at the end of the chapter.

4.1: Arthur D Little – Descriptive Data about the Case Study.

Arthur D. Little is the world's first consulting firm founded in 1886 (ADL.com). Their business remit is one of a global management, technology and environmental consulting group. They serve both public and private sector clients with more than 1000 staff members based across 40 different sites in 30 countries including the USA, United Kingdom, Sweden, France etc… Arthur D. Little is owned by Altran, a French consultancy firm which is one the largest firms of its type in the world.

Founded in France in 1982, Altran "has pioneered innovation consultancy and has become the European leader in this area" (Altran.com). They currently employ 16,530 employees and have a turnover of €1,400 million per year. As a share-holder organisation the key stakeholder for Altran are the owners (shareholders) and it is the management's task to respond and do the bidding of these key stakeholders.

The Environment & Risk section of Arthur D. Little is based in its Cambridge offices, the site and service area upon which this thesis turns its attention. There are 70 employees in the Cambridge office providing tailor-made services to clients. This tailor-made approach raises many issues when trying to deal with a life-cycle assessment model as there is a blurring of the boundaries between the groups. Determining which aspects are ascribed to the individual stages of the life-cycle is therefore not clear-cut: are post-delivery telephone calls to be included as a usage phase of a consultancy product or as a facility operation?

Another major difference between the case study used here and previous work conducted with and on life-cycle assessments is the way in which Arthur D. Little' employees relate to their work space. Many organisations would have all work conducted on the site premises, or at a clients' (alpha & beta-type service provision). However Arthur D. Little recently introduced the concept of flexi-time (where an employee defines their own schedule) as long as 40 hours are worked per week. A similar initiative is the ability to work from home. Unless an employee has a meeting in the Cambridge offices or with a client they are free to work wherever they like. Again this poses problems for anyone trying to understand and quantify the extent of the environmental impact of their operations. For example, any measure of energy use might well include the offices but is unlike to include energy used for working from home.

Ownership of Arthur D. Little is also slightly different from previous examples covered in the literature, which has implications for the driving forces behind the reasons for change. Altran, who own ADL outright state that ADL must set their own targets and rate performance based on the ability to meet these targets, as opposed to gross profit or revenue etc… (Interview 6) This has many positive implications, such as the ability to forgo large profit margins in the interest of environmental performance improvement. The next most important stakeholder, as defined by ADL itself (Interview 6), is the client-base and then the staff. It is in this order that the mangers must respond: Altran, clients, staff. However, as mentioned above, Altran are a share-holder owned organisation and if the shareholders were to ask for specific changes then they would have to be implemented.

4.2 Applying the Streamlined Life Cycle Assessment

By organising the data gathered during the interview process, the following section will outline why each of the 25 subgroups have been awarded their respective 'scores'. In the case of stage 1 & 4 (Site and Service development and closure) these are both owned by another organisation and so ADL have little influence here, so it is sections 2 & 3 (a & b) of the SLCA where most of the results have been generated. It is also in these areas where ADL have the most influence and can therefore make the largest improvement.

4.2.1 Site and Service Development (Stage 1)

Interview 1 established that Arthur D. Little rent their premises on a 'science park'. The site was developed by Trinity College Cambridge who subsequently has ownership of the facilities and so any development related impacts will be attributed to the owner-organisation, not the lessee. Trinity College, Cambridge, has owned the land since 1546 when King Henry VIII established the college and bestowed large amounts of land to the college. Prior to 1945 the site was used as farm-land and then requisitioned by the US Army for troop and vehicle preparations prior to the D-day landings. It was then a derelict site until 1970 until it was developed into a science park.

The development was a response to a report by the Mott Committee, a special Cambridge University Committee set up under the Chairmanship of Sir Nevill Mott (then Cavendish Professor of Experimental Physics) to consider an appropriate response from Cambridge to an initiative of the Labour government following its election in 1964. Whitehall had urged UK universities to expand their contact with industry with the objective of technology transfer and also to increase the payback from investment in basic research and an expansion in higher education, in the form of new technologies.

The Mott Committee, in its report published in 1969, recommended an expansion of 'science-based industry' close to Cambridge to take maximum advantage of the concentration of scientific expertise, equipment and libraries and to increase feedback from industry into the Cambridge scientific community. Since Trinity had a piece of land available, it decided to apply for planning permission to develop it as a science park, an idea born during the 50s in the USA where the first science park was established by Stanford University (Cambridge Science Park: 2004).

All of the telecommunications infrastructure as well as energy, water and gas will already have been constructed prior to Arthur D. Little establishing an office on the premises. If ADL were to have commissioned the construction specifically for their use then these attributes would have been included

in the SLCA analysis. Resultantly, the site and service section of the SLCA matrix have been given a rating of 4 (negligible environmental impact).

