An Evaluation of the Sustainability of the Tramlink in Croydon

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Thesis submitted for Master of Philosophy (Town Planning)
ABSTRACT

This thesis is a descriptive analysis of the sustainability of the Croydon Tramlink, using indicators as the bases of the examination.

A sustainable transport system is vital for the wellbeing of society. However the present British system, with the emphasis on road building rather than improving the dilapidated public transport network, is experiencing problems on an enormous scale. Current Government policy such as Transport 2010 has been heavily criticised and is in urgent need of review.

The rise of the concept of sustainability has increased awareness of transport problems and of the disastrous consequences if predicted trends of growth in cars materialise. Whilst the concept of sustainability has generally been accepted in modern society, debate continues about the implications of sustainable transport, and how best to improve the situation.

The main objective of the report is to evaluate the sustainability of the Croydon Tramlink within environmental, social and economic sub-contexts. Indicators for each of the sub-contexts shall be drawn from the literature review in preparation for the analysis. Case studies of European tram networks are also introduced to allow for any comparison between the performances of systems.

The research paradigm is of a positivist nature and this is reflected in the choice of a survey to collect primary data that is allocated into categories under a quantitative approach. Secondary data is also presented to add weight to the arguments.

The analysis argues that the Croydon Tramlink is a highly sustainable mode of transport and one key inference is that more networks should be considered across the country. Other conclusions include changes in policy reform and social values as attempts to highlight the benefits of sustainability to both natural and human environments.
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1.0 INTRODUCTION

1.1 Report Structure

The research report is divided into six parts:

I: Introduction
II: Literature Review
III: Methodology
IV: Results
V: Analysis and discussion
VI: Conclusion

The introduction gives a brief background to the thesis and discusses the research problem and questions. The literature review considers the concepts of sustainability and sustainable transport and introduces the indicators of sustainability that will be examined later on. The methodology outlines the research paradigm and the theoretical bases of the report.

The results are predominantly presented in tabular form and consist of primary and secondary data. These will subsequently be analysed and the research questions answered. Concluding remarks will summarize the findings of the investigation and suggest further spheres of study.
1.2 Background to the Research

1.2.1 Setting the Scene

"In the autumn of 2000 British transport policy finally blew up in the government's face. Problems which had festered for decades erupted in crisis: a series of well-publicised train crashes on Britain's underfunded and recently privatised railways coincided with a Poudjadist-style uprising of farmers and lorry-drivers, angry at the high price of petrol and diesel fuel. The travelling public felt that they were paying too much for a wretched and dangerous rail service. To make matters worse for the hapless government, the weather conspired against it and Britain had the worst floods for half a century; Britons were wet, angry and immobilised."

(Bagwell & Lyth 2002, p.IX)

One of the principal icons behind personal mobility is the motorcar. For several decades it promised the sense of freedom people desired, promoting a world of speed and convenience with the aspiration that owners could go where the road took them. Given these alluring qualities, it is not surprising that people around the world enthusiastically embraced the dream of owning a car. Only after the publication of the Brundtland Report in 1987 was the public awareness for the concept of sustainable transport raised. It started to become apparent to wider parts of society that the potential of the car to fulfil travel aspirations and enable greater choice of where people live, work and spend free time was offset by its contribution to some of the most severe economic, social and environmental problems which society now faces as a result (ibid.).

For societies that have built their transport systems around the fulfilment of such desires, the actuality of the automobile provokes a much harsher reality (Lowe 1990).
Engine produced air pollution is a widely perceived consequence of car use, but there are broader issues such as quality of life for those without cars. When the car is the dominant mode of transport for any society, those without access to cars, such as the poor, the elderly, the disabled and children, have only restricted transport options. This is exacerbated by the provision of roads making non-car transport options (with the exception of buses) even less likely (ibid). Road provision uses up land that could be used for walking, cycling or other uses not associated with transport, such as agriculture and tourism, which may have great economic benefit. In his book *Transport in Transition* Peake (1994) examines the effects of the current problems of growing car traffic, general motorized mobility and the accommodation of global trade. He concludes that it is leading to:

- climate instability (through global warming and the depletion of the ozone layer);
- air pollution (from engines, factories and power stations): this can take the form of various gases (as displayed in the table below);
- resource depletion (loss of the fossil fuels-coal, oil and gas-and timber)

These facts challenge the feasibility and wisdom of meeting unbounded transport growth with purely technological palliatives. Yet on the other hand, the benefits of the car include improved economic wellbeing and enhanced levels of social welfare and mobility for drivers.

It has been established the car as it exists today is unsustainable. This mode of transport does not contribute towards fostering and promoting the general welfare, creating and maintaining conditions under which man and nature can exist in productive harmony, and fulfil the social, economic, and other requirements of present and future generations (US Federal Government 2002). The search is on for sustainable modes of transport to replace the popularity of the car.
Historically transport issues have for decades been disregarded, by both Conservative and Labour governments alike. The result of this negligence is that Britain, once the birthplace of the world’s first steam locomotive, now has a sadly dilapidated transport system. It has the most clogged-up roads in Europe, a rail network infamous all across the world for its elaborate excuses for delays, the appallingly overcrowded London Underground and buses used predominantly by the socially excluded (Winkley 2001). On all such transport networks the evidence of increasing demand, coupled with under-investment and bad planning (or no planning at all), is all too clear. Indeed, according to a Planning report, the UK does not have an integrated transport network; instead it has several badly run, under-funded modes going their own sweet way (ibid). The chairman of the Commission for Integrated Transport, Professor David Begg has described the transport malaise as “a situation that forces people into their cars whether they want to or not” (ibid).

At a local level, the deleterious side affects of the neglected public transport systems are:

- loss of community ‘spirit’: street life retreats behind closed doors;
- continued social problems (health of those living by busy roads and congestion)
- social exclusion and immobility for people who do not drive

1.2.2 Latest Update

Until recently transport was part of a larger government department known as the Department of Transport, Local Government and the Regions (DTLR). However, given the significance and media coverage of the apparent crises in the industry, the Prime Minister has decided to focus solely on transport, thus creating a whole new department, the Department for Transport (DfT).
"It may have taken five years, but Mr Blair has finally accepted that the task of sorting out Britain's creaking transport system is a big enough job on its own for any one person. (www.bbc.co.uk/politics)

The current Minister for Transport, Alistair Darling is re-examining the government's entire 10-year transport plan, criticised by experts and ordinary travellers alike. The job is arguably very challenging with added pressures of heavy scrutiny; many have tried and failed under the spotlight of media attention. "What is needed in the department of transport is someone who can apply themselves, ignore all the distracting media attention and come up with workable solutions" (ibid.). Yet the problems ahead are complex and include organising the successor body to Railtrack and keeping up the pressure on the railways to improve performance and safety. Public confidence in the railways is at an all time low, with disgruntled commuters and Railtrack shareholders blaming the Department of Transport (www.bbc.co.uk/politics). Mr. Darling has in addition the task of tackling growing congestion on Britain's roads, amid demands for congestion charges and tolls, while still keeping motorists on side. In London there is also the continuing row over the part-privatisation of the underground system.

1.3 Solutions to Car Reliance

The campaign group Transport 2000 argue that car reliance could be reduced if tram systems were more widely used in urban areas and connected city centres to the outskirts (see also Bagwell & Lyth 2002, p.216). Indeed, many important urban rail investment projects are currently in operation in the UK, as part of a new interest in urban rail-based systems. Investments in new trams have taken place in Manchester (Metrolink) and Sheffield (Supertram), whilst other tram initiatives are being built in the West Midlands (linking Birmingham and Wolverhampton) or being considered (between Camden and Brixton). A £290 million tram link is being considered to ferry people between central
London and Heathrow (see The Metro 28th February 2002, p.5). It would take 40 minutes and could get one in five motorists on the route out of their cars.

1.4 Study Outline

With trams advocated as part of a sustainable solution to the current crises the main concern is in how far the tram proves to be sustainable in its every day running. This study investigates the sustainability of a Tram scheme locally on the following dimensions: economically, for example in terms of value for money for passengers; socially, for instance in terms of accessibility; and environmentally, for example in terms of resource usage and pollution. The research case study is the Tramlink in Croydon, completed in spring 2000.

1.5 History behind the Croydon Tramlink

A study carried out by London Transport (LT) and British Rail in 1986, which covered all of London highlighted the huge traffic problems cars were creating in the Croydon area. In 1988, a study was carried out by British Rail and London Transport to identify good opportunities for light rail in the South London area to bring trams back to London. The current routes to Central Croydon from Wimbledon, Elmers End, Beckenham Junction and New Addington were configured. Following this report from 1990 onwards the Croydon Council and LT began to promote the idea of a Tramlink for Croydon.

In 1991 public consultations took place-discussing routes and testing public feeling - 80% of those asked believed the Tramlink to be a good idea (Tramlink Consultation Report 1991). A bill was developed and put to Parliament in November 1991. After a few amendments the Croydon Tramlink Act received Royal Assent on 21st July 1994 giving London Regional Transport (LRT) the legal power to build and run Tramlink. Such powers included the acquisition of buildings, both residential and commercial, to be demolished to provide the Tramlink and stations. Furthermore sites were configured
according to their location within the Tramlink limits of deviation for construction purposes. As with many new schemes, the contract available was a Design, Build, Finance and Operate Concession. The successful consortium was Tramtrack Croydon Limited (TCL) who was given a 99-year concession to run the system. The Croydon Tramlink started fully operating on 30th May 2000, reintroducing street running light rail to London after an absence of almost 50 years (see Figure 1).

Figure 1: Trams outside East Croydon Station

(Source: www.staceyharris.com)
Tracks totalling 28 kilometres in length run largely on an east-west axis through a central loop around Croydon Town Centre (see Figure 2).

![Figure 2: Tramlink Map](Source: www.tfl.gov.uk)

The first part of the system, New Addington to Croydon, opened on Wednesday 10th May; the second part, Beckenham Junction to Croydon, on 23rd May; with the final part, Wimbledon to Elmers End, opening on 30th May 2000 (www.croydon-tramlink.co.uk).

Croydon Tramlink, as previously mentioned, is not the first tram system in Croydon - old London trams used to run through the town along the A23, which was London Road, North End and High Street. The Addiscombe route, branching off the mainline at the Almshouses and running up George Street, passing East Croydon station and into Cherry Orchard Road, closed in 1927 to make way for buses both electric and diesel.

By the 1950s the trams and their infrastructure were past their useable lifespan because, unlike on continent, they were not updated. They made way for buses and cars as part of the scheme Tramaway. The Trams along North End closed in April 1951 (Purley - Embankment and Croydon Grayhound - Thornton Heath).
1.6 Aims of the Study

1.6.1 Research Purpose

The research purpose is to conduct a sustainability study of the Croydon Tramlink transport system. A sustainability study assesses the economic, social and environmental sustainability of a project, strategy or plan, in this instance a transport mode (WWF). This will entail measuring and evaluating various sustainability indicators applied to the Croydon Tramlink, and based purely on its own merits. Through the collation of the results it will be possible to draw conclusions on the successes or failures of the system and lessons that can be learned.

1.6.2 Research Questions

The main research question (see Table 1) evaluates the sustainability of the Croydon Tramlink within the context of the transport crises.

<table>
<thead>
<tr>
<th><strong>Main Research Question</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Is the Tramlink sustainable?</td>
</tr>
</tbody>
</table>

*Table 1: Main Research Question*

Sub-questions (Tables 2 & 3) will be answered within the research process.
Sub-question I
What are the environmental indicators of sustainable transport?

Sub-question II
What are the economic indicators of sustainable transport?

Sub-question III
What are the social indicators of sustainable transport?

Table 2: Sub-questions I, II and III

Sub-question IV
Is the Tramlink environmentally sustainable?

Sub-question V
Is the Tramlink economically sustainable?

Sub-question VI
Is the Tramlink socially sustainable?

Table 3: Sub-questions IV, V and VI
1.6.3 Research Objective

The research objective is to:

- identify environmental, economic and social indicators of sustainability (see literature review)
- evaluate the environmental sustainability of the Tramlink
- evaluate the economic sustainability of the Tramlink
- evaluate the social sustainability of the Tramlink
- evaluate the overall sustainability of the Tramlink

The research approach synthesizes three distinct stages. The first stage involves a review of sustainability indicators, in an effort to gather information on the broad field of sustainability indicators. In a second stage the understanding of sustainability indicators gained from the literature review will be utilized for the selection of transport sustainability indicators. These will then be individually assigned to one of the three sustainability indices; social, economic and environmental identified. In the third stage the findings from the survey and secondary data will be analysed.

1.7 Justification for Study

There are several arguments that support the undertaking of a sustainability study on the Croydon Tramlink. Damning transport statistics impart a generalised overview of current problems in Britain (they are themselves motivation enough to conduct a dissertation on a transport case study). Many of the more common problems are outlined in the table below.
<table>
<thead>
<tr>
<th>25% of main roads jammed for at least an hour a day</th>
<th>Highest proportion of income in Europe spent on transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average daily commute: 46 minutes</td>
<td>Lowest rail subsidy in Europe</td>
</tr>
<tr>
<td>87% of road journeys by car</td>
<td>Only the Greek population walk less</td>
</tr>
<tr>
<td>Fuel tax highest in Europe</td>
<td>Britons cycle less than half the European average</td>
</tr>
<tr>
<td>Rail fares third highest in Europe</td>
<td>Coach and bus use in decline by a quarter</td>
</tr>
<tr>
<td>Delays cost British business more than £5 billion a year</td>
<td>Delays each day equivalent to seven peoples’ entire working lives</td>
</tr>
</tbody>
</table>

Table 4: Transport Statistics (Source: www.bbc.co.uk/news)

In the literature the significance of trams as one of the solutions to Britain’s transport crises is repeatedly emphasised. Corydon’s network is highlighted in particular, whilst there are numerous references for more such systems to be introduced in other areas of the country that would adopt similar working patterns.

"Potentially the most important system is Croydon Tramlink, opened in 2000, incorporating some existing rail alignments, also with street running and new reserved sections, forecast to carry 20 million a year. In contrast to the systems in deregulated areas much fuller pricing and route integration with buses is evident." (White 2002, p.78)

Croydon is the largest settlement outside the capital within the M25 and the Borough itself the most heavily populated. The map below shows the Borough’s position (in purple) within Greater London.
This investigation represents an excellent opportunity to study the system and produce a report that, whilst not groundbreaking in terms of developing new theories, is nevertheless the first sustainability study of a tram system in Britain. From a researcher’s point of view it is submitted that a case study using such a rail system represents an excellent opportunity for an investigation into one such solution for alleviating Britain’s current overcrowded and inefficient networks.

1.8 How the Tramlink came to be Launched

The history of Croydon with its unique conditions provides a backdrop to the decision-making process, construction and operation of tram network.

In 1956 The Croydon Corporation Act was passed, leading to the building of new offices in the late 1950s. At the same time that the Government was beginning to encourage businesses to move out of central London. Croydon, with its excellent rail links, was an ideal site for relocation. In the 1960s the town was booming as an important business centre,
with an increasing number of office blocks being built (especially in the area between Wellesley Road and East Croydon Station). Taberner House, finished in 1967, became the administrative centre of the enlarged London Borough of Croydon, created in 1965.

Croydon also developed its town centre for shopping during this time (the Whitgift Centre opened in 1969). In the same period, Fairfield Halls opened (1962); and a new underpass, flyover, and several multi-storey car parks were built throughout the following decade (www.croydon.gov.uk).

The town continued to flourish in the 1980s, as the largest office and retail centre in south-east England outside central London. At the same time, however, it was often described as inhuman and congested. The reverse side of its success was that too many people were crowding into too small an area and the local transport networks were proving to be inadequate (ibid.). In a context where pre-existing trams and some suburban railway lines had been closed down under Government policy guidelines, social changes such as escalating second car ownership and increased commuter and leisure travel meant that movement patterns and the range of travel options had to be improved in and around Croydon (for a comparative study see Church & Frost, Job Creation and Work-Travel Impacts of Docklands and Regeneration, 1999). These enhancements to travel occurred gradually and the options became more varied due to a number of initiatives. The three most positive influences were the renovation and extension of East Croydon Station (one of the busiest in the country), the development of the extensive Purley Way out-of-town retail and leisure parks, taking some of the pressure off the town centre (Pierson, 2002), and, most recently, the completion of the Tramlink.

The Tramlink’s contribution has been crucial for the changing face of Croydon, giving it particular pertinence. It undoubtedly represents one of Greater London’s largest transport initiatives. As the level of sustainability of Croydon’s boldest venture has yet to be researched, this report will present an original piece of work on a mode of transport that
experts and government alike believe to be one strategy to rescue British transport from its current crises.

1.9 Assumptions

It is important to state any assumptions of the research at the beginning of the report to set the scene:

• "People want more choice, more alternatives to using their cars and more reliable journeys when they do drive. They want a better public transport system that doesn’t let them down. They want better protection for the environment, and they want less pollution because they are worried about their health" (Transport White Paper 1998).

• Any data that refers indirectly to people’s needs can be taken as a reflection of the success or failure of the Tramlink in meeting the criteria of sustainability. For example patronage figures; people do not necessarily need a transport mode that grows in terms of passenger numbers year-on-year, but such data still indicates in how far it meets people’s needs, for if they are met, people will continue to use it.

• Public perceptions are very important in sustainability (…), as the perceived quality is what matters (Berk 1994, 2:2).

• The Croydon Tramlink is a localised system with geographically local effects.

• The Tramlink is being examined purely on its own merits that is "the actual and intrinsic rights and wrongs of an issue" (Collins Dictionary 1993, p.833); in this case the sustainability of the Croydon Tramlink.

• A sustainability study assesses the economic, social and environmental sustainability of a project, strategy or plan (WWF).
• A sustainability study is different from other studies and is not meant to replace other kinds of studies but instead deepen the community dialogue and decision-making concerning the critical issues facing society today. Using the lens of sustainability, environmental, economic, social and individual well-being trends that affect the general population are examined (www.hciflorida.org/news/cysr.html).

• The single market consisting of Tramlink users and the suppliers of the tram; the micro-scale will be studied exclusively. Therefore for the purposes of this study the spatiality of the network and of the area it serves, and issues of the economics of financing and financial viability have been omitted.

• The survey conducted is representative of the population of Tramlink users.

• For the purposes of this study Croydon is defined by the limits of the Tramlink, as shown by Figure 2.

• Any difficulties experienced in finding 500 Tramlink users to participate in this study would already suggest that the Tramlink is not sustainable.

• When analysing transport systems, an assessment of the effectiveness of the system in achieving its objective is an important consideration. A low environmental cost system that achieves nothing useful is just a waste of resources (www.bathtram.demon.co.uk).
2.0 LITERATURE REVIEW

2.1 Introduction

The literature review is concerned with the discussion of relevant literature in relating to sustainability in order to the answer sub-research questions I, II and III on the indicators of economic, social and environmental sustainability.

2.1.1 Purpose

The literature review sets out the grounds for research into the main themes outlined in the opening chapter. "The literature review is an exploration of an area, which at best will provide definition and a framework for a piece of research" (www.lib.unimelb.edu.au). Its purpose is to give a critical overview of the published works and opinions of respected authors and academics in the fields of sustainability and sustainable transport.

2.1.2 Structure

The literature review will commence from the general, theoretical issues towards more specific, pragmatic concerns. This chosen method of deductive logic (Hussey & Hussey 1997) allows a division of sets of ideas, thus maintaining as clear and cohesive an arrangement as possible.

The chapter will begin with a review of the concept of sustainability. The subsequent sections will consider whether progress is being made towards a universal recognition of the need for sustainable transport, for example through a reduction in reliance on the private motorcar. Furthermore, sustainable transport systems at national and European scales, specifically relating to existing urban light rail networks, will be discussed.
Figure 4 outlines the structure of the literature review. At the base apex of the triangle the concluding section will review the indicators of sustainability.

![Figure 4: Structure of Literature Review](image)

2.2 The Concept of Sustainability

2.2.1 Overview

The search for a meaning of the concept of sustainability is ultimately a somewhat thankless task for those expecting clarity, as there are innumerable definitions of sustainability. Sustainable development encompasses an astonishing range of concerns, issues and topics. There is a tendency in the literature to define the concept of sustainability in a way that excludes topics that by rights ought to be included (Humphreys 2000); maintaining a social consensus on the value of the concept of sustainability may well require that not too many questions are raised. Too many authors dwell on rationalising the concept rather than giving it meaning (Duncan 2001).
2.2.2 History

The concept of sustainability has significant theoretical roots in the biology of natural systems (Jepson 2001). Early efforts to define sustainability focused almost exclusively on the relationship between human economic activities and the impact of those activities on the natural environment (Meadows 1977; Hardin 1968). Economists and biologists, interested in the use of models to predict sustainable levels of natural resource extraction, economic production and consumption, conducted much of the early work exploring the concept of sustainability. The volume of information about sustainability and sustainable development has grown exponentially since the 1960s.

Critiques advocating sustainability began to emerge as part of an increasing awareness of environmental degradation in the late 1960s and 1970s (see Figure 5).

Figure 5: The Global Challenge (Source: www.wri.org)

The most important departure of the sustainability concept from orthodox management theory lay in the realisation that economic sustainability alone was not a sufficient condition for the overall sustainability of a corporation (Gladwin et al 1995).
Garret Hardin's essay in 1968, *The Tragedy of the Commons*, focused on the increasing environmental problems of the Earth, spurred in part by the failure of human societies to carefully manage finite natural resources. Hardin (1968) argued that exploitation of a resource by many individuals, without effective management oriented toward sustainable use, would ultimately result in the deterioration of natural resources for which there are no substitutes, leaving all resource users worse off. In 1972 a group of scientists sponsored by the Club of Rome published the study *The Limits to Growth* (Meadows 1977). The study used a mathematical model based on system dynamics to predict the future relationship between global economic growth and global ecological carrying capacity. The model predicted that based on 1970 data, existing rates of population growth, industrial expansion, natural resource stock depletion and environmental destruction would begin to overwhelm global human society early in the 20th century.

Since the 1970s the concept of sustainability has been expanded beyond the economical/environmental dichotomy to include the social dimension of sustainability with the widespread belief that in the long-run sustainability actually requires all three dimensions, social, environmental and economical, to be satisfied simultaneously. There will be an in-depth discussion of the three dimensions of sustainability in another section.

