A Communication Platform to Facilitate Knowledge Transfer between Different Stakeholder Groups in Sustainable Student Accommodation Design

Volume I

BING CHEN

A THESIS SUBMITTED FOR THE FULFILMENT OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN ARCHITECTURE

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May 2009

To my mom and dad, for their 30th wedding anniversary

献给我的父亲母亲，执手相伴三十年的贺礼

Sometimes it falls upon a generation to be great.
You can be that great generation.

– Nelson Mandela 2005

RESEARCH SUMMARY

It is widely acknowledged that sustainability principles should be addressed in the housing market to tackle climate change. In this research, particular attention is paid to latent issues (people's knowledge, motives and values) related to energy saving and carbon reductions in the operational phase of house occupation. In this research, design process is described as a transfer between areas of knowledge bearing on a particular project, aiming for consensus of problem solving. Hence better results can be expected if a close consensus on the alternative options could be achieved between different stakeholder groups. However, stakeholders from different groups often have different systems for value judgement in reality and it is difficult to get the message across in the design decision-making process.

To provide a deep insight into the given phenomena, this research explores priority variances between four key stakeholder groups in terms of student accommodation design: designers, clients, occupants and legislators. A multi-strategy research framework is designed for the collection and analysis of data. In this hierarchical context, consultation responses from different stakeholder groups are compared against an agreed set of issues (drawn from EcoHomes). Among these four key stakeholder groups, particular attention is paid to the Occupant Group as its members, student residents (both future housing designers and current housing occupants), are supposed to be better educated on sustainability issues and have a positive effect, through changes in their attitudes, social values and inspirations (willingness to change their lifestyles towards greater environmental sensitivity), over the vast campaigns of education, debate and public participation.

It is found that current architectural education frequently overlooks that adapting to climate change could involve carbon-intensive actions – though architectural students have had a general awareness of sustainability principles, it has so far made limited impact on their design protocols or lifestyle choices. Other important findings, such as the interrelationship between education and its effect on student residents' environmental awareness and social desirability, can be fed back into the socio-technical research model (e.g. Bayesian Belief Network model) or used to inform current sustainability-related education. The significant priority variances between different stakeholder groups are also specified. It is concluded that a complete consensus across all stakeholders is unlikely to be achieved in the near future. To achieve better design results, therefore, a communication platform is proposed to facilitate knowledge transfer. Two approaches are addressed to introduce the principle of trans-disciplinary communication: a common language and a broader collaborative decision-making process. Furthermore, by criticising the weighting exercise underpinned BRE's EcoHomes, a Code for Sustainable Student Accommodation (CSSA) is proposed. Rather than achieving a broad consensus, it represents opinions from all levels of decision-makers and acknowledges the priority variances within and between them. As an exploratory case study, the weighting method of CSSA needs to be further verified and developed in the future for legitimate purpose. All research findings are explored and interpreted to the degree of an architect's knowledge level, which reflects the researcher's personal values.

ACKNOWLEDGEMENTS

I am deeply indebted to many people who have contributed to this research.

Greatest thanks are due to Prof. Adrian Pitts for his supervision and support to this PhD programme. Without his help, this work could not be proceeded. I wish to acknowledge Prof. Jiang Kang in particular, who is my second supervisor, for his sincere encouragement and generous help in a variety of aspects. Thanks are also due to Mr. Ian Ward, who co-supervised this research at the very beginning and provided much valuable information after Adrian left to Sheffield Hallam University.

I'd also like to pass my gratitude to those people who have participated in this study and given much valuable feedback. Thanks are due to Dr. Hasim Altan who provided many important suggestions to this study; to Dr. Rosie Parnell, Dr. Hanwen Liao, Ms. Lei Gao, Dr. Rong Li and Ms. Bing Jiang for those useful discussions regarding research methodology; to Ms. Mengwei Lin, Mr. Mu Niu and Ms. Sara Ernst for their help with data collection; and to Dr. Mei Zhang, Ms. Wenjia Zhang, Dr. Qiming Lv, Ms. ChiaJen Yu and Ms. Lei Yu for the useful discussion relating to statistical analysis. I'd also like to pass my thanks to Ms. Emily Rahtz, Ms. Hannah Lilley, Ms. Hil Yin Man, Ms. Sarah Bramall, Ms. Jo Winter and Mr. Tom Saxton, who helped me proofread the thesis context and gave me a lot of encouragement when I worked part-time in the International Office (SRAM). Thanks are also given to my friends, colleagues and whoever has contributed to this study.

I'd also like to take this opportunity to pass my thanks to the Sheffield University Fee Bursary Programme, the Henry Lester Trust, the Great Britain-China Educational Trust and the Churches' International Student Network (CISN) Hardship Fund that provided financial support to this study.

Special and forever thanks are given to my parents, my grandparents and everyone in the big family, for their love, understanding, support and encouragement. Also, I'd like to pass my best gratitude to Dr. Peng Zeng who gave me a lot of help.

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CHAPTER 1

INTRODUCTION

1.1 CHAPTER OUTLINE

This chapter aims to give a brief introduction and show the scope of the entire interdisciplinary research work. Some important issues and ideas are introduced, including research objectives and methods. In addition, structure of the thesis and the way it is built is described and the research framework is explained.

1.2 RESEARCH MOTIVATION:

As climate change is widely acknowledged as an important issue in the world, much research has been carried out to support a worldwide campaign for energy saving and carbon dioxide emissions reductions (IPCC 2007; DEFRA 2006a; Climatechallenge 2007). In the construction sector, buildings have been required to be designed towards sustainability standards as they contribute in a very significant way to today's energy consumption and carbon dioxide emissions[i]. A particular building type, university student accommodation (a part of the more general housing stock), is selected as the basis for this research to investigate some important issues. This is mainly because occupants of this kind of accommodation, university students, will play an important role in the campaign to tackle climate change (Details of the deductive process can be found in Chapter 2).

Research work cannot be value-free. Rather than carrying out consciously value-laden research determined by a specific theoretical perspective, the researcher aims instead to be self-reflective. In this way the researcher seeks to acknowledge the potential influence of his or her values, biases and assumptions on the research design procurement, data analysis and subsequent discussions and findings. Due to this point, the basic principle held by this researcher, which permeates all of his work, is to make each procurement step explicit. Other basic driving principles are related to the researcher's experience in both design and research, interest in social interventions and knowledge background from his master studies (M.Arch Studies). Some of these principles become relevant in the light of this thesis when one draws parallels between different issues.

Having a background in both design and research, the researcher is concerned with the interrelationship between these two types of work. Literature review and empirical analysis show that historically these two aspects have been somewhat separated in practice from the beginning – research is mainly about 'problem description' while design is generally about

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i Energy use in homes and offices accounts for nearly 50 per cent of national carbon emissions. (DCLG 2007c) 'problem solution'. Communication between these two fields also remains uncomfortably remote (as shown in Figure 1.1) as there is a lack of a '***common language***', and neither of them is likely to operate in more genuinely collaborative roles. As a result, in the architectural domain, researchers have gone on researching, and architects designing. To alleviate this problem, it is important to bridge the communication gaps and construct a platform to enable knowledge transfer. This incentive, constructing a ***communication platform*** on which the final decision is to be based, leads to the primary theoretical basis of this research and influences the formulation of the integrative research framework. To some extent, the focus of this research, the interrelationship between the solution-focused perspective on technical response and the problem-focused perspective on lifestyle change, can also be seen as a reflection of the interaction between design processes and research work.

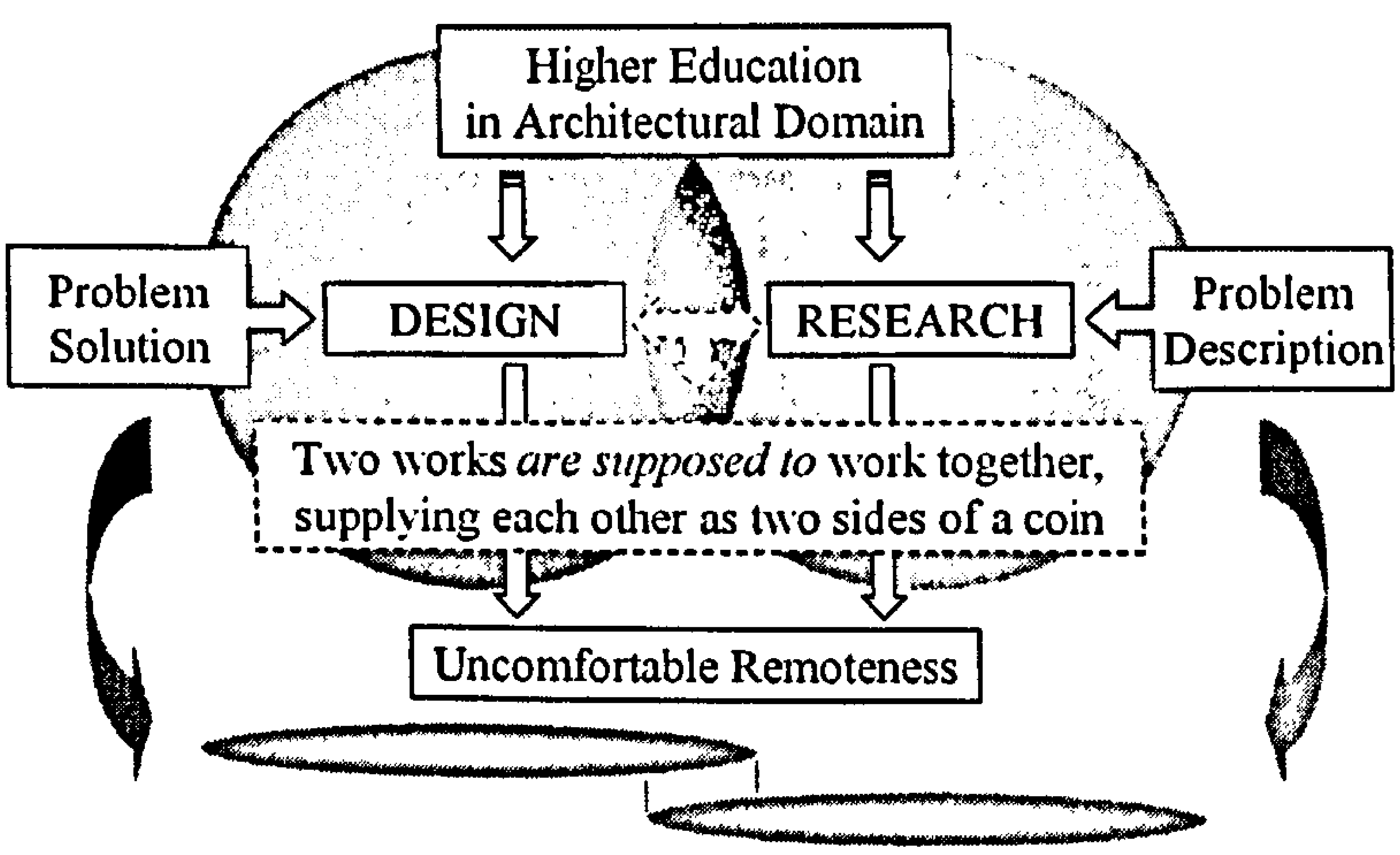

Figure 1.1: Interaction between Research and Design

Since this research is about design of accommodation for university students, the researcher shows a strong interest in the education programme. This interest leads to the second principle that, according to the core concept of sustainable development, social authority should provide discipline-based support or intervention to enhance students' awareness of sustainability issues and engage them to live in a more environmental friendly way (CEBE 2007). Therefore, besides applying technical measures to improve the building stock, this research also concentrates on another important approach in the decision-making processes – the 'human factor'. It is argued that these strategies or measures, based on the theory of social intervention, can potentially change student residents' attitudes, beliefs and behaviour (focusing on their purchase and use patterns for energy in their future lives in particular) towards more sustainable options if they could be properly addressed in the occupant-inclusive decision-making processes. Since this so-called lifestyle change requires understanding be widely shared rather than just information, some essential issues, such as prospective perception of sustainable living from different stakeholder groups, are also further examined. To a great extent, this discipline also determines the main attitude and methodology of this research – a survey based on case studies from the ***socio-technical perspective.*** As research for design, moreover, this research itself can also be used as a template for the later work, in which particular design problems are expected to be analysed from a more integrated ***stakeholder-oriented perspective.***

The last principle, or motivation of this research, comes from the researcher's early experience in his master dissertation work. To investigate the potential possibility and feasibility of enacting zero emissions/energy development in China (Chen 2004), a survey was carried out based on the case studies of Beddington Zero Emissions/Energy Development (BedZED) in the UK. The survey implied that, due to various background and diverse motives, there were potential ***cognitive gaps*** for current socio-technical activities between designers' intentions and occupants' awareness of sustainability issues. Likewise, communication and knowledge transfer between designers and occupants also remained unfortunately remote. In terms of practice, as general public and ultimate building users, occupants' perspectives about energy use, carbon reductions and climate change had been excluded outside of the decision-making processes, which might lead to an unsatisfactory outcome in the domestic dwellings' operational phase. This interesting finding leads to an ambitious assumption that a similar situation also exists in the UK housing market (especially for student accommodation development), which then turns into the main hypothesis of this research. To alleviate this conflict and ***get the message across*** (letting stakeholders from different groups understand the principles of sustainability – sustainable design and sustainable lifestyle), this research aims to define an effective user interface. But first of all is the need to explore the differences between professionals' (the Designer Group and the Legislator Group) and non-professionals' (the Occupant Group and the Client Group) attitudes in energy saving, carbon reductions and climate change, and to validate the hypothesis and make the cognitive gaps explicit.