4.2.2 Service Provisioning (Stage 2)

Operation of a service requires that office machines, computers, furniture etc… are purchased, or leased for use in the offices. In interview 3 it was highlighted that the use of computers which can contain heavy metals and require vast resources during the production stage are of particular concern to the organisation. In our case study the current purchasing of I.T. equipment is processed by Greg Saunderson (Interview 4). During the interview he stated that the micro-computer industry is currently very competitive and the difference between brands is hard to determine as they all offer similar products for similar prices. When asked if a purchasing-policy with a specific environmental tilt would be difficult to implement he argued that it would be advantageous to him as a purchaser as it may make it easier to differentiate between and choose the most appropriate product to ADL' core values.

From this it is a fair inference that the organisation is concerned with the origin of its computers and other office machines, although have no effective measures in place at the moment. But as no individual metrics are currently being employed a rating of 1 (concerned about impacts) is given for all elements of service provisioning.

4.2.3 Stage 3

Separation of the two stages, 3a and 3b, proves quite problematic in practice as many of the facility operations, such as energy use are also required to perform the service. To determine how much energy is used for the operation of the computers and printers and other office equipment to perform the service as opposed to generic operations performed at the facility would require detailed logging of when and for what purpose each factor is used. A theoretical look at the operation provides an insight and, as the study is only semi-quantifiable, will produce an appropriate result in lieu of such data.

4.2.3.1 Performing the Service (Stage 3a)

As a consultancy, the services provided by ADL are knowledge-based and delivery of the service can be over the phone, via email, in person or despatched as tangible documentation. The actual operation of performing the service requires energy to run the computers and phones and other communication tools, such as email, which the employees use to deliver the service. It also entails a lot of printing as many documents, which may be voluminous, need to be distributed to clients. Distribution of the service also requires delivery, either by

4.2.3.1.1 Material Use

Interview 6 with Stephen Watson revealed that ADL do not have a specific policy with regards to material use, or any of the other environmental aspects, during service provisioning but instead have a set of 'core values' to which all actions must adhere to. The core value that represents their environmental policy reads; "We will measure and minimise the consumption of non-renewable resources, waste and pollution associated with our business activities". From this we can infer that ADL are at least concerned about most of the impacts examined in the SLCA (giving a minimum rating of 1 across most categories). This is a revelatory case as a consultancy with en environmental slant they know more than the average firm with respect to environmental impacts and aspects and, as a direct result, one can expect a higher score than a non-environmental firm.

For material use, paper is likely to be the highest concern as the most common materials required to perform the service are documents. All paper purchased is made from high-recycled content and toner cartridges used are also refilled. Recent printer purchases were made with the stipulation that the printing should be 'duplex' i.e. all documents can be printed on both sides. Resultantly paper use can be reduced without effective the overall productivity of the firm. We can therefore say that ADL are not only concerned about the material use but have effective measures in place to reduce it, so a score of 2 (effective measures) can be inferred for this attribute.

4.2.3.1.2 Energy Use

Energy use was an element mentioned by all interviewees as one of the most important factors to consider in the project. There is only one meter at the Arthur D. Little' Cambridge offices so determining whether it is computer or light use that has the largest effect is hard to determine, although individual meters could be installed for a sample of offices to gain insight into this area.

Table 4.1 Energy use (Gas and Electricity)

Energy use for the employees when they are not on-site (ie in the Cambridge offices) is hard to quantify as this would encompass energy used for computers, lighting and telecommunications provided by other clients and by employees within their own home. As this project is looking to generate realistic and appropriate recommendations for all offices, the out of office resource use will not be accounted for, rather qualified and regarded as important issues for further investigation and measurement. Interview 5 highlighted that increasing prices were making the purchasers increasingly wary of buying energy produced from non-renewable resources. The energy use is also measured, if remedial action is not being taken to reduce this use. Resultantly a score of 2 can be ascribed, if reduction were to be made through energy-saving policy then this rating could be increased during the next measurement phase.

	kwh
Gas	547,258
Electricity	561,966

4.2.3.1.3 Solid, Liquid and Gaseous Residues

The majority of these residues will come once the service has been provided and no further requirements for any documentation are needed. This can then be disposed of as paper waste which can be recycled but no measures are in place to ensure this happens. Therefore, a rating of 1 (showing concern for the issue) is attributed. The liquid and gaseous residues here pose little concern and are resultantly given a rating of 4.

4.2.3.2 Facility Operations (Stage 3b)

The impact of any facility on the environment is influenced heavily by transport use for activities on the site. Frequently staff travel either to generate new clients at trade fairs or to fulfil client requests by visiting their own sites. Often travel is by train, often chosen instead of the car as it enables work to be done whilst in transit – advantages posited by both Stephen Watson and Rick Eager (interviews 6 & 7, respectively). Due to the global nature of the business, with offices in 40 locations and 30 countries, and the centralised element of the environment and risk offices in Cambridge, long-haul flights are

frequently made with one interviewee, Stephen Watson, having just returned from Qatar the day before our interview. For trade fairs and recruitment fairs, stands and other materials must be transported to the location and often courier/logistics firms are employed for this purpose. An employee taking the train as opposed to a car might seem to be advantageous, environmentally-speaking, but if these materials were to be transported at the same time as employees in one vehicle the environmental impact may be less than using two methods of transport concurrently. Without a specific metric in place it is hard to effectively reduce this impact as there is no indication towards progress. Table 4.2 shows the expenditure to gauge a rough idea as to the quantity of travel and the modes used.