In the late 1980s environmentalism suddenly became a part of the mainstream political agenda, which was in itself a development of some consequence. The idea that limits exist in the capacity of the natural environment to support human activities resulted in a worldwide discussion about how to distribute the (no longer viewed as unlimited) resources of the natural environment. In 1987 the World Commission on the Environment and Development (WECD) issued a report titled *Our Common Future*, more commonly known as the *Brundtland Report*. Most of all though, the Brundtland Report (1987) is notable for the centring of human concern at the heart of the environmental debate, and for the revolution of thought to acknowledge what the concept of equity between generations entails.
By the 1990s, many models were translated into indicator frameworks (United Nations 2002). Out of the discussion about the availability and the distribution of resources, the concept of sustainability begun to take on a functional form to its application in human society, which revolves around the concept of reconciling the “three E’s”, environment, economy and equity (Jepson 2001; Holling 2001). Jepson (2001) characterizes this framework as follows:

"(...) The emerging sustainability doctrine holds that the natural environment can be protected, the economy developed and equity achieved all at the same time (...). What is required (...) is effective balancing of objectives related to these three dimensions." (p.501)

In summary, recent definitions of the concept of sustainability attempt to reach beyond the environment/economy dichotomy, and embrace elements of the human social community.

2.2.3 Defining Sustainability

2.2.3.1 Sustainability and Sustainable Development

One of the ambiguities surrounding sustainability is the question of whether the term ‘sustainability’, or ‘sustainable development’ should be applied. The terms sustainability and sustainable development are often used interchangeably in policy documents and in literature (Maclaren 1996).

"It is considered that both words can be used interchangeably provided the reader understands the relationship to human and ecosystem development over time and so long as it is recognised that
both terms are dynamic in that they allow us to continually adapt
and change as we have naturally done throughout evolution." (AGS;
www.globalsustainability.org)

However, not everybody agrees that sustainability and sustainable development
are interchangeable (Maclaren 1996; OECD 1997). For the purposes of this study, the two
phrases describe different phenomenon. Sustainability is best described as a state or a set of
conditions that persist over time. A community may create a goal of achieving sustainability
in a given period. The State of Oregon’s Executive Order, promoting sustainability in
internal state government operations, directs the State to meet a goal of sustainability within
one generation. Achieving sustainability would require the community to meet a series of
conditions that define the term. These conditions could include social equity, protection of
the natural environment, minimal use of non-renewable resources, economic vitality and
diversity, community self-reliance, individual well being, and satisfaction of basic human
needs (Maclaren 1996). Sustainable development implies a process or series of incremental
changes that move a community toward sustainability (ibid).

Sustainable development can be characterized as a pattern of social and structural
economic transformations, optimising the economic and social benefits available in the
present, without jeopardizing the likely potential for similar benefits in the future (Zhao
1999). Rather than being a principle or a standard, sustainable development is a ‘way of
approach’ (OECD 1997). It is a journey rather than a destination, and the flexibility of its
meaning makes the concept applicable to the full range of policies that accompany society
on this journey. Sustainable development entails a means of acting rather than, as is the case
for the term sustainability, a means to an end.

Using indicators, the choice to measure sustainability or sustainable development
could potentially influence the constitution of the indicator set. A choice to measure
sustainability, as is the case in this study, may favour the selection of indicators that track
the extent to which a set of desired states have been achieved, for example, a non-polluting
transport system or efficient transportation. On the other hand, an indicator set measuring
sustainable development may provide measures of desired states, but would also track
progress of responses to non-sustainable conditions; not only monitoring the state of
pollution levels of the transport mode, but also community efforts (for example spending,
taxation, policy initiatives) designed to reduced pollution.

2.2.3.2 Generic Definitions

Few can contest the contribution that the *Brundtland Report* (1987) has made
towards the universal recognition of sustainability as a concept. Evident in dozens of
sources; it is *the* global definition (NIWA, 2002). In the *Brundtland Report* sustainability is
defined as "meeting the needs of the present without compromising the ability of future
generations to meet their needs" (WECD 1987).

The concept of needs identified in the WECD (1987) definition of sustainability is
ambiguous. The decision about for whom resources are to be managed is ultimately a
political issue because it involves social equity and the potential redistribution of resources
(Gahin 2001).

More recent definitions take their lead from the Brundtland Report. The UK
Government’s understanding of sustainability is that it should ensure a better quality of life
for everyone in the present as well as for future generations (2002).

In the State of Oregon’s Executive Order 00-07, signed by Governor Kitzhaber in
May 2000, the notion of the three dimensions of social, economic and environmental is
introduced to sustainability:

"Sustainability requires simultaneously meeting environmental,
epicomic and community needs" (...) "within one generation—by
2025." (ibid).
In pursuit of sustainability US Federal Government:

"(...) Will foster and promote the general welfare, create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations."

(http://pasture.ecn.purdue.edu)

Two points arise from the definitions given so far: Firstly ‘Future generations’ covers periods of ~25 years and more (State of Oregon, Executive Order 00-07). Therefore sustainability research needs long-term, targeted outcomes. This does not imply that projects need to last 25 years, but it does mean that sustainability research needs to demonstrate a contribution to long-term outcomes. There are three dimensions to sustainability: apart from the social and economic aspects, the environment is an integral part of sustainability. This is highlighted particularly well in the Executive Order 00-07 of the State of Oregon. The Alliance for Global Sustainability (AGS) reflects such concerns:

"Sustainability refers to the ability to maintain and continue that which sustains us, and that we find sustaining. It is a multi-dimensional concept that has environmental, social, political, economic, cultural and spiritual dimensions". (AGS 2003)

2.2.3.3 Criticism

Universal ideas run throughout most generic definitions of sustainability, in which academics or organisations try and relate their own practices to the concept. There is a heated debate over the use of the term sustainability. The AGS (2003) points out:
"Part of the problem is it can mean a variety of things depending on how you use it, the context. From a natural resource perspective sustainability is the ability to continue to use a practice for an indefinite period of time. It's as broad or narrow as you care to make it. There is no parameter on it that it has to be a purely natural process".

Others look past definitions. "Why is it important to have a common definition of sustainability? What will we gain?" said Denise Lach (2002), a sociology professor at Oregon State University.

"Sustainability is like love and democracy—multiple meanings, not always perfectly realized, but always struggled for, at least by most of us. I think we do agree, basically, on what it is. We disagree when we must make specific choices in our lives. I think the major questions are: Who does not want a sustainable society? Why?"

(Lach 2002)

Whilst Lach's argument may seem a pleasantly democratic turn of events for (international) law and the interpretation of rules, it leads to the conclusion that any meaning given to sustainability must be set within a context, in this case transport.

2.2.3.3 All-Encompassing

All the points raised so far lead to the selection of the following definition for sustainability: "Sustainability requires simultaneously meeting environmental, economic and community needs" (State of Oregon, Executive Order 00-07, State of Oregon, signed by
Governor Kitzhaber in May 2000) as out of all generic definitions it encompasses all three dimensions.

2.2.4 Models of Sustainability

Pinder's model of sustainability (1997) explains the concept of sustainability as being the middle ground between the Environment, the Community and the Economy (see Figure 6).

"The area where the three circles overlap is the area of sustainability, the area of liveability—the area where all the threads of a person’s quality of life come together. If we are to ‘have it all’ we must recognize that we have a responsibility towards our world and that these three dimensions are not separate, unrelated entities. Rather they are the common desires and aspirations and we must
therefore strive to ensure that our efforts result in simultaneously meeting environmental, economic and community needs. (Kitzhaber, Can We Have It All?, 2000)

The World Resource Institute (WRI) model (see Figure 7) also has three dimensions of social, economic and environmental with sustainable growth existing in the space where all three meet. The difference between the two models is the terminology used. Pinder (1997) refers to community development whereas in the WRI model it is social dimensions.

Figure 7: World Resource Institute Model
(Source: www.wri.org)
2.2.5 Dimensions

The three ‘dimensions’ of social, environmental and economic described in the Kitzhaber and in the models of sustainability (Pinder 1997; WRI) quote are the starting points for this research. Figure 7 outlines the three main aspects and provides a general overview of the principal factors relating to each dimension. It is possible to elaborate briefly on each and provide more considerations for each.

2.2.5.1 Social Dimensions

Social dimensions denote or relate "to human society and any of its subdivisions" (Collins Dictionary 1993, p. 1275; see Figure 7) and entail (WRI):

- Fair and equal access to information and knowledge
- Participation in decision-making processes that are transparent and accountable
- Shared responsibility among societal actors for creating sustainability
- Profound respect and protection for human rights

The issue of acceptability in terms of sustainable transport further enriches the discussion on sustainability. There are some processes capable of continuation, which are however not accepted politically or by society as a whole. For example solar power in Britain is a source of energy that is environmentally sustainable, but the general population does not embrace it.

‘Sustainable’ has become as uncomfortably vague as ‘good’, meaning both ‘politically supportable sustainability’ and ‘developments that can be continued’ (Humphreys 2000). It is applied to a surprising number of processes, not least significantly ‘sustainable transportation’, and then perhaps more arcane, ‘sustainable deforestation’.
2.2.5.2 Economic Dimensions

Economic dimensions refer to "concerning or affecting material resources or welfare" (Collins Dictionary 1993, p.407). This concentrates on issues regarding the interface of the economy and the biosphere, with the need to arrive at a well-founded conception of what the notion of sustainability implies as an injunction to the economic system at the national, regional and global levels (Opschoor et al 1996). Some of the considerations are: "What experiences and proposals can be used in restructuring economies in a sustainable way?" and "What are the implications of economic development along traditional lines ('business as usual') or along alternative, ecologically restructured ones?" (ibid, 2:1). The following concerns are of relevance (see www.wri.org):

- Continuous improvement in economic wellbeing
- Investment in the infrastructure, goods, and services that improve our lives whilst meeting people's needs
- Greater economic equality; narrow the gap between the world's haves and have-nots
- Meet material and energy needs by efficient use of renewable resources

2.2.5.3 Environmental Dimensions

Environmental dimensions include "external conditions and surroundings" (Collins Dictionary 1993, p.429). The environmental dimension refers above all to the management of natural resources and is defined by the total of renewable resources, seminatural and natural land, and the entirety of other ecological assets (Montgomery, 2001, p.4). Traditionally environmentalists feel proprietary about 'sustainability'. They point to early publications such as in the Ecologist (1972) constructing sustainability as a concept concerned with the protection of the natural environment (Dyllick & Hockerts 2002). Other
authors echo this theme (Meadows 1977; Norgaard 1985). The issues of environmental sustainability are (see www.wri.org):

- Renewal and stewardship of natural resources and natural systems
- Renewable energy and materials and food
- Reduction of environmental footprint
- Doing more with less
- Learning from natural systems

2.2.6 Summary

By combining the definition of sustainability as meeting “(...) simultaneously environmental, economic and community needs within one generation” (Oregon, Order 00-07) with Pinder's model (1997), an appropriate foundation towards defining sustainable transport can be formed as it:

1) invokes a visual picture;
2) is applicable to the research on the Croydon Tramlink;
3) asserts that all concerns need to be confronted and acted upon;
4) acknowledges that sustainability should be treated within the framework of a total system; various dimensions are contained within (see below);
5) suggests that it seems likely that those indicators seeking to blend measures from an environmental, economic and social perspective will be of the most use in evaluating the sustainability of a process.

Whilst the concept of ‘sustainability’ is now part of widely shared public awareness, its implications are that in any given situation and country its context may vary
widely. The next section will further specify the definition of sustainability when referred to a transport system.

2.3 Sustainable Transport

2.3.1 Introduction

Only in the last ten or 15 years has society started to take issues relating to sustainability seriously (The Learning Group 2002). It was not until the start of the 20th century that concepts such as road safety, smog and pollution started to be recognised, although the government did little to tackle the problem (ibid). By today's standards the problems were small, but nevertheless important if a sustainable transport policy was to be adopted in the UK. As more and more roads were built and the traffic increased, the effect on the environment was starting to be noticed, as countryside was lost to road building. Early research in the 1970s came to the conclusion that if capacity was not provided then to some extent demand would shift with changing travel behaviour, which refers to the personal habits of choice of transport mode for a particular journey. By the end of the 1970s government policy had started to promote alternative means of transport such as buses and trains.

By the 1980s the transport sector of the UK had dramatically changed, with much of it privatised or deregulated under the policies of Prime Minister Margaret Thatcher. Many ambitious road schemes had been cancelled and new environmental pressure groups such as Greenpeace and Friends of the Earth became prominent.

In the 1990s various government reports were published and they all suggested much on the same stance that road building and car usage could not go on as they had. Cleaner and greener ('environmentally friendly' in terms of emissions and sustainability methods of transport) were seen as the way ahead. The next important milestone was the 1992 Rio Earth Summit, which led to the introduction of the Agenda 21 legislation (ibid).
Agenda 21 took into account a wide range of issues relating to transport, such as demographic and technological change encouraging a worldwide shift in government policy.

Several reports over the next three years supported the UK Sustainable Development Plan, such as the SACTRA report *Trunk Roads and the Generation of Traffic* (1986). This report criticised the government's traffic forecasting, and suggested controversially that new roads induced traffic.

In 1996 the government's Green Paper *Transport – the Way Forward* indicated an important change in policy, away from roads and towards integrated planning and measures to reduce traffic growth, by making efficient use of existing infrastructure, reducing car dependence and investing in public transport.

Recent developments in sustainable transport since the election of the current Labour regime will be discussed at a later stage under current government policies.

### 2.3.2 Definitions of Sustainable Transport

In 1994 Peter Nijkamp published the paper *Roads towards Environmentally Sustainable Transport*. Although the paper does not give a definition as such it includes some observations on sustainability within the context of transport:

Sustainability "(...) is often narrowed down to environmental concerns, but it has to be recognised that a broader interpretation in terms of balanced (co-evolutionary) commercial, social, ecological, and economic development is more adequate (...). In general, sustainability refers to long-term availability of proper means that are necessary for a long-term achievement of pre-specified goals."

*(ibid, p.261)*
This quote sets the scene for the selection of a definition for sustainable transport and can be referred back to the previously discussed concepts and models of sustainability.

In the beginning of the 1990s publications on sustainable transport failed to offer any operational definitions for sustainable transport (Kågeson 1994). Both the 1992 Green Paper *A Community Strategy for Sustainable Mobility* published by the European Commission (EC) and the 1992 White Paper *The Future Development of the Common Transport Policy* provided no principles or targets related to the impact of transport on the environment (Kågeson 1994). The EC White Paper on growth, competitiveness and employment (1993) is a further example of the lack of an operational definition of sustainability (Kågeson 1994). For the selection of indicators for this research an operational definition of sustainability is needed as a framework.

The review of the literature revealed three valuable sources providing operational definitions of sustainable transport published in recent years: the UK Round Table on Sustainable Development report in 1996, the OECD report in 1997 and a publication from the Centre for Sustainable Transportation in Toronto from 1997.

The UK Round Table on Sustainable Development, established by the UK Government, published the report *Defining a Sustainable Transport Sector* (1996) which though not providing an explicit definition included transport policy objectives for a sustainable transport system (see Appendix I).

In 1997 the OECD produced the Vancouver Conference paper *Towards Sustainable Transportation*. This report was based on Per Kågeson's paper *The Concept of Sustainable Transport* (1994), a comprehensive approach towards a definition of sustainable transport. According to the OECD:

"Sustainable transportation is achieved when needs for access to people, services and goods are met without producing permanent harm to the global environment, damage to local environments and social inequity." (ibid)
The OECD report also included principles for sustainable transport (see Appendix II).

In the same year the Centre for Sustainable Transportation (CST) in Toronto, Canada, published Definitions and Visions of Sustainable Transportation. In the paper a sustainable transportation system is defined as one that (see CST):

- allows the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations,

- is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy,

- limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, reuses and recycles components, and minimizes the use of land and the production of noise.

The chapter What transportation should do to be sustainable elaborates on the social, economic and environmental aspects of sustainable transport (see Appendix III).

The guidelines for a sustainable transport system presented by the three sources fail to mention the most fundamental requirement of a sustainable transport: people utilising the mode of transport on a regular basis. The definition of a sustainable transport system in this research will include the consumerism of the tram as a criterion for sustainability. In addition the following criteria were selected from the range of operational definitions and principles published by the CST, UK Round Table and OECD presented on pages. These were deemed to be most suitable within the context of evaluating a tram system:
1) With respect to social sustainability, a transport mode should:

a) Health and Safety: Meet basic human needs for health (physical, mental and social well-being) as well as safety in ways that enhances the quality of life in communities. (CST, OECD)

b) Access: Give people reasonable access to other people, places, goods and services. (OECD)

c) Equity: Meeting the basic transport-related needs of all people, including women, the poor, the rural, the disabled, and children, nation, states thus ensuring social, interregional and intergenerational equity. (OECD)

2) With respect to economical sustainability, a transportation mode should:

a) Demand: Provide cost-effective, financially affordable service as well as the capacity to ensure demand for the transport mode. (CST)

b) Consumerism: Be regularly and frequently utilised.

c) Competitiveness: Enable the industry to remain competitive. (CST, UK Round Table)

3) With respect to environmental sustainability, a transport mode should:

a) Resource Usage: Make efficient use of land and other natural resources using energy sources that are essentially renewable or inexhaustible. (OECD, CST)

b) Noise and Visual Impact: Produce no more noise or visual impact in terms of design than is acceptable by communities. (CST)
c) Pollution Prevention: Transport needs must be met without generating emissions that threaten public health, global climate, biological diversity or the integrity of essential ecological processes. (OECD)

d) Traffic Flow: Reduce the growth in car and lorry traffic growth. (UK Round Table)

2.3.3 Survey of Public Attitudes

The 2001 Survey of Public Attitudes highlighted traffic (congestion, fumes and noise) as the environmental issue predicted to cause the most concern in the next 20 years. Table 5 gives a brief overview of some of the pollutants created in Britain through for example motor vehicles. With growing concerns over traffic it comes as no surprise that public transport was identified as a key area for government, with an increasing number of respondents mentioning it as a government priority. Without prompting, the proportion of respondents mentioning public transport as an issue for government was three times higher than in 1996/7. The number of respondents mentioning public transport, as an issue the Government should be dealing with, increased for the fourth consecutive survey. The number mentioning public transport rose from six per cent in 1996/7 to 18 per cent in 2001.

Respondents were split over the issue of whether or not there should be more roads being built in the countryside. Support was high for potential government actions that would reduce the environmental impacts of car driving, but respondents were less supportive of actions that would see them paying more money.
<table>
<thead>
<tr>
<th>Substance produced</th>
<th>Resulting affects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Monoxide (CO)</td>
<td>A highly toxic gas formed by the incomplete combustion of fuel; 88% of UK emissions from vehicle exhausts (official UK National Road Traffic Forecasts for the next 30 years depict declining gross transport intensity but still a doubling of gross mass movement)</td>
</tr>
<tr>
<td>Carbon Dioxide (CO2)</td>
<td>Formed by combustion of fossil fuels and oxidation of CO and linked to global warming; 19% of UK emissions from exhaust pipes</td>
</tr>
<tr>
<td>Sulphur Dioxide (SO2)</td>
<td>Produced when fossil fuel is burned and associated with acid rain; just 2% of emissions from road vehicles</td>
</tr>
<tr>
<td>Oxides of Nitrogen (NOX)</td>
<td>Produced when anything is burned and causes global warming; 48% of emissions from UK’s motor vehicles</td>
</tr>
<tr>
<td>Smoke particles and organic</td>
<td>From the burning of fossil fuels these cause problems with respiration and can damage plant life, also cause dirt on buildings</td>
</tr>
<tr>
<td>compounds</td>
<td></td>
</tr>
<tr>
<td>Lead</td>
<td>A toxic substance that can lead to brain damage in humans, emissions have been substantially reduced in recent years by the growing use of unleaded petrol</td>
</tr>
</tbody>
</table>

*Table 5: Types of Pollution* (Macpherson 1993, p.248-9)

Similar surveys and sources are too numerous to mention, with academics, the media and even current Labour Government publications and websites jumping on the bandwagon and having their say about why Britain’s transport network is in such demise. The previous Conservative Government is often made a 'scapegoat'. Rather than continuing to focus on the past and discussing at which point things started to spiral out of control, the literature review shall move on to tram systems themselves.
2.3.4 The Tram - a sustainable mode of transport

"Trams can play a key role in reducing congestion, which is shown in that around 20 per cent of light rail passengers previously travelled by car. In addition to raising the standards of service and quality of public transport, they also help improve the urban environment and contribute to urban regeneration." (Keeble 2001)

Walking and cycling are the most environmentally friendly ways of getting about. They are, however, not always practical, especially for longer or bad weather journeys, for elderly or disabled people, for parents with young children or anyone loaded with heavy shopping (Harding 2003). Light rail systems, such as Tramlink, are regarded as the best public transport choice from the point of view of the environment (Harding 2003).

In comparison to the private motorcar, trams result in both lower congestion and pollution. The energy it takes to run trams is much less per kilometre compared with a car, which makes it a more environmental friendly alternative: trams are run on electricity which can be relatively easily generated from a variety of renewable sources, which is better than petrol and reduces pollution. This makes trams more attractive from a supply security and sustainability perspective (http://bathtram.org/ftp; Murdoch University 2003).

Trams are also a very space efficient transportation mode, which is important since land often is in shortage in cities. They also produce less noise than cars and the noise level becomes even lower if grass is planted between the tracks (Gunnarsson & Lofgren 2001).

"Whilst railways could relieve intercity travel, we believe that it is trams, or light railway systems, which hold the key to urban public transport's revival in Britain in the twenty-first century. They are adaptable to both the suburban and inner city conditions and are
attractive to urban travellers; with dedicated rights of way they have
the reassuring and predictable performance of the train combined
with the accessibility of the omnibus". (Bagwell & Lyth 2002, p.216)

Summing up, in the literature the tram is viewed as a sustainable mode of
transport.

"The electric tramway is almost certainly the most sustainable form
of motorised transport available. The vehicles and track are made
from readily available materials, with very little use of scarce
resources. Most of these materials are recyclable. As well as being
sustainable in term of materials, the tram also fulfils the other major
requirement of a sustainable transport system - it is effective. Trams
have a proven record for getting motorists out of their cars and onto
public transport." (http://bathtram.org/tfb)

2.4 Current Government Policies

UK Government policies are examined on two scales: national, regional and local.

2.4.1 National Policies

Transport until recently was part of a larger government department known as the
Department of Transport, Local Government and the Regions (DTLR). However, given the
significance and media coverage of the apparent crises in the industry, the Prime Minister
has decided to focus solely on transport, thus creating a whole new department, the
Department for Transport (DfT); Local Government and the Regions have since joined to
form the Office of the Deputy Prime Minister (ODPM). In this section the major papers
recently published in response to the demand for sustainable transport will be reviewed starting with Planning Policy Guidance 13 (PPG13).

2.4.1.1 PPG13

In the PPG 13 the Government Sustainable Development Strategy on planning issues is set out. It also provides guidance to local authorities and others on policies and the operation of the planning system. The key aim in the Strategy is to ensure that Councils carry out their land-use guidelines and transport programmes in ways which help to reduce growth in the length and number of motorised journeys, encourage alternative means of travel which have less environmental impact and hence reduce reliance on the private car.