All these principles are rooted in the fundamental belief that the building users play an important role in energy saving and carbon reductions in the operational phase of house occupation. Moreover, their existing lifestyles can be positively influenced towards greater environmental sensitivity through a user-centred collaborative learning programme. Some important issues include:

- Existing knowledge and experience of lay stakeholders (occupants of the student accommodation or other domestic buildings) are valuable;
- Lay stakeholders should be involved in the decision-making processes to identify the needs, set the goals and plan the relevant activities;
- Professional stakeholders (designers, developers and local authorities of community development) should both facilitate and inform;
- Interaction between professional and lay stakeholders should be based on their own knowledge levels of sustainability issues.

1.3 RESEARCH AIMS:

This research aims to identify the possible interventions that might help reduce energy consumption and carbon emissions during the operational phase of domestic building occupation, focusing on university student accommodation. To achieve this objective, the research attempts to answer the following questions:

- ***To facilitate knowledge transfer between different stakeholder groups, what characteristics should an effective communication platform have? Furthermore, how can the communication platform benefit the design decision-making processes?***
- ***Are architectural students aware that their dual status, as both future housing designers and current housing occupants, would cause them to contribute to both problems and solutions in tackling climate change? Moreover, are they likely to take responsibility and address housing environmental issues from different perspectives, both in the design processes as designers and in the accommodation seeking processes as end users?***
- ***Is there a close consensus on the relative importance of different housing environmental issues between different stakeholder groups? If there is not, what is the significant priority difference within and between them?***

Although this study is carried out based on BRE's EcoHomes (a housing environmental assessment method from BREEAM), it is important to emphasise that the aim of this work is not only the amendment of EcoHomes weighting system or the proposal of a bespoke environmental programme for student accommodation design, but also the design of a broader conceptual framework. This framework, or communication platform, is devised to facilitate knowledge transfer between different stakeholder groups in collaborative design decision-making processes.

1.4 RESEARCH METHODS:

To answer the questions above, a multi-strategy research framework is designed from an integrated perspective and different research methods are introduced to the key stages of the hierarchical framework according to their specific features and desired outcomes. Specifically, based on a wide spectrum of literature review, a theory-building approach is carried out to describe the conceptual basis and research context. A set of official documents relating to housing environmental assessment are then reviewed, cross-compared and studied to identify the essential characteristics that a communication platform should have in order to get the message across. By using the weighting system in EcoHomes as the benchmark, survey design and case studies are carried out to explore the priority variances within and between different stakeholder groups. This practice-oriented work is conducted in two stages: first, a small-scale pilot study is carried out within a group of postgraduate architectural students to see whether these students are well educated on sustainability issues; second, a large-scale survey is carried out to collect and analyse opinions from different stakeholder groups (the Occupant Group, the Client Group and the Designer Group based on the Sheffield Student Village project). Some specific recommendations are also made to improve the effectiveness of applying the design measures addressed in BRE's EcoHomes Method to support future student accommodation design. More details relating to research methods can be found in Chapter 3.

1.5 THESIS STRUCTURE AND RESEARCH FRAMEWORK:

Following the *Introduction*, the background of this research is described in the second chapter *Literature Review*. Based on a deductive procedure, this chapter identifies the principal research questions, modifies the original research boundaries and sets up the main research scenarios. By making this procurement route itself explicit, the research framework (as shown in Figure 1.2) can be openly inspected and critically evaluated at an early stage. Moreover, by arguing against the use of technology-dependent measures in sustainable housing design processes alone, the researcher highlights the following point in the research that the 'human factor' should be addressed because housing occupants' attitudes and behaviour can be influenced by social interventions. Based on this socio-technical perspective, the main research hypothesis is then brought forward.

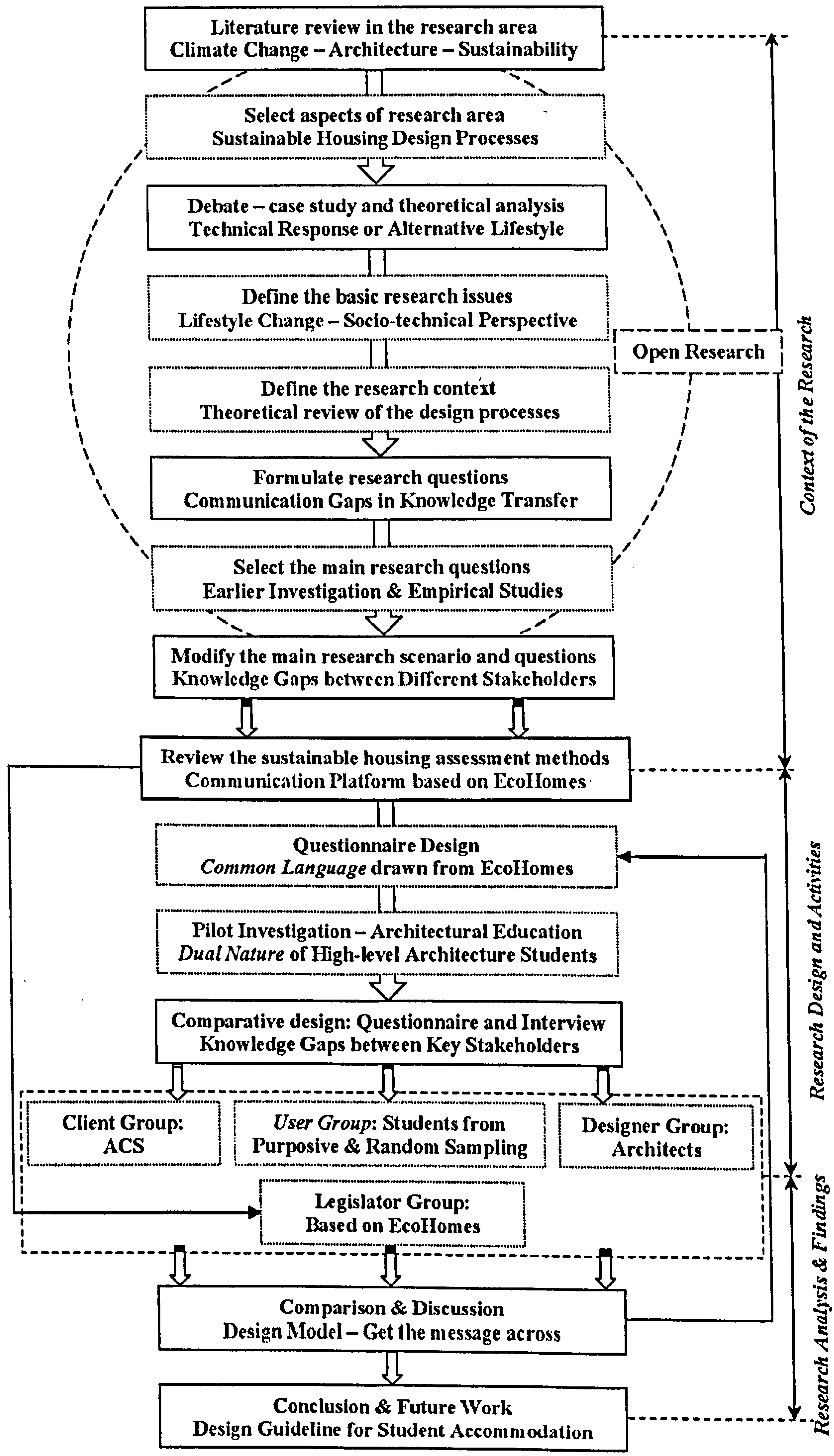

Figure 1.2: Research framework

After the research framework is designed, the researcher proceeds to develop methods for the research problems, presented in the third chapter *Research Design and Methodologies.* Certain important social research methods are reviewed and different research methods are introduced to the key stages of the hierarchical framework according to their specific features and desired outcomes. This multi-strategy methodological approach influences and is also influenced by the researcher's principal attitudes, which later modify the research framework. At this point, detailed research phases are defined.

In the fourth chapter, *The Application of EcoHomes to Support Decision-making Processes*, BREEAM housing version EcoHomes is examined as the prototype of the communication platform based on literature review and critical analysis of the existing building environmental assessment methods. To facilitate knowledge transfer, the means to transfer EcoHomes into an appropriate format to support the decision-making processes and the kind of essential features that an effective communication platform should possess are extensively discussed. In Chapter Five, *Questionnaire Design and A Pilot Investigation*, sustainability issues addressed in EcoHomes are re-arranged according to the typical decision-making workflows of different stakeholder groups. After these items are identified, two questionnaires are used to explore the dual nature of higher-level architectural students, their intention to create sustainable housing design as future designers and awareness of sustainable living issues as current housing occupants. Based on the comparison, further discussions are raised regarding architectural students' responsibility in the campaign of education, debate and public participation.

Chapter Six *Consultation Responses from the Occupant Group*, Chapter Seven *Consultation Responses from the Client Group* and Chapter Eight *Consultation Responses from the Designer Group* can be taken together as they concentrate on the collection and analysis of data from different stakeholder groups. Some preliminary findings are put forward at this stage. However, the main outcome analyses (cross comparisons of the systems for value judgement between different stakeholder groups) are left to the following chapter *Comparison and Discussion.* In this chapter, main findings from each phase of this research are drawn together in discussions and some recommendations are made for future work. The guideline of collaborative decision-making process for the development of student accommodation is then built and modified in Chapter Ten (*A Code for Sustainable Student Accommodation*). The final result, the Code for Sustainable Student Accommodation (CSSA), as a shared communication platform, is expected to be used by developers as a guide to understand market behaviour and modify the project brief, by architects as means to evaluate competing parameters and by student residents as a handbook to improve or determine living qualities.

The final chapter *Conclusions* reviews the whole research procedure, evaluates research methods applied, summarises important research findings and provides suggestions for future work.

1.6 TERMINOLOGY:

Carbon reductions: carbon dioxide emissions reductions.

Consensus: focusing on the concept of obtaining general agreement, this term is defined as the objective of collaborative decision-making approach in which 'the interested [or disputing] parties identify common ground and work voluntarily towards finding a mutually acceptable solution towards a contentious problem' (Environment Council 1995, cited in Sidaway 2005: 67). It is important to note that, in this thesis, this term represents a meaning between 'full consensus' and 'informed consent' (for more details regarding distinctions between these two terms, see Sidaway 2005: 67-69) in order to remove misunderstanding, clarify interests and establish common ground between participants.

Lay: extensively used in this thesis to describe groups that are not professionals in architecture field. It does not have any meaning of interclass discrimination, but only refers to those with less knowledge of building environmental issues compared to experts or specialists.

Lifestyle: extensively used in this thesis to refer to patterned differences in knowledge, attitude, behaviour and some consequent issues among sub-groups of society. It can be seen as a combined symbol of culture, social class, consumer choices, behaviour and historical trends (Kempton 1993: 221). However, it is important to note that this expression is not related to fashion in this thesis.

Stakeholder: extensively used in this thesis to 'emphasize the interests or concerns which people or organizations may have with the outcome of a decision' (Sidaway 2005: 38). It is also acknowledged that stakeholders often 'have an interest in what happens because they will be affected by the outcome or can have some influence over it' (Wilcox 1994, cited in ibid: 38). In terms of conflict analysis or cooperation via consensus, their 'beliefs', 'interests', 'data and understanding', 'relationships' and 'procedures' are often addressed as important factors (Sidaway 2005: 44-45).

Weighting: multiplication by a weight, or importance factor, in order to allow comparisons between 'Apples' and 'Pears'.

1.7 CHAPTER SUMMARY:

This chapter gives the entire research work a brief introduction. Some important issues related to the research work are identified and structure of the thesis is designed. It also demonstrates the researcher's principal attitude to this research, which is to let every research step explicit.

CHAPTER 2

LITERATURE REVIEW:

BACKGROUNDS, PROBLEMS, QUESTIONS AND SCENARIOS

2

2.1 CHAPTER OUTLINE

This chapter describes the background of this research and builds a framework for the investigation. In this 'open' research phase, the researcher defines the principal research boundaries, identifies the primary research problems and sets up the main research scenarios. Rather than coming from any random proposals or subjective prejudgements, the research framework is developed from a cautious deductive process on the basis of a wide spectrum of literature review and empirical studies. By making this procedure explicit, this early work can be openly inspected and critically evaluated.