Table 4.2: Travel Expenses

Company Vehicles	£5,370.25
Air Travel	£67,326.02
Bus	£200.07
Car Parking	£7,634.54
Own Car Mileage	£25,327.46
Taxi	£27,115.05
Train	£42,143.91
Total	£175,117.30

4.2.3.2.1 Material Use

Material entering and leaving the facility should be managed effectively with a structured programme to evaluate each one. As previously mentioned, this is not always possible in a small-medium enterprise. It was not, however, even a concern mentioned during the interviews. Topics raised included cleaning fluids used and food provided in the canteen but at no point were the negative environmental impacts of these mentioned by the interviewees. Notices in the toilets have been placed to encourage people to reduce water usage but the overall impression was little had been done to reduce these impacts. Resultantly a rating of 1 has been specified, representing a concern for the effects from these activities but that no steps have been taken to reduce them.

4.2.3.2.2 Energy Use

This is closely linked with the energy use of stage 3a but covers slightly different aspects such as lighting and heating of the facility. Currently the heating of water and space is performed by a highly efficient gas-burning combination boiler (interview 5) and is quite effective at reducing gas use. No energy-saving measures are in place, despite the concerns of the interviewees (1,2,3,5 & 6). Energy use for the facility operations is therefore rated as a concern but without effective measures in place (1).

4.2.3.2.3 Solid, Liquid and Gaseous residues

Solid waste generation is currently not measured. The majority of the waste is likely to be paper generation and packaging materials for items brought into the facility, such as computers or snack foods. These are concerns that the company is aware of, even making attempts to measure the amount of paper that is recycled as opposed to disposed of in land fill. A mark of 1 is hence appropriate as concern is evident but no effective measures are being taken to reduce this impact.

Liquid residues are all dealt with by the water board who deal with waste water (Anglian Water, in this case). The only inorganic liquid residues are in the cleaning of toilets and kitchens etc… These are performed by a subcontractor who is free to use whatever products they choose. Company policy could require these firms to use natural cleaning products such as Ecover (readily available across the UK) and to provide organic detergents for hand-washing. Resultantly a rating of 1 is awarded for this area of the SLCA.

The air-conditioning unit operates on a modern fluorocarbon alternative to CFCs but this still persist for long periods in the environment and is not as ideal as a building designed to provide air-conditioning naturally. These are the only major gaseous emissions from the site and resultantly a rating of 2 is given as the unit is effective at reducing emissions in comparison to a traditional CFC unit but is not measured and therefore hard to determine whether or not improvements are being made.

4.2.4 Site and Service Closure

Just as with the Site development ADL, as the lessee, passes responsibility for any environmental impacts once they leave the site onto the landowner. The landowner is then able to re-let the office to a new organisation without much need for alterations and their resultant environmental impacts. The infrastructure will also remain the same so the incoming organisation does not have to account for emissions from the installation of new infrastructure. Material and energy use for moving to a new office may be high, due to transportation requirements and packaging of sensitive equipment such as computers. This will need to be monitored to ensure it is as environmentally conscious as possible. This, however, would be included in the life-cycle assessment of the new facility. Solid waste generated from moving and gas and liquid residues will be negligible, hence a rating of 4. It may be necessary to monitor the amount of solid waste generated from destroying files.