PPG13 states:

"The Government recognises that forecast levels of traffic growth, especially in urban areas, cannot be met in full and that new road building or the upgrading of existing highways will in some cases be environmentally unacceptable. It is Govt. policy not to build new trunk or local roads simply to facilitate commuting by car into the more congested urban centres." (DoE/DoT, 1994)

PPG13 has resulted in new road constructions to provide by-passes and inner ring roads, or the diversion of traffic away from shopping streets; a lot of progress having been made in creating townscapes that are visually attractive and are no longer designed entirely around the motorcar (Macpherson 1993).

However, PPG13 also refers to the car remaining the main source of transport in rural areas. Presumably this is because such regions lack good transport provision and work places nearby. There are more remote parts in Croydon, from where facilities are relatively difficult to reach by public transport. In such areas therefore it must be realised that the car will remain the primary source of transport and will need to be considered.
The policies need to make a significant contribution to the goal of improving urban quality and vitality, and to achieving a healthy rural economy and viable rural communities (PPG13 1994, p.3). It states that they should seek to revitalise traditional urban centres, improve their attractiveness as places to live, work and shop, and maintain their competitiveness (1994 Para. 2.8). Paragraph 4.24 is of particular relevance to this research stating:

"Rail services with their fixed infrastructure (...) can provide a focus for regeneration and comprehensive redevelopment. Stations or light rail stops should be the preferred location for travel-intensive development. Local planning authorities (...) may want to explore the potential for the reopening of rail lines or the provision of new stations or revived passenger services on existing lines with rail authorities in drawing up their plan policies." (ibid, Para. 4.24)

In striving for developments that are sustainable, PPG13 needs to be applied to a wider range of objectives than is currently permitted for it to reach. Further, it should emphasize the importance of funding, via a faster, efficient and more effective decision process (www.bevanashford.co.uk), allowing local authorities more discretion to reflect local circumstances (www.london.gov.uk).

2.4.1.2 White Paper 1998

The Labour Government’s Transport White Paper of 1998 marked a shift in policy. It embodied new, modern thinking on integrating transport with other aspects of Government policy. A greater emphasis was placed on the potential role of public transport, given growing importance attached to environmental issues and an acknowledgement that major road building would not be a feasible option. This led to a wider role for public
transport, both to improve mobility for those without cars (increasing social equity and accessibility) and to act as an alternative to extending road capacity.

"This latter effect is more marked on rail than for local buses, and even so would only accommodate a small part of the road traffic growth otherwise anticipated, much of which will have to be constrained by policies such as fuel taxation, road pricing, etc."

(White 2002, p. 189)

The House of Commons' Environment, Transport and Regional Affairs Committee's report, according to the Friends of the Earth (2003), declared that the White Paper 'A New Deal for Transport: better for everyone' only aims to reduce road traffic growth, and described criticisms of the Government's 'failure to provide for road traffic reduction' as 'powerful'. Friends of the Earth welcomed the endorsement of their position by the report of the influential Parliamentary Committee. Ron Bailey, Friends of the Earth's Parliamentary Campaigner, said:

"The Select Committee has hit the nail on the head. Government policy will allow an increase in traffic levels despite Government commitments to help people use their cars less. Ministers urgently need to set national targets for road traffic reduction to give their policies teeth." (www.foe.gov.uk)
2.4.1.3 Transport 2010

In July 2000 a £180 billion investment package to modernise the nation's transport system, to cut congestion and deliver real choice, was unveiled. The investment programme of public and private cash was to provide £60 billion for railways, £60 billion for roads, and around £60 billion for local transport including London. Over 10 years the aims are to deliver (see www.dtlr.gov.uk):

- reduced congestion on roads
- modernised trains with better services and reduced fares
- a 50% increase in passenger use of the railway
- resources to enable the Mayor to reduce over crowding on the Underground and congestion in London - with £3.2bn investment in the first three years
- 100 new bypasses
- 360 miles of trunk road and motorway widening
- big improvements in rural transport
- better bus services and a 10% growth in passenger use
- up to 25 new light rail projects in major cities
- safer roads and railways
- lower emissions and better air quality

Various sources have condemned this transport policy in the wake of rising road congestion, failing railways and travel chaos. "It's a bit like a heroin addict's last fix. It will feel good at the time, but it's not sustainable" (Begg 2002). The plan boasted that road congestion would be cut and public transport improved, but the government has already had to backtrack on many of its targets. Transport Secretary Alistair Darling recently admitted that, far from being reduced by 6%, congestion would probably increase by up to 20% at the end of the decade (www.bbc.co.uk/panorama). Former government chief transport adviser
Professor Phil Goodwin, adviser on the 1998 Transport White Paper, supports Mr Darling's estimates. He believes that the government are failing to deliver an integrated transport policy.

"The suggestion that you can allow traffic growth to go on unimpeded and still reduce congestion simply was not realistic. If traffic grows faster than the capacity of the system to take it, congestion has to increase." (http://www.bbc.co.uk/panorama)

Professor Goodwin also believes the 10-year plan is doomed to failure and will not deliver on its promises. In the 10-year plan the motorist is not given an alternative form of transport and, at the same time, very little is to be invested into the network (Hounsham 2002). Due to the heavy criticism of the Government's stance the policy is currently being reviewed.

2.4.2 Regional Plans

In accordance with modern Government advice, regional location strategies focus development on existing urban areas as the principal centres for living and working. In March 1994 the Government published updated Regional Guidance for the South-East for the period 1991-2011, advice intended to form the framework for the production of structure and local plans throughout the region. In the White Paper This Common Inheritance, the Government committed itself to the principle of sustainability.

Large developments such as the Tramlink offer significant benefits to the community (through planning obligation) such as improved schools, libraries and other public transport services. It is much more difficult to secure such gains from small, dispersed initiatives, which may be costly to service by public transport, and unsustainable (Town and Country Planning Association (TCPA) 2000, p.1-2).
However, as with most structure plans, the policies sit uncomfortably between national guidance and local plans. Regurgitation of Government advice provides no new insights whilst the policies are not specific enough to deal with issues at a local level, which are in any case provided by development plans (Edwards 2002).

2.4.3 Local Level

2.4.3.1 Croydon Interim Transport Plan

The Croydon Interim Transport Plan 2001/2002 (CITP) sets a local theme on a scale that is crucial for examining the city and its suburbs. It explains that lifestyles and travel patterns have become increasingly car dependant, and that land use dispersal has adapted to reflect this, with out of centre shopping and Government policy, for example the introduction of parental choice for children's education, increasing the number and distance of journeys (CITP 2001/2002, p.1). The integration of land use and transport planning, movement from the concept of 'predict and provide' to 'plan and manage' and sustainability through partnership and consultation are some of the interesting principles outlined in this document.

Many objectives drafted have a direct reference to the Tramlink, including Policy SP21 of the Unitary Development Plan (UDP) that states "The Council will promote the development of an efficient, accessible and reliable public transport system, so as to provide an attractive alternative to the car, by supporting the introduction of the Light Rail System to link Croydon with Wimbledon, Beckenham and New Addington, together with the investigation of further extensions to that network" (Croydon UDP 1997). However, despite the fact that both plans announce extensive consultation and good intentions, neither really goes into great detail about how they are to go about achieving their objectives.
2.4.3.2 Local Agenda 21

The role of local authorities, laid out in Agenda 21, is ‘educating, mobilising and responding to the public to promote sustainable development’ (www.odpm.gov.uk).

In developing local strategies and service delivery plans, the goal of sustainable development will be vital. Audit Commission research into public opinion shows that providing adequate social and transport facilities for young people is the key quality of life issue in Britain at the moment. It ranks lower than crime levels, quality of healthcare and schools when ranked purely in terms of importance, but is the clear leader when people are asked which factors most need improvement in their area. Green issues have a very low profile in this respect.

Then again, some Local Agenda 21 (LA21) officers (who, in many authorities, take the lead on sustainable development and quality of life) report that LA21 has a high profile among people in their area, or that recycling is a key local issue (Hatter 2003). In most areas, this is hard to believe (ibid). Too often, consultation takes place amongst people who have been ‘self-selected’ (ibid.). It is false for officers and members to think that a standing panel of ten or so local activists, who have considered views of the local recycling strategy, are somehow representative of the wider community. "It would be great if most people did think globally and act locally. As it stands, this is not the case" (ibid.).

At the moment, within too many authorities, sustainable development specialists tend to mobilise at the expense of being responsive to the priorities of their own citizens. They need to avoid the narrow focus on ‘green’ issues and embrace quality of life concerns such as local facilities. In the long-run, this would make councils seem more relevant to the people they serve, and give them more of the credibility they need to help the public to ‘think global and act local’ (Hatter 2003).
2.5 Tram Systems in Europe

2.5.1 Introduction

It will become apparent that countries such as Germany and France are "light-years" ahead of Britain in their tram systems. Whilst the terminology of sustainability is mainly found in British and American literature and policies, it is however possible to make inferences from the statistics and discussions available on the European trams concerning sustainability. Valuable lessons for the owners of the Croydon Tramlink can be gained from a close examination of the various solutions chosen by our continental counterparts.

2.5.2 Tram Case Studies

2.5.2.1 Introduction

"Trams and light rail can cover the whole spectrum of public transport provision, and international experience of 350 systems worldwide confirms that this is the most successful intermediate mode, with over 100 years of development behind it, yet incorporating the latest technology for the future." (Taplin 1998)

During the first half of the 20th century trams were a common site in European cities but were disposed of during the 1960s. Motor traffic took over and roads replaced tram tracks. Later, with an increase in congestion problems and an increasing awareness of environmental issues trams were reintroduced as a solution to the problem.

Light rail was first created in mainland Europe as street tramways were upgraded with new rolling stock and segregated alignments. The concept owes much to the planning which took place in Gothenburg, Sweden, where over a period of 15 years an ordinary city
street tramway was extended through new and established suburbs on high-speed reserved track. A fleet of high-performance trams replaced all rolling stock, and effective traffic restrictions were introduced in the central area to give priority to trams and every encouragement to use public transport. "All this was achieved without the expense of digging any tram subways, keeping public transport on the surface as a visible and accessible system" (ibid).

Defining 'light rail' is not straightforward as tram systems differ depending on their location. Light rail is generally seen as any tram system that can go on both tram tracks and train tracks (Gunnarsson & Lofgren 2001).

2.5.2.2 Germany: Hanover

One of the first cities to open a light rail system in 1975, Hanover planners combined a light metro running underground in the city centre and an advanced tram system on the peripherals. Retractable steps are used on the vehicles to adjust to high and low platforms at stations. The network has proved to be very flexible, offering full use within every stage of its development from traditional tram to modern light rail. Total track length is nearly 100km, with 15% underground, 60% segregated railroad and 25% shared right of way. The tram is economically sustainable serving 330,000 passengers daily, nearly 75% of the total users of the Hanover Transport Authority, a very high percentage of users indeed (Gunnarsson & Lofgren 2001).
2.5.2.3 Germany: Karlsruhe

The growth of the Karlsruhe public transportation system is impressive (see Table 6).

<table>
<thead>
<tr>
<th>Year</th>
<th>Track length (km)</th>
<th>No. of stops</th>
<th>No. of tram carriages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>82,7</td>
<td>100</td>
<td>98</td>
</tr>
<tr>
<td>1980</td>
<td>86,5</td>
<td>109</td>
<td>96</td>
</tr>
<tr>
<td>1985</td>
<td>88</td>
<td>112</td>
<td>128</td>
</tr>
<tr>
<td>1990</td>
<td>112,3</td>
<td>144</td>
<td>140</td>
</tr>
<tr>
<td>1995</td>
<td>140,5</td>
<td>200</td>
<td>175</td>
</tr>
<tr>
<td>1998</td>
<td>179</td>
<td>201</td>
<td>185</td>
</tr>
<tr>
<td>1999</td>
<td>195,9</td>
<td>202</td>
<td>185</td>
</tr>
<tr>
<td>2000</td>
<td>197,7</td>
<td>202</td>
<td>215</td>
</tr>
</tbody>
</table>

Table 6: Statistics on the Karlsruhe Tram (Source: www.euronet.nl/~wijzer/success.htm)

The total number of passengers (yearly) grew from 55 million in 1985 to 80 million in 1995 and over 143 million in 2000.

A key element in the Karlsruhe system is simplicity: operations are no more complicated than the local situation demands, making the most of the land and resources available.

This simplicity also allows the trams to be very long. A typical 8-axle articulated tram is 33 or even 36 metres long, and is frequently coupled with another car. "These giants of almost 75 meters length, carrying over 400 passengers, co-exist peacefully with the pedestrians and bicyclists in the street and negotiate the rather sharp curves with ease" (Gunnarsson & Lofgren 2001).
2.5.2.4 Summary of German Case Studies

Gunnarsson & Lofgren (2001) conclude that it has been crucial for both systems to be integrated into the urban fabric, to benefit environmental sustainability. One of the major benefits of these light rails is that a lot of people can be transported down a street, whilst pedestrians can still cross the same street without becoming unduly delayed by traffic or infrastructure. Segregated paths or subways improve average speed in city streets and the stops provide comfortable access in convenient locations, with personal safety for people, who can observe others and also been seen themselves (2001, p.16).

One of the most important factors to the public transport customer if a new line is installed is the amount of time saved. It is assumed that with each 1% time saving, additional demand of 0.75% for light rail service is created, making it economically sustainable (www.euronet.nl/~wiizer/success.htm). Furthermore the assumption is that the transfer is made by the car users and not from any other mode. In reality, there is little evidence on how many people actually switch from car to public transport. Neither the public transport operators nor the Federal Government seemed to be interested in this question (Crampton & Hass-Klau 1999).

2.5.2.5 France: Strasbourg ‘Eurotram’

The first line of this system was opened in 1994, with 26 trams serving 18 stops. The trams run 24 hours a day with trams every ten minutes throughout the night. The reason for this is that the inhabitants feel safer with a tram always available, benefiting the community and making it socially sustainable (Muller 1994).

The appeal, comfort and modern design (see Figure 8) of the trams are some of the reasons for the success of the Strasbourg network with 60,000 passengers using the system everyday, ensuring the future of the tram (Gunnarsson & Lofgren 2001, p.37).
The design was of particular importance to the Council, and again the integration into the urban fabric was significant (Muller 1994). To make the light rail a part of the city there was a great deal of construction around the tracks, to make the centre of Strasbourg more beautiful. In fact as much money was spent on the appearance of the system as was spent on trams and tracks to enhance the visual amenity of the system: the stops, trees around the tracks (1600 were planted), the electrical wiring and grass on the tracks, which reduces noise levels (see Figure 9). Bicycles are even provided for tram users to further integrate the system into the day-to-day workings of the city. The total cost was two billion French francs (ibid).

Figure 8: The Strasbourg Tram  
(Source: www.tramdev.clara.net/stras98-2.htm)
2.5.2.6 France: Montpellier

With the expectation of a rapidly increasing population over the next twenty years, Montpellier sought to equip itself with a modern transport system, which opened in July 2000.

The choice of a modern tram, or light rail system, was largely determined by the city leaders' desire for a system with its own dedicated alignments. Bus lanes, often open to abuse by car drivers, were not seen as a viable solution, and as existing bus routes were already at, or near, capacity, a new high-capacity articulated tram system, similar to those which had already proved popular and successful in many other growing central European cities, was seen as the ideal solution (www.railway-technology.com/projects/montpellier).

A detailed study of ridership and performance has yet to be conducted of the scheme. However, it is safe to say that the trams have transformed the city's main square,
with road traffic now banned. Much of the route is laid on grassed reservation and a 11
kilometre long cycleway has been created alongside the tramway, with bicycle racks at all
stops. It is estimated that 60,000 passengers are carried per day, with two more lines
approved for opening in 2003 (Line 2) and 2007 (Line 3) (ibid.). Further extensions to these
routes (shown in dotted lines in Figure 10) reflect the success of the tram in meeting social,
economic and environmental needs (Gunnarsson & Lofgren 2001). However, even these
extensions are still uncertain as they serve quiet rural areas and communes, some of which
are not all that keen to join with Montpellier in an overall transport/planning syndicate for
fear of the effect on their local area.

Figure 10: Montpellier Network (Source: www.lrta.org/montpellier)

2.5.2.7 The Netherlands

Light rail studies abound in the Netherlands, yet realisation is another matter. One
reason for it is government money for investment in public transport for the next decade is
destined for the big projects: Betuwelijn, a high-speed line to Belgium, and Amsterdam and
Rotterdam metro projects. There is also the feeling that projects centre too often on too
heavy and rigid solutions, and that in many cases (though not in all) investment cost in tunnels could be put to better use. "Especially in the Netherlands policy makers seem to have an obsession with building tunnels for established or potential urban light rail networks" (www.euronet.nl/~wijzer/r1.htm). Tunnels are expensive and require significant measures to reduce the danger of a build up of any noxious fumes and are in the long term deemed environmentally and economically unsustainable (ibid).

The *Randstadrail project* is currently one of the most ambitious transport projects in the Netherlands, with completion due in 2005. It will connect the existing railway lines from Zoetermeer to Den Haag and Den Haag-Pijnacker-Rotterdam (the so-called 'Hofpleinlijn') to the tramway system in Den Haag and, on the southern end, to the metro system in Rotterdam. No new rail lines are planned. Although several studies have been undertaken, no final decisions have been made. In the latest *Aanvullend advies* a complete separation of light and heavy rail is envisioned. "It is judged that especially here opportunities are missed by looking for too expensive and complicated solutions. A two-system tram operation, however successful elsewhere, seems to be a horror for the Dutch planners" (www.euronet.nl/~wijzer/r1.htm).

A very unique approach is carried out in the Netherlands. A traditional cost benefit analysis is combined with a multi-criteria approach, consisting of 20 different criteria each of them valued and weighted. Emphasis on high quality schemes is considered to be decisive (Crampton & Hass-Klau 1999), however it is submitted that money is wasted on unnecessarily complex infrastructure rather than keeping systems simple and allocating more funds towards design and local character (more in keeping with the systems of Karlsruhe and Strasbourg for example (www.euronet.nl/~wijzer/r1.htm)).

2.5.2.8 Luxembourg

In Luxembourg plans were developed for a Karlsruhe-type transport system, called 'BTBunn'. The main axe was to run as tramway line from the main railway station
trough the city centre to Dommeldingen in the north, where another connection to the railway system was planned. By rail almost all towns of the small country would have had a direct connection to the centre of the capital, with a total net length of over 150 km. However there were concerns over investment and finance and after the 1999 elections the project was abandoned (www.euronet.nl/~wijzer/r1.htm).

2.5.2.9 Conclusion

The main issues identified from the European experiences are:

Positive experiences

- The reasons for cities to choose trams as a new transportation mode are many: they have environmental, economic and social advantages (Gunnarsson & Lofgren 2001, p.45).
- The trams in some cases, for example Strasbourg and Karlsruhe, have even become symbolic for the city: the people are proud of their system (ibid.).
- Tracks and rights-of-way are flexible and the infrastructure can be designed to blend in with urban street furniture.
- If the success of light rail is measured in passenger growth then ridership levels on most established networks are increasing (Crampton & Hass-Klau 1999).
- Public transport experts believe that modern trams are perceived by the public to be a superior transport mode (ibid.).
- Much evidence suggests extensions to many existing lines and entire new networks are being considered: it can be inferred that the future looks promising for light rail.
Negative experiences

- The ugliness of overhead cabling is often an issue (Crampton & Hass-Klau, 1999).
- If success is measured by the extent to which car drivers are lured out of their cars, then most light rail lines are not as successful as they could be, possibly because there is a lack of policy measures that could be used to strengthen the role of light rail (ibid).
- Extensions to networks can adversely affect the quality of life, that is the area of liveability (Kitzhaber 2001) of peripheral settlements.

2.6 The Tram in Britain

2.6.1 Introduction

"People want more choice, more alternatives to using their cars and more reliable journeys when they do drive. They want a better public transport system that doesn’t let them down. They want better protection for the environment, and they want less pollution because they are worried about their health". (Transport White Paper 1998)

At a local level, Gibbs (2002) notes that sustainability is not just about reducing the number of cars on the road.

"That is just one facet of the subject. It is also about providing an alternative to the car (including walking) and making that mode of movement safe. It is about integrated transport systems and what decisions people make about movement in the period that it takes to provide such a system, which of course could be many years if not generations." (ibid, p.2)
An ideal transport network would be one in which supply exactly met demand without any spare capacity. Demand, however, varies with time, so such a system would have to be infinitely inflexible, an objective for which we might strive but which we will certainly never reach (Macpherson 1993). Despite this, he elaborates using the notion that although an ‘ideal network’ (*ibid.*) is impossible in Britain, certain infrastructures are of particular importance in achieving at least an efficient network. He insinuates that even at such early stages in their operation, the two tram networks in Manchester and Sheffield can be highlighted as ‘high profile projects’ (*ibid.*). Gibbs (2002) writes that at present the concentration seems to be directed towards reducing the need for cars in urban areas through the improvement of other modes of transport, be it cycle ways, buses, railways or light rail networks. To achieve sustainability in the mobility sector transport needs to be enhanced quantitatively and qualitatively within the constraints of the environment as well as to provide sustainable and implementable technologies (*ibid*; AGS). Gibbs notes that Croydon’s Tramlink could, through integration with the existing transport provision, ‘secure a higher living standard for the residents of Croydon whilst at the same time protect and enhance the environment’ (2002, p.12).

2.6.2 Tram Context

Tram systems are constantly being monitored for update and expansion, which surely can be taken as an indication of their success. The Government’s 10 Year Transport Plan includes a target of doubling light rail use in England (measured by the number of passenger journeys) by 2010 from 2000 levels. It provides funding for up to 25 new lines in cities and conurbations around the country. In September 2001, Transport Minister Sally Keeble announced that the number of passenger journeys on trams has risen by 27 per cent in the past year.
2.6.3 Tram Statistics and Research

It has been established that there is a new interest in urban rail based systems and investment has taken place across the country as a result of three most recognised systems of Manchester, Sheffield and Croydon. Banister and Edwards (1995) acknowledge that the transport and environmental benefits of urban light rail networks "are clear as road congestion is reduced and the quality of public transport services is substantially improved" (p. 17). There is no extensive sustainability study on a tram system in Britain. There have been other types of research on trams; however as a sustainability study is different from other reports other types of research do not replace the need for a sustainability study (www.heiflorida.org/news/cysr.html).

A frequently found investigation in Britain is an impact study (see for an example the Sheffield Supertram Impact Study 1997). The task of an impact study is to ascertain the conditions of a site prior to the realisation of a project, to analyse its possible impacts and compensative measures (General Environmental Multilingual Thesaurus 2000). There has been only one study so far undertaken on the Croydon Tramlink since its introduction. The Croydon Tramlink Impact Study (CTIS) was conducted by Transport for London in June 2002 and is a valuable source of information and reference.