This research mainly focuses on the UK housing market. Although many similar works have been carried out in other European countries or in the US and many pilot case studies have been done, they are only introduced briefly with the most important experiential ideas.

2.2 ARCHITECTURE IN CLIMATE CHANGE

Building energy use and related carbon dioxide emissions are discussed in the following sections as they contribute significantly to today's universal concerns for climate change. Between different building types, domestic buildings are identified as the principal research boundaries at this stage. This is because the strategies for energy saving and carbon dioxide emissions reductions in this building sector can probably relate to building users' attitudes towards sustainability and their lifestyles (including purchase and use patterns for housing and energy).

2.2.1 CLIMATE CHANGE

Climate change is acknowledged as the greatest environmental challenge today. In the Fourth Assessment Report (AR4) released on 6th April 2007, *Climate Change 2007: Impacts, Adaptation and Vulnerability*, the Intergovernmental Panel on Climate Change (IPCC 2007) presented a devastating outlook for the world's environment and asked for immediate actions to stop climate change. As claimed in this report and many other related documents (i.e. BBC 2007a, Climatechallenge 2007, DEFRA 2006a, Meteorological Office Hadley Centre 2007, and WWF 2007), the earth has been getting warmer, especially during the last three decades. The average global temperature has risen 0.74 °C over the last hundred years (1906-2005), of which 0.4 °C occurred since the 1970s (DEFRA 2006a, Meteorological Office Hadley Centre 2007). Although many initial actions, in response to the Kyoto Protocol which was set up by the United Nations Framework Convention on Climate Change (UNFCCC) in 1997, have tried to cope with this change, climate continues changing and global warming continues worsening. To avoid further negative consequences caused by ongoing climate change, a number of nations have approved an addition to the Kyoto Treaty to standardise more powerful and legally binding measures based on their own national circumstances. Many policy-focused strategies and measures have been enacted at international, national and local levels to interpret the IPCC report, for business, government and public (i.e. DEFRA 2006a, DEFRA 2007a, Meteorological Office Hadley Centre 2007, and DCLG 2007). Moreover, these activities also intend to bring a 'greater awareness and a sense of urgency' to the campaign against global warming (Gore A., cited in BBC 2007d).

In the UK, tackling climate change is considered one of the overwhelming challenges and responsibilities for the government. It is argued in the recent *Stern Review* (DCLG 2006a) that taking immediate actions will cost less than waiting until later to deal with the consequences of climate change. Thus, many concerted activities have been enabled by the Department of Communities and Local Government (DCLG) through its responsibilities on planning, housing, building regulations and local government. At the domestic level, the main actions include updating the Climate Change Programme (DEFRA 2006b, 2006d) and creating a draft for the Climate Change Bill (DCLG 2006a, DEFRA 2007a), through which some of the key environmental issues are combined as an important part of current government policies. At the international level, the UK government is also playing a leading role in building a global consensus on climate change. For instance, climate change was one of the priorities of the UK's Presidency of the G8 in 2005. Other significant contributions are also made, such as funding the Meteorological Office Hadley Centre to analyse the economics and science of climate change, investing in a series of low-carbon technology researches and demonstration projects and so on (DEFRA 2007a).

To achieve long-term success, the new *Climate Change Strategic Framework* (DEFRA 2007a) (2012 onwards – after the end of the first commitment period of the Kyoto protocol) has been set up to address key issues, mainly dealing with long-term goals such as global carbon price, technology and energy efficiency, deforestation and adaptation, etc. Obviously, in the debate on climate change, particular attention has already been paid to carbon dioxide emissions. Related strategies for its reduction are summarised in the following sections.

2.2.2 CARBON REDUCTIONS AND ENERGY SAVING

As mentioned above, reducing carbon dioxide emissions is an important activity in tackling climate change. This is mainly because carbon dioxide (CO_2) is an important component of 'greenhouse gases' and has been seen as the most significant contributing factor to global warming over the period since 1750[ii] (Office of Climate Change 2007). Today, most current energy demand is still supplied by carbon intensive fossil fuels (coal, oil and gas) and more than two thirds of human carbon dioxide emissions come from the way people produce and use energy (DTI 2007: 7). Therefore, more attention has been paid to the use of energy and its effect, through greenhouse gases emissions, on the world's climate. And the debate on carbon dioxide emissions reductions is often raised in conjunction with energy demand as well as secure, clean and affordable energy supply. In tackling climate change, these two topics are integrated to help people understand how the global carbon cycle works. This perspective is well demonstrated in the coupled climate-carbon cycle project at the Hadley Centre (Meteorological Office Hadley Centre 2007). Furthermore, carbon reductions and energy saving have implicitly been considered the proxy of the larger issue of sustainability in recent government proposals, such as the Code for Sustainable Homes. This will be further discussed in Chapter 4.

As stated by the Department for Environment, Food and Rural Affairs (DEFRA 2007a), there are normally three ways to incentivise investment in energy efficiency and low-carbon technologies and to change behaviour: regulations, emissions trading and taxation. The UK government has enabled all these measures from an integrated perspective. However, it is still questionable whether these kinds of strategies can truly facilitate a collaborative social campaign.

Regulations

The UK government continues to play a strong role in the worldwide campaign against climate change and push for the agreement among all countries to halt and reverse the increase in greenhouse gas emissions. Domestically, the Climate Change Programme has been updated to meet and attempt to exceed the short- and long-term carbon reductions targets (DEFRA 2006b; 2006c), which include:

- Meet and exceed the UK's Kyoto Protocol target to reduce greenhouse gas emissions by 12.5 per cent below base year levels (relative to 1990 levels) by 2008-2012;
- Move the domestic goal forward and make it closer towards the ambitious target of reducing carbon dioxide emissions by 20 per cent below 1990 levels by 2010;
- Set up a long-term goal of achieving carbon dioxide emissions reductions of some

ii Carbon dioxide, methane and nitrous oxide have contributed the majority of all the warming effect contributed by greenhouse gases, accounting for over 75 per cent of the radiative forcing of greenhouse gases since 1750 (to 2005). Between them, moreover, carbon dioxide accounts for around 56%. (Office of Climate Change 2007)

60 per cent by 2050, with real progress by 2020 (between 26 and 32%) in the 2003 UK Energy White Paper, *Our energy future – creating a low carbon economy.*

As claimed by the government, so far the UK is well on track to meet its target for the first commitment period. Without introducing any additional measures, UK's greenhouse gas emissions are expect to reduce by around 19.4 per cent below base year levels (relative to 1990 levels) in 2010 (DEFRA 2006c).

In the mean time, to stimulate investment in a low-carbon economy and meet the energy challenge, the Climate Change Bill has been proposed to make the long-term targets of carbon dioxide emissions reductions (by 60% below 1990 levels by 2050, with real progress by 2020) legally binding. In the Bill's draft, the concept of 'carbon budget' is introduced to engage the government to take the responsibility of capping the commitments over a five-year period through a series of regulations, such as the Energy White Paper, the Marine White Paper, the Planning White Paper and the Waste Strategy (DEFRA 2007a, 2007d). Moreover, an independent Committee on Climate Change has been set up to steer the programme in a way that maximises benefits and minimises costs. By being clear about the level and timescale for commitments while allowing for appropriate flexibility, this committee advises on the setting of the five-year carbon budgets and reports annual progress to the Parliament. Nevertheless, Michael Meacher, the former environment minister, also admitted that it was 'disappointing' that the bill draft lacked policies on airport expansion, car emissions and carbon allowances for private households (BBC 2007c).

Besides setting long-term goals in reducing carbon dioxide emissions within the country and abroad, the UK government considers having a secure, clean and affordable energy supply another important challenge as the UK is becoming increasingly dependent on imported fuel. Improved energy efficiency therefore becomes a key element in the UK Climate Change Programme, which sets out the full range of activities envisaged. Moreover, this viewpoint has also been well demonstrated in the latest White Paper on Energy (DTI 2007), which aims to promote the implementation of the political measures set out in the Energy Review Report in 2006. Four energy policy goals are set in this White Paper. Besides the long-term goal for carbon dioxide emissions reductions, the other three are: 'to maintain the reliability of energy supplies; to promote competitive markets in the UK and beyond; and to ensure that every home is adequately and affordably heated' (ibid). Moreover, although currently renewable energy only contributes about 4.2 per cent of the total amount of electricity generated, a new target has been set by the UK government to generate 20 per cent of energy from renewable sources by 2020 (ibid).

Emissions trading

Another instrument to improve energy efficiency in a cost-effective way is through marketing-oriented emissions trading. The rationale is that emissions of greenhouse gases have the same effect everywhere. Thus, it is possible for the government to regulate the amount of emissions produced in aggregate by setting the overall cap while leaving flexibility to the market. Based on this principle, a trading system (Emissions Trading Registry) has been introduced from a marketing-oriented perspective where each allowance, representing a tonne of the relevant emission (carbon dioxide), has been allocated to the participants (Climate Change Agreements holders) and can be traded between them (DEFRA 2007b). Once the amount of allowances in the market is fixed, the environmental outcome will not be affected. Compared with regulation which imposes emission limit values on particular facilities, emissions trading prices carbon in the economy and provides participants the flexibility to meet the targets according to their own strategies, either by reducing emissions on site or by buying allowances from other companies who have excess allowances.

The UK government also plays an important role in international emissions trading. As the world's first economy-wide greenhouse gas emissions trading scheme, the UK Emissions Trading Scheme (launched in 2002 and ended in 2006, with final reconciliation completed in March 2007) can be seen as the prototype of the European Emissions Trading Scheme (which began in 2005)[iii]. Carbon Trading has already been seen as an important financial incentive to respond to the Kyoto Protocol and facilitate cooperation between different countries. Moreover, this strategy also incentivises investment and development in energy efficiency and low-carbon technologies, such as solar panels, wind farms, CHP (Combined Heat and Power), etc. In the UK, based on the early achievements (emissions reductions of over 7.2 million tonnes of carbon dioxide equivalent (CO_2e) from 2002 to 2006 between thirty-three Direct Participants), the new Carbon Reduction Commitment[iv], announced in the Energy White Paper 2007, sets an ambitious target to cut carbon emissions from large commercial public sector organisations (including supermarkets, hotel chains, government departments, large local authority buildings). By using a mandatory emissions trading

iii 'The EU Emissions Trading Scheme (EU ETS) is a Europe wide scheme which aims to reduce emissions of carbon dioxide and combat the serious threat of climate change. EU ETS puts a price on carbon that businesses use and creates a market for carbon. It has been in place since 2005 and is the first scheme of its kind in the world' (DEFRA 2007b).

iv Carbon Reduction Commitment is the new name for the Energy Performance Commitment proposal on which the Government consulted in 2006 (DEFRA 2007b).

strategy rather than a voluntary one, this new scheme aims to cut carbon dioxide emissions by 1.2 MtC / year by 2020 (DEFRA 2007b).

Taxation

Besides regulations and trading schemes, green taxation has been introduced to the markets at the same time. As an economic instrument with a wide range of forms, green taxation aims to internalise some of the costs incurred by processes or actions that damage the environment and incentivise more benign technologies and environmental behaviour (British Energy 2006). By making more transparent the environmental benefits and disadvantages associated with technologies, green taxation is likely to implement a multi-level playing field on environmental issues for all technologies currently available in the market.

Take the proposals for VAT and fuel duty on domestic flights as an example. The plans to introduce 'green' taxes on air travel in order to cut carbon emissions, proposed by the Conservative party, received support from less than half of the UK population (UK-airport-news 2007). According to a survey by London-based Continental Research & KNOTs Research, people in the UK expressed the highest concern (89%) regarding climate change compared to that in the US (63%, the lowest), Germany and Japan (UK-airport-news 2007). Even though, only 44% of the 250 people questioned in the poll said that they would like to support green taxes on domestic flights and only 29% said they had cut back on air travel in light of environmental concerns. Obviously, green taxation is not only about political engagement, but also about economic acceptability and social awareness. Green taxes fell as an overall proportion of government revenues to 7.3% in 2006, although they are predicted to rise to 7.5% in 2007 thanks to fuel duty and VED (vehicle excise duty) rises (BBC 2007b).

In terms of practice, 'Green Taxation' often takes a wide variety of forms, such as taxes, regulation, obligations or commitments, and sometimes even trading schemes.

To a great extent, these three strategies, regulations, emissions trading and taxation, are interrelated and should be implemented from an integrated perspective in order to achieve the most effective collaboration. It is proposed that achieving this integrated environmental goal needs to go hand in hand with pursuit of social justice and equality of opportunity, by engaging more people to look hard at how energy is produced, how transport is used, how technology is harnessed, etc. As argued by the UK government (DCLG 2007), this is an ambitious but necessary target. However, although the government is optimistic in achieving the long-term objective of carbon reductions, so far progress in reaching this target has been little and in doubt[v] (Environment Agency 2007, Sayce *et al.* 2007: 633). It is also questionable whether the general public is aware of this and would like to become involved.