4.3 Summary

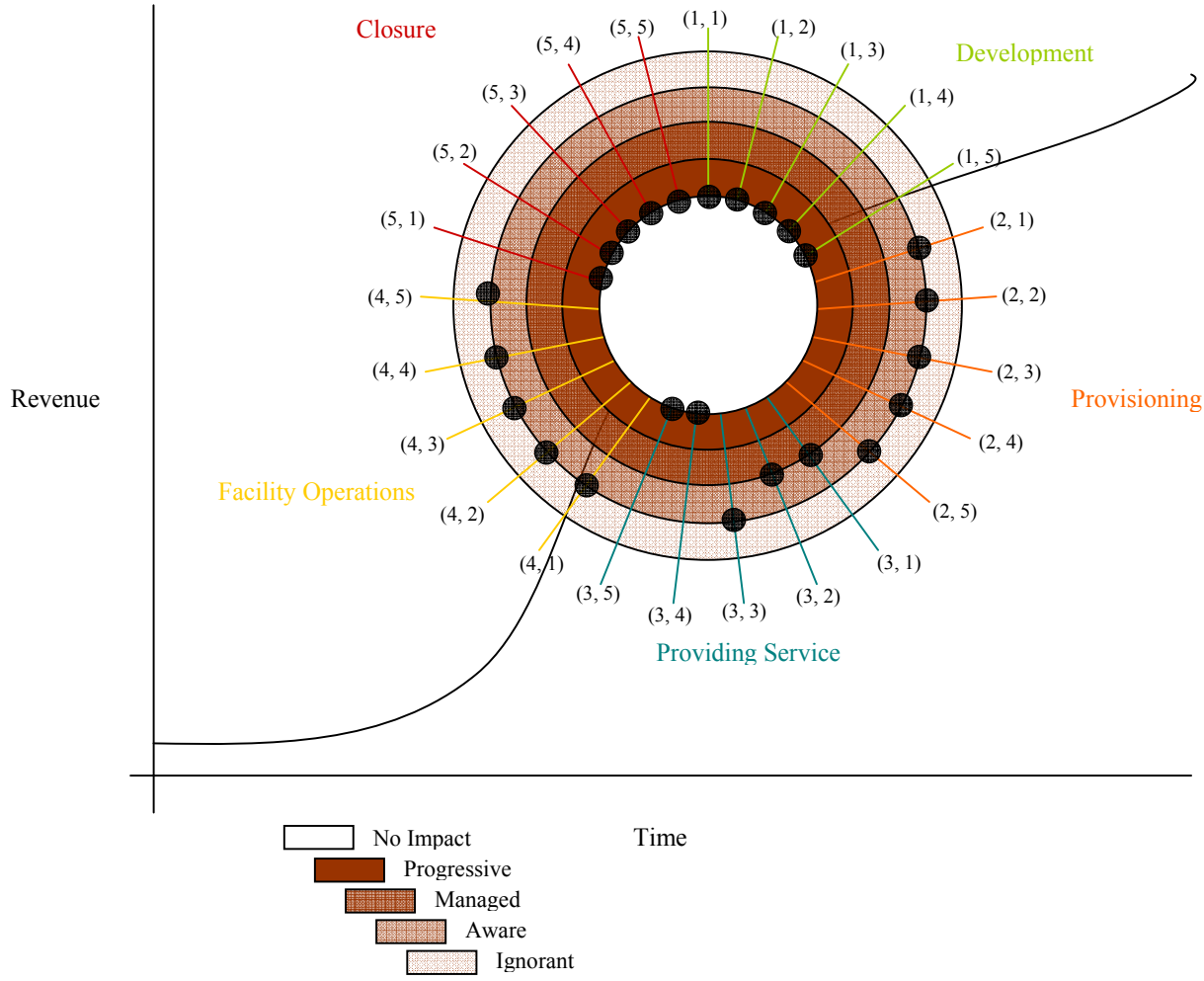
The results are summarised in the table below showing the individual score for each sub category of the matrix. The matrix tables are then presented as target plots to aid visualisation of the key areas of concern. Example plots of an environmentally responsible and an environmentally irresponsible firm are included to gauge the activities of ADL.

Table 4.3 Service Assessment of Arthur D Little

	Environmental Aspect					
Life Stage	**Material Use**	**Energy Use**	**Solid Residues**	**Liquid Residues**	**Gaseous Residues**	**Total**
Site and Service Development	**4**	**4**	**4**	**4**	**4**	**20**
Service Provisioning	**1**	**1**	**1**	**1**	**1**	**5**
Performing the Service	**2**	**2**	**1**	**4**	**4**	**13**
Facility operations	**1**	**1**	**1**	**1**	**2**	**6**

Site and Service Closure	**4**	**4**	**4**	**4**	**4**	**20**
Total	**12**	**12**	**11**	**14**	**15**	**64**

Figure 4.3 Service Assessment Target Plot of Arthur D Little



It must be noted that, due to the rating scale used, this does not present an indicator of the conditional metrics of ADL. Rather, the matrix shows the attitude of the organisation towards the abatement of these effects and what measures have been taken towards implementing a reduction strategy.

5. Analysis

This section of the thesis will present further insights into the data presented in the results section. It is more practical to deal with individual aspects and impacts as opposed to looking at the individual characteristics across the five stages identified in the life-cycle analysis. Consequently this analysis is divided into the following environmental concerns: material use; energy use; and solid, liquid and gaseous residues.

5.1 Material use

As shown in the streamlined life-cycle assessment matrix (Table 4.3) material use is an environmental concern with one of the lowest aggregate scores (12). The purpose of the 5 rating criteria used in the matrix is to highlight the environmental aspects that require the most attention. By highlighting the aspects that are not measured or where a visible improvement is not being made the most neglected aspects can be focused upon. And so it can be inferred that the lowest scoring area requires the highest attention, i.e. material use and solid residues.

The development phase across all five environmental aspect areas, including material use, was a benign influence on ADL's environmental performance. The offices are rented and subsequently the owner is environmentally responsible for these actions, as Arthur D. Little were not affiliated with the site during its construction. The lessee can attempt to influence the facility operations stage, such as property maintenance and the communal resources provided for the science park as a whole. During contract negotiations a firm may influence the operations of its subcontractors (for which a landlord could be classed in this situation). The organisation's policy should stipulate that they seek contractors who are environmentally sound and could suggest the use of a similar semi-quantifiable tool to aid in the evaluation of any subcontractors' operations.

Material use in the Service Provisioning stage was a concern highlighted in several interviews (1, 2, 3 & 6). It has a knock on effect on the solid, liquid and gaseous residues too. If a definite policy towards choosing equipment and supplies from environmentally responsible suppliers is enforced then the resultant waste products that this equipment generates will be reduced. The selection of fittings that are ecologically sound will also reduce any energy use connected to their operation. So provisioning has a complex rôle in our model as it interacts with later stages of the life-cycle assessment.