2.6.4 Manchester

The notion here is that the scheme in Manchester, the first example of street-running light rail in Britain and whose trunk Bury-Manchester-Altrincham line opened in 1992, has exceeded initial predictions on patronage. There is evidence, according to Banister and Edwards, of users switching from their car. At the time of their article the statistics available indicated that 17% of Metrolink journeys used to be made by car, amounting to 2 million car trips a year out of the total 12 million passengers using the system in 1992 (ibid.). These figures are contradicted somewhat in an article printed in
1994, where it was claimed that former car users made up 10 per cent of Manchester Metrolink passengers, totalling some 1 million car trips (Metrolink 1994). This implies that the Metrolink actually lost passengers; still it can be assumed that different measurements were taken to produce this data, else the implications for tram systems as a whole would surely have been brought into question. The warning here is that statistics and sources do not always complement each other, which can result in contradictions in an investigation of this type: inquiries need to be made into the reliability of supporting secondary data, especially when numbers and percentages are involved.

In reference to the Manchester Metrolink reassurance is provided by Knowles' more recent study after an extension to Salford Quays and Eccles opened in 1999/2000. "Ridership has been around or above forecasts, at about 13-14 million passengers per year. More major extensions have been approved" (Knowles 2001, p.7).

Figure 11: Manchester Metrolink Unit (Source: www.mercurio.iet.unipi.it)
2.6.5 Sheffield

The Sheffield Supertram was opened in 1994-1995, with a much larger percentage of street running. "Average speeds are lower and the relative attractiveness vis-à-vis competing bus services somewhat less. Initial ridership was well below forecasts, at about 8 million per year, but has since improved to about 11 million per year following marketing and pricing initiatives" (White 2002, p.78).

In his report on the impact of the urban rail development in Sheffield, Townroe suggests that the affects of such developments can be looked at through a cost benefit framework similar to that used for intercity trunk road and motorway schemes (1996, p.167). He notes that allowance for the disruption effects during the construction period and linkages to town planning considerations have relevance for appraisals of urban light rail systems. However, such an approach needs to include a focus on vehicle rather than passenger journeys, distinctive adjustment for goods vehicles, a valuation of pollution effects, reference to distributional impacts and a counting in of trip generation effects, as discussed by Townroe & Dabinett (1994) and Bateman et al. (1993). This is of some use as there are recommendations for more areas of possible research.

While Townroe (1996) sees the relief of congestion on the urban road network as a primary consequence of the integration of a tramway into a settlement, he also implies secondary impact benefits, which have wider implications, and are "frequently put forward as an urban economic regeneration argument for development" (p.167). There are similarities between his work and that of Banister (1996):

"Transport has a major impact on the spatial and economic development of cities and regions. The attractiveness of particular locations depends in part on the relative accessibility, and this in turn depends on the quality and quantity of the transport"
infrastructure (...) It is necessary to promote cities as desirable places in which to live, with a high quality of life." (ibid, p.1)

The last sentence is a rather restrained view. The concept of promotion is only one-way, from the developers or Council to potential businesses. More important are the citizens' perceptions, showing the extent to which the promotion was successful in the first place.

Worsely's chapter (1996) is on collecting evidence on the impacts of such a development. Once again the Sheffield project is utilised as an example. He notes that surveys will grant information identified according to proximity to a tram-stopping place. "Analysis of these data will make it possible to identify the effect, if any, of Supertram on the various themes and hence the pattern of urban development in Sheffield (...) a model of the impact can be built" (1996, p.184). He also points out an opportunity for a before and after study of a range of possible consequences of such an initiative. Recognition of the likely local nature of such consequences is once more conceded. The suggestions described in this section are helpful in that the inclusion of a survey should be a pre-requisite and thought should be given to possible queries and their likely inferences.

Overall, these three chapters are a great aid, highlighting different aspects important in the investigation. The first chapter reviews the theory; Townroe's chapter outlines a case study whilst Worsely gives advice on collecting evidence.
As discussed by Townroe and Worsely (1996), the outcomes have been measured in one instance in terms of physical development and jobs, and such concerns are addressed in the Sheffield Supertram Impact Study (1993) conducted by Sheffield Hallam University. Whilst this is restricted in that the investigation is nearly ten years old, nevertheless it offers some intriguing themes for study. These are split into four themes: city image, land usage, economic activity and labour market patterns. From a researcher’s point of view it is judged that this particular research forms another adequate reference for an examination into the impact of the Tramlink on Croydon. Some of the layout and sub-headings are of pertinence and allow for elaboration of the main key issues. The Tramlink will have affected many different aspects of Croydon, and this literature contains much to consider. The limitation of the study is that it does not consider the effects on natural environments.

The report found that the Supertram "has had only a limited impact on the regeneration of Sheffield" (1993, p.76). This follows on from Banister & Edwards’ (1995) views that influences of such systems are variable and very local in nature. However,
academics acknowledge that the monitoring exercise completed by the Hallam University was only able to assess the affects of the full Supertram network for little more than a year. It is put forward that such influences would become more apparent over a longer time horizon. Also changes in policy environment may have produced different results. "Potential modifications here include tighter restrictions on the penetration of vehicular traffic and efforts to create a more integrated transport system" (1993, p.76). This furthermore supports the notion that research into a similar scheme could provide unexpected and wide-ranging outcomes. A section on 'informing future activity' is of great interest as it suggests how any analogous projects might be attempted that could be crucial for the conduction of this thesis.

2.7 Measurement of Sustainability

2.7.1 Introduction

Whether a system is characterised as successful or not will depend on the indicators used (Crampton & Hass-Klau 1999). The final section of this literature review is to examine specific indicators of sustainable transport, in relation to all that has been discussed previously. The selected indicators will be used in the survey.

2.7.2 Indicators

An indicator is "a variable, a pointer, an index of a complex phenomenon" (Food and Agriculture Organization (FAO)).

"Its fluctuations reveal the variations in components of the ecosystem, the resource or the sector. The position and trend of the indicator in relation to the criteria indicates the present state and
dynamics of the system. Ideally, composite indicators are needed, the position and trajectory of which, within a system of reference of related criteria, would allow simple holistic assessment of sustainability." (FAO)

An indicator is created through the collection and organization of raw data (Innes 1990). The indicator itself is a phenomenon or concept that a researcher is interested in measuring. However, no phenomenon is immediately and directly accessible to us without the mediation of instruments of measurement.

Developing indicators requires decisions on two separate components, 1) the phenomenon to be measured, and 2) the raw data sets that will make up the measurement. Indicator titles are often framed in general terms (for example a 'living wage' indicator). Policy makers, program developers and the public can often agree that an indicator for a 'living wage' is important. However, the second component, the deciding on the data that measures 'living wage', is often difficult to agree upon and the data can be hard to obtain. The determination of indicators and the data that measure them involves making judgments and applying normative and analytical models. Data are the result of inquiry, and inquiry is based on a subjective interest in collecting certain information. Structuring indicators based on raw data requires a simplification and ordering of the data to make it easier to comprehend and analyse (Innes 1990).

2.7.2.1 History of Indicator Development

This section briefly reflects on the historical trends in indicator development during the 20th Century. The current interest in sustainability indicators can be placed in an evolving history of indicator development. Table 7 charts indicator development in the Twentieth Century, starting in the 1920s.
Initial work done in the Indicator Area

<table>
<thead>
<tr>
<th>Initial work done in the</th>
<th>Indicator Area</th>
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<tbody>
<tr>
<td>1920's-1930's</td>
<td>Social Indicators</td>
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<td>1940's-1950's</td>
<td>Economic Indicators</td>
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<td>1960's</td>
<td>Quality of Life Indicators</td>
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<tr>
<td>1970's</td>
<td>Health Information System Indicators</td>
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<td>1970's</td>
<td>Environmental Indicators</td>
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<td>1980's</td>
<td>Healthy Communities Indicators</td>
</tr>
<tr>
<td>Current</td>
<td>Sustainability Indicators</td>
</tr>
</tbody>
</table>

Table 7: History of Indicator Development (Source: Innes 1990)

Innes (1990) identified two distinct periods of interest in social indicators during the twentieth century. The first period gained momentum in the 1920s and 1930s, and crystallized with the publication of a report entitled *Recent Social Trends* in 1933 by a Presidential Committee. The report included a discussion of trends and available data around a wide-range of issues, for example race, ethnicity, education, women, health and environment (Innes 1990). The beginning of the second period is manifested with a report published by NASA studying the impact of the space program on society. Further work in social indicators coincided with the Johnson Administration’s emphasis on social programs in the 1960s.

2.7.3 Indicators and Sustainability

Indicators are the end result of a complex process of technical and political decision-making. Patterson (2000) argues that indicators should be developed in response to policy need and stakeholder need. The information in indicators should be crafted to fit the target audience. The movement to develop indicators for sustainability began in large part with the publication of *Our Common Future* by the World Commission on the Environment.
and Development in 1987. The report concluded that economic signals alone were a faulty measure of assessing societal progress. Traditional economic measures such as gross domestic product had to be combined with measures of environmental and human well being in order to get a sense of the true state of human progress.

Although the movement to develop indicators of human and environmental activities was decades old (see Table 7), *Our Common Future* (1987) highlighted the need to develop an overarching framework to connect the economic, environmental and social aspects of the planet. Up to the 1980s, researchers and policy makers in social science, economic and environmental disciplines worked in relative isolation, developing indicators that applied to their specific areas of research or policy. The idea of sustainability required the establishment of an intellectual link between disciplines (Hodge 1997).

Over the past two decades, worldwide efforts to identify indicators of sustainability resulted in the creation of hundreds of indicators. Most of the indicators identified are linked to environmental sustainability. A 1998 report by the OECD listed 51 environmental indicators designed to measure progress toward sustainable development. The indicators are broken down into environmental indicators and socio-economic indicators (OECD 1998). New systems of sustainability indicators are appearing that stretch beyond the discreet measurement of environmental and economic conditions. An emphasis on community wellbeing and social capital is influencing the make up of sustainability indicators (Meadows 1998). Good measurements of environmental and economic conditions remain very important to gauging progress toward sustainability; however, other indicators, especially social indicators, are playing a role in helping communities determine sustainability.

The increased awareness that sustainability means more than just a sustainable natural environment resulted in a number of efforts to tie together environmental, economic and social indicators (Bay Area Alliance for Sustainable Development 2000). In multiple examples, researchers and policy makers have identified sets of environmental, economic
and social indicators that can assist in measuring sustainability. Gustavson (1999) points out that indicator development efforts can often be reduced to a laundry list of available statistical data that may or may not be truly relevant to the specific research study.

Interpretation of the usefulness of the data sets is hotly debated, and the result is often a retreat to discussions of the philosophical underpinnings of sustainability. Whilst a discussion of the definition of sustainability is useful, the exercise usually fails to provide useable indicators for policy makers (Brugmann 1997). Gustavson (1999) identifies useable indicators as those that are easy to understand and inexpensive to measure. According to Opschoor & Reijnders (1991) the indicators of most relevance for a sustainability study of a transport system form a combination of attitude/impact indicators geared towards measuring the use of a transport network, its impacts on the population that it serves and their attitudes towards it.

In summary, there is a significant movement towards design indicator programs that respond to the concept of sustainability. Indicators focused on measuring economic and community sustainability have been relatively quick to emerge, while social/community wellbeing indicators of sustainability have taken longer to materialize. Indicators for research purposes should be easy to understand and inexpensive to measure (Gustavson 1999). The indicators of most relevance for this research are a combination of attitude/impact indicators geared towards measuring the use of a transport network, its impacts on the population that it serves and their attitudes towards it could be used (Opschoor & Reijnders 1991).

2.7.4 The Use of Indices in Indicator Analysis

An index is a single indicator variable developed through the mathematical combination of multiple indicator variables. Initial forays into sustainability thinking dealt primarily with the perceived limits of natural capital consumption. Significant work was done to explain interaction between human activities and the health and availability of
natural resources (see Meadows 1977; World Commission on the Environment 1987). Several leading models emerged advocating sustainability measurements that fit a three-dimensional format of environment, economy and community (Meadows 1977). In certain circumstances, index frameworks may contribute to an improved understanding of trends relating to sustainability. However, indices also have drawbacks that should be carefully examined before using index-based information to draw any kind of conclusion.

The advantage of an index format is that it allows aggregation of disparate indicators to give more general indications of sustainability (Hoffman 2000), enabling several variables to be represented by a single score that reduces the complexity of the data presentation. Additionally, indices allow variables to be grouped in such a way as to improve the precision of measurement. For example, in instances when a set of variables is combined in an index to capture change in a broader area, the creation of an index can reduce the significance of outlying variables (Nachmias & Nachmias 1997).

Indices are also beneficial because they represent complex phenomena in relatively simplistic ways. Furthermore the use of an index for the creation of local indicators of sustainability offers some apparent advantages. The base of the index can be used to identify a level of performance that is considered sustainable. An example of an index is the Consumer Price Index (CPI). The CPI is a popular index used for comparing consumer spending power over time and in different geographic regions. The CPI combines variables from eight different categories (food, housing, apparel, transportation, medical care, personal care, reading and recreation, and other goods and services) into a single number for a given geographic area. The commodities and services included in each category are representatives of subgroups of related items (Nachmias & Nachmias 1997). However critics claim that indices do little to provide the proper diagnosis of a situation that would lead to appropriate policy responses.
"To say that certain areas get high scores is not to give any idea what to do. Such aggregate indices normally have to be broken down again into their components to get a handle on whether to deal with housing problems, for example, through community organization, code enforcement, subsidies to landlords, or subsidies to tenants."

(Innes 1990, p.223)

In conclusion, the question is not whether indicators can be aggregated into indices, but whether, given the circumstances, there is a compelling reason to create an index. In terms of sustainability, indices are useful for measuring the concept of sustainability in compact form. Further, a single indicator to match the appeal of the CPI is highly prized because of its capacity to fit an alternative view into a popular ‘niche’ of information. However, those working with sustainability issues are quick to note that no single number should be solely relied on to assess the complex relationships inherent to the concept of sustainability (IISD 2002). An index therefore should be evaluated not in isolation but within the context of the results from its various components (indicators).

2.8 Transport Indicators

2.8.1 Environmental

Table 8 shows the environmental indicators at a local level for sustainability set out by the government.
Characteristics of environmental sustainability | Local quality of life indicators in the menu
---|---
Protect and Enhance the Environment | Environment
Use energy, water and other **natural resources** efficiently and with care | **Prudent use of resources**
Minimise **waste**, then re-use or recover it through recycling, composting or energy recovery and finally dispose of what is left | Energy use (gas and electricity)
Limit **pollution** to levels which do not damage natural systems | **Protection of the environment**
Value and protect the diversity of nature |

| Table 8: Environmental Indicators | (Source: [www.sustainable-development.org.uk](http://www.sustainable-development.org.uk)) |

With respect to environmental sustainability, a transport mode should:

a) **Resource Usage**: Make efficient use of land and other natural resources using energy sources that are essentially renewable or inexhaustible.  
   (OECD, CST)

b) **Noise and Visual Impact**: Produce no more noise or visual impact in terms of design than is acceptable by communities. (CST)
c) Pollution Prevention: Transport needs must be met without generating emissions that threaten public health, global climate, biological diversity or the integrity of essential ecological processes. (OECD)

d) Traffic Flow: Reduce the growth in car and lorry traffic growth. (UK Round Table)

Sub-question I: What are the environmental indicators of sustainable transport?

The following indicators were selected to measure environmental sustainability (selected in accordance to the criteria from the CST and OECD):

1) Traffic noise
2) Visual impact
3) Air pollution
4) Traffic flow/congestion
5) Resource usage

Secondary data is available for numbers 1, 3, 4 and 5.

2.8.1.1 Traffic Noise

Traffic Noise is defined as "the perceived sound emitted by road traffic" (MEA 1983), in this case noise produced by the Croydon Tramlink. The noise itself comes from the working of the engine, the movement of all moving parts of the vehicle, vibration of the bodywork and components and the noise of brakes.

Noise is measured in decibels (dB). Any degrees of annoyance are not only dependent on the characteristics of the individual being annoyed and the noise level being emitted; they can also depend on the tone of the noise and climatic conditions. Some would
argue that a sudden, loud noise (for instance an aircraft flying overhead at low level) is more annoying than a steady noise (road traffic) of the same intensity (Macpherson 1993). If the loudness produced by road vehicles are to be compared the sound pressure level has to be adjusted to give comparatively more weight to the frequencies, which are detected more regularly by the human ear (MEA 1983). Scientists have therefore developed the 'A' weighting referred to as dB (A), proven to give the best correlation between perceived and actual loudness MEA (1983). Figure 18 in the analysis gives an indication of the sound levels of some of the most common sounds. The point at which noise levels are considered to be a nuisance is 68dB (A) (Macpherson 1993).

Noise is a very subjective matter (ibid) and it would be difficult for interviewees to judge the level of noise pollution produced by the Tramlink from the overall noises of other road traffic. This research will therefore examine secondary data on the noise levels of the Tramlink itself.

2.8.1.2 Visual Impact

It is important for people that the area they live in is not blighted by development. Traffic and its associated infrastructure is often a problem when it comes to improving the appearance of a settlement (Gunnarsson & Lofgren 2001, p.45). The MEA (1983) describes two kinds of visual impact: obstruction and intrusion. The former occurs when a road, for example, or some feature of it such as an embankment, a viaduct or a sign gantry, impedes a view that would otherwise be available. The latter is what a landscape would look like after a development is completed.

Again both kinds of impact are essentially subjective. The MEA (1983) recommends a categorisation on a three-point scale of high, moderate or slight bands according to whether human responses are shown to be highly dissatisfied, dissatisfied or indifferent. However this three-point scale does not accommodate every possible scenario. People's perceptions of a new development's visual impact could potentially be positive, for
example in the case of a new building replacing an ugly, run down building or in the case of a new park being built on wasteland. The three-point scale should therefore be extended to include 'positive' as a response choice.

2.8.1.3 Air Pollution

People’s perceptions of air pollution caused by a new development are likely to vary. Their responses will be influenced by how close they live to the infrastructure and individual differences. Tunnels would require significant measures to reduce the danger of a build up of any noxious fumes (Macpherson 1993).

For research purposes air pollution is unlikely to feature prominently in a framework (Macpherson 1993; MEA 1983) and so it is considered to be best observed using secondary data (instead of surveys), as the various sources of pollution make it difficult to isolate and categorise people’s attitudes towards it. The only exceptions are where the fumes are markedly obvious—the sight of black smoke for instance—or a distinctive smell (MEA 1983). The unit of measurement for air pollutants is parts per million.

2.8.1.4 Traffic Flow/Congestion

Congestion is one of the biggest problems in a city. It is the affect of too many vehicles on a limited road area. It is acknowledged by most sources that the solution is to increase public transportation and make it more effective (see for example Gibbs 2002; AGS).

Second-hand influences due to the introduction of a tramway can be increased or decreased traffic flow on surrounding roads. ‘When a tramline is introduced in a city, traffic flows will change depending on how the lines have been planned’ (Gunnarsson & Lofgren 2001, p.51). For example, some roads may be closed off entirely to vehicular traffic to make way for a tram, others narrowed, made one-way or given restricted access (ibid.).
Traffic flow is measured on a 3-point scale of increase, decrease or no change (www.tfl.gov.uk)

2.8.1.5 Resource Usage

Resource usage is concerned with the way human societies manage finite natural resources. Hardin (1968) argued that exploitation of a resource by many individuals, without effective management oriented toward sustainable resource usage, would ultimately result in the deterioration of natural resources for which there are no substitutes, leaving all resource users worse off.

Land is a finite resource in cities across Britain and trams in general are a very space efficient transportation mode (Gunnarsson & Lofgren 2001). They are much less intrusive than conventional railways, as they generally do not need such wide sections of segregated track. Innovation is an important aspect of sustainability, as new technology can ensure that any intrusion is kept to a minimum (Harding 2003). They can climb steeper gradients and handle tighter curves, thereby fitting in around existing buildings and spaces. Stretches of some routes will use converted railway tracks previously left redundant (ibid).

"The electric tramway is almost certainly the most sustainable form of motorised transport available. The vehicles and track are made from readily available materials that are recyclable, with very little use of scarce resources." (www.bathtram.org/tfb)

It is important to minimise the amount of energy that a transport mode uses, especially given that the sector as a whole consumes nearly a third of all final energy and this figure continues to increase, mainly due to growing demand solely in the transport sector (European Environment Agency 2001).
The energy it takes to run trams is much less per passenger kilometre compared to a car, which makes it a more environmental friendly alternative: trams run on electricity which can be relatively easily generated from a variety of renewable sources (although it is acknowledged that the generation of electricity needed to run trams has the potential to create air pollution from the power station (www.tfl.gov.uk/trams/abouttrams), which is better than petrol. This makes trams more attractive from a supply security and sustainability perspective (www.bathtram.org/tfb; www.istp.murdoch.edu.au/teaching/istpline/studygds). Electricity in transport is measured in Megajoules per passenger kilometre.

2.8.2 Economic

Table 9 shows the Government’s economic indicators for sustainability.

<table>
<thead>
<tr>
<th>Characteristics of economic sustainability</th>
<th>Local quality of life indicators in the menu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promote Economic Success</td>
<td>Economic</td>
</tr>
<tr>
<td>Create a vibrant local economy that gives access to satisfying and rewarding work without damaging the local, national or global environment</td>
<td>Sustainable local economy</td>
</tr>
<tr>
<td></td>
<td>Cost of living</td>
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<td></td>
<td>Business start-ups and closures</td>
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<td></td>
<td>Accessibility</td>
</tr>
<tr>
<td></td>
<td>Social and community enterprises</td>
</tr>
</tbody>
</table>

Table 9: Economic Indicators (Source: www.sustainable-development.gov.uk)

With respect to economical sustainability, a transportation mode should:

a) Demand: Provide cost-effective, financially affordable service as well as the capacity to ensure demand for the transport mode. (CST)
b) Consumer satisfaction: Be reliable and regularly and frequently utilised.

c) Competitiveness: Enable the industry to remain competitive. (CST, UK Round Table)

Sub-question II: What are the economic indicators of sustainable transport?

The following indicators were selected to measure economical sustainability (selected in accordance to the criteria from the CST and UK Round Table):

1) Value for money
2) Consumer satisfaction
3) Capacity
4) Time/efficiency
5) Image
6) Competitiveness

Secondary data is available for number 2, 3 and 6.

2.8.2.1 Value for Money

Measuring value for money is an evaluation of the function of the service against the price or general affordability of that service. It is a subjective rather than an objective evaluation. If cost is poorly calculated or displayed, the evaluation of value for money provides an ambiguous result (Langmaid 2003).

In this case the cost of ticket prices for the Tramlink was made available in the form of a table to be compared against the general service of the Tramlink. People's perceptions of the value for money of the tram are best measured in a survey (ibid).
2.8.2.2 Consumer satisfaction

Consumer satisfaction relates to "the advocacy of a high consumption of a service as the basis for a sound economy" (Collins Dictionary 1993, p. 283). It may be achieved for example through ticketing and public relations. Such approaches are known as complementary methods and may also be used to support light rail by 'persuading' a transfer from car to tram. Such practices are termed 'soft' measures (Crampton & Hass-Klau 1999). As outlined in the assumptions in the introduction, there is no point in a transport network that is environmentally friendly but is not utilised (www.bathtram.demon.co.uk). In this case, if most passengers only use the network on an occasional basis then it is considered that the competitiveness of the system would be undermined and its overall sustainability brought into doubt (Harding 2003). These two sources both agree that to be competitive, that is, sustainable, a transport system not only needs to be used, but the emphasis is also that passengers return to use a mode on a regular basis: demand for the service must be buoyant and have a steady, incremental growth (ibid).