As stated earlier, between these possible activities, measures in greening built environment represent a huge opportunity for carbon reductions as energy use in homes and offices accounts for nearly half of national carbon emissions and the transport used to travel between them accounts for another third (DCLG 2007). Therefore, the Department for Communities and Local Government (2007) states that, after embedding measures to tackle climate change within the planning system, particular attention should be paid to increasing building standards as a follow-up step. As a result, 'Climate change mitigation' becomes a core part of government's Sustainable Construction Strategy (HM Government 2008).

Since most people spend more than half of their lives in homes and 'high quality and well-managed housing is a cornerstone of sustainable communities' (Housing Corporation 2003: 3), domestic stock holds the most important position in the built environment. In fact, in most countries, domestic sector of the economy consumes more energy and resources than the commercial sector. As Vale points out (2002), 'the Central Business District (CBD) towers may look spectacular, but it is peoples' homes that are causing more damage to the environment, and making the larger contribution to climate change'. Another large part of energy consumption is related to transport. Again, it is the domestic part of transport, such as reliance on privately owned vehicles, that has a significant impact. Therefore, the debate on greening built environment is concentrated on the domestic sector in the following sections, which sets the main boundary of this research.

2.2.3 MAIN RESEARCH BOUNDARY – DOMESTIC SECTOR

According to statistics from Department for Environment, Food and Rural Affairs, carbon dioxide emissions caused by energy use in homes are a significant source of greenhouse gas emissions, accounting for over a quarter of the UK's total carbon output (DEFRA 2005, DCLG 2006b). Moreover, households account for around 30% of all UK energy consumption. Of this, around 80% is for space heating and hot water (over 50% for space heating and around 20% for hot water respectively), with the remainder for appliances (16%), lighting (6%) and cooking (5%) (DEFRA 2005), though recent trends indicate that there is increasing energy use in lighting and appliances and decreasing use in cooking (Banfill and

[v] Planning Policy Statements (PPS) 22 contains, 'inter alia, a requirement for plans to consider the obligation fro developments to have some on-site renewable energy provision. A review undertaken in June 2006 indicates that almost half of the plans that could have been expected to contain provisions for the requirement for on-site renewable energy production do not contain such a provision' (Sayce *et al.* 2007: 643).

Peacock 2007: 427). To a great extent, carbon dioxide emissions reductions and energy efficiency in domestic sector play a central role in tackling climate change. This aspect is also envisaged by the UK government as a potential opportunity to bring real social and economic benefits to the country as a whole and especially to low income people (DEFRA 2006c: 19). Actions are carried out from two aspects: design and construction for new homes and refurbishment of the existing housing stock, although the government holds a strong bias towards the first route because the retrospective change to existing buildings is perceived as difficult and unpopular[vi] (Banfill and Peacock 2007: 427).

As it is expected that one-third of the total housing stock will be built between 2006 and 2050 with the balance already in existence (DCLG 2006c), it is important to ensure that these new homes are designed and built in a way that minimises energy use and reduces harmful emissions. A consultation on progressive changes to building regulations has been published to achieve the mandatory objective of zero-carbon new homes by 2016[vii] (DCLG 2006b, DEFRA 2007a, BBC 2007c), though it has been criticised as unrealistic in some quarters (see CIRIA 2009: 4).

Date	2010	2013	2016
Energy efficiency improvement of the dwelling compared to 2006 (Part L Building Regulations)	25%	44%	Zero carbon
Equivalent standard within the Code	Code level 3	Code level 4	Code level 6

Figure 2.1: Gradual introduction of the new standards (Source: DCLG 2008b)

vi 'The government justifies this focus on new build by asserting that making every possible cost-effective energy improvement to existing homes would reduce the annual CO_2 emissions in 2050 by only 25% of what is necessary: the rest must be achieved in new homes.' (Banfill and Peacock 2007: 427)

vii 'This will cut our carbon emissions by around 7 million tonnes a year by 2050. That's equivalent to around 20 per cent of housing emissions. Or, to put it another way, more than the total emissions from the 8 largest English cities outside London.' (DCLG 2006a)

In this shift, new standards are proposed to be introduced step by step (as shown in Figure 2.1): in 2010, new homes must be built to the very highest energy efficiency standards; then in 2013 and 2016, application of renewable energy sources in homes are required to be increased[viii] (DCLG 2006b). This gradual introduction of changes will give business and the market time to adjust and innovate to drive costs down. Moreover, three measures have been proposed by the government to facilitate this change: creating fiscal incentive (by exempting zero carbon homes from stamp duty), enacting the new Code for Sustainable Homes (to emphasize sustainability issues in design and construction protocols), and introducing a new low carbon consumerism to the housing market (by providing mandatory 'green' star-ratings or energy performance certificate for new properties) (DCLG 2006a; BBC 2007b).

Although many positive actions have been taken by the UK government to improve sustainability standards in the aspect of new home development, some scholars (in the Royal Institution of Chartered Surveyors) argue that Chancellor Gordon Brown might have missed an opportunity by focusing solely on new homes (BBC 2007b). According to them, environmental issues, especially those arising in the existing housing use, should also receive attention in moving towards zero carbon development. In reality, existing housing stock in the UK has one of the lowest levels of energy efficiency in Western Europe. Compared to SAP 70 (Standard Assessment Procedure), a rating generally accepted in the region as recommended minimum (NEA 2002: 3), current levels in English housing stock are much lower, approaching just SAP 43 (source BRE domestic energy fact file, DTI 2003: 83; cited in Parnell 2003a: 7). To achieve improved well-being and quality of life, a wide range of measures have been introduced to encourage households to take up energy efficiency measures, such as regulatory and incentive-based policies, grants and other economic incentives, and related cross-referencing information and advice, etc.[ix]

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viii 'The time scale proposed for implementing these improvements (in *the Code for Sustainable Homes*) to the performance of new homes is that in 2010 the minimum requirement will be three stars, in 2013 it will be four stars, and in 2016 it will be six stars.' (Banfill and Peacock 2007: 429) For more information about the Code, see 4.5.4.

ix Based on the *Energy Efficiency: The Government Plan for Action*, detailed measures, including information and awareness-raising campaigns, have been described in the revised Climate Change Programme to improve energy efficiency in UK homes. Likewise, building regulations have also been developed to steadily drive up the minimum energy standards to new build and refurbished buildings. By implementing part of the EU Energy Performance of Buildings Directive and working together with the 2002 revisions, the new measures launched from April 2006 aim to improve new build standards by 40 per cent and cut fuel bills by up to 40 per cent for new homes built in the UK from 2006 onwards compared to pre-April 2002 stock. Other Government Programmes that will deliver energy efficiency in housing, and combat fuel poverty, include the 'Decent Homes' standard in England (created in 2000), The Warm Front scheme in England (launched in 2000) and the Community Energy Programme (launched in January 2002). (DEFRA 2006c)

Besides those incentives or technical advances that can improve building fabric, there is an additional opportunity to facilitate the progress of sustainable development, which is to engage householders, energy suppliers, appliance manufacturers and other related stakeholders to participate in an awareness-raising campaign. For example, the statutory consultation on a Carbon Emissions Reduction Target (CERT) for 2008-2011 (new name for the Energy Efficiency Commitment) has been launched alongside the latest White Paper. From a long-term perspective, this scheme aims to support a transformation in the way energy suppliers view their relationship with end consumers, 'helping their customers save energy, by shifting their focus to the provision of energy services, rather than simply selling units of energy' (DTI 2007: 10).

Obviously, success of carbon reductions and energy saving in housing development rests on more than technical know-how. It also demands social awareness and how the general occupants can be engaged in the campaign of energy saving and carbon reductions. Therefore, it is important to see if these housing occupants are aware of and appreciate these existing housing sustainability performance standards, especially those related to daily behaviour and attitudes, such as purchase and use patterns for energy and so on.

2.2.4 OCCUPANTS' ATTITUDES – PUBLIC SECTOR

Based on a wide range of research (e.g. BBC 2007d, DEFRA 2006a, IPCC 2007), there is an ever-broader informed consensus that human activities are the primary driver of these observed and predicated long-term climate changes, including not only global warming trend, as shown in Figure 2.2, but also those physical and biological systems discernibly influenced by them. Moreover, since energy consumption at home is a personal issue which is closely related to the individual's lifestyle, there are wide differences observed between similar households in nominally identical houses (Banfill and Peacock 2007: 430). Obviously, besides understanding the uncertainty of climate change, it is important to get the important message (purposes of sustainable design and principles of sustainable lifestyle) across to the general homeowners or occupants.

To relate climate change to general public's daily lives and achieve the objective of One Planet Living (WWF 2006), the Climate Change Bill has been proposed. As a critical foundation, it aims to facilitate the low-carbon economy by establishing this goal in legislation (DEFRA 2007a). Although some people may argue that there is no need to reduce our living standards or slow down economic progress, it becomes an ethical priority, as much as an economic priority, to defend what remains of nature on this planet (WWF 2007). Extending and deepening action for changes in investment and behaviour across society from government and business to individuals will be necessary. As an echo, social participation, especially from those stakeholders with little specialist knowledge in the decision-making processes, has been taken as an important principle in the updated Climate Change Programme (DEFRA 2006b, BBC 2007a)

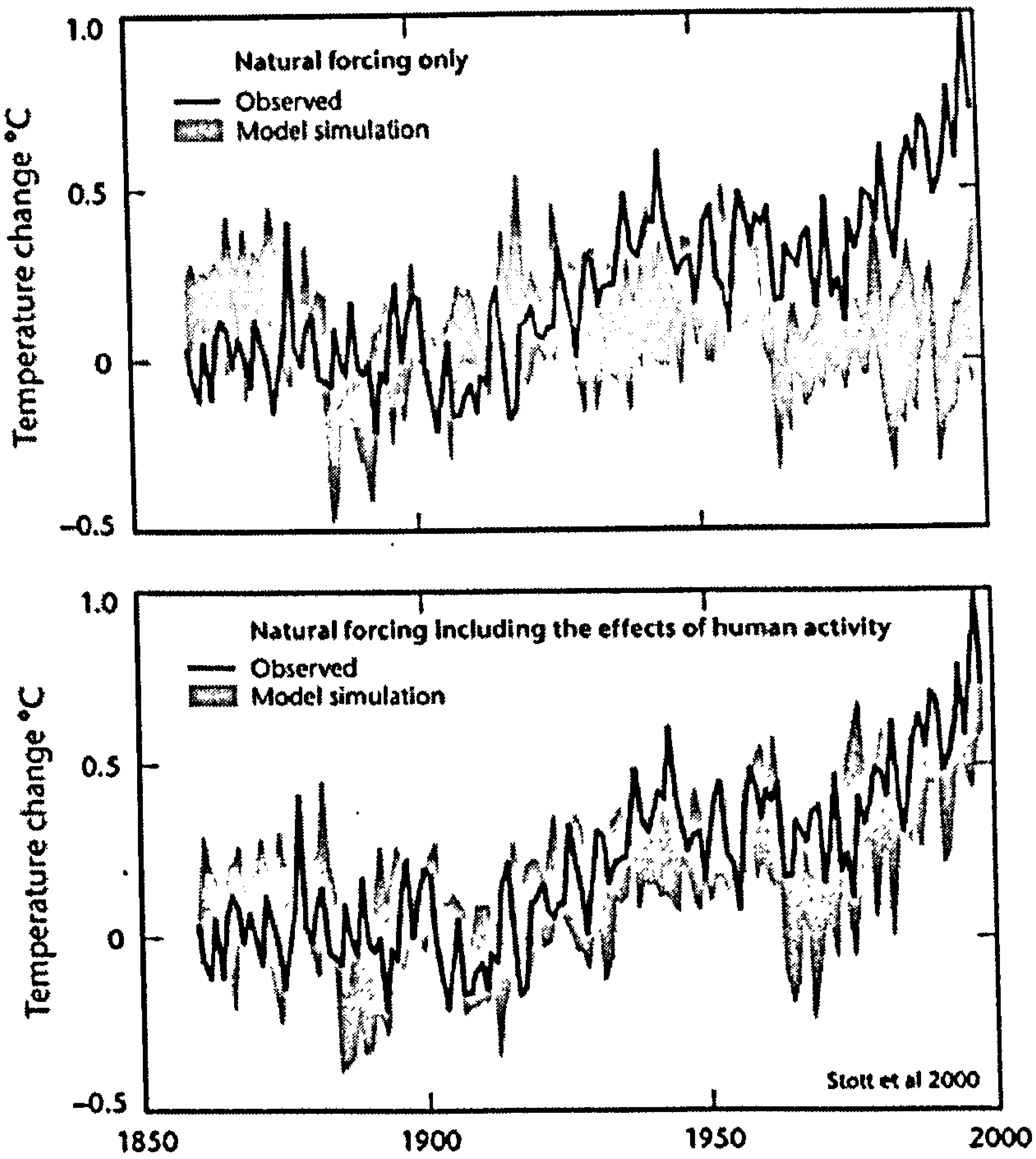

Figure 2.2: Interrelationship between temperature change and human activities
(Source: Meteorological Office's Hadley Centre 2007)

In this awareness-raising campaign, incentives are necessary to mobilise behaviour change, yet it will be unnecessarily costly if relying on them alone. To avoid a sharp price increase in high-carbon goods and services[x], a range of other measures have been proposed to facilitate individuals' and businesses' participation. As argued by the Department for Environment, Food and Rural Affairs (2007a: 18),

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x 'It is estimated that each percentage point increase in gas and electricity price creates 40 000 new fuel-poor households (Department of Trade and Industry (DTI), 2003). (A household is said to be fuel poor if it needs to spend more than 10% of its income on fuel to maintain a satisfactory temperature in the main living area.)' (Banfill and Peacock 2007: 428)

'Individuals and businesses often fail to act because they lack information and feedback on how their behaviour incurs energy costs, and how simple changes can reduce them; inconvenience and relatively low rewards mean that citizens do not make investments that will save them money; and citizens and businesses may be put off changing their behaviour if they do not believe there is a shared willingness to act, cannot see any role models, and feel their contribution will not be matched by others.'