When providing the service, material use is relatively low being confined to mainly paper use. As previously mentioned, if purchasing is made environmentally responsible the material use at all other stages can be reduced as it becomes more efficient (e.g. duplex printing). Purchasing of recycled paper is also an effective way of reducing the material use during this phase of any gamma-type organisation. It is important to note that reducing material use to zero in the 'paperless office' is a long way off (Interview 6). Interview 6 made known that paper use is positively encouraged in Arthur D. Little as it can encourage and foster cognitive ability whilst at work and creates a tangible product of work undertaken by said employees.

The use of material within the facility operations was found to be an area of concern for the employees interviewed. Most of these services, such as grounds keeping and cleaning are performed by other beta-

type service providers. This aspect can be mediated during contract negotiations with sub-contractors; if contractors were unwilling to supply their own environmentally-sound materials to be utilised within the offices, the company could provide its own, bypassing this problem. By monitoring how much of the individual products is used it would be possible to make further recommendations once it is being measured.

During closure the site is reuse-adaptable and so requires little material use in closing the service there. If the company were to relocate then it would require materials to package goods to be moved and the use of materials (petrol) to transport the goods. This, however, would be included in the life-cycle assessment of the new facility under the development phase.

5.2 Energy Use

Much coverage has been given to CO_2 emissions in recent times due to its strong connection to Global Warming. The interview with Martin Scutt revealed that energy was purchased from a local supplier who has recently introduced large increases in prices due to increasing raw material costs. Resultantly gas prices rose 29% from September 1st 2004 and electricity prices rose 19% for daytime usage and a staggering 47% in the evening. The energy sector in the UK has warned of further rises due to increased prices of coal and oil and the UK has started to import gas from foreign markets as the North Sea gas and oil fields are starting to dry up (reference). Energy usage statistics for the previous year-to-date can be seen in table 4.1.

These increased prices have created a strong business-case for switching to alternative suppliers. All major energy suppliers in the UK now offer a sustainable alternative to energy provision (with generation being made from renewable resources such as wind). This adds another element of complexity in the system that we are seeking to analyse as nuclear power emits no CO_2: but should it be classed as sustainable? The depleted uranium is very dangerous and costly to dispose of but the full implications of nuclear on our environment are not easy to quantify as it falls into the third category of risk as previously outlined in Adams' work (1995). The unknown, or virtual, risk involved is, as yet unknown, and so little can be said other than to state a preference for renewable, non-nuclear alternatives.

To gauge an overall opinion of savings that can be made a comparison needs to be made. If we examine a similar gamma-type service provider in Cambridge we can contrast and compare energy usage to see whether ADL is performing well, relatively. ARM (Advance Research Machines) are one such firm. They provide the architecture for the manufacture of semi-conductors. A theoretical exercise, where nothing is actually produced other than a design. There are over 500 employees on their Cambridge site (ARM: 2004) and energy use is around 3.8×10^6 kWh (7,600 kWh per employee). Conversely, Arthur D Little has 70 employees based at their Cambridge site and consumes 5.6×10^{-5} kWh (8,030 kWh per employee) so, it can be said that, Arthur D. Little' electricity consumption is relatively in-line with other similar firms in the region.

ADL gas use, however, is a different story. ARM consume 8.8×10^5 kWh of gas for heating purposes (1,760 kWh per employee). ADL, on the other hand, use 5.5×10^5 kWh of gas (7,900 kWh per employee). It must be noted that ARM moved into purpose built facilities in 2002 and the design is aimed at reducing spending on heating etc… If energy saving measures similar to the one's employed

for the ARM offices were implemented in an office for ADL, gas expenditure could fall by a factor of 5. This would save the organisation somewhere in the region of £6,000 per year, savings that could be used to offset any investment in the energy saving efforts.

5.3 Solid, Liquid and Gaseous Residues

The majority of the solid residues in a gamma-service industry are likely to occur during the facility operations and provisioning of the service. Packaging of items during transit, e.g. laptops for delivery, for use in the office can be quite bulky, containing cardboards and frequently Styrofoam. But as there are a relatively small number of deliveries for a small-medium enterprise it is unlikely that they will be disposed of safely as there is never enough bulk to justify taking it to a recycling centre. In fact it may be that the environmental impacts from tail-pipe emissions generated by driving to the recycling centre to deposit one box will have a larger environmental impact than the deposition of the waste in a land-fill.

However, Arthur D. Little and the other companies that operate on the science park have a strong influence over the way that the science park is run. If a consortium of companies were to club together and organise a weekly collection of recyclable goods, this could initiate a good forum to begin discussing collaboration and resource sharing to increase environmental efficiency in many other areas. Any proactive measures taken may also encourage the council to initiate similar schemes in other areas leading to a reduction in the regions environmental impacts.