The unit of measurement for consumerism is passenger journeys per year, available as secondary data (CTIS 2002; Harding 2003), and how often on average people travel on the tram, ascertained through a questionnaire.

2.8.2.3 Capacity

The capacity of a transport system is the amount of passengers that can be contained (Collin Dictionary 1993, p.195). It is measured by the seating capacity (CTIS 2002), available as secondary data, and people's perceptions of the crowding of the tram, best measured in a survey (Hussey & Hussey 1997).
2.8.2.4 Time/Efficiency

"There is no universally accepted single figure that is attached to a time saving by a vehicle. The benefit is not saving in the vehicle's time, it is saving of the occupant's time" (Macpherson 1993, pp. 346-347). The age-old fact is that time is money. A quick and reliable, in short efficient service is needed for people to be able to go about their daily lives (CTIS 2002).

Time saving is also linked to the level of demand for a service. In European Countries such as Germany or France it assumed that with each 1% time saving, additional demand of 0.75% for light rail service is created (www.euronet.nl/~wijzer/success.htm). The perception of the time/efficiency of a transport mode is very subjective and primary data collated through a survey should provide a valuable source of information and insight (Harding 2003).

2.8.2.5 Image

"Image is a mental picture; an idea produced by the imagination" (Collins Dictionary 1993, p.645). An attitude survey enables the collection of information on people's image perceptions. In the case of a transport system there are two different entities, the first being the public perception of the area in which they live and secondly the service that they use. People are more likely to visit a city centre for example if it has enough attractions. These attractions would include shopping and other leisure facilities, nightlife, accessibility by road or public transport and general affordability.

Within the notion of using a mode of public transport, people's opinions of the image of a service are influenced by the level of cleanliness and comfort (CTIS 2002). People will have a negative image of a tram system if it is dirty and uncomfortable and therefore it is necessary to measure cleanliness and comfort within the context of the Tramlink.
2.8.2.6 Competitiveness

The transport industry can be closest associated with the operation in an oligopolistic market, where there are only a few sellers and many buyers (Beardshaw 1992). In the case of a transport mode, any service is economically viable, that is, competitive, if people switch to this mode of transport from another during its introductory phase and continue to utilise it on a regular basis in the long term (Gunnarsson & Lofgren 2001).

As outlined in the assumptions in the introduction, there is no point in a transport network that is environmentally friendly but does nothing useful (www.bathtram.demon.co.uk). In this case, if only a small percentage of passengers are drawn to the Tramlink from other modes of transport (primarily the car) then it is considered that the competitiveness of the system would be undermined and its overall sustainability brought into doubt (Harding 2003). These two sources both agree that to be competitive, that is, sustainable, a transport system needs to show that it has been able to capture passengers, of whom a significant number should previously have used the car (ibid). The unit of measurement is the percentage of passenger transfer (CTIS, 2002).

In the case of the Croydon Tramlink, secondary data (from Tramtrack Croydon) is available on the number of users and people who have switched to this mode from another transportation method. This report examines the Croydon Tramlink by demonstrating the number of people switching to this mode of transport in comparison to other tram networks' figures that exhibit passenger transfer.

2.8.3 Social

Social measures are focused on the human component of the eco-sphere; the measures are concerned with human wellbeing in all its facets (Rutherford 1997). Table 10 shows the social indicators at a local level for sustainability set out by the government.
<table>
<thead>
<tr>
<th>Characteristics of sustainability</th>
<th>Local quality of life indicators in the menu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meet Social Needs</td>
<td>Social</td>
</tr>
<tr>
<td>Encourage necessary access to</td>
<td><strong>Access to local services and travel</strong></td>
</tr>
<tr>
<td>facilities, services, goods and</td>
<td>Access to key services</td>
</tr>
<tr>
<td>other people in ways which make</td>
<td>Travel to work</td>
</tr>
<tr>
<td>less use of the car and minimise</td>
<td>How do school children travel to school?</td>
</tr>
<tr>
<td>impacts on the environment</td>
<td>Overall traffic volumes</td>
</tr>
<tr>
<td>Make opportunities for <strong>culture</strong>,</td>
<td></td>
</tr>
<tr>
<td>leisure and recreation readily</td>
<td></td>
</tr>
<tr>
<td>available to all</td>
<td></td>
</tr>
<tr>
<td>Meet local needs locally wherever</td>
<td></td>
</tr>
<tr>
<td>possible</td>
<td></td>
</tr>
<tr>
<td>Create or enhance places, spaces</td>
<td><strong>Shaping our surroundings</strong></td>
</tr>
<tr>
<td>and buildings that work well,</td>
<td>Public/private partnership</td>
</tr>
<tr>
<td>wear well and look well</td>
<td>initiatives</td>
</tr>
<tr>
<td>Make settlements 'human' in scale</td>
<td>LA21 schemes</td>
</tr>
<tr>
<td>and form</td>
<td></td>
</tr>
<tr>
<td>Value and protect diversity and</td>
<td></td>
</tr>
<tr>
<td>distinctiveness and strengthen</td>
<td></td>
</tr>
<tr>
<td>local community and cultural</td>
<td></td>
</tr>
<tr>
<td>identity</td>
<td></td>
</tr>
<tr>
<td><strong>Empower</strong> all sections of the</td>
<td><strong>Empowerment and participation</strong></td>
</tr>
<tr>
<td>community to participate in</td>
<td>Social participation</td>
</tr>
<tr>
<td>decision making and consider the</td>
<td>Community well being</td>
</tr>
<tr>
<td>social impacts of decisions</td>
<td></td>
</tr>
</tbody>
</table>

*Table 10: Social Indicators*  
(Source: [www.sustainable-development.org.uk](http://www.sustainable-development.org.uk))
With respect to social sustainability, a transport mode should:

a) Health and Safety: Meet basic human needs for health (physical, mental and social well-being) as well as safety in ways that enhances the quality of life in communities. (CST, OECD)

b) Access: Give people reasonable access to other people, places, goods and services. (OECD)

c) Equity: Meeting the basic transport-related needs of all people, including women, the poor, the rural, the disabled, and children, nation, states thus ensuring social, interregional and intergenerational equity. (OECD)

Sub-question III: What are the social indicators of sustainable transport?

The following indicators were selected to measure social sustainability (selected in accordance to the criteria from the CST and OECD):

1) Community severance
2) Social equity/accessibility
3) Stress
4) Comfort of journey
5) Safety

Secondary data is available for 2 and 5.
2.8.3.1 Community Severance

Community severance is defined as "(...) the separation of residents from facilities and services they use" (MEA 1983, Part B, Section 4) as a result of changes in the infrastructure.

The construction of any development, for example a road or light rail track, would impede or prevent journeys across the line of the development either because the journeys will be longer in distance and/or time or because travellers are dissuaded from making the journey at all (Gunnarsson & Lofgren 2001, p.47). 'Severance may be absolute, that is, caused by a physical barrier, or relative, caused by the difficulty of crossing a road carrying significant traffic' (Macpherson 1993, p.267). On the other hand there can also be the scenario where a reduction in severance may take place if with the introduction of a new mode of transport facilities or services become more accessible or traffic is rerouted due to pedestrianisation or the formation of one-way systems and restrictions.

The MEA (1983, Part B, Section 4) recommends that severance be classified on a four-point scale of none, slight, moderate and severe.

2.8.3.2 Social Equity/Accessibility

All people are entitled to reasonable access to other people, places, goods and services (OECD 1997). Providing a transport mode that is available to all meets the basic transport-related need for accessibility of all people (including women, the poor, the rural, the disabled, and children (OECD 1997)); thus ensuring social and intergenerational equity.

For several decades cars promised the sense of freedom that people desired, promoting a world of speed and convenience with the aspiration that owners could go where the road took them. When car use is the dominant mode of transport in society, those without access to cars, such as the poor, the elderly, the disabled and children, have only very restricted transport options (Lowe 1990). In the 1990s this social inequality was recognised, shifting
the focus away from promoting mobility towards giving people access (OECD 1997). New rail constructions could potentially result in a significant increase in accessibility for certain parts of society. This could be accompanied by a reduction in severance where facilities or services have become more accessible or when traffic is rerouted due to pedestrianisation or the formation of new one-way systems or restrictions. Such approaches are known as complementary or 'soft' methods and may also be used to support light rail by 'forcing' a transfer from car to tram (Crampton & Hass-Klau 1999). People need to get from A to B to C, and they might choose to go out more or visit new places if a new transport project gives them new options. For some people (for example physically handicapped, the elderly or mothers with prams) find it difficult embarking and disembarking; so apart from a system physically giving people access to new places the transport mode itself must be available for everyone equally. The trams affect on accessibility can be measured with the TfL’s model CAPITAL. It provides a measure of travel time from trip origin(s) to destination(s). The model calculates walk access times between enumeration district centroids and public transport access points. Public transport journey times are calculated from the public transport access point to the destination point using TfL’s rail plan model. The minimum overall travel time (public transport access point time + onboard public transport time) is then selected from the origin enumeration district to the destination point.

2.8.3.3 Stress

For this study stress is defined as the adverse mental and physiological effects experienced by a Tramlink user (adapted from MEA 1983, Part B, Section 11).

Stress is a significant aspect of sustainability, although there are considerable difficulties in attempting to evaluate it (Macpherson 1993). For a Tramlink user negative experiences of stress would most likely occur at any of the following three stages: waiting for the service, the journey itself and the embarking and disembarking. The stress indicator is closely linked to other indicators in this research that influence the level of stress such as
convenience and comfort, safety, accessibility of tram and the tram's reliability and efficiency.

The DoT proposes in the MEA (1983, Part B, Section 11) that stress levels should be assessed using a scale of none, low, moderate and high.

2.8.3.4 Comfort of Journey

In the CTIS (2002), 39.2% of respondents asked for the main reason for their level of use of Tramlink answered that it was because the tram was comfortable. These findings are supported by the 2001 Survey, in which people clearly stated their need for a comfortable and convenient mode of transport. If a comfortable journey is high on the list of people's priority any transport mode that does not fulfil those criteria will be unsustainable, as not enough people will use that mode of transport. The level of perceived comfort provided by the tram service is highly subjective and best measured within the framework of an attitude survey.

2.8.3.5 Safety

Safety for passengers is comprised of two components: no fear of accidents when using the tram and safety in terms of crime.

The safety of a tram system in terms of accidents can be measured using safety statistics from Her Majesty's Railway Inspectorate.

In terms of preventing crime stops should be designed to provide no dark 'lurking places' for attackers. The shelters should be made of glass or other see through materials so that passengers are always on full view and the entire waiting area should be well lit.

Other security measures could include (see Harding 2003):
• Two-way alarm and information link with a control centre, staffed all the time during service operation

• CCTV links to a control centre, ensuring all waiting areas and ticket machines are under constant surveillance

• A public pay-telephone

• Patrol of the system by the police and security personnel, both in plain clothes and uniform
3.0 FIELD RESEARCH

3.1 Research Foundation

3.1.1 Introduction

There is a vast amount of literature on research methods, each publication advocating different sets of guidelines as well as their own version of existing terminology. For example, Hussey & Hussey (1997) refer to 'the paradigm' in their chapter dedicated to conceptual issues, whereas Crotty (1998), avoiding this vague term, prefers instead the use of the term 'theoretical perspective' for the same concept. Due to the inconsistency in the literature it is advisable to select one author's publication as the main source of reference. In this case, Michael Crotty's book *The Foundations of Social Research* (1998) was chosen due to the depth and relevance of the literature in relation to the research topic. At the same time Crotty's views are complimented with other authors' ideas, avoiding any inconsistency.

Unless stated otherwise all the concepts and ideas presented in this section are from Crotty (1998).

3.1.2 Research Choices

At the beginning of any research process the researcher is confronted with four decisions that need to be taken:

1. The choice of methods that are to be used
2. The kind of methodology
3. The theoretical perspective
4. The epistemology informing the theoretical perspective
Table 11 presents some examples of the choices available in each of the four elements. This is not intended to present an exhaustive list.

<table>
<thead>
<tr>
<th>Epistemology</th>
<th>Theoretical Perspective (examples of)</th>
<th>Methodology (examples of)</th>
<th>Methods (examples of)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectivism</td>
<td>Positivism (and post-positivism)</td>
<td>Research</td>
<td>Sampling</td>
</tr>
<tr>
<td>Constructionism</td>
<td>Interpretivism</td>
<td></td>
<td>Questionnaire</td>
</tr>
<tr>
<td></td>
<td>• Symbolic interactionism</td>
<td>• Experimental</td>
<td>Interview</td>
</tr>
<tr>
<td></td>
<td>• Phenomenology</td>
<td>• Phenomenological</td>
<td>Case study</td>
</tr>
<tr>
<td></td>
<td>• Hermeneutics</td>
<td>• Survey</td>
<td>Life history</td>
</tr>
<tr>
<td></td>
<td>Critical inquiry</td>
<td>• Action</td>
<td>Data reduction</td>
</tr>
<tr>
<td>Subjectivism (and their variants)</td>
<td></td>
<td>Grounded theory</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Heuristic inquiry</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Discourse analysis</td>
<td></td>
</tr>
</tbody>
</table>

Table 11: Epistemologies, Theoretical Perspectives, Methodologies and Methods
The four elements and their relationship are depicted in Figure 13 as existing on four levels.

![Diagram of the four elements relationship]

**Figure 13: The Relationship between the Four Elements**

The presentation of the four elements on the four levels helps to avoid any confusion or contradiction in the choices made during the research process, ensuring a sense of stability and direction in the study. For example one of the more common mistakes in research is the setting of representatives of different process elements side by side under the heading of methodologies. Only one representative of each element may be chosen, with the exception of methods where a number of techniques and procedures may be applied to gather and analyse data. Also a particular item may be related to more than one of the items available in the column below it. For example an epistemology may be embedded in several theoretical perspectives.

The arrows depicted in Figure 13 refer to the notion that each element influences the element in the column below. There are of course typical constructions such as a positivist perspective linked to survey research and the collection of quantitative data. This does not necessarily mean that for example a choice of a theoretical perspective will
predetermine certain methodologies as "any of the theoretical perspectives could make use of any of the methodologies, and any of the methodologies could make use of any of the methods" (Crotty, 1998, p.12). These typical combinations used in research are nonetheless very useful tools for justifying a research methodology on the basis of the underlying theoretical perspective and epistemology.

The only restrictions according to Crotty to the choices that can be made are inherent in the selection of the epistemology and the theoretical perspective's concepts, which will be discussed in more detail in the next section.

3.2 Epistemology

Epistemology is "the theory of knowledge embedded in the theoretical perspective" (Crotty 1998, p.3).

The epistemology is inherent in the theoretical perspective, thus a choice made in one predetermines the other. For example a positivist theoretical perspective is constructed on the notion of objectivity and would by definition require an objectivist epistemology. Nor will a researcher with a subjectivist epistemology choose a positivist theoretical perspective. Therefore the selection of an epistemology will determine the available theoretical perspectives and vice versa. This research is based on an objectivist epistemology. The assumption underlying this report is that "meaningful reality exists as such apart from the operation of any consciousness" (Crotty 1998, p.8). Objects exist regardless of whether or not human beings are aware of it because reality is a concrete structure.

3.3 Theoretical Perspective

The theoretical perspective is the philosophical stance in which the epistemology is inherent.
Built on the notions of objectivism presented in the previous section on epistemology the author is a positivist. A positivistic approach by and large sees the nature of reality as objective, detached from the researcher. The researcher is viewed to be autonomous from what he is researching, and positivists believe "(...) that only phenomena which are observable and measurable can be validly regarded as knowledge. They try to maintain an independent and objective stance" (Hussey & Hussey 1997, p.49). Positivist researchers view themselves as:

"(...) Detached from what they are researching and regard the phenomena which are the focus of their research as objects. Furthermore they believe that the objects under study are unaffected by their research activities and will still be present after the study has been completed" (ibid, p.49).

Usually large samples are used which then need to be treated statistically. Due to this very scientific approach the language used reflects the neutrality of the researcher, mostly applying the third person.

An example of the other extreme to positivism is the phenomenological perspective where reality is seen to be subjective, largely dependent on the perception of the researcher. Phenomenological researchers will interact with the objects of their research, not believing it possible to remain in a completely neutral position. The underlying belief of this perspective is that researchers "have values, even if they have not been made explicit. These values help to determine what are recognised as facts and the interpretations which are drawn from them" (ibid, p.49). This leads to a language that is less formal and expressions are formulated in the first person. Usually smaller samples are looked at with the intention to "understand what is happening in a situation and looking for patterns which may be repeated in other similar situations" (Hussey & Hussey 1997, p. 50; (see Table 12)).
### Table 12: Features of Positivistic and Phenomenological Perspectives
(Source: *ibid*, p.54)

<table>
<thead>
<tr>
<th>Positivistic perspective</th>
<th>Phenomenological perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tends to produce quantitative data</td>
<td>Tends to produce qualitative data</td>
</tr>
<tr>
<td>Uses large samples</td>
<td>Uses small samples</td>
</tr>
<tr>
<td>Concerned with hypothesis testing</td>
<td>Concerned with generating theories</td>
</tr>
<tr>
<td>Data is highly specific and precise</td>
<td>Data is rich and subjective</td>
</tr>
<tr>
<td>Reliability is high</td>
<td>Reliability is low</td>
</tr>
<tr>
<td>Validity is low</td>
<td>Validity is high</td>
</tr>
<tr>
<td>Generalises from sample to population</td>
<td>Generalises from one setting to another</td>
</tr>
</tbody>
</table>

### 3.4 Methodology

Methodology is defined as the strategy, plan of action, process or design lying behind the choice and use of particular methods that forms part of the wider research process (Crotty 1998; see Figure 6).

The methodology adopted in this study is the survey research. The survey is traditionally associated with interviews and questionnaires (Bryman 1989). There are various definitions of a survey research reflecting the different variations of a survey research. The two major types of survey are the analytical and the descriptive survey (Hussey & Hussey 1997). A researcher will use an analytical survey for determining a relationship between two variables. On the other hand a descriptive survey, as chosen for this investigation, is used to identify and count the frequency of a specific population (*ibid*). In this case, the survey will obtain people’s responses to questions on the sustainability of the Croydon Tramlink in an attitude survey, frequently used as a form of descriptive survey (*ibid*).

The justification for choosing the survey as research methodology stems from the underlying theoretical perspective as well as from the aim of this research. The justification for the survey from a philosophical standpoint is the close association of the survey research with positivism. As Crotty (1998, p.6) writes:
"research done in a positivist spirit might select to engage in survey research."

Hussey & Hussey (1997) also refer to the survey research as a positivist methodology. It is most suitable for positivists because it allows the collection of a large quantity of data from which reliable conclusions can be drawn from. The research in itself also justifies the choice of a survey research. The author wishes to generalise the findings beyond the research location of Croydon to the entire UK in light of the need for a sustainable transport mode.

3.5 Methods

3.5.1 Introduction

Methods are "the techniques or procedures used to gather and analyse data related to some research question or hypothesis" (Crotty 1998, p.3).

The model by Crotty (1998) adopted for this study makes the distinction between qualitative and quantitative research as part of the discussion on methods.

3.5.2 Quantitative versus Qualitative Methods

Quantitative methods aim to collect a large amount of data, for example using a sampling process, whereas qualitative methods are more concerned with collecting insights through, for example, observations or interviews. In this thesis a survey will be conducted—a quantitative method.

Perhaps as a response to the dominance of quantitative research, some qualitative researchers such as King (1994) seem to assume a fixed preference or predefined evaluation of what is good and bad research methodology. Such normative assumptions have, of course, been around for many years and are illustrated in Table 13. However the choice of quantitative and qualitative methods should be determined by the requirements of the research problem itself (Bryman 1989), as well as to some extent the underlying
assumptions of the researcher (Crotty 1998). In many research studies a combination of qualitative and quantitative methods is deemed most suitable to apply. In this research the quantitative method of questionnaires was selected for collating information.

<table>
<thead>
<tr>
<th>Table V Claimed features of qualitative and quantitative method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantitative</strong></td>
</tr>
<tr>
<td>Inquiry from the outside</td>
</tr>
<tr>
<td>Underpinned by a completely different set of epistemological foundations from those in qualitative research</td>
</tr>
<tr>
<td>Are simply different ways to the same end?</td>
</tr>
<tr>
<td>Involves the following of various states of the scientific research</td>
</tr>
<tr>
<td>The results are said to be &quot;hard generalisable data&quot;</td>
</tr>
</tbody>
</table>

Table 13: Qualitative vs. Quantitative Methods (Source: Amaratunga et al 2002)

3.5.3 Data Objective

The data collected was used, for the most part, to judge the sustainability of the Tramlink, with reasoning applied to precision, objectivity and rigour. The information collected from the questionnaire reflects the opinions and attitudes of interviewees to the questions asked; it is of a subjective nature. Through rating scales and closed-ended

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questions the information was quantified into measurable units as implied by a positivistic approach.

The secondary data provided information that could not otherwise be drawn from the primary source. Some aspects are too specific to expect rich insights from primary data.

3.5.4 Data Access

The author lives in close proximity to the Croydon Tramlink network allowing physically easy access to the research object and the survey sample. Furthermore Croydon Tramlink staff have been very cooperative in providing secondary data on the tram. Figure 14 gives an overview of the research procedure, described in detail in the sections to follow.

**Procedure of Research**

- Quantitative Method chosen
- Research Site chosen
- Development of Interview-guide
- Pilot Study
- Interviews Conducted
- Analysis of Data

*Figure 14: Procedure of Research*
3.5.5 Collection Methods

There are generally three methods of gathering data in survey research: personal interviews, mail questionnaires and telephone interviews (Nachmias & Nachmias 1996). All three methods have advantages and disadvantages. In this case personal interviews in a face-to-face situation were chosen because out of all three methods it allowed the collection of information from the sample without any need for prior contact or any arrangements to be made. To obtain the interviews people were approached in Croydon Town Centre at various locations in and around the pedestrianised area of the High Street between East and West Croydon railway stations.

In a first step an appropriate pilot study was performed, derived from the literature review. A sample of 25 people (chosen randomly from the Tramlink user population) answered the questionnaire. The wording of the questions was modified accordingly.

The initial contact involved a brief explanation of the research objectives and a short description of the project and a request for collaboration. The conversation was then followed up with the interviewees being asked a series of questions in an informal setting. While conducting the interview a laptop computer was used to collate the responses on a spreadsheet at location. This saved on the amount of paperwork that would have been produced and possible confusion later on during the transfer of data to its electronic form.