To solve these problems, a variety of changes are introduced:

Information: To get the message across to individuals and allow them to make informed decisions for themselves and their families, related information is provided online in a wide range of sources normally joint initiatives. These include *Hadley Centre Review* by the Meteorological Office Hadley Centre (2007), *Fourth Assessment Report* by Intergovernmental Panel on Climate Change (IPCC 2007), *The UK Climate Change Programme* by Department for Environment, Food and Rural Affairs (DEFRA 2007c), *Every Action Counts* (Everyactioncouts 2007) by a consortium of national organisations in partnership with DEFRA on behalf of the government, *Tomorrow's Climate Today's Challenge* (Climatechallenge 2007) by the Climate Change Communication Initiative led by DEFRA in partnership with the Energy Saving Trust, the Carbon Trust, the Department of Trade and Industry, the Environment Agency, the UK Climate Impacts Programme (UKCIP) and the Department of Transport, etc. However, the problem is that it is unlikely for an average person to read such documents written in a professional language. Information presented in these documents needs to be further interpreted and represented at a suitable level. This concept, using a common language to facilitate knowledge transfer, is extensively discussed in Chapter 4.

Moreover, in the latest Energy White Paper (DTI 2007), proposals on real-time information on energy consumption are created, including clearer information on bills and more advice about energy efficiency. The Energy Performance Certificate[xi] is introduced as a mandatory

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[xi] As a compulsory part of Home Information Packs, Energy Performance Certificate (EPC) has been introduced in the UK from June 2007, initiated by the EU European Energy Performance of Buildings Directive in January 2003. It details average costs for heating, hot water and lighting in the home. Based on a scale of A-G, Energy Efficiency Rating in the EPC quantifies how energy efficient the home is (those in band A will have the lowest fuel bills) and how to cut costs with energy efficiency measures. At the same time, Environmental Impact Rating in the EPC, based on the same A-G scale, indicates the impact the home has on the environment, where

label for new and existing homes in the market. By better co-ordinating advice and support provided to householders on energy efficiency and micro-generation, the government aims to help all homes achieve their cost-effective energy potential progressively, leading to net zero-carbon dioxide emissions in 2016 (DTI 2007: 10-11). From an individual perspective, an online Personal Carbon Calculator will be enabled, which aims to help householders to understand how their everyday activities contribute to carbon dioxide emissions (DEFRA 2007a: 18).

- *Making change convenient*: Based on analysis of cost-effectiveness and trade feasibility, personal carbon allowances are considered from a long-term perspective. By working with companies (such as airlines, travel companies and energy suppliers, etc.), the government aims to ensure that all citizens are given the explicit choice to offset their emissions at the point of sale or as a potentially 'default' option (DEFRA 2007a). For example, smart meters and real time displays are already under trial (DTI 2007). Moreover, the possibility of establishing new methods of financing energy audits and energy-saving measures that could over time pay for themselves in lower fuel bills is also examined (DEFRA 2007a).

- *Shared willingness to act*: The UK Government is committed to set an example to facilitate individuals and businesses to contribute by reducing carbon emissions from its offices by 30% by 2020 and making the office estate Carbon Neutral by 2012 (DEFRA 2007a). To reach a wider public sector on green issues and its supply chain through a focus on sustainable procurement, the campaign 'We're in this together' is proposed (ibid). Furthermore, as addressed by the framers of the United Nations Decade of Education for Sustainable Development[xii] (UNESCO 2005: 6; cited in Blewitt 2006: 5), 'Education for Sustainable Development (ESD) is for everyone, at whatever stage of life they are. It takes place, therefore, within a perspective of lifelong learning, engaging all possible learning spaces, formal, non-formal and informal, from early childhood to adult life'.

Based on these measures, it is argued by the Department for Communities and Local Government (DCLG 2006a; 2006c) that today's public is more environmentally conscious and aware of the urgent need to limit its effect on climate change. Research suggests that there is a growing appetite among consumers for more sustainable products and services, as

better-rated homes should have less impact through carbon dioxide (CO_2) emissions. Currently the average property in the UK is in Bands D-E for both ratings. (Home Information Pack 2007)

xii As a global initiative, the United Nations Decade of Education for Sustainable Development, from 2005 to 2014, aims to establish a broad context for learning about sustainability. (Blewitt 2006: 5) evident that around two thirds of consumers are more likely to buy products with a low carbon footprint (DCLG 2006a). In the housing market, therefore, there is an increased need for home builders to demonstrate their capacity in sustainable development and market the sustainability performance of their homes to respond to what the public wants. The Code for Sustainable Homes and its prototype BREEAM EcoHomes are both designed for this purpose. However, it is questionable whether the environmental issues addressed in these kinds of assessment systems can truly meet house occupants' requirements, and whether house designers agree with them at the same time. This topic is extensively discussed later, which contributes to the principal hypothesis of this research.

2.3 SUSTAINABLE ARCHITECTURE

Nowadays sustainability is widely acknowledged as a multi-disciplinary concept that requires close collaboration between different professionals. This section reviews prevalent sustainable design theories and related strategies, based on which feasible measures to implement sustainability in the architectural domain can be explored.

2.3.1 CONCEPT OF SUSTAINABILITY

Early concepts of 'sustainable development' emerged from the 1972 United Nations Conference on the Human Environment in Stockholm. Then in 1987, the World Commission on Environment and Development (WCED) released a report, *Our Common Future*, calling for 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (Bruntland 1987: 8). This later became the widely used international definition for sustainable development. As a multi-disciplinary concept, sustainable development requires close collaboration between many subjects. Built on this academic discipline, by combining 'sustain' and 'ability' together, the word 'sustainability' is endowed with many new meanings today. Compared with 'sustainable development' which addresses a universal object, 'sustainability' represents a system of trinity, including three key components, Social (Equitable), Economical and Environmental (Edwards 2000, Pitts 2004). In the UK, it is argued that the centre of gravity of this campaign is moving from sustainable development (as defined by the Brundtland Commission) to sustainability[xiii] (as signalled by the Blair government).

[xiii] As stated in the UK Strategy for Sustainable Development (DETR 2000), four underlying themes that describe the sustainability objective for development are: 'social progress which recognises the needs of everyone; effective protection of the environment; prudent use of natural resources; maintenance of high and stable levels of economic growth and employment'.

Recently there is 'an emerging consensus' that achieving the objective of sustainability will require 'substantial changes to human lifestyles and behaviour' (Proops and Wilkinson 2000: 17). To successfully implement sustainability principles, 'people' are put to the first and foremost position based on 'a common endeavour' and 'new norms of behaviour at all levels and in the interests of all' (Bruntland 1987: xiv). This core concept attempts to engage people in re-evaluating everything they do with a broader public purpose in mind and re-appraising their daily lives in a brand new way. As summarised by Layard *et al.* (2001: 8), sustainability is always an anthropocentric concept from its outset. Therefore, people, especially those who are stakeholders and decision-makers, hold an important position in the interpretation and implementation of sustainability principles. Moreover, since the changes in 'attitudes', 'social values' and 'inspirations' will heavily depend on 'vast campaigns of education, debate, and public participation' (Bruntland 1987: xiv), peoples' awareness of sustainability issues and lifestyle choices will decide how far this world-wide campaign will progress (HM Government 2005).

As a fashionable yet ambiguous discipline, 'sustainability' possesses the ascendancy in almost every human activity. However, although the word has a specific implication of infinite capability, its respective definition fails to satisfy various critics (Porteous 2002). Thus, as a broad, holistic definition yet with many ambiguous contents at the same time, sustainability is often taken as an alluring Utopia by many people in terms of practice (Blewitt 2006: 1). Since the key concerns of sustainability sometimes seem to be overridden or ignored in the rush to inclusiveness (Layard *et al.* 2001: 12), people ask for more detailed objectives and more effective interfaces which they can follow in practice. As Guy (2005: 470) points out, 'it is at this point that one finds a familiar response to the confusions and contradictions inherent in the sustainability challenge, that of a call for more information, training, education and awareness-raising'. Based on this quest, many explorations are carried out, covering a wide range of approaches. Inevitably, present architectural activities are also thoroughly affected by this sustainable tendency.

2.3.2 ARCHITECTURAL DESIGN TOWARDS SUSTAINABILITY

From a review of human history, it can be found that architectural activity seems to play an ambivalent role in the human evolutionary process – generating the social advancement and prosperity of the cost of consuming environmental resources. As argued by Benton (1998: 75) 'buildings are among the most long-lived physical artefacts that society produces'. Unlike any commodities, which can be recycled after a short time, today's designs will exist for many decades, even long after oil and natural gas are no longer available as fuels. This ascendancy pushes architecture to the edge of implementing sustainability. The challenge is nothing but an intrinsic change. Today, architecture has taken the lead in incorporating the concept of sustainability in its principles, and in practice (Blutstein and Rodger 2001: 133). Several research approaches are built with the 'positive' attitude towards sustainability (see Chen and Pitts 2005). However, since the concept itself is contentious, these explorations arouse another large-scale discussion in architectural activities.

The early debate in the architectural domain concentrates on 'rhetorical semantics'. Many interpretations are provided to formulate this special topic, sub-headed with 'Eco-', 'Green-', 'Renewable-', or 'Integrated-' and so on. Clearly these kinds of prefixes tend to represent a desire for 'environmental optimisation' after it is neglected for a long time in architectural activities. But some opponents argue that there is still 'a very fine difference' between them in terms of practice (Porteous 2002: x). As a discourse of academic diversity, this kind of debate facilitates the collaboration between different sustainability principles and attracts various professionals to participate in the worldwide campaign.

Recently the centre of gravity of this controversy is moved to 'project scale' for sustainable architecture, combining with a discussion for 'procedural sequence'. Some scholars claim that truly effective sustainable development and its 'relative balance' will only be achieved at a larger urban scale (Thomas 2003, Pitts 2004). Moreover, since the scope of sustainability is now firmly embedded in the socio-political arena, proponents suggest that a top down decision-making process based on a mandatory perspective will be inevitable and necessary for implementation. On the other hand, however, there are also many opponents arguing against this viewpoint by insisting that the practical realisation of sustainability will depend on personal preferences and how successfully each particular component can be carried out. From a democratic perspective, a bottom up decision-making process is proposed. It addresses the individual conscience and insists that 'decision-making at all levels and all along the supply chain is likely to be increasingly susceptible to community expectations on sustainable development' (Blutstein and Rodger 2001: 139).

Since this evolution of sustainable architecture is still in progress, no one model of planning, design and development is supposed to be pursued above others. As argued by Ratner (2004: 62), in order to address sustainability as a meaningful concept, it is important to 'bring differences of belief and opinion, values and conviction into a common field of dialogue and so enhance the potential for agreement on collective action'. In terms of practice, top down and bottom up decision-making processes need to be addressed in parallel (see Sayce *et al.* 2007: 632). The former intends to establish sustainability as a matter of regulation in architectural domain, going with more responsible ethics (Edwards 2002: 7). The latter aims to force architects to re-evaluate their design processes with a more open attitude, moving towards collaborative direction.

However, it is questionable whether architects are aware of all underlying issues and would like to take leadership to accommodate the diverse conflicts in practice. To seek the opportunity for a close collaboration with other stakeholders, more detailed discussions are carried out in the following sections.

2.4 TECHNICAL RESPONSE OR ALTERNATIVE LIFESTYLE

In terms of architectural practice, technical response from the perspective of professional stakeholders (people with more specialist knowledge, including legislators, designers, developers, etc.) and lifestyle change from the perspective of general stakeholders (people with less specialist knowledge, including occupants, clients, etc.) emerge together to respond to the requirements of sustainability. However, it is still contentious which stakeholder group should contribute more to the final decisions. To understand this research problem better, a debate is raised in the following sections. It focuses on the architectural domain and is followed up with an exploratory case study.