As mentioned previously, the liquid residues can be limited by careful purchasing during the provision stage. Cleaning fluids are the main concern here. But many alternatives exist on the market. In the UK Ecover, a company established 20 years ago to provide ecological sound detergents (see www.ecover.com), provide non toxic alternatives to the bleaches and traditional surfactants used.

The Institute for Applied Environmental Technology at the University of Göteborg (Sweden) carried out research on the toxicity of detergents for water life in 1996 (Ecover: 2003). The 25 top selling detergents in Sweden were examined closely during the test. As Sweden was a pioneer in the area of ecological detergents, all of these products (with one exception) bore one of the two Swedish environmental labels. Ecover turned out to be the only detergent entitled to carry the description 'not toxic for aquatic life'. Compared with Ecover, the toxic materials content in other detergents was several times higher. Ecover washing up liquid was compared with the market leader's washing up liquid on the basis of internationally recognised OECD test methods. This turned out to be no less than 40 times more toxic than Ecover.

The Gaseous emissions connected with Arthur D. Little come mainly from the energy use (and resultantly, will not be touched upon here) transport use and air conditioning units. As outlined below, transport is a complex issue that is not described or explained sufficiently under the five-factor system currently employed. Air-conditioning units should now all have moved away from using CFCs, ozone depleting substances, to HFCs – a more benign, although still harmful element. This has occurred at ADL, but measures of how much HFC is emitted may prove to be a useful metric for reducing the impact of these activities. However, cooling needs are mush lower than transport needs, which will prove to be the largest hurdle in dealing with beta and gamma-type service industries.

5.4 Transport Use

This is an additional factor to be considered in the operation of gamma-type services. Although the influences of any transport use upon the environment are included in the sub-sections listed here it is likely to be one of the major factors influencing a gamma-type service sector organisation. Therefore, any further replication of the methodology used here might like to acknowledge this and count transport as a section in its own right.

Arthur D. Little uses a computer based system for managing all of their expenses. At the end of the week employees not only record the number of hours spent working on various projects but also all expenses which need to be attributed to the individual projects. Unfortunately, when a travel expense is registered, the beginning and final destination of the journeys are not recorded. This would be a simple way to generate an indicator for the impact of travel as a table for emissions could then be employed as suggested by Hillman (2004). As can be seen from table 4.2 the only information that can be gathered under the present system is the expenditure on differing types of transport as opposed to the impact of these transport elements. But a problem highlighted during the interviews is that in order to generate this metric it would require the participation of all members of staff when submitting their expense sheets. Although it would allow later analysis of data based roughly around distances travelled and mode of transport employed, encouraging employees to enter another two fields of information for every transport cost might not be straightforward. The person placed in charge of generating a final figure for CO_2 would then have to calculate the distances travelled, although there may be many repetitions of data, there are over four and a half thousand individual claims for travel expenses. This would become a laborious task, but a necessary one for all gamma-type service sector firms due to their heavy reliance on transport (Kander & Lindmark 2003).

5.5 Using the SLCA

Transport use should be isolated from material and energy use as well as the gaseous residues that it emits and dealt with in its own right. It is also likely to prove to be a major area as the expenditure results indicate (table 4.2). With such a large amount of travel it may appear problematic to encourage staff to enter such detailed information and then how can it be reduced without impinging too much upon the activities of the business. But in order to reduce the negative impacts of the organisation to within the limits set by nature will require serious change. It may not require a company to actually alter its travel activities to increase its score on the SLCA, just to measure it. This encourages use of the SLCA in the short-run as targets appear more achievable as it rewards intentions as well as actions.

If the organisation employ a metric for transport use this positions it in a positive situation if it needs to cut back on this aspect. If the government introduced a carbon tax on all emissions, the organisation will already have a metric in place, encouraged by the SLCA, which is already monitoring these impacts. They can then be reduced, pro-actively and can produce a competitive advantage as adaptations to working in a sustainable enterprise will be under way. Often market leaders gain an edge when they can gather a large customer base before competitors become involved and gather good media coverage. So the SLCA can also be used as a barometer to measure a company's ability to react to and deal with future environmental constraints and any risks that this may incur.

The addition of transport aspect to the three areas of concern the SLCA has highlighted; solid residues (waste), energy use and material use (mostly attributed to purchasing), covers all the major aspects of a gamma-type service sector organisation. Individual metrics for these areas can then be established to monitor and optimise the facility's environmental impact (Graedel: 1998).

The SLCA can encourage employee participation in environmental reduction if it is communicated effectively. As it is a very visual representation it can encourage meeting any targets set by metrics in place. By encouraging a firm to increase its score towards 100 (total sustainability) the size of the circle can slowly be reduced as firms move towards measuring and reducing environmental impacts.

The SLCA can also be used as a decision making tool. This can best be illustrated with the example of energy use. In our case-study, let us assume have a decision to make about choosing a new energy supplier and had a choice of two alternatives; a cheaper, gas-fired power generator or a green-energy supplier providing energy from wind turbines at a slightly higher price. The price factor would, traditionally, have won the argument and the gas-fired alternative would be chosen. But with the use of the SLCA we can see that by switching to a green supplier will change the energy use column of the matrix to read 4 across the board – negligible impact. This is assuming that heating is generated by the same source and that transport use is confined to a separate aspect area. This would create an 8 point increase in their SLCA score, it is currently 12 out of a maximum 20. This may encourage the decision makers to choose the green option.