In the second stage of the survey 502 valid responses were collected in a six-week period during April and May 2003, on weekdays and at the weekend, at various times of the day. As a laptop was used to record people’s responses and for personal safety reasons no interviews were conducted after 6pm.
3.5.5.1 Interviewing

The interviews themselves were designed to last a maximum of seven minutes. The interview-guide provided a good structure for the interview and intentionally left little opportunity to deviate from the questions reflecting the closed nature of quantitative data collection. Some questions were preceded by an introductory preamble to guide the interviewee through the questionnaire avoiding misunderstandings or misinterpretations.

3.5.5.2 Selection of Sample

"Selecting a sample is a fundamental element of a positivistic study" (Hussey & Hussey 1997, p.144). It consists of a number of members within a wider population; in this case the population is defined as the users of the Croydon Tramlink. If the sample is representative, it is possible to use statistical techniques to demonstrate the likelihood that the characteristics of the sample will also be found in the population. "In other words, it may be possible to generalise from the findings" (ibid, p.64).

A sample must be (ibid, p.144):

- large enough to satisfy the needs of the investigation being undertaken
- unbiased.

There are two types of categories of sampling: probability and nonprobability sampling (Nachmias & Nachmias 1996). Probability sampling is the case where the probability of each sampling unit's (in this case the sampling unit is a single Tramlink user) inclusion into the population can be specified (ibid). In nonprobability sampling the probability of each sampling unit being included in the population cannot be specified. In this case the only information available on the population of Tramlink users stems from a sample of 3,124 Tramlink users collected by the Croydon Impact Study (2002). As is the case "when a list of the sampling population is unavailable" (Nachmias & Nachmias 1996,
p.184), the researcher used the nonprobability sampling method of quota sampling where the sample is selected so that it is as similar as possible to the sampling population (ibid). In this case the characteristics of the demographics obtained in the Croydon Tramlink Impact Study (2002) on 3,124 tram users were consulted for the selection of the interviewees. The CTIS (2002) results have an accuracy of +/- 1.9%. This technique was applied to ensure a sample that was as closely as possible representative of the entire population, thus ensuring the possibility to generalise from any findings.

Gender

The Croydon Tramlink Impact Study (2002) found that 58% of passengers were female and 42% were male. Using these figures as a guideline for the ratio of males to females 213 males (~42%) and 289 females (~58%) were interviewed for this research project.

Age profile

The age group ranges selected in the Croydon Tramlink Impact Study (2002) and the findings of the age profile of Tramlink users (see Table 14) were used as a guideline.

The Impact Study's (2002) 8 age groups were for the purpose of this study reduced to four.

<table>
<thead>
<tr>
<th>Age group</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 16</td>
<td>2</td>
</tr>
<tr>
<td>16-19</td>
<td>5</td>
</tr>
<tr>
<td>20-24</td>
<td>7</td>
</tr>
<tr>
<td>25-34</td>
<td>18</td>
</tr>
<tr>
<td>35-44</td>
<td>18</td>
</tr>
<tr>
<td>45-59</td>
<td>24</td>
</tr>
<tr>
<td>50-64</td>
<td>7</td>
</tr>
<tr>
<td>65 or older</td>
<td>19</td>
</tr>
</tbody>
</table>

*Table 14: Age Profile of Tramlink User*  
(Source: CTIS 2002, p.3)
The reasoning behind this was that it enabled the classification of people according to their age group without having to ask for their age, thus avoiding any affront. The age group categories for this research are (see Table 15):

<table>
<thead>
<tr>
<th>Age group</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 21</td>
<td>7</td>
</tr>
<tr>
<td>21-40</td>
<td>29</td>
</tr>
<tr>
<td>41-60</td>
<td>38</td>
</tr>
<tr>
<td>61+</td>
<td>26</td>
</tr>
</tbody>
</table>

*Table 15: Age Profile of Sample*

**Sample size**

Aiming for quantitative information and knowing the target population the objective was to collect data from at least 500 people, using a series of questions relating to economic, social and environmental matters. The choice of a sample of 500 interviewees was predetermined by time and resource constraints.

**3.5.5.3 Questionnaire Design**

See Appendix IV for the questionnaire. The questions were designed to illicit people's opinions on various issues identified in the latter section of the literature review. The questions were adapted from a variety of sources as displayed in Table 16.

Due to the choice of a positivist methodology for this research project the questions for the collection of the primary data were designed to reflect this paradigm by categorising the qualitative opinions of interviewees to obtain mainly quantitative data. The benefit associated with the analysis of quantitative data is that there is "a clear and accepted set of conventions for analysis" (Robson 1993, p.370).
Closed-ended questions (as opposed to open-ended questions) were chosen as the most appropriate format for "when the researcher's object is to lead the respondent to express agreement or disagreement with a (...) point of view" (Nachmias & Nachmias 1996, p.254).

In terms of contents "most questions can be classified in either of two general categories: factual and questions about subjective experiences" (ibid, p.251). "Factual questions are designed to elicit objective information from the respondent" (ibid, p.251); and in this case were applied in the collection of information on gender, age, place of living, usage of Tram, social mobility and severance (questions 1, 2, 3, 4, 12 and 13). The remaining questions are about subjective experiences illicit respondents' beliefs, attitudes, feelings and opinions (ibid; see table 16).

Rating scales are one of the most common question formats in social science surveys (Nachmias & Nachmias 1996). They are commonly used when wishing to "ask respondents to make a judgement in terms of sets of ordered categories, such as 'strongly agree', 'favourable' or 'very often' " (ibid, p.258) as was the case for this questionnaire. The questions that do not have a rating scale have a simple format presenting all possible answers for the respondent to choose from. Table 16 gives an overview of all the questions describing the original source from which each question was adapted from, under which index, the content and format of each question and a brief description on the type of information that the question was designed for.
<table>
<thead>
<tr>
<th>No.</th>
<th>Source</th>
<th>Content</th>
<th>Purpose of question/ justification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Index set</td>
<td>Format</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>CTIS</td>
<td>Factual</td>
<td>Demographic information of gender used to collect a representative sample of the population of Tramlink users</td>
</tr>
<tr>
<td></td>
<td>Not applicable</td>
<td>Simple</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CTIS</td>
<td>Factual</td>
<td>Demographic information of age used to collect a representative sample of the population of Tramlink users</td>
</tr>
<tr>
<td></td>
<td>Not applicable</td>
<td>Simple</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CTIS</td>
<td>Factual</td>
<td>Demographic information of people's place of living, monitoring emerging patterns of responses related to the area of living</td>
</tr>
<tr>
<td></td>
<td>Not applicable</td>
<td>Simple</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>CTIS</td>
<td>Factual</td>
<td>Collection of information on sample's habit of usage of the Tramlink</td>
</tr>
<tr>
<td></td>
<td>Economic</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>TFL</td>
<td>Subjective</td>
<td>Gauges people's views on what linkage there is between volume of road traffic and the Tram</td>
</tr>
<tr>
<td></td>
<td>Environmental</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>MEA</td>
<td>Subjective</td>
<td>Visual impact of the Tramlink's infrastructure on Croydon Town Centre</td>
</tr>
<tr>
<td></td>
<td>Environmental</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>MEA</td>
<td>Subjective</td>
<td>Visual impact of the Tramlink's infrastructure on green areas</td>
</tr>
<tr>
<td></td>
<td>Environmental</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>CTIS</td>
<td>Subjective</td>
<td>Assesses the opinions of respondents regarding whether the Tramlink is good value for money</td>
</tr>
<tr>
<td></td>
<td>Economic</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>CTIS</td>
<td>Subjective</td>
<td>Assesses the opinions of respondents regarding the Tramlink's punctuality</td>
</tr>
<tr>
<td></td>
<td>Social</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>CTIS</td>
<td>Subjective</td>
<td>Assesses the opinions of respondents on whether a journey on the Tramlink is quick and efficient</td>
</tr>
<tr>
<td></td>
<td>Economic/ social</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>CTIS</td>
<td>Subjective</td>
<td>Assesses the opinions of respondents regarding the Tramlink's cleanliness, comfort and maintenance</td>
</tr>
<tr>
<td></td>
<td>Economic/ social</td>
<td>Rating</td>
<td></td>
</tr>
</tbody>
</table>
### Questions

<table>
<thead>
<tr>
<th>No.</th>
<th>Source</th>
<th>Content</th>
<th>Purpose of question/ justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>MEA</td>
<td>Factual</td>
<td>Determines the severance caused by the Tramlink’s infrastructure</td>
</tr>
<tr>
<td></td>
<td>Social</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Parkhurst</td>
<td>Factual</td>
<td>Social accessibility: determining what effect the Tramlink has had on peoples’ travel habits</td>
</tr>
<tr>
<td></td>
<td>Social</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>CTIS</td>
<td>Subjective</td>
<td>Assesses the opinions of respondents in regards to overcrowding in the carriages</td>
</tr>
<tr>
<td></td>
<td>Economic/social</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>CTIS</td>
<td>Subjective</td>
<td>Assesses the opinions of respondents as to whether the Tramlink is safe and secure</td>
</tr>
<tr>
<td></td>
<td>Social</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>CTIS</td>
<td>Subjective</td>
<td>Assesses the opinions of respondents on how easy it is to get on and off the tram</td>
</tr>
<tr>
<td></td>
<td>Social</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>CTIS</td>
<td>Subjective</td>
<td>Gauges people’s stress levels as a result of the presence of the Tramlink</td>
</tr>
<tr>
<td></td>
<td>Social</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>CTIS</td>
<td>Subjective</td>
<td>Determines effect of the tram’s image on Croydon</td>
</tr>
<tr>
<td></td>
<td>Economic</td>
<td>Rating</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Kitzhaber</td>
<td>Subjective</td>
<td>The potential of longevity for the Tramlink based on interviewees’ perceptions of the system</td>
</tr>
<tr>
<td></td>
<td>Economic</td>
<td>Rating</td>
<td></td>
</tr>
</tbody>
</table>

Table 16: Questionnaire

#### 3.5.5.4 Questionnaire Scales

As previously established the questionnaire contained factual questions and questions about subjective experiences. It was necessary to develop different types of scales to questions as the nature of the individual questions required specific scales identified in the literature review.

The scales of the demographic questions 1, 2 and 3 were adapted from the CTIS (2002) (see chapter 3.5.5.2). Out of the remaining 16 questions 13 had a scale of 1-4; one on a scale of 1-6 (question 4); one on a scale of 1-3 (question 5); and question 13 gave two options ('Yes' or 'No').
Question 4's scale of response was adapted from the CTIS. The scale of question 5 of increase, decrease or no change was recommended by Transport for London for measuring traffic flow.

Questions 8, 9, 10, 11, 14, 15 and 18 gave statements to which the respondents were asked to express on a scale of 1 to 4 the degree to which they agreed or disagreed with the claim.

For questions 6 and 7 a four-point scale for visual impact was adapted from the MEA (1983) ranging from highly dissatisfactory to positive.

In question 12 the scale of none, slight, moderate and severe was set according to the MEA (1983) guidelines on measuring severance. This scale was also deemed effective for measuring people's difficulties in getting on and off the carriages for questions 16 and the level of stress experienced by passengers (question 17).

Question 13's two-point scale of 'Yes' or 'No' was determined by the simple matter of fact that people have either been or not been to new places.

The four-point scale of question 19 was chosen to allow people a definite answer of yes or no with the option of two of the in-between scales if they felt any degree of uncertainty.

All subjective questions had the additional option of 'do not know'. This was to prevent interviewees from making wild guesses, ensuring the accuracy of data collected. Any responses of this nature were later to be discarded.

Please see chapter 2.9.1 onwards for more background information.
3.5.6 Analysing Methods

3.5.6.1 Index Construction

An index is a single indicator variable developed through the mathematical combination of multiple indicator variables (see literature review).

There are four steps in constructing indexes (see Nachmias & Nachmias 1996):

1. defining the purpose for which the index is being compiled
2. selecting sources of data
3. selecting the base for comparison
4. selecting methods of aggregation and weighting

1. The purpose of the index is to provide a scale for the level of sustainability. The index will be used to judge the extent to which the Croydon Tramlink is sustainable in terms of economic, environmental and social dimensions as well as overall sustainability.

2. See chapter 2 for details on the indicators selected.

3. For comparison purposes the index consists of 8 categories each category representing a percentage range. Hall (2003) recommends that whilst an index of sustainability is subjective it should be composed of an 8-point scale. One hundred was divided by eight to give ranges of 12.5% (see Figure 15 below).

4. The choice of components and the way in which they are weighted together, is largely subjective. A different choice of components, or of weights, would give different results, and hence the resulting measures are potentially misleading. Further, conflicting movements in the individual components may result in the masking of important underlying trends (UK Government 1999).
In line with the descriptive survey the data analysis will be of a descriptive nature and require the most basic selection of tools and formulas for its analysis. In a first step, the data was entered into an SPSS package. In second stage questions 12, 13 and 17 were recoded because unlike the others they reflected a pattern of positive to negative rather than vice versa.

There are three instances where recoding variables is appropriate (see Coakes & Steed 2001, p.41):

1. Collapsing continuous variables into categorical variables.

2. Recoding negatively worded items.

Figure 15: Index
3. Replacing missing values and bringing outlying cases into distribution.

In these instances negatively coded queries were rearranged so that all responses spanned from being unsustainable to sustainable. As an index should be evaluated within the context of the indicator results it is composed from (Innes 1990), each indicator was given its own index score. The two aggregation methods most commonly used are simple and weighted aggregation. Using the Consumer Price Index as an example, simple aggregation creates an index by adding the price of all the variables (products) and dividing the total by the number of variables.

The measures that compose the sustainability indices in this research are simple. That is, individual benchmarks were not assigned more or less importance compared to other benchmarks within an individual index. The three sustainability indices created for this research were the result of a simple aggregation process. For the primary data from the questionnaire the response numbers for each question were added together and then divided by the number of valid answers giving a simple aggregative response for each question. In a next step the simple aggregative response for each question responses were then divided by the number of available responses (6 or 4 or 3 or 2), giving a percentage of the level of sustainability: "a common method for the development of indexes" (Nachmias & Nachmias 1996, p.461). See Figure 16 for the formula.

\[
\text{Formula: sustainability indicator} = \frac{1}{502} \left( \frac{\sum x_i}{502} \right)
\]

\[
\frac{502}{n}
\]

where \( x_i \) = individual response to a question

\( n \) = number of options on a scale

*Figure 16: Formula for Sustainability Indicator*
In each case this figure was then assigned to a category (see Figure 15).

In dealing with the secondary data, the Tramlink was compared with either other modes of transport or against other tram systems, be they in Europe or in the UK, or both together or neither. For example, in terms of environmental sustainability tram systems are fundamentally the same and so any contrasts would be insignificant between systems; it is hoped that assessment alongside other modes of transport will produce better insights.

Economically the Tramlink needs to show that it is self-sufficient, and therefore comparisons with other systems are deemed relevant and necessary. Some social issues are impossible to compare and are therefore presented on their own merits.

The primary and secondary categories within each indicator were tallied and then averaged to give a final score for environmental, economic and social sustainability. The overall sustainability score was achieved by determining the mean of the three indices.
4.0 RESULTS

4.1 Statistics

Table 17: Statistics

<table>
<thead>
<tr>
<th>Number</th>
<th>Gender</th>
<th>Age</th>
<th>Area</th>
<th>Q4</th>
<th>Q5</th>
<th>Q6</th>
<th>Q7</th>
<th>Q8</th>
<th>Q9</th>
<th>Q10</th>
</tr>
</thead>
<tbody>
<tr>
<td>valid</td>
<td>502</td>
<td>502</td>
<td>502</td>
<td>502</td>
<td>502</td>
<td>487</td>
<td>418</td>
<td>502</td>
<td>502</td>
<td>502</td>
</tr>
<tr>
<td>missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>84</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 18: Question 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Q11</th>
<th>Q12</th>
<th>Q13</th>
<th>Q14</th>
<th>Q15</th>
<th>Q16</th>
<th>Q17</th>
<th>Q18</th>
<th>Q19</th>
</tr>
</thead>
<tbody>
<tr>
<td>valid</td>
<td>502</td>
<td>502</td>
<td>502</td>
<td>502</td>
<td>502</td>
<td>502</td>
<td>502</td>
<td>502</td>
<td>502</td>
</tr>
<tr>
<td>missing</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

4.2 Demographics

As discussed in the field research chapter, the demographics retrieved from questions 1 and 2 monitored the sample to reflect the gender and age profile found in the Croydon Tramlink Impact Study (2002), ensuring a representative sample (see chapter for more detail). Question 3 monitored emerging patterns determined by where people lived.

Question 1: Male or female?

Table 18: Question 1

<table>
<thead>
<tr>
<th>Number</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>213</td>
<td>42.4</td>
<td>42.4</td>
<td>42.4</td>
</tr>
<tr>
<td>female</td>
<td>289</td>
<td>57.6</td>
<td>57.6</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Question 2: Age?

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 and under</td>
<td>35</td>
<td>7.0</td>
<td>7.0</td>
<td>7.0</td>
</tr>
<tr>
<td>21-40</td>
<td>146</td>
<td>29.1</td>
<td>29.1</td>
<td>36.1</td>
</tr>
<tr>
<td>41-60</td>
<td>191</td>
<td>38.0</td>
<td>38.0</td>
<td>74.1</td>
</tr>
<tr>
<td>61+</td>
<td>130</td>
<td>25.9</td>
<td>25.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 19: Question 2*

Question 3: Where do you live?

<table>
<thead>
<tr>
<th>Area</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Croydon</td>
<td>229</td>
<td>45.6</td>
<td>45.6</td>
<td>45.6</td>
</tr>
<tr>
<td>Beckenham</td>
<td>47</td>
<td>9.4</td>
<td>9.4</td>
<td>55.0</td>
</tr>
<tr>
<td>Elmers End</td>
<td>19</td>
<td>3.7</td>
<td>3.7</td>
<td>58.7</td>
</tr>
<tr>
<td>Mitcham</td>
<td>61</td>
<td>12.2</td>
<td>12.2</td>
<td>70.9</td>
</tr>
<tr>
<td>Junction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Addington</td>
<td>102</td>
<td>20.3</td>
<td>20.3</td>
<td>91.2</td>
</tr>
<tr>
<td>Shirley Hills</td>
<td>16</td>
<td>3.2</td>
<td>3.2</td>
<td>94.4</td>
</tr>
<tr>
<td>Wimbledon</td>
<td>12</td>
<td>2.4</td>
<td>2.4</td>
<td>96.8</td>
</tr>
<tr>
<td>Others</td>
<td>16</td>
<td>3.2</td>
<td>3.2</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 20: Question 3*
4.3 Environmental Indicators

4.3.1 Traffic Noise (secondary data)

The Tramlink has been designed to ensure that for areas with (Harding, 2003):

- existing noise levels less than 59dB(A), the increase in noise shall not exceed 59 dB(A)
- existing noise levels greater than 59dB(A), the increase shall not exceed 3dB(A).

All noise levels refer to 24 hour LA(eq) at one meter from relevant façade.

4.3.2 Traffic Flow

Question 5: Has there been an increase, decrease or no change in traffic flow due to the opening of the Tramlink in May 2000?

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>increase</td>
<td>110</td>
<td>21.9</td>
<td>21.9</td>
<td>21.9</td>
</tr>
<tr>
<td>no change</td>
<td>296</td>
<td>59.0</td>
<td>59.0</td>
<td>80.9</td>
</tr>
<tr>
<td>decrease</td>
<td>96</td>
<td>19.1</td>
<td>19.1</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 21: Question 5*

Nearly six out of ten people questioned reported no change in the amount of traffic in their area as a result of the Tramlink. The remaining 40 per cent was split almost evenly between those who perceived an increase or those who believed that traffic had decreased.
4.3.3 Visual Impact

Question 6: What is the visual impact of the Tramlink on the character of Croydon Town Centre?

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>highly dissatisfactory</td>
<td>60</td>
<td>12.0</td>
<td>12.3</td>
<td>12.3</td>
</tr>
<tr>
<td>dissatisfactory</td>
<td>136</td>
<td>27.1</td>
<td>27.9</td>
<td>40.2</td>
</tr>
<tr>
<td>indifferent</td>
<td>262</td>
<td>52.2</td>
<td>53.8</td>
<td>94.0</td>
</tr>
<tr>
<td>positive</td>
<td>29</td>
<td>5.8</td>
<td>6.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>487</td>
<td>97.0</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Missing system</td>
<td>15</td>
<td>3.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 22: Question 6*

Over half of users are indifferent to the impact of the Tramlink on the character of Croydon Town Centre. A little over a quarter are dissatisfied, with one in eight highly dissatisfied. Just 29 of the 502 questioned believe the infrastructure is positive and a further 15 felt unable to give an answer.
Question 7: What is the visual impact of the Tramlink on the character of the green areas outside town?

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly dissatisfactory</td>
<td>136</td>
<td>27.1</td>
<td>32.5</td>
<td>32.5</td>
</tr>
<tr>
<td>dissatisfactory</td>
<td>144</td>
<td>28.7</td>
<td>34.4</td>
<td>67.0</td>
</tr>
<tr>
<td>indifferent</td>
<td>132</td>
<td>26.3</td>
<td>31.6</td>
<td>98.6</td>
</tr>
<tr>
<td>positive</td>
<td>6</td>
<td>1.2</td>
<td>1.4</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>418</td>
<td>83.3</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Missing system</td>
<td>84</td>
<td>16.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 23: Question 7*

The results show a more even spread to the previous query with a little over a quarter of users each either highly dissatisfied, dissatisfied or indifferent to the impact of the Tramlink on the character of green areas. Just 6 of the 502 questioned believe the infrastructure is positive and a further 84 people were unable to answer the question.

**4.3.4 Air Pollution (secondary data)**

Overhead power lines are used to provide the electricity required for the trams. These consist of single wires, or pairs of wires, suspended from poles or buildings.

Although the generation of the electricity needed to run the trams does have the potential to create air pollution from the power station, this source is subject to Government controls. "Trams do not emit fumes or pollutants at street level" (Harding 2003).
4.3.5 Resource usage (secondary data)

A double track is 6m wide and more than 60% of the route incorporates previously disused or lightly used Railtrack lines.

Trams are electrically powered by 750-volt direct current supplied through the overhead wire. The Croydon Tramlink uses 0.92 Megajoules per passenger kilometre (Gunnarsson and Lofgren 2001; Harding 2003)

4.4 Economic Indicators

4.4.1 Value for money

Question 8: The Tramlink is good value for money

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>41</td>
<td>8.2</td>
<td>8.2</td>
<td>8.2</td>
</tr>
<tr>
<td>disagree</td>
<td>99</td>
<td>19.7</td>
<td>19.7</td>
<td>27.9</td>
</tr>
<tr>
<td>agree</td>
<td>257</td>
<td>51.2</td>
<td>51.2</td>
<td>79.1</td>
</tr>
<tr>
<td>strongly agree</td>
<td>105</td>
<td>20.9</td>
<td>20.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 24: Question 8

With the aid of the prompt card of ticket prices (see Appendix V), over half of those questioned agreed that the Tramlink was good value for money. One in five strongly agreed, whilst a similar proportion disagreed. Less than 10 per cent strongly disagreed.
4.4.2 Consumerism

Question 4: How often on average do you use the tram?