2.4.1 DEBATE: TECHNICAL RESPONSE OR ALTERNATIVE OPTIONS

The early technical response can be traced back to the Industrial Revolution. Based on technological development, the relationship between human activities and the environment is transformed from 'adaptation' to 'evolution' (Altomonte 2004). For a long time thereafter, indoor-climate and outdoor-climate are separated artificially and human's increasing ability in controlling indoor-environment means changes in outdoor-environment become less obvious to them. This, to a great extent, reduces peoples' concerns for global climate change. Today, although it is widely acknowledged that people should rethink their daily activities by shifting their lifestyles from 'shielding from' to 'reconciliation with' nature (Jones 2000: 10), most of current sustainable research concentrates on technology related approaches that can improve indoor-environment immediately. Likewise, in the architectural domain, to avoid the complicated and frequently contested academic principles in the initial design process, architects are often likely to fix sustainability into practice by relying on what they are most familiar with – 'technical response'.

In 1995 Richard Rogers re-classified his high-tech approach to match the prevalent green idea and suggested that 'current and future advanced technologies could redress the problems created by the cruder processes and products of industrialization' (Farmer 1996: 180). Supporters, such as Norman Foster, Ian Ritchie, Webler+Geissler and Thomas Herzog and so on, also indicate that this viewpoint is exemplified in the Earth Summit at Rio in 1992 (ibid: 180). This assumption, in favour of technology-dependent development, presents a tendency of 'technological sustainability' (Orr 1992: 23-24), which is coincident to the prevalent developmental objective at global and governmental scale. Until now these technology-dependent measures are widely carried out, covering almost every aspect of the architectural research domain, such as lighting, ventilation, thermal insulation and so on. However, to some extent, this view also endows the design process with relatively unlimited freedom by providing potential design principles that heavily rely on technical innovation.

Thus, some argue against this technology-dependent view and suggest that there are no completely green or sustainable technologies. At the same time, they also indicate that all detailed technology-dependent trials are 'patchy' and 'not fully backed by systematic investigation' (Farmer 1996: 185). To respond to the request for sustainable architecture, they propose an 'ecological version' (Orr 1992: 23-24) which insists that 'passive strategies' should be involved in the design processes before any other techniques are added on. Compared with the technological view, which relies on advances in technology or market solutions to solve the problems, the ecological view tries to find alternatives for the practices that generate the problems in the first place.

Since the views on technical response for sustainable architecture are still debateable, many scholars are likely to seek a balance between the two extremes and some of them prefer a neutral position. To these compromisers, sustainable architectural design is proposed to 'minimise environmental impact without waiting for any further development of technology and without asking society to bend its existing rules with regard to building standards' (Farmer 1996: 180). Clearly these advocates for 'technical eclecticism' try to achieve a win-win result by limiting their practices to certain technical issues and working within the parameters of 'existing legislation and lifestyles' (ibid: 181). However, since the building itself has to be designed and built in accordance with current building norms and procurement procedures, its limited contribution to sustainable architecture is still considerable in technical terms.

Therefore, it is believed that, to some extent, technical response has become the centre of gravity in current architectural explorations aiming for sustainability. Actually, there is also a prevalent uneasiness about making design without technical add-ons when considering the increasingly strict regulations (Melet *ed.* 1999: 10). Even some advocates insisting in the ecological view embrace this technological view as a necessary supplement in order to take the first step in UK society's transition to sustainability (Parnell 2003a: 13). As Orr points out (Orr 1992: 24):

> '... I consider both to be necessary parts of a sustainable world. To use a medical analogy, the vital signs of the heart attack victim must be stabilized first or all else is moot. Afterward comes the longer-term process of dealing with the causes of the trauma which have to do with diet and lifestyle. If these are not corrected, however, the patient's long-term prospects are bleak.'

Then the questions coming from the analogy above are: whether technology-based solutions can stabilize the present status of sustainable architecture development *alone*, especially for energy saving and carbon reductions in the operational phase of house occupation; and how the win-win effect, improving indoor-climate and outdoor-climate at the same time based on the technological support, can be validated through the design protocol.

Besides the debate on environmental aspects, another discussion raised by the technology-dependent view on sustainable architectural design lies in the economic aspect: that advanced technologies often cost somewhat more than normal (at least 3-7% uplift in capital cost, see Sayce *et al.* 2007: 634). Since the current economic accounting system does not comprehensively recognize value of depleted resources, such as cost of pollution and diminishing biodiversity etc., the economic case is difficult to prove at the very least and the extra construction costs for technical add-ons have to be offset by reduced running costs of buildings (Blutstein and Rodger 2001: 134). In the main boundary of this research, this economic conflict for technological sustainability is more sensitive – unlike office buildings or some public buildings which can sometimes find some extra money to afford the high cost of technical add-ons, budget for housing construction is limited by market economy. This is even true for social housing developments, which are expected to have a longer term view.

As summarised by Guy (2005: 469), 'the mainstream of architecture is in some disagreement about design priorities, the role of technology, the importance of aesthetics, the relationship between natural and built environments, and the degree of optimism or pessimism the current state of sustainable architectural practice should invoke'. To understand the current sate of sustainable architectural practice better, an evaluation is presented in the following sections in order to close the loop.

2.4.2 CLOSE THE LOOP & CAPACITY BUILDING

Based on recent rapid technological development, many technology-dependent architects argue that their sustainable designs could be both valuable and profitable according to 'a rule of thumb', which means that 'the reductions in annual operating costs can be multiplied by 10 (capitalization rate) to estimate increased building value' (Mendler and Odell 2000: 15). However, since images and forms of technology are often 'illusory' (Farmer 1996: 184) and whether a building is really sustainable is 'something we can only determine retrospectively' (Melet *ed.* 1999: 9), these architects are asked to re-evaluate their intentional contributions more carefully, with the benefit of hindsight. Currently buildings are still assessed on their designs rather than on performance of completed construction, though pressure testing is applied as an important exception to ensure compliance with energy efficiency standards (DCLG 2006c, cited in Banfill and Peacock 2007: 428). Therefore, many scholars (for instance, Roaf *et al.* 2004, Banfill and Peacock 2007, Sanders and Phillipson 2006, and CIRIA 2009) indicate that there are often *significant differences* (sometimes about half) between the predicted, simulated performance of many new buildings during their design phase, and the actual energy consumption and carbon dioxide emissions in their operational phase. This discrepancy indicates that present technology-based measures can hardly stabilize the current status of sustainable architecture development alone. A third dimension, related to the occupants' concern, has to be introduced into the existing benchmarking processes.

To help close the loop between design predictions and performance-in-use, research activities in post-occupancy evaluation (POE) are established, raising a 'Probe-Style'[xiv] discussion in architectural practice (see Cohen *et al.* 2001, Whyte and Gann 2001, Bakens *et al.* 2005). However, as Lutzkendorf and Lorenz (2005: 215) point out, in the UK, demand for POE studies is limited and only growing slowly, due to 'corresponding recommendations of Egan's Construction Task Force' (Egan 1998, cited in ibid) and 'the success of Probe (Post-occupancy Review Of Buildings and their Engineering) studies'. Furthermore, although much information indicates that predicted performance can be over three times better than what is achieved in reality, developers and designers often keep describing their building's performance with the predicted figures rather than figures actual measured (Roaf

[xiv] 'PROBE (Post-occupancy Review Of Buildings and their Engineering) was a research project which ran from 1995-2002 under the Partners in Innovation (jointly funded by the UK Government and The Builder Group, publishers of *Building Services Journal*). It was carried out by Energy for Sustainable Development, William Bordass Associates, Building Use Studies and Target Energy Services. PROBE studies include a review of design intent and site documentation, technical survey (walk-through and spot checks), energy survey with CIBSE TM22 analysis, envelope pressure test, occupant questionnaire survey, management interviews, designers' response, and publication of the results.' (Todd and Fowler 2007)

et al. 2004: 9).

To rid this embarrassment, it is crucial to make sure that various stakeholders share understandable information relating to sustainability during the building's developmental process. To close the loop, awareness of 'capacity building' is also addressed by the construction community (Roaf *et al.* 2004: 13). This concept indicates that, since everyone is a stakeholder in the future, it is important to give people, especially those with little specialist knowledge, maximum access to expert information on sustainability. It aims to help more people understand the most important sustainability issues that may affect their own lives and then be capable of making informed choices for their day-to-day lifestyles. This viewpoint is strongly supported by Dunster (BDa 2003) who claims that, since current technologies cannot satisfy present lifestyles, an essential change in occupants' lifestyles (attitudes and behaviour shaping energy use in particular) has to be made along with the technology. To a great extent, these two interrelated views ('closing the loop' and 'capacity building') show that sustainable buildings are actually designed for performance, resilience and adaptability rather than fashion or style (Roaf *et al.* 2004: 15, Bakens *et al.* 2005: 149). In addition to reduced construction, operating, and maintenance costs, sustainable buildings themselves are also expected to provide more valuable characters to owners and occupants, both quantitative and qualitative.

Nevertheless, Dunster (BDa 2003) points out, although buildings could be designed to encourage lifestyle changes, it is left to occupants to decide how far they want to go to make the changes. Likewise, it is also argued that, since the main energy consumption and pollution emissions from the construction industry concentrates in the building's operational phase, occupants' misuse or distrust could lead to significant differences from architects' expectations. Based on this viewpoint, the success of sustainable building will depend heavily on its proper operation, built on better appreciation by its occupants. Moreover, unlike any commercial or office buildings where relatively regular human activities allow the buildings to be monitored by professionals or intelligent systems, homes have to rely on maintenance initiatives from their residents, typically with little specialist knowledge (see Parnell 2003a: 79). This viewpoint has also been highlighted in recent studies to avoid the so-called Khazzoom-Brookes postulate[xv] (see Sayce *et al.* 2007: 633). As Keith Clarke, Chief Executive of ATKINS and Deputy Chairman of the Construction Industry Council

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[xv] 'This theoretical positioning first developed by Khazzoom (1980) and later by Brookes (1990) suggests that energy efficiency reduces price to the consumer who then will either increase demand through price elasticity or choose to spend their increased disposable income on other energy-consuming goods and services' (Sayce *et al.* 2007: 633)

(CIC), points out,

> 'The Government targets for zero carbon buildings are driving innovation amongst leading designers although this is presently an area where even the largest design consultancies can only claim a few expert teams. At present, there seems to be more worthy debate about what constitutes zero carbon homes than the design, construction and monitoring of such buildings.' (Clarke 2009: 19)

To achieve positive sustainability objectives, besides the environmental and economic aspects, this research pays particular attention to the social issues arsing in the housing design processes, which have not yet been fully explored in previous studies. Further, these human-related issues should not be regarded as an 'accessorial' effort only, though many scholars argue that they could be satisfied along with the success in environmental and economic aspects of sustainability. As argued by Guy (2005: 471), 'while acknowledging how a technical, performative approach to understanding environmental design has brought undoubted benefits in terms of highlighting the issues of energy efficiency in buildings, one must fundamentally revise the focus and scope of the debate about sustainable architecture and reconnect issues of technological change with the social and cultural contexts within which change occurs'. To better understand this phenomenon, an exploratory case study, focusing on BedZED, is carried out from a socio-technical perspective in the following sections.

2.4.3 EXPLORATORY CASE STUDY – BEDZED

In the UK, the idea of Zero Emissions Development, or Zero Energy Development, has been in existence for a number of years and is often known as its abbreviation – ZED. As an exponent of this concept, Bill Dunster successfully represents this notion with a complete housing scheme at Beddington in London, the Beddington Zero Emissions and Zero Energy Development or BedZED (Figure 2.3).

BedZED is a joint initiative between the BioRegional and the Peabody Trust. In her speech *Shaping a low carbon future – our environmental vision* (DCLG 2006a), Ruth Kelly also uses BedZED as the case to show the gradual changes in ordinary housing construction. In this research, the case study of BedZED provides some important principles for later work.

Figure 2.3: BedZED, London

- ***BedZED***

Located in the London Borough of Sutton, BedZED is a mixed-tenure, mixed-use 'solar urban village' that also includes some commercial units and community facilities. This scheme aims to enable people to live in a sustainable way without sacrificing 'a modern, urban and mobile lifestyle' (BioRegional 2002). Details of the design features for this scheme have been widely publicised and can be seen as an integration of social amenity, financial effectiveness and reduced environmental impact (Pitts 2004). The main design strategies have been summarized in the following:

Social aspect:

Mixed-use & mixed-development for tenure

Living and working from home

Outdoor private space for all properties

Green transport plan: pedestrian first; bicycle storage

Proximity to community facilities for local activity

Local car pool

Choice for an alternative carbon-free lifestyle

Economical aspect:

Affordable accommodation with high design quality

Commands margin over market value

High-density plan to add development value

Low energy running bills

Low risk based on existing prototype: Hope House

Environmental aspect:

Zero fossil fuel and carbon neutral

100% renewable energy use: PV & Bio-fuelled CHP

Zero heating by passive solar gain & high insulation

Heat recovery ventilation systems powered by wind

Low embodied energy materials: sourced locally

Recycled materials – timber and steel

Water recycling and water efficient appliances

Waste recycling

In terms of sustainability, all these design measures are integrated in BedZED. As a result, this scheme was on the short-list for the Stirling Prize 2003 as the only residential project (BioRegional 2007, Peabody Trust 2007), which demonstrates its special value in the housing market. Although not all the sustainable features work entirely as planned during their later operational processes (for instance, some problems exist in the CHP and the water recycling systems), they have shown some good ideas. For example, BedZED delivers low fuel bills and a warm, well-designed home, where many residents are in credit on their electricity bills because they are producing more than they are consuming (DCLG 2006a).