5.6 Wider Implications

But, in order for an increase in an SLCA score to be given serious credence by mangers and organisations it must be given weighting by the outside world. Encouragement through governmental policy, local and national, could be one way of implementing the widespread use of an indicator of environmental impacts. Through the use of such environmental tools the government could subsidise any improvements made or tax any existing environmental 'bad's. The SLCA is presented here as one alternative in a myriad of tools currently in use. The SLCA is particularly appropriate for use in service-sector organisation where industrial metrics such as the toxic release inventory (TRI) do little to measure or describe the environmental aspects and impacts of these organisations. But it may be more appropriate to use a different tool to measure a construction firm, for example.

If the GRI and ISO continue to refuse to produce cut down versions of their environmental management systems, many small to medium enterprises will not be able to incorporate their systems. This then leaves a wide gap for a streamlined system to be implemented that is quick and easy to implement and with enough benefits to encourage small to medium enterprises to incorporate it in their operations.

5.7 Summary

The SLCA has been applied to the case-study and the results analysed to produce four key aspects that require attention. These four aspects are energy use, material use, transport use and solid residues. If Arthur D. Little wishes to manage their environmental impacts the matrix highlights the key areas where metrics need to be developed.

6 Conclusions

At present the environmental impacts of service sector organisations are being paid little attention. This paper shows that this is a concern that can no longer be ignored due to the vast quantity of such organisations and their impacts. In particular small-medium enterprises are extremely important as they do not have the resources of larger organisations to use the pre-existing indicators to measure their impacts. By presenting a modified version of a streamlined life-cycle assessment, the thesis has shown that it is possible to isolate areas that need the most attention in order to focus resources and efforts towards these areas.

But without the widespread use of some form of tool, whether it be the one presented here or another different but equally well-suited tool, there will be little ability to measure companies' improvements. Within sector, cross-sector and international measurement are necessary for us to monitor our impacts and iterate towards the eventual goal of a steady-state economy (Daly, 1996).

7. Bibliography

Adams, J., 1995. Risk. London: UCL Press.

Galbraith, J. K., 1987. A History of Economics: The Past as the Present. London: Penguin.

Global Reporting Initiative, (2002), *Sustainability Reporting Guidelines*, Boston: GRI Interim Secretariat.

Graedel, T.E., (1998), 'Life-Cycle Assessment in the Service Industries', *Journal of Industrial Ecology,* Vol.**1** No.4, 57-70.

Harris, J., (2002), *Environmental and Natural Resource Economics: A Contemporary Approach*, Boston, MA: Houghton Mifflin.

Von Helmholz, H., (1995), *Science and Culture: Popular Philosophical Essays* Chicago: University of Chicago Press.

Hoy, D., (1978), *The Critical Circle: Literature, History, and Philosophical Hermeneutics,* in Mueller-Vollmer, K., ed., *The Hermeneutics Reader* (1985).

Kander, A. & Lindmark, M., (2003), The Environmental Kuznets Curve – based on too short time series? Working paper, available from: astrid.kander@ekh.lu.se.

Kwiatkowska, T., 2001. Beyond Uncertainties, Some Open Questions about Chaos and Ethics. *Ethics & the Environment* **6 (1)**, 97 – 113.

Meadows, D., 1972. The Limits to Growth, A Global Challenge; a Report for the Club of Rome Project on the Predicament of Mankind. Universe Books: New York.

Munasinghe, M., (1992), *Water Supply and Environmental Management.* Boulder, CO: Westview Press.

Munasinghe, M., (1995), *Implementing Sustainable Development: The Rôle of Environmental Economics*, World Bank.

Polanyi, K., (2002), *Great Transformation*, Boston, MA: Beacon Press.

Schumacher, E.F., 1973. *Small Is Beautiful: Study of Economics as if People Mattered.* London: Vintage.

WCED, (1987), *Our Common Future: The Brundtland Report.* New York, NY: UN.

White, L. Jr., 1967. The Historical Roots of Our Ecological Crisis, in: *Science*, **155**, no.3767, 1203-1207.

Williams, E. D., Ayres, R. U. & Heller, M. The 1-7 kilogram microchip: energy and material use in the production of semiconductor devices. *Environmental Science and Technology*, Published online, (2002).

Wuori, M., (2003), World View and Reality: The Present and the Future in a Historical Perspective. Lecture series given at Lunds Universitet to Masters in Environmental Science, [10th & 13th October 2003].

Yin, R.K., (2003), *Case Study Research – Design and Methods,* Thousand Oaks, California: Sage.

8. Appendices

Appendix I – Interviews.

8.1 Interview 3 – Alan Marples

3 Key environmental aspects established:

1) Travel
2) Energy Use
3) Purchasing (e.g. IT equipment)

It is possible to use quantity of travel performed on behalf of a business as a proxy for economic activity. The financial sector often use this as a valid indicator of the general health of a company as a well-performing firm will travel more to generate new business, meet potential employees at recruitment fairs etc…

Current cost reporting measures only the financial impact and does not include the distance of a journey made or to which project energy use is attributed or purchasing, for that matter. There already exists stigma attached to filling in of forms. If employees are asked to enter even more data there may be a negative reaction.

Energy use should be no better or worse than any other firm within the same sector. A possible measure of CO_2 in kg.employee^{-1} may be a useful indication of energy efficiency over time but would not indicate how this relates to economic productivity.

Does the advent of increased communications actually reduce travel? It actually drives the production of computer technology and its subsequent logistical implications. Many computers are assembled from components manufactured world-wide. The majority of microprocessors are manufactured in the Asian-tiger economies of South Korea, China and Taiwan. The subsequent transportation requirements that this global manufacturing process necessitates may well out weigh any savings in transport through the use of email and conference calling.

Interview 4 – Greg Saunderson

Criteria for purchasing of IT equipment are currently not explicit and decisions are now based on performance and price. However, the competition between rival computer manufacturers is tight and little differences appear between price and performance across the variety of products of these firms. Resultantly, Mr. Saunderson welcomed any policy for responsible purchasing as it would enable him to justify his purchasing decisions more readily and align itself with the company's environmental policy (as stated below).

"We will measure and minimise the consumption of non-renewable resources, waste and pollution associated with our business activities."

The manufacturers mention many details about their companies on their corporate websites, however little environmental knowledge is accessible. Concerning the end-life of products, extended producer responsibility is being mentioned within increasing frequency. Components purchased without a take-back policy are often sold on to staff members and stakeholders from the local community but all consumables for printers are recycled, as well as the printers themselves.

Interview 6 – Stephen Watson

"What gets measured gets managed". Environmental management systems such as ISO14001 and EMAS are not really attractive to ADL as they require a long time to implement and then do nothing to indicate the state of the actual environmental impacts of an organisation, only ensure improvement.

Mr Watson highlighted the client based nature of the work undertaken by ADL and as a major stakeholder; client requests are one of the most important driving factors for ADL's activities. Oftentimes clients may even purchase flights etc… for ADL staff as the client may have a discounted rate with an airline. The political business environment of the sector encompassing ADL often requires travel. If ADL were to operate a 'no-impact' business they may be pushed out of the market by competitors who were willing to meet the travel requirements of their clients.

The concept of a paperless office was also mentioned. Many published documents are available in electronic format and do not require any printing or paper use. They are electronic and use only energy and the existing communications infrastructure to be transferred. Often case-books are required to be kept as a safe method of recording all work done on a particular project and this would not facilitate a paperless office. However all paper that is used has a high recycled content and is itself recycled at the end of its life. Confidential materials are shredded and recycled by a private-sector waste removal firm. Justin Keeble created a metric to measure the amount of paper used in the office and the percentage that is recycled, however this was only performed once.

Only ⅓ – ½ of all employees are in the office at any one time due to client-work, flexi-time and recent distance working, whereby all employees can work from home if appropriate. This makes it extremely hard to quantify energy or material use, but it does offer the opportunity for reduced transportation impacts. As the staff have the ability to work from wherever they like, redundant commuter journeys can be eliminated. However flexi-time also reduces the ability to lift share as two employees may be neighbours but are unable to travel to work at the same time.

Mr Watson also emphasised the specialist nature of services today. ADL do little beyond their business remit, i.e. cleaners are subcontracted as are ground staff and their offices are in a leased building. This creates complications when trying to analyse the environmental impacts of their activities as asking the cleaners to monitor their solvent emissions to water is a little unrealistic.

Highlighting decision drivers is a key area in analysing problems. With respect to travel decisions, Mr Watson ranked them in the order of personal preference, cost and then environmental benefit. Many employees will choose the train over the car for the ability to continue to work whereas one can only make phone calls if you are driving. Keeping costs down is always a key factor involved in any project and this leaves the environmental consequences in third place.

Responses to environmental concerns can be both reactive and proactive. For example the use of CFCs has been abolished (practically) however there existing use in air conditioning systems is not outlawed. A firm could either; remove these units and replace them with what are considered to be more benign air-conditioners or wait until they are forced to do so by legislation and its subsequent enforcement.

Interview 7 - Rick Eager

The only Environmental Performance indicators that ADL really need to worry about are the ones necessary as pre-qualification steps. For many governmental projects there needs to be both an equal opportunities and environmental monitoring. This means that 80% of all clients are uninterested in indicators, especially when they are supplying consulting services from a practice other than environment and risk.

The business case for any metrics or indicators used would have to weigh up the effort and the cost against the benefits and how 'fit-for-purpose' the data proved to be. Marketing communications would be able to employ the data for use with both clients and during recruitment. A major consideration for the environment and risk practice is that many members of staff are interested in environmental issues and to be employed by a company that does not measure its own environmental impact seems a little duplicitous. The argument is often that ADL advises organisations with larger impact environmentally speaking and so ADL's impact is actually negative due to the benefits of the work they perform.