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>never</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>I have only used the Tramlink once</td>
<td>3</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>rarely</td>
<td>17</td>
<td>3.4</td>
<td>3.4</td>
<td>4.0</td>
</tr>
<tr>
<td>occasionally</td>
<td>30</td>
<td>6.0</td>
<td>6.0</td>
<td>10.0</td>
</tr>
<tr>
<td>weekly/at weekends</td>
<td>91</td>
<td>18.1</td>
<td>18.1</td>
<td>28.1</td>
</tr>
<tr>
<td>2-3 days a week</td>
<td>149</td>
<td>29.7</td>
<td>29.7</td>
<td>57.8</td>
</tr>
<tr>
<td>4 or more days a week</td>
<td>212</td>
<td>42.2</td>
<td>42.2</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 25: Question 4*

Over forty per cent used the network at least 4 times a week, with a further three in ten utilising it 2-3 times every seven days. 91 out of the 502 interviewed used it weekly or at weekends and the final ten per cent at less regular intervals.

4.4.3 Consumerism: Passenger figures (secondary data)

The CTIS estimates "that 17.3 million passengers travelled on Tramlink in the year to September 2001" (p.3).

More recent figures estimate Tramlink patronage has grown to 19m passengers in the year to 31st March 2003 and is expected to top 20million in the current financial year (Harding, 2003).
4.4.4 Capacity

Question 14: Overcrowding is a problem on the carriages

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly agree</td>
<td>45</td>
<td>9.0</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>agree</td>
<td>84</td>
<td>16.7</td>
<td>16.7</td>
<td>25.7</td>
</tr>
<tr>
<td>disagree</td>
<td>216</td>
<td>43.0</td>
<td>43.0</td>
<td>68.7</td>
</tr>
<tr>
<td>strongly disagree</td>
<td>157</td>
<td>31.3</td>
<td>31.3</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>502</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 26: Question 14

One quarter of interviewees either agreed or strongly agreed with this statement.

4.4.5 Capacity (secondary data)

A 30-metre tram, the length of six cars, can carry up to 208 people with 70 seats and approximately 208 standing spaces (www.tfl.gov.uk).

4.4.6 Time/efficiency

Question 9: The Tramlink is on time

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>disagree</td>
<td>10</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>agree</td>
<td>99</td>
<td>19.7</td>
<td>19.7</td>
<td>21.7</td>
</tr>
<tr>
<td>strongly agree</td>
<td>393</td>
<td>78.3</td>
<td>78.3</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>502</strong></td>
<td><strong>100.0</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 27: Question 9
Nearly four out of five interviewees strongly agreed that the Tramlink is punctual, a further fifth agreed and 2 per cent disagreed.

Question 10: The Tramlink gets you from A to B quickly and efficiently

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>1</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>disagree</td>
<td>12</td>
<td>2.4</td>
<td>2.4</td>
<td>2.6</td>
</tr>
<tr>
<td>agree</td>
<td>119</td>
<td>23.7</td>
<td>23.7</td>
<td>26.3</td>
</tr>
<tr>
<td>strongly agree</td>
<td>370</td>
<td>73.7</td>
<td>73.7</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 28: Question 10

Just under three-quarters strongly agreed with this notion, a further fifth agreed. 13 people from 502 (2.6%) showed any disagreement with the statement.

4.4.7 Image

Question 11: The carriages are clean, comfortable and well kept

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>3</td>
<td>.6</td>
<td>.6</td>
<td>.6</td>
</tr>
<tr>
<td>disagree</td>
<td>10</td>
<td>2.0</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>agree</td>
<td>198</td>
<td>39.4</td>
<td>39.4</td>
<td>42.0</td>
</tr>
<tr>
<td>strongly agree</td>
<td>291</td>
<td>58.0</td>
<td>58.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 29: Question 11
Nearly all interviewees (97 out of 100) either agreed or strongly agreed to this statement.

Question 18: The Tramlink makes a positive contribution to the image of Croydon

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>2</td>
<td>.4</td>
<td>.4</td>
<td>.4</td>
</tr>
<tr>
<td>disagree</td>
<td>94</td>
<td>18.7</td>
<td>18.7</td>
<td>19.1</td>
</tr>
<tr>
<td>agree</td>
<td>361</td>
<td>71.9</td>
<td>71.9</td>
<td>91.0</td>
</tr>
<tr>
<td>strongly agree</td>
<td>45</td>
<td>9.0</td>
<td>9.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 30: Question 18*

This question showed a split of 80-20 in agreement with the statement.

Question 19: Will the Tramlink still be present in 20 years time?

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>no</td>
<td>74</td>
<td>14.7</td>
<td>14.7</td>
<td>14.7</td>
</tr>
<tr>
<td>not very likely</td>
<td>107</td>
<td>21.3</td>
<td>21.3</td>
<td>36.1</td>
</tr>
<tr>
<td>more than</td>
<td>202</td>
<td>40.2</td>
<td>40.2</td>
<td>76.3</td>
</tr>
<tr>
<td>likely</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>yes</td>
<td>119</td>
<td>23.7</td>
<td>23.7</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 31: Question 19*

Just over a third of people showed a negative attitude towards the potential longevity of the Tramlink. Four out of ten thought it more than likely that the system would survive the next twenty years.
4.4.8 Competitiveness (secondary data)

<table>
<thead>
<tr>
<th>Modes Previously Used</th>
<th>Bus</th>
<th>Car Driver</th>
<th>Rail</th>
<th>Walk</th>
<th>Car Passenger</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>69%</td>
<td>16%</td>
<td>7%</td>
<td>4%</td>
<td>3%</td>
<td>1%</td>
<td></td>
</tr>
</tbody>
</table>

Table 32: Modes Previously Used By Tramlink Passengers

The majority of people interviewed for the Croydon Tramlink Impact Study previously used buses; still the CTIS reports that "as a result of car users transferring to the Tramlink a total of 7,028 vehicles a day have been removed from the road network" (2002, p.8). Harding (2003) calculates that over 2.5 million car journeys a year are therefore lost, nearly 12.8% of the total passenger patronage (2003).

4.5 Social Indicators

4.5.1 Community Severance

Question 12: Have you ever experienced any obstruction in a journey caused by the introduction of the Tramlink?

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>143</td>
<td>28.5</td>
<td>28.5</td>
<td>28.5</td>
</tr>
<tr>
<td>slight</td>
<td>257</td>
<td>51.2</td>
<td>51.2</td>
<td>79.7</td>
</tr>
<tr>
<td>moderate</td>
<td>96</td>
<td>19.1</td>
<td>19.1</td>
<td>98.8</td>
</tr>
<tr>
<td>severe</td>
<td>6</td>
<td>1.2</td>
<td>1.2</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 33: Question 12
Just slightly over half of the sample detected a slight obstruction (50-250m walking or 1-5min driving) in their journey due to the Tramlink. Nearly 30 per cent opted for no obstruction at all, with the vast majority of the remaining 20 per cent selecting moderate (250-500m walking or 5-10min driving)

4.5.2 Social Equity/Accessibility

Question 10: The Tramlink gets you from A to B quickly and efficiently

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>1</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>disagree</td>
<td>12</td>
<td>2.4</td>
<td>2.4</td>
<td>2.6</td>
</tr>
<tr>
<td>agree</td>
<td>119</td>
<td>23.7</td>
<td>23.7</td>
<td>26.3</td>
</tr>
<tr>
<td>strongly agree</td>
<td>370</td>
<td>73.7</td>
<td>73.7</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 28: Question 10*

Just under three-quarters strongly agreed with this notion; a further fifth agreed.

13 people of the 502 (2.6%) showed any disagreement.

Question 13: Have you started going to any new places, or are starting to go anywhere more, because it is easier to get there since the Tramlink opened?

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>440</td>
<td>87.6</td>
<td>87.6</td>
<td>87.6</td>
</tr>
<tr>
<td>no</td>
<td>62</td>
<td>12.4</td>
<td>12.4</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

*Table 34: Question 13*
Nearly 90 per cent believed that they had more opportunity to visit new places or go out to areas more frequently due to the Tramlink. One in eight did not think that the Tramlink had changed their habits.

4.5.3 Social Equity/Accessibl...
4.5.5 Accessibility of the Tramlink Carriages (secondary data)

All stops are accessible to the disabled with the help of well-lit ramps from the pavement to the low Tramlink platform. When embarking and disembarking the carriages the internal floor of the tram is level with the platform edge. The carriages provide safe 'parking' spaces for wheel chairs and prams away from the main gangway. Each stop is announced through a public address system and the doors open automatically at each stop.

4.5.6 Stress

Question 17: Given all the questions above do you feel any stress caused by the Tramlink?

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>429</td>
<td>85.5</td>
<td>85.5</td>
<td>85.5</td>
</tr>
<tr>
<td>low</td>
<td>64</td>
<td>12.7</td>
<td>12.7</td>
<td>98.2</td>
</tr>
<tr>
<td>moderate</td>
<td>9</td>
<td>1.8</td>
<td>1.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 36: Question 17

17 out of 20 interviewed did not feel any stress whilst using the system. Of those remaining, the majority felt only slight stress levels.

4.5.7 Safety

Question 15: It is personally safe (in terms of accidents) and secure (in terms of crime) to use the Tramlink.
Table 37: Question 15

Only seven per cent had any safety issues; most interviewees felt strongly that no security or safety matters arose from the tram.

4.5.8 Safety (secondary data)

Her Majesty’s Railway Inspectorate (HMRI) issues safety statistics on an annual basis for all Tramways in the UK. The most recently published statistics are shown below:

Table 38: Tramlink Incidents

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incidents</td>
<td>RTAs*</td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>38</td>
</tr>
</tbody>
</table>

* RTA = Road Traffic Accident included in incident total
4.5.9 Comfort of Journey

Question 11: The carriages are clean, comfortable and well kept

<table>
<thead>
<tr>
<th>Response</th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>3</td>
<td>.6</td>
<td>.6</td>
<td>6</td>
</tr>
<tr>
<td>disagree</td>
<td>10</td>
<td>2.0</td>
<td>2.0</td>
<td>2.6</td>
</tr>
<tr>
<td>agree</td>
<td>198</td>
<td>39.4</td>
<td>39.4</td>
<td>42.0</td>
</tr>
<tr>
<td>strongly agree</td>
<td>291</td>
<td>58.0</td>
<td>58.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 29: Question 11

Nearly all interviewees (97 out of 100) either agreed or strongly agreed with this statement.

Question 14: Overcrowding is a problem on the carriages

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Valid percent</th>
<th>Cumulative percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly agree</td>
<td>45</td>
<td>9.0</td>
<td>9.0</td>
<td>9.0</td>
</tr>
<tr>
<td>agree</td>
<td>84</td>
<td>16.7</td>
<td>16.7</td>
<td>725.7</td>
</tr>
<tr>
<td>disagree</td>
<td>216</td>
<td>43.0</td>
<td>43.0</td>
<td>68.7</td>
</tr>
<tr>
<td>strongly disagree</td>
<td>157</td>
<td>31.3</td>
<td>31.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>502</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 26: Question 14

Three quarters of interviewees had experienced no problem with overcrowding on the carriages.
5.0 ANALYSIS AND DISCUSSION

5.1 Introduction

This chapter analyses the results obtained through the methods outlined in Chapter Three. A summary of the results will be presented and discussed. The report on each research sub-question is separated into two parts: 1) a summary of the results obtained, and 2) the allocation of an index score based on the sustainability of the Tramlink: Figure 15 is provided for ease of reference. Further arguments will subsequently be considered. Please refer to Chapter Three for a more detailed discussion of the methodology used in each section.

5.2 Research Questions

The following main question and three sub-questions were first presented at the outset:

Main question: Is the Tramlink sustainable?

Sub-question IV: Is the Tramlink environmentally sustainable?

Sub-question V: Is the Tramlink economically sustainable?

Sub-question VI: Is the Tramlink socially sustainable?

Table 39: Research Questions
5.3 Research Objective

The research objective was to:

- identify environmental, economic and social indicators of sustainability
  (accomplished in the literature review)
- evaluate the environmental sustainability of the Tramlink
- evaluate the economic sustainability of the Tramlink
- evaluate the social sustainability of the Tramlink
- evaluate the overall sustainability of the Tramlink

1 = completely unsustainable (0-12.5%)
2 = to a high degree unsustainable (12.6-25%)
3 = to a moderate degree unsustainable (25.1-37.5%)
4 = to a small degree unsustainable (37.6-50%)
5 = to a small degree sustainable (50.1-62.5%)
6 = to a moderate degree sustainable (62.6-75%)
7 = to a high degree sustainable (75.1-87.5%)
8 = fully sustainable (87.6-100%)

*Figure 15: Index*
5.4 Environmental Sustainability of the Tramlink

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Discussion</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic noise</td>
<td>The tram's noise level of 59 - 62 dB (A) is much lower than other modes of transport (see Figure 17). More importantly it is below the level of 68dB(A) considered to cause a nuisance (Figure 18). This level of noise is comparable to working in a typical office environment (MEA 1983; Macpherson 1993) and does not cause any level of unsuitable noise pollution.</td>
<td>8</td>
</tr>
<tr>
<td>Traffic flow</td>
<td>The Tramlink has not had a significant positive affect on the traffic flow in the local area.</td>
<td>5</td>
</tr>
<tr>
<td>Visual impact</td>
<td>In Croydon Town Centre the Tramlink's infrastructure of overhead cabling, steel supports, stops and tracks blends in with the townscape leaving over half of the people questioned indifferent to the visual impact. Figure 19 displays part of the infrastructure within the context of Croydon Town Centre.</td>
<td>6</td>
</tr>
<tr>
<td>- Urban</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Green areas</td>
<td>In green areas the infrastructure represents a more intrusive element and not unsurprisingly 55.8% of people questioned were dissatisfied or highly dissatisfied with the visual impact. Figure 20 shows part of a greener area that has had to accommodate the Tramlink's infrastructure.</td>
<td>5-6</td>
</tr>
</tbody>
</table>

Table 40: Environmental Indicators
Figure 18: Decibel Scale
(Source: MEA B:2)
The photo highlights how the infrastructure of the network blends in satisfactorily in a town centre that is a mass of high buildings and with typical street furniture such as tall lampposts and street signs.

Figure 20: Tram Tracks and Cabling in Woodland (taken near Coombe Lane)
The photo in Figure 20 however argues the case that the affect on the eye is more intrusive in green areas where the tram has cut large swathes through woodland.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Discussion</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air pollution</td>
<td>The Tramlink does not produce any direct air pollution (Harding 2003).</td>
<td>8</td>
</tr>
<tr>
<td>Resource usage</td>
<td>The Tramlink uses less than a third of the energy of a motorcar and but consumes more energy than a trolley bus (see Figure 21). The tram's infrastructure requires very little land; the Tramlink with a larger capacity than a dual carriageway requires only one third of the space (6m. width compared to nearly 20m for a dual carriageway (see Figure 22). Tramlink does not need wide swathes of segregated track in comparison to conventional railway. It climbs steeper gradients and negotiates tighter curves than a conventional railway, thereby fitting in around existing buildings and spaces (Harding 2003). The tram's energy consumption (MJ per passenger-km travelled) is 0.55 MJ/pkm, far more energy efficient than most other modes of transport. It is not fully sustainable as the electricity it uses is not from a renewable source (Harding 2003).</td>
<td>7</td>
</tr>
</tbody>
</table>

|                |                                                                                         |       |
| Total          |                                                                                         | 33.5  |
| Mean           |                                                                                         | 6     |

Table 40: Environmental Indicators
Figure 21: Energy Consumption of Trams against other Transport
(Source: Gunnarsson & Lofgren 2001, p.49)

Figure 22: Land Area Requirement of Trams against other Transport
(Source: Gunnarsson & Lofgren, 2001, p.51)
5.5 Economic Sustainability of the Tramlink

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Discussion</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value for money</td>
<td>The Tramlink's ticket prices (see Appendix III) were perceived to offer value for money to a moderately sustainable extent.</td>
<td>6</td>
</tr>
<tr>
<td>Consumerism</td>
<td>Most people used the system several times a week and this is reflected to a highly sustainable degree. This however is balanced out as even though patronage of the system has risen from 17.3 million in the Tramlink's first year (May 2000-May 2001) to 19 million in 2003 and is predicted to be 20 million in 2003-2004: an increase of approximately 9.8% over four years (Harding 2003), it is a relatively low increase in comparison to French systems, for example, which have seen an increase in passenger figures of some 50 per cent over their first five years <em>(<a href="http://www.parliament.the-stationery-office.co.uk/pa">http://www.parliament.the-stationery-office.co.uk/pa</a>)</em></td>
<td>7</td>
</tr>
<tr>
<td>Capacity</td>
<td>The majority of people did not find the tram to be overcrowded. This result is backed up by the capacity of a tram to carry ~210 people, nearly three times as many as a double-decker bus <em>(<a href="http://www.tfl.gov.uk">www.tfl.gov.uk</a>)</em>.</td>
<td>7</td>
</tr>
<tr>
<td>Time/efficiency</td>
<td>The system was perceived to be a punctual, quick and efficient mode of travel thus scoring full marks for its sustainability overall.</td>
<td>8</td>
</tr>
</tbody>
</table>
The carriages were judged to be clean, comfortable and well maintained. The questions on image and longevity both revealed that the Tramlink was sustainable to a moderate extent.

The Tramlink has captured 12.8% of car users in the Croydon area; still research shows that almost one-fifth of the passengers using the first phase of Manchester Metrolink, for example, had previously made their journey by car, whilst in Sheffield the figure stands at 22.8% (www.parliament.the-stationery-office.co.uk/pa).

<table>
<thead>
<tr>
<th>Image</th>
<th>The carriages were judged to be clean, comfortable and well maintained. The questions on image and longevity both revealed that the Tramlink was sustainable to a moderate extent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competitiveness</td>
<td>The Tramlink has captured 12.8% of car users in the Croydon area; still research shows that almost one-fifth of the passengers using the first phase of Manchester Metrolink, for example, had previously made their journey by car, whilst in Sheffield the figure stands at 22.8% (<a href="http://www.parliament.the-stationery-office.co.uk/pa">www.parliament.the-stationery-office.co.uk/pa</a>).</td>
</tr>
</tbody>
</table>

| Total | 42 |
| Mean  | 7  |

*Table 41: Economic Indicators*
### 5.6 Social Sustainability of the Tramlink

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Discussion</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community severance</td>
<td>The presence of the Tramlink network has caused little obstruction (see Figure 23 for an example of the type of slight severance that may be incurred) and is to a high degree sustainable.</td>
<td>7</td>
</tr>
<tr>
<td>Social Equity/Accessibility</td>
<td>The system was perceived to be a quick and efficient mode of travel and the carriages easily accessible. Travel patterns have changed, the tram enabling more journeys to be made and more places to be visited. The Croydon Tramlink Impact Study (2002) stated that 22% of passengers interviewed did not previously make their current journey, whilst time savings of up to 25 minutes have made destinations far more accessible to travellers, which is comparable to other tram networks (Gunnarsson and Lofgren 2001; Harding 2003)</td>
<td>8</td>
</tr>
<tr>
<td>Stress</td>
<td>Full sustainability was achieved for the tram not raising stress levels.</td>
<td>8</td>
</tr>
<tr>
<td>Comfort of journey</td>
<td>Whilst the carriages were judged to be clean, comfortable and well maintained, the score had to be adjusted because some passengers found the carriages to be overcrowded.</td>
<td>7</td>
</tr>
</tbody>
</table>
Table 43 shows that in relation to accidents the Tramlink is the 3rd safest of the 5 established tram networks in the UK. However, when compared to the safety records of other modes of transport, it excels. For example, in the borough of Croydon alone, there were over 1,500 incidents involving road traffic (Croydon Guardian 28 May 2003).

<table>
<thead>
<tr>
<th></th>
<th>Table 42: Social Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
</tr>
<tr>
<td>Mean</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 42: Social Indicators

Figure 23: Severance Affect outside East Croydon Station

Almost dead centre in the photo above is a woman who has tried to cross the road, to get to the bus stop opposite, and found a barrier in her way. To reach the stop she will have to walk some 50m and then back again.
### Tramway Incidents

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Incidents</td>
<td>RTAs*</td>
<td>Incidents</td>
<td>RTAs*</td>
</tr>
<tr>
<td>Midland</td>
<td>15</td>
<td>7</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Manchester</td>
<td>33</td>
<td>31</td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>Croydon</td>
<td>44</td>
<td>38</td>
<td>36</td>
<td>23</td>
</tr>
<tr>
<td>Sheffield</td>
<td>47</td>
<td>44</td>
<td>57</td>
<td>48</td>
</tr>
<tr>
<td>Blackpool</td>
<td>39</td>
<td>28</td>
<td>72</td>
<td>47</td>
</tr>
</tbody>
</table>

* RTA = Road Traffic Accident included in incident total

**Table 43: Accidents Involving Trams**

(Source: HMRI 2002)

### 5.7 Summary of Results

The sustainability rating responses for each indicator were totalled, and an average rating generated. Table 44 shows the average sustainability ratings for each indicator studied, in descending order.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social sustainability</td>
<td>7</td>
</tr>
<tr>
<td>Economic sustainability</td>
<td>7</td>
</tr>
<tr>
<td>Environmental sustainability</td>
<td>6</td>
</tr>
</tbody>
</table>

**Table 44: Sustainability Indicator Scores**

Table 44 shows that the environmental indicator achieved a rating of six, denoting a moderate level of sustainability. The social and economic indicators received a score of seven, signifying a high level of sustainability.
5.8 Overall Sustainability

By adding the three scores together and then dividing by three, an overall mark can be obtained. The resulting score of 7 indicates that the Tramlink overall is sustainable to a high degree.

5.9 Comparison of Findings with Literature Review

Taking as a foundation the positive and negative experiences of European networks (as outlined in the literature review) the following arguments arise:

- Positive experiences

  1. *The reasons for cities to choose trams as a new transportation mode are many: they have environmental, economic and social advantages*

     *(Gunnarsson & Lofgren 2001, p.45)*

     The data collected can be seen to support this statement. In terms of the indicators, the Tramlink's lowest score on the index is sustainable to a slight extent. In many categories such as noise or air pollution this research has found it to out-perform other transport means. It is considered that light rail could be the future of British transport as was advocated by Keeble (2001) and Trams for Bath, with the proposals for further networks or extensions to established systems being fully justified in terms of sustainability.