Moreover, compared with a typical UK family (based on a 4-person household) that is now consuming three times ecological resources than they should (BDa 2003), people in BedZED have reduced their ecological footprints [xvi] to a considerable extent by using ZED's technology-dependent facilities, recycling their waste and having local food. However, as shown in Figure 2.4, if people stick to their *conventional* everyday lives, they would still need two planets to maintain them though living in BedZED (Twinn 2003). In other words, our existing lifestyles can hardly be sustained by the carrying capability of our planet and technologies currently available. Even with BedZED's standard, a substantial change for the living manner has to be made properly and quickly!

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xvi 'The Ecological Footprint is an [ecological] accounting tool that compares a particular human demand on the Earth's biosphere in a given year to the available biological capacity of the planet in that year. It can also be compared to the biocapacity of a nation or a region in that year. The Ecological Footprint documents what has occurred ...' Moreover, by providing a snapshot in time, the Ecological Footprint attempts to answer a central question of sustainability: 'how much of the bioproductive capacity of the biosphere is used by human activities' (GFN 2006)

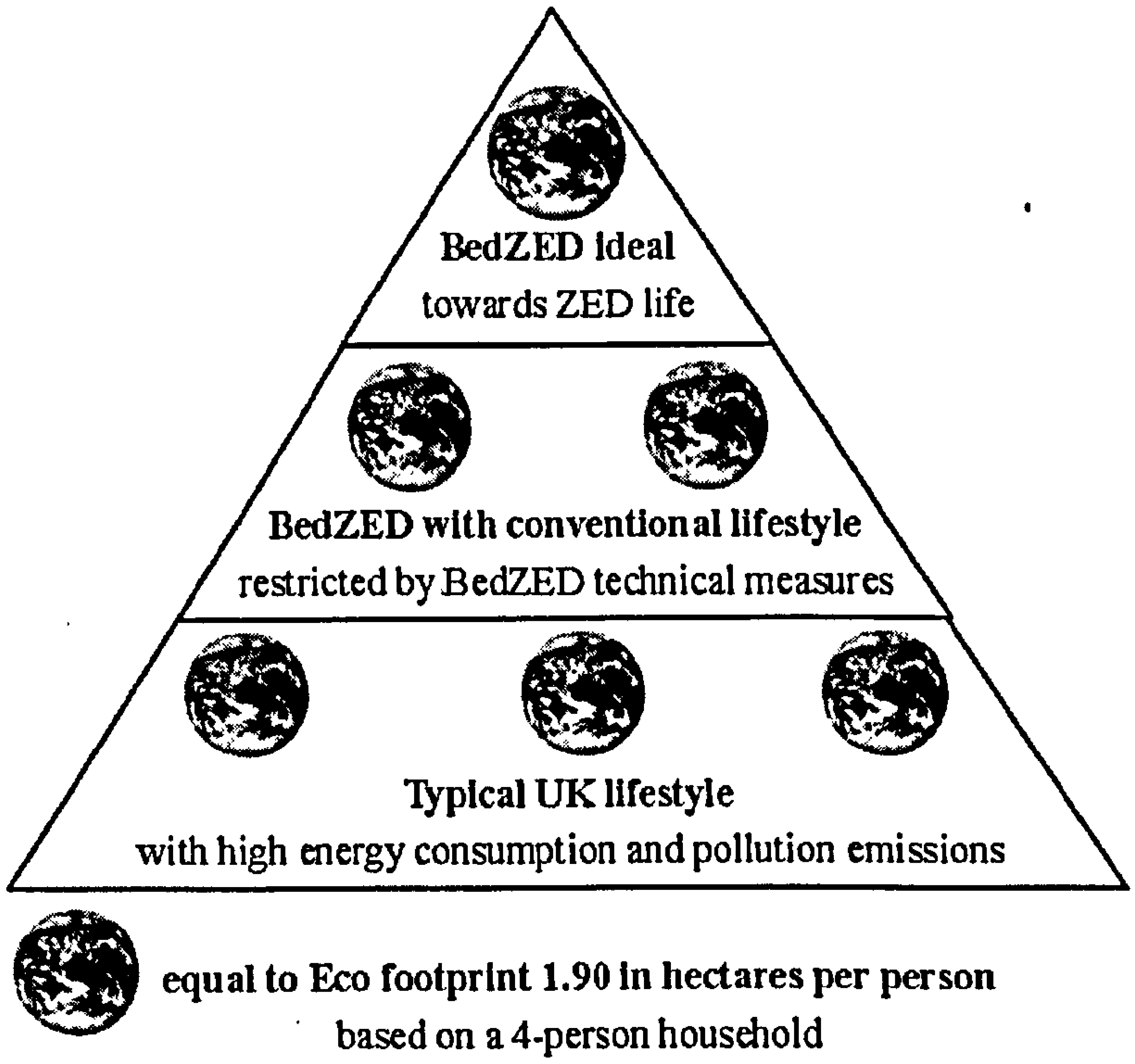

Figure 2.4: Ecological Footprints in BedZED (Data sources: BDa 2003)

- ***Lifestyle Change towards One Planet Living – ZEDlife***

As argued by Blewitt (2006: 3), understood as 'a dialogue and a heuristic', sustainability is 'process oriented' and 'will come about through learning and reflecting on everyday assumptions, habits of behaviour, structures of feeling and expectation'. A term borrowed from marketing research, 'lifestyle' is now widely used by sustainability researchers to refer to patterned differences in knowledge, attitude, behaviour and some consequent issues among sub-groups of society. It can be seen as a combined symbol of culture, social class, consumer choices, behaviour and historical trends (Kempton 1993: 221).

By examining typical lifestyles in the UK, it can be found that British people are now consuming 300% more than the planet can sustain in the long term if everyone had the same lifestyle (WWF 2006a). Moreover, as noticed in the case of BedZED above, current technologies in the housing market cannot satisfy the existing lifestyle requirements. An essential lifestyle change (attitudes and behaviour shaping energy use in particular) has to be made to maintain living within the carrying capacity of one planet.

To achieve this objective, therefore, the concept of 'One Planet Living' is proposed towards a user-centred theory of the built environment (see Vischer 2008), categorised as the following ten guiding principles: Zero Carbon; Zero Waste; Sustainable Transport; Sustainable Materials; Local and Sustainable Food; Sustainable Water; Natural Habitats and Wildlife; Culture and Heritage; Equity and Fair Trade; Health and Happiness (WWF 2006a). It is a joint initiative between World Wildlife Fund (WWF) and BioRegional. The first five principles relate to the main categories used in ecological footprint analysis, while the remaining five are relatively 'softer' regarding water, biodiversity and social issues (BioRegional 2006, WWF 2006a). To a great extent, the idea of lifestyle change towards One Planet Living can engage people to re-evaluate everything they do with a broader public purpose in mind and from a relatively longer-term perspective.

Back to the case study of BedZED. It can be found that a holistic and thorough approach to sustainable living (ZEDlife) is designed for the future residents before the buildings are constructed. This alternative lifestyle does not require any intrinsic sacrifice to future resident's existing lives. In contrast, it demonstrates a more environmentally friendly way of living where, with more options available to reduce the collective environmental impact, it becomes possible for people to achieve carbon neutral and zero emissions in their everyday lives. Compared with conventional lifestyles, however, some attitudes and behaviour changes will be inevitable, such as 'don't spend a fortune on expensive cars – simply borrow one when need; use energy efficiently and reduce the unnecessary energy consumption; don't have to eat organic vegetables flown in from the other side of the world; etc.' (BDa 2003). Moreover, to sustain a good quality of life for future generations, all competing parameters that shape peoples' daily lives, including not only energy efficient buildings but also transport and foodmiles[xvii] are integrated from an architectural outset. Actually, the strategy of enacting an alternative lifestyle is extremely important to implement sustainability principles as it is the residents' personal attentions, to a great extent, that decide whether they would like to be part of the problems or the solutions.

In BedZED, although lifestyle transition is enabled on site, post-occupancy monitoring is carried out to examine its performance in use and how much the residents are likely to adapt their daily behaviour to fit the alternative lifestyle. As stated before, only when the residents

[xvii] The term 'food/goods miles' has been used here to imply the transport for food or goods in our everyday lives and some consequent environmental issues potentially related to it, such as energy consumption and CO_2 emissions during the food and goods transport. For example, '"natural" market forces and local food sourcing would seem to be more logical because, as Jones (2002) deduces, supplying one kilogram of apples from New Zealand to a home in Britain consumes 17.75 mega joules of energy in crude oil equivalent, while causing emissions of 609 grams of CO_2. At the same time British farmers have been discouraged from apple production by EU grants to "grub-up" orchards. This raises the question of imposing eco-labelling regimes on the supermarkets.' (Pincombe 2005)

adopt a living perspective of ZEDlife, can the local ecological footprint be reduced to the ideal of one planet (see Figure 2.4).

The viewpoint, lifestyle change towards One Planet Living, is supported by Al Gore, the former US Vice President and environmental campaigner. In the documentary *An Inconvenient Truth* (Gore 2006), he confronts today's environmental issues and their impact on civilisation. As a wake-up call, he notes that people must act now to save the earth. To persuade people to change their existing lifestyles and become part of the solution for carbon reduction, ten simple tips are provided. They are: 'change a light, drive less, recycle more, check you tires, use less hot water, avoid products with a lot of packaging, adjust your thermostat, plant a tree, turn off electronic devices, and be a part of the solution' (Gore 2006). His individual efforts to build up and disseminate knowledge about man-made climate change also helped him win an Oscar and recently share the Nobel Peace Price in 2007 with the UN's Intergovernmental Panel on Climate Change (IPCC) (BBC 2007d).

Thus, the essential success of BedZED will rely heavily on the occupants' 'consciousness' and 'awareness'. In other words, to achieve the objective of One Planet Living, it is proposed that all stakeholders, especially those typically with little specialist knowledge, are associated together in a positive way at the initial stage of design.

- ***A Socio-technical Perspective***

From the case study of BedZED above, it can be found that the two approaches of sustainable housing design, technical potentials and their social context, are never supposed to be applied separately. On the contrary, as two sides of the same coin, they should supplement each other in collaborative design processes and together contribute to a synthesis with both sociological and technical perspectives (Rohracher 2001, Shipworth 2005). This socio-technical perspective becomes the researcher's main attitude towards sustainable design and it goes through the entire research design processes.

Most early socio-technical studies are related to certain types of policy instruments that intend to develop an understandable language and conceptual framework to analyse processes of system-building, interactions between stakeholders in the networks, or controversies of relevant social groups (Rohracher 2001). The benefits are bidirectional. To stakeholders with professional knowledge, these measures can help them improve their understanding of the innovation of sustainable design, provide tools and concepts for analysis, inform programmes to promote certain technologies and provide tools to evaluate them. To stakeholders typically with little specialist knowledge, they would also feel more content when being required to change their daily behaviour towards sustainability since they are involved in the decision-making program in a positive way (Rohracher 2001, Leaman and Bordass 2007: 665).

A more focused discussion related to this subject is raised in later chapters, where a comparison between the varying options from different stakeholders is carried out based on a policy/standard-oriented communication platform, the BREEAM EcoHomes (the prototype of *the Code for Sustainable Homes*). Yet before that, it is important to have a brief idea about the interrelationship between different stakeholder groups in the design processes. This, leading to the main research hypothesis, is reviewed in the following sections.

2.5 REVIEW OF DESIGN PROCESS

As argued in Section 2.3, sustainability is acknowledged as an anthropocentric concept from its outset and only humans can decide what sustainable values are in social, ethical and cultural aspects (Farmer 1996: 185, Flanagan *et al.* 1998: 9). Hence it becomes vital that everyone in the vast campaigns of 'education, debate, and public participation' (Bruntland 1987: xiv) has a proper system for value judgement. However, as Pitts (2004: 4) points out, in today's modern societies, there seems to be a great tendency that people focus on *rights* rather than *responsibilities* and pay attention to *price* rather than *value* in their daily lives. As a result, although many scholars realise that sustainable design can only be fully assessed, optimised and promoted with the adoption of holistic and reasoned approaches, there are only few attempts, which lead to fragments of the prospective integrated processes (ibid: 4).

To address sustainable design issues and opportunities, Mendler and Odell (2000: 3) suggest that architects need two vital things: 'a greater base of information to inform the decision-making', and 'a revised and expanded design process'. A deeper understanding of the myriad interactions can help architects find out opportunities for improvement. On the other hand, to achieve the objective fully, a more inclusive and rigorous design process can be helpful to pursue integrated design solutions (ibid: 3). This research, nevertheless, emphasises that these two approaches cannot be addressed individually. In contrast, to fully realise sustainability principles, they need to be carried out at the same time. This means that the basic information leading to the decision-making has to be shared and accepted furthest by different stakeholders in collaborative design processes, rather than by the architects group alone. It asks for a communication-oriented multi-disciplinary collaboration between all participants.

However, this cannot easily be achieved in practice. As mentioned earlier (see 2.4.2), although architects try to convert their linear design to cyclical ones processes (Mendler and Odell 2000: 17; Lotspeich *et al.* 2003, cited in Kaatz *et al.* 2005: 447), many components may be really out of their professional control. No matter how hard they try to advocate holistic decision-making systems, results coming out from practices always seem to be vague or incompatible, compared with their 'deliberate' perspectives (Roaf *et al.* 2004). Clearly there must be some hidden causes! To understand this inconsistency better, a study of the design processes is carried out in the following sections, mainly focusing on the interrelationships between different stakeholder groups in the design decision-making processes.

Based on a wide spectrum of literature review and empirical studies, Lawson (1997: 121-127, 2004) argues that design processes, design problems and design solutions can be endowed with some general characteristics,, as shown in Table 2.1. Since these features can be comparably applied to building design processes, they should be buried in mind as they provide a general picture for the follow-up discussions.

Table 2.1: Essential Characteristics of Design *Source: Lawson 1997, 2004*

Design problems	• Design problems cannot be comprehensively stated • Design problems require subjective interpretation • Design problems tend to be organised hierarchically
Design solutions	• There are an inexhaustible number of different solutions • There are no optimal solutions to design problems • Design solutions are often holistic responses • Design solutions are a contribution to knowledge • Design solutions are parts of other design problems
Design processes	• The process is endless • There is no infallibly correct process • The process involves finding as well as solving problems • Design inevitably involves subjective value judgement • Design is a prescriptive activity • Designers work in the context of a need for action

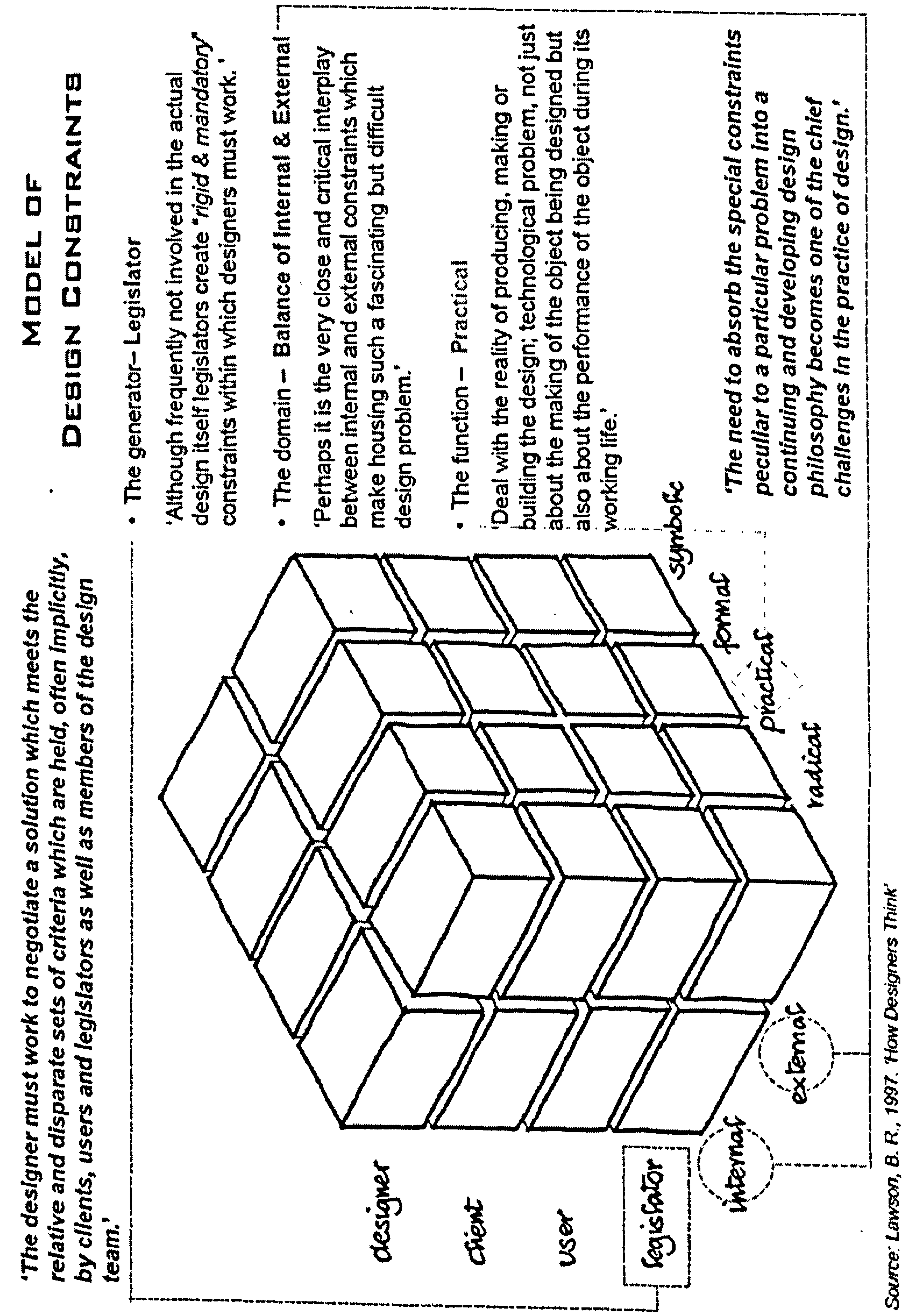

Figure 2.5: Model of Design Constraints (Sources: Lawson 1997: 107)

2.5.1 STAKEHOLDERS (GENERATORS OF CONSTRAINTS) IN DESIGN PROCESSES

As argued by Lawson (1997, 2004), design can be described as a transfer between areas of knowledge bearing on a particular project, aiming for consensus of problem solving. In this research, domestic buildings are identified as the principal boundaries and problems in the design process are expected to be solved based on sustainability principles. Further, the stakeholders, who are supposed to be responsible for bringing their knowledge in, include ***clients***, ***users***, ***designers*** and other members from the design team, ***legislators*** and those with influence and power over what is possibly or eventually done (are shown in Figure 2.5). Although, at times, their roles may be switched or combined in some cases, this research concentrates on a typical but simplified design process, in which these four elements coexist at the same time and act respectively. Design process can then be portrayed as interactions between these four essential member-groups who have various knowledge background and diverse motives or power for the eventual decision-making. It is generally acknowledged that the more harmoniously they communicate with each other, the more deliberate design process can be carried out.

To understand the interrelations between different stakeholder groups more precisely, roles of the generators of constraints are interpreted in the following sections, one by one firstly.

- It is still very arguable whether the *Legislator Group* should be included in such a dynamic decision-making process since it is perhaps the most remote from the other groups. However, although legislators are rarely involved in the actual design process directly, they do establish strict boundaries within which other stakeholders have to work. Such constraints, including legislation and control, ranging 'from standards and codes of practice to guidelines and recommendations', often already exist even before the design starts (Lawson 1997: 89). They are tailored to regulate design to achieve certain objects, but not unnecessarily to restrict future designers (Lawson 2004). Obviously this deliberate thought requires a huge amount of knowledge about design as well as much correlative experience, which could provide the legislators with both sensible and rational senses. Sadly, as argued by Lawson (2004), few legislators actually possess this background. In terms of practice, this knowledge gap between what the legislators have and what they should have may lead to significant problems in setting building sustainability criteria. As argued by Meacham *et al.* (2005: 93), 'a disconnect was observed between standards, performance criteria and verification methods referenced by regulations and the qualitative performance or functional objectives found within the regulations'. Further, since sustainability issues often rise interdependently, they can be addressed from different perspectives based on the live project's particular circumstances and none of them is supposed to be pursued above others. To achieve a better result, therefore, it is important to share the related information widely between different stakeholders in the decision-making process instead of letting the regulators enjoy them autocratically. In this research, some existing sustainability regulations (e.g. EcoHomes, the Code for Sustainable Homes, etc.) are analysed and discussed in Chapter 4. However, since the concept of sustainability focuses on what is really desirable rather than what can easily be measured, this focus discussion aims to construct an effective communication platform, based on which all related items can be formulated, rather than paying attention to the fixed criteria.

- As argued by Lawson (1997, 2004), the *Client Group* holds an important position in the decision-making process. Usually clients bring a design commission to the design process at its very beginning. However, since they are unable to 'solve the problem', or probably 'fully understand it without help' sometimes, initial briefs generated and expressed by clients may be ill-defined (Lawson 1997: 84). That is exactly why Eva Jiricna complains, 'We never, ever get a brief from the client which we can start working on' (cited in Lawson 1994: 50). Interestingly, however, this is not because the briefs coming from clients are vague. In contrast, they are often too specific. Thus some architects, for instance Michael Wilford and Ken Yeang, suggest that briefs from clients be concentrated on 'strategic requirements' rather than 'schedules of accommodation', especially at the outset of the project (cited in Lawson 2004). Likewise, some scholars, such as Richard Burton, further this idea and imply that the design brief should also be taken as a continuous process, which could keep refining itself along with the design process (Lawson 1994: 12). In this research, sustainability seems to be a good design brief as its principles are still vague and contentious. However, since most clients or developers truly look forward to the profits, few of them are interested in investing time and money in sustainable design even though it yields demonstrable benefits (Melet *ed.* 1999: 9). For them, the risk of applying innovative technical add-ons is certain, but the long-term benefits are not. In many cases, therefore, sustainability is taken as an alluring notion by clients or developers rather than effective actions, where the economical growth has been highlighted imperatively as a single brief (Farmer 1996: 180). To avoid improper implementations of sustainability principles, clients' or developers' partial understanding of sustainability issues cautiously deserves more attentions during the knowledge transfer processes.

- The *User Group* is a very special 'puny colony' in the architectural design process (Lawson 1997). Although everyday users occupy and use the finished product, few of them are involved in the decision-making process in person. Unlike legislators who can influence the design process by enacting or revising regulations, building users or occupants can rarely do anything but 'enjoy' the fixed setting, regardless whether it fits their requirements rightly or not. Although some scholars argue that, as consumers, users can select future developments through 'either actions of the free market or governmental intervention of the carrot and stick variety' (Farmer 1996: 180), it is still questionable whether this perspective would be truly effective in terms of practice, especially in current housing market. To a great extent, today's users' group is the weakest link in the design process, getting remote from other stakeholders. However, as mentioned earlier, in order to close the loop, the building's post-occupancy phase should also be considered as an important part of the holistic design process (Roaf *et al.* 2004: 12). There is no doubt that, when evaluating the building's performance in use, building users play a dominant role than any other stakeholders. Actually, as pointed out by Hill (1998: 3), the term 'user' is more appropriate than occupant, occupier or inhabitant because it implies 'both positive action and the potential for misuse'. To achieve the integrated objective of sustainability, therefore, it is appreciated to involve users' knowledge in the design process at the very beginning rather than leaving them any possibilities of random misuse in the end.

- Compared with the other three stakeholder groups, the *Designer Group* normally plays a dominant role in the design process. As argued by Lawson (1997: 87), designers are expected not just to solve problems but also to bring their specific perceptions and creative concerns into the design process. In other words, the benefits that designers seek from the design process are not just economic profits which are necessary, but also realisation of their personal values – keeping up their positions with dignity by cherishing a good reputation (Vitruvius Pollio: 8). Obviously to achieve this objective, designers have to be equipped with 'knowledge of many branches of study and varied kinds of learning' as it is by their judgment that all work is done and then put to test (ibid: 5). However, since the very essence of designers' job is to create the future, or at least some features of it, it is easier for designers, with the benefit of hindsight, to see design failures than anticipating possible flaws and then figuring them out in the foregone design process (Lawson 1997: 113). To minimise shortcomings in the 'faulty' design process, designers are required to work together with other stakeholders in the decision-making process and share their knowledge in an effective way. As a catalyst, the concept of sustainable design encourages a more collaborative knowledge transfer, which can be taken as not only a good opportunity but also a big challenge.

As concluded by Lawson (1997: 91-92), 'the legislators demand is fixed, the users may well not be around to be consulted, the client may adjust priorities as the design implications unfold and the designer may think of a new set of constraints altogether'. The four principal stakeholder groups are presented but it is important to note that they do not exist independently. On the contrary, it is their interdependent interactions that constitute the complicated but interesting design processes.

2.5.2 INTERACTIONS BETWEEN DIFFERENT STAKEHOLDERS

To better understand the decision-making procedure, it is important to identify different contributions to the problems made by each of the major generators of constraints (Lawson 1997: 91). Interrelations between these four groups of stakeholders are