  2. *The trams in some cases, for example Strasbourg and Karlsruhe, have even become symbolic for the city: the people are proud of their system*

     *(Gunnarsson & Lofgren 2001, p.45)*
Croydon should be proud that it is the ‘London Borough with the Tram’ (www.tfl.gov.uk). It reflects the Strasbourg and Karlsruhe networks in that results indicate that the majority of people believe that it represents a positive image and therefore it can be argued that the tram is economically sustainable and is likely to contribute to the vitality and viability of the settlement on a much wider scale than has been approached in this study.

3. *Tracks and rights-of-way are flexible and the infrastructure can be designed to blend in with urban street furniture*

In Croydon it is judged that the tram blends in with the urban fabric. Tracks have been laid in the centre on existing roads and railways without the need for additional construction of this type. It has meant that the layout of Croydon has had to change very little. Pillars and cabling are no more intrusive than lampposts or other electricity cables.

4. *If the success of light rail is measured in passenger growth then ridership levels on most established networks are increasing (Crampton & Hass-Klau 1999)*

The patronage figures and usage rates collected support this statement. In Britain the signs are that passenger levels are increasing year by year, as many sources have claimed. It is deemed that this is a further reflection of the tram system as the transport mode of the future.
5. Public transport experts believe that modern trams are perceived by the public to be a superior transport mode (ibid.)

Again, judging by the primary data on comfort, efficiency and stress levels it can be argued that this statement is true. Whether or not people care that they are utilising a network that might be considered a more environmentally friendly form of transport, evidence suggests that socially and economically the tram has developed a customer base all of its own, and is perceived to be a value for money, efficient, comfortable and stress-free type of travel.

6. Much evidence suggests extensions to many existing lines and entire new networks are being considered: it can be inferred that the future looks bright for light rail

Across Europe academics stipulate and politicians promise that further developments in light rail should or will be implemented in many more areas. Given the success in most aspects of Croydon Tramlink it is argued that new tram projects cannot come soon enough, especially in Britain where it has been established that the transport network is at crisis point.
• Negative experiences

1. *If success is measured by the extent to which car drivers are lured out of their cars, then most light rail lines are not as successful as they could be, possibly because there is a lack of policy measures that could be used to strengthen the role of light rail* (Crampton & Hass-Klau 1999)

This suggestion is supported by the secondary data on people switching from cars to the Tramlink. However the system has not been as successful as other networks in reducing the reliance on the motorcar, one of the most significant factors in achieving sustainability. Certainly a case could be made for stronger policy measures to ensure a greater transfer of people from motorcar to tram.

2. *The ugliness of overhead cabling and other infrastructure is often an issue* (ibid.)

The Strasbourg tram network is considered to be the benchmark for evaluating visual amenity and environmental sustainability. Pictures of the Strasbourg system and pictures of the Croydon Tramlink in comparison show a marked difference in appearance between the two systems. In Strasbourg it is apparent that more money has been spent on minimising the affect of the network on the environment. The tram carriages are more impressive, overhead cabling and supports less intrusive and landscaping schemes include trees and grass on tracks, creating a tram network that puts the Croydon Tramlink to shame. In Britain there is a culture of trying to get things ‘on the cheap’ (Pelling 1998), which in the long run would diminish
environmental sustainability. In the urban area of Croydon it is not such a major issue, but as is shown by Figure 20, the system has had a detrimental impact on woodland in peripheral districts. Planting grass between the tracks for example, whilst acknowledged would be expensive as in the case of Strasbourg, would at the very least be likely to significantly reduce the visual affect. Pelling (1998) continues to voice disappointment that having sold the tram system to the public it has failed to melt into the background. "I suspect it is a short cut to save money" (2003, p.2).

There needs to be more emphasis on such environmental concerns, not just for natural ecosystems but also the local environments in which people live. Whilst Hatter (2003) implies that people want more social accessibility for children, some of the results of this research indicate that this is clearly not the case.

3. Extensions to networks can adversely affect on the quality of life, that is the area of liveability, of peripheral settlements

Certainly the extension through the green areas of Shirley Hills and Addington Village has adversely affected the character of these predominantly sylvan districts. As implied above, extra attention to the appearance of any further expansion of the Tramlink should be taken into account.

However, that is just one aspect of the area of liveability. To dwell on the negatives is in no way doing the Tramlink justice. In other instances the tram has been a monumental success. A few of the most significant examples are that the tram has allowed people greater social equity and
accessibility. It is a value for money, efficient and on-time network that inhabitants recognise as a symbol of Croydon.

5.10 Other Emerging Patterns

Question 3 of the survey allowed for further investigation into the relationship between people’s responses according to where they lived. Significantly there was a connection between this and question 5, concerning traffic flow, with more than half of the people who felt that traffic in their area had increased living in Croydon (57 out of 110). The literature review discussed that some parts of Croydon would benefit as traffic is diverted away from some streets or one-way or timed restrictions are imposed. Yet there are the inevitable knock-on affects too; the Tramlink has created rat-runs on arterial routes within the main urban centre as a result of these alterations.

This is a case of removing the problem from one area only for it to re-emerge in another; a solution has not been found. This is a reflection of the Congestion Charge in London, where traffic on orbital thoroughfares just outside the charging zone has increased. It is submitted that this dilemma is endemic within most new transport systems. Whilst a certain proportion of the population will respond to changes positively and alter their habits in attempts, for example, to save money or be sustainable, independence is part of human nature and the symbol of independence and convenience that the motorcar represents will cause other people to simply change their driving route or times of travel. It is argued that some people will only change their travel patterns so long as this means that they can continue to use their car.

Again however such points should not be over-emphasised as the positives outweigh the negatives. The notion of an ideal transport system (Macpherson 1993) is an unlikely consideration, but trams at least make giant steps towards efficiency and sustainability. Human nature is something outside of the trams’ influence: one successful
system and even the entire thriving network of light rail will not have their maximum potential without more effective state policy to change people's habits.

5.11 Relevance of Findings

The findings presented are of particular relevance to Britain's struggle to find a workable solution to its crumbling transport network. Sustainability has been investigated and found to be one of the key words in today's society. Governments and academics alike are keen on its achievement.

The findings of this study determine the sustainability of the Tramlink and within the wider picture an indication of the sustainability, as well as recommendations for, other tram systems. The indicators have been developed in response to a serious policy need, as argued by Patterson (2000), because of the lack of other such studies and the failure of current government policy to address transport crises adequately. It is considered that the simple aggregation of indicator marks to achieve an overall sustainability score has been a process easy to understand, and this understanding has been aided by the production of an index: it is argued that in support of Innes (1990) there has been a compelling reason to create an index in an attempt to decipher the measurement of sustainability in compact form. The results have been relatively inexpensive to measure, reflecting the ideals of Gustavson (1999).
6.0 CONCLUSIONS

The first part of the conclusion is dedicated to the presentation of the main findings of this thesis. The value of the project for research in the field of sustainability and in particular sustainable transport, and the practical problems encountered during fieldwork will then be discussed. In doing so, these sections provide an introduction to more detailed considerations of the implications of the research findings, in the latter stages. Finally, recommendations and suggestions for any future studies will be expressed.

6.1 Sub-questions I, II and III

The in-depth literature discussion conducted in the early stages of the research project allowed for rich insights into the indicators that could be used to measure environmental, economic and social sustainability.

6.1.1 Findings Relating to Sub-question I

Sub question I asked what the indicators of environmental sustainability were. From the literature review these were derived to be:

1. Traffic noise: to produce no more noise than is acceptable by communities
2. Visual impact: to produce no greater visual impact in terms of design than is acceptable by communities
3. Air pollution: to meet transport needs without generating emissions that threaten public health, global climate, biological diversity or the integrity of essential ecological processes
4. Traffic flow/congestion: to reduce the growth in car and lorry traffic growth
5. Resource usage: to make efficient use of land and other natural resources using energy sources that are essentially renewable or inexhaustible

6.1.2 Findings Relating to Sub-question II

Sub question II asked what the indicators of economic sustainability were. From the literature review these were found to be:

1. Value for money: to provide cost-effective, financially affordable service
2. Consumer satisfaction: to be regularly and frequently utilised
3. Capacity: to ensure demand for the transport mode
4. Time/efficiency: to provide a reliable service
5. Image: to be regularly and frequently utilised
6. Competitiveness: to ensure the industry remains competitive

6.1.3 Findings Relating to Sub-question III

Sub question III asked what the indicators of social sustainability were. From the literature review these were found to be:

1. Community severance: to meet basic human needs for health (social well-being)
2. Social equity/accessibility: to give people reasonable access to other people, places, goods and services
3. Stress: to meet basic human needs for health (physical and mental)
4. Comfort of journey: to meet the basic transport-related needs of all people
5. Safety: to enhance the quality of life in communities

6.1.4 Overall Findings Relating to Sub-questions I, II and III

The literature revealed that there is no framework for the measurement of sustainable transport available to researchers. Constructing a framework was like trying to piece together a jigsaw puzzle, with indicators having to be drawn from various sources. This study contributes towards the development of a framework of indicators for sustainable transport.

6.2 Sub-questions IV, V and VI

The primary and secondary data outlined in the results provided rich insights into sustainability allowing for the determination of the Tramlink's environmental, economical or social sustainability.

6.2.1 Findings Relating to Sub-question IV

Sub question IV asked whether the Tramlink was environmentally sustainable. It was found that the Tramlink was environmentally sustainable to a moderate extent (6 on the index).
6.2.2 Findings Relating to Sub-question V

Sub question V asked whether the Tramlink was economically sustainable. This research concludes that the Tramlink is highly economically sustainable (7 on the index).

6.2.3 Findings Relating to Sub-question VI

Sub question I asked whether the Tramlink was socially sustainable. According to the analysis the Tramlink is to a high extent socially sustainable (7 on the index).

6.2.4 Overall findings relating to sub-questions IV, V and VI

The results and subsequent analysis revealed that the Tramlink is environmentally sustainable to a moderate extent and socially and economically sustainable to a high extent. This report contributes towards studies of sustainable transport by presenting the performance of a transport mode that it is hoped will proliferate across the country and help to alleviate Britain's transport crisis.

6.3 Findings Relating to Main Research Question

The main research question was: Is the Tramlink overall sustainable? The answer is yes; it is to a high extent sustainable with a 7 on the index scale.

Still the Tramlink has its weaknesses and it is submitted that conclusions can be drawn highlighting improvements that could be made to future tram projects, taking their lead from the Croydon Tramlink's experience. Such inferences will be presented in section 6.5.
6.4 Limitations of the Study

One of the limitations of this research is the use of indices: although useful tools for describing the general condition of the Tramlink in regards to sustainability, the selection of the composition for the indices is based on subjectivity and influences the research outcome.

The indices should be considered instructive, but not prescriptive. The indices themselves are constructed in such a way as to facilitate understanding of the indicators of sustainability. However, the indices do not provide the complex framework necessary to understand how individual indicators positively or negatively affect other indicators, or how any policy responses to individual indicators could positively or negatively affect short-term and long-term outcomes (Innes 1990).

On a wider scale, the subjectivity of what constitutes sustainability also has its limitations. In this report 50% was the cut-off point between unsustainable and sustainable: purely a reflection of proportionality. As was reported by the UK Government, it is virtually impossible to justify a chosen benchmark of sustainability and therefore completely arbitrary weightings have had to be adopted. It is therefore important to ascertain the weight that can be given to such evidence for any meaning and value to be demonstrated. The literature review provides evidence of the thoroughness of secondary research conducted to support the findings of this study. The expertise and advice of academics and government think tanks have been adopted to produce the results and analysis. Ultimately the reader has to decide to what degree weight can be given to this part of the thesis, with its foundations within typical modern practice (www.defra.gov.uk; Harding, 2003).

The thesis was conducted solely on a micro scale, so the overall sustainability of other modes of transport was not recognized. Other transport means were used only for comparison, to ascertain levels of sustainability for aspects of the Tramlink. Therefore integration within a wider network was not considered. The survey also stipulated in its preamble that only those people who actually used the Tramlink would be chosen, ensuring
accuracy of accounts. Whilst this has increased the reliability of the results, it contains an element of bias.

Furthermore spatial forces and circumstances that led to the creation of the Tramlink have only briefly been discussed in the introduction. Also the spatiality of the network and of the area it serves, and issues of the economics of financing and financial viability have for the purposes of this study been omitted (see recommendations for future study for further consideration of this topic).

The literature search found no previous sustainability studies to create a precedent. Whilst it might therefore be judged that this report is an original piece of work, there are some aspects that need further investigation, for example the issue of subjectivity in the selection process of indicators and development of index.

The validity of some secondary data, for example, the proportion of Tramlink trips diverted from private cars of 12.8% (Harding 2003), might also be highlighted. As this figure is not from an impartial source its validity could be brought into question. A more insightful picture could have been gained by asking only previous car users whether they had switched. Many of those interviewees queried about their previous mode of transport may not own a car or have begun visiting new places as a result of the Tramlink. Harding's result does not indicate how far an increase in car traffic has been curbed and does not include passengers changing from buses to trams, relieving traffic. Furthermore evidence published by the Department of Transport suggests that the introduction of a major transport scheme will result in generated trips, that is trips that were not previously made. It is acknowledged that this is an extremely complex area and additional research is required (www.dft.gov.uk).

Finally the expected restrictions of time, money and word constraints are acknowledged.
6.5 Implications of the Study

The implication of this study is that the tram, that is, the system currently operating in and around Croydon, presents a solution towards sustainable transport and should be considered as a solution for other British cities and their surroundings, thus transforming the transport network in the country’s urban areas. However, it should be acknowledged that modes of transport are not sustainable or unsustainable in the abstract and for all situations. There are only certain contexts in which a transport network such as the Tramlink would be appropriate. For example it would not be as highly sustainable in more rural or isolated areas.

The thesis makes a unique contribution to the field of sustainable transport. A detailed sustainability study of a tram network has yet to be conducted in Britain and it is considered that this research represents a template for any future investigation into the performance (in terms of sustainability) of transport modes.

Conclusions can be drawn from the positive and the negative findings for the Tramlink, improving on the system. It can be concluded that this study supports the notion of a transport mode that does not produce any direct air pollution and makes little noise; one that allows improved social accessibility and gives passengers a sense of security; one that provides value for money and is quick and efficient.

However, one lesson to be learnt from the study is that more care and attention should be paid to construction and design, even if this means investing more capital. Such a system is a long-term investment and local residents have to live with its presence 24 hours a day.
6.6 Recommendations and Suggestions for Further Study

One possibility for future sustainability studies is to assign relative weighted responses to the indices. Weighting could place emphasis on specific indicators that record very small measurement changes that are related to significant on-the-ground changes.

Limitations of the study are a source for future research recommendations. To examine the effects of the sustainability of the Tramlink on a wider scale, including people in the sample who do not use the system, and to analyse its integration with other transport modes would certainly be a worthwhile task.

After establishing the grounds on which the Tramlink is to different degrees sustainable, a further study based on the findings of this report should be conducted to establish the specific local conditions and circumstances that enable the Tramlink to be economically, socially and environmentally sustainable. For example, ‘Why is the Tramlink sustainable?’ is a question that could address spatial aspects of the network.

It would also be valuable to indicate the conditions under which such tram networks might be built elsewhere with the expectation of what is sustainable reflecting the scoring system of this thesis. This could involve some attention to the spatial configuration and densities of development, as well as the funding and decision environment of any potential future initiatives.

Guidelines for the development of a framework for a sustainability study on transport are currently unavailable and an investigation towards introducing guidelines would prove crucial for supporting future researchers in their venture.
7.0 APPENDICES

7.1 Appendix I

1. Provide access to goods, resources and services, while reducing the need to travel, so that economic, environmental and social needs can be met efficiently and in an integrated manner.

2. Ensure that transport infrastructure and travel use does not exceed the capacity of the environment to withstand their impact.

3. Ensure that users pay the full social and environmental cost of their transport decisions, without making industry uncompetitive or preventing those on low incomes from meeting their transport needs.

4. Increase the choice, and encourage the use, of economically, environmentally and socially efficient transport modes.

5. Protect critical natural and physical capital.

6. Establish environmental quality standards based on critical ecological limits and precautionary public health requirements.

7. Ensure that renewable natural resources are managed and used in ways which do not diminish the capacity of ecological systems to continue providing those resources over time.

8. Ensure that non-renewable natural resources are managed and used in ways which account for future needs and the availability of alternative resources.

9. Enhance public health and safety and reduce accidents.

10. Reduce the growth in car and lorry traffic growth.

Source: UK Round Table (1996) *Defining a Sustainable Transport Sector*
7.2 Appendix II

- Access: People are entitled to reasonable access to other people, places, goods and services.

- Equity: In meeting the basic transport-related needs of all people, including women, the poor, the rural, the disabled, and children, nation, states and the transport community must strive to ensure social, interregional and intergenerational equity.

- Individual and Community Responsibility: All individuals and communities have a responsibility to act as stewards of the natural environment, undertaking to make sustainable choice with regards to personal movement and consumption.

- Health and Safety: Transport systems should be designed and operated in a way that protects the health (physical, mental and social well-being) and safety of all people, and enhances the quality of life in communities.

- Education and Public Participation: People and communities need to be fully engaged in the decision-making process about sustainable transport, and empowered to participate.

- Integrated Planning: Transport decision makers have a responsibility to pursue more integrated approaches to planning. They must involve partners from relevant sectors such as environmental, health, energy, financial, urban design.

- Land and Resource Use: Transport systems must make efficient use of land and other natural resources while preserving vital habitats and maintaining biodiversity.
• Pollution Prevention: Transport needs must be met without generating emissions that threaten public health, global climate, biological diversity or the integrity of essential ecological processes.

• Economic wellbeing: Taxation and economic policies should work for, and not against sustainable transport. Market mechanisms must account for the full social, economic and environmental cost, both present and future, in order to ensure users pay equitable share of costs.

Source: OECD (1997) *Towards Sustainable Transportation*
7.3 Appendix III

1) With respect to society, transportation systems should:
   a) Meet basic human needs for health, comfort and convenience in ways that do not stress the social fabric.
   b) Allow and support development at a human scale, and provide for a reasonable choice of transport modes, types of housing and community, and living styles.
   c) Produce no more noise than is acceptable by communities.
   d) Be safe for people and their property.

2) With respect to the economy, transportation systems should:
   b) Provide cost-effective service and capacity.
   c) Be financially affordable in each generation.
   d) Support vibrant, sustainable economic activity.

3) With respect to the environment, transportation systems should:
   a) Make use of land in a way that has little or no impact on the integrity of ecosystems.
   b) Use energy sources that are essentially renewable or inexhaustible.
   c) Use other resources that are renewable or inexhaustible, achieved in part through the reuse of items and the recycling of materials used in vehicles and infrastructure.
d) Produce no more emissions and waste than can be accommodated by the planet's restorative ability.

Source: CST (1997) *What transportation should do to be sustainable*
"Hello, I am a student at University College London and am conducting a survey about the Croydon Tramlink. Have you ever been on the Tramlink? If yes would you mind answering a few questions about it? I hope you do not object if I use this laptop to record your answers, it saves me having to write everything down. I do not need to take your name or exact address so please rest assured that your answers will be treated in the strictest of confidence."

1. Male or female?

1.1 Male
1.2 Female

2. Age?

2.1 20 and under
2.2 21-40
2.3 41-60
2.4 61+

3. Where do you live?

3.1 Croydon
3.2 Beckenham
3.3 Elmers End
3.4 Mitcham
3.5 Addington
3.6 Shirley Hills
3.7 Wimbledon
3.8 Other (please state)
4. How often on average do you use the tram?

4.0 Never
4.1 I have only used the Tramlink once
4.2 Rarely (monthly)
4.3 Occasionally (fortnightly)
4.4 Weekly/ at weekends
4.5 2-3 days a week
4.6 4 days or more a week

5. Has there been an increase, decrease or no change in traffic flow since the Tramlink opened in May 2000?

5.1 Increase
5.2 No change
5.3 Decrease

“Visual impact is the affect of a development on the character and appearance of an area in terms of the infrastructure it uses”

6. What is the visual impact of the Tramlink on the character of Croydon Town Centre?

6.1 Highly dissatisfactory
6.2 Dissatisfactory
6.3 Indifferent
6.4 Positive
7. What is the visual impact of the Tramlink on the character of the green areas outside town?

7.1 Highly dissatisfactory □
7.2 Dissatisfactory
7.3 Indifferent
7.4 Positive

Please indicate in how far you agree or disagree with the following 4 statements:
Please look at this card. It contains a layout of the Croydon Tram's ticket prices.

8. The Tramlink is good value for money.

8.1 Strongly disagree □
8.2 Disagree
8.3 Agree
8.4 Strongly agree

9. The Tramlink is on time.

9.1 Strongly disagree □
9.2 Disagree
9.3 Agree
9.4 Strongly agree

10. The Tramlink gets you from A to B quickly and efficiently.

10.1 Strongly disagree □
10.2 Disagree
10.3 Agree
10.4 Strongly agree
11. The carriages are clean, comfortable and well kept.

11.1 Strongly disagree  
11.2 Disagree  
11.3 Agree  
11.4 Strongly agree

"As a result of the introduction of the Tramlink you may have found that you have to travel further to a destination, in order to avoid part of the infrastructure. It may be the distance that you have had to walk or the amount of time you have spent driving the car to steer clear of one-way systems or other restrictions."

12. Have you ever experienced any obstruction in a journey caused by the introduction of the Tramlink?

12.1 None (no appreciable change in journey distance)  
12.2 Slight (50-250m walking or 1-5 min driving)  
12.2 Moderate (250-500m walking or 5-10 min driving)  
12.3 Severe (500+ walking or 10+ min driving)

13. Have you started going to any new places, or are starting to go anywhere more, because it’s easier to get there since Tramlink opened?

13.1 Yes  
13.2 No

Please indicate in how far you agree or disagree with the following 2 statements:

14. Overcrowding is a problem on the carriages.

14.1 Strongly agree  
14.2 Agree  
14.3 Disagree  
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14.4 Strongly disagree

15. It is personally safe and secure (in terms of crime) to use the Tramlink.

15.1 Strongly disagree
15.2 Disagree
15.3 Agree
15.4 Strongly agree

16. Do you have any trouble getting on and off the carriages?

16.1 None
16.2 Slight
16.3 Moderate
16.4 Severe

17. Given all the questions above, what is the level of stress caused by the Tramlink?

17.1 None
17.2 Low
17.3 Moderate
17.4 High

Please indicate in how far you agree or disagree with the following statement:

18. The Tramlink makes a positive contribution to the image of Croydon.

18.1 Strongly disagree
18.2 Disagree
18.3 Agree
18.4 Strongly agree
19. Is the Tramlink still going to be there in 20 years time?

19.1 No
19.2 Not very likely
19.3 Yes more than likely
19.4 Yes

[ ] do not know
7.6 Appendix V

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*Table 45: Table of Ticket Prices*  
*Source: www.tfl.gov.uk*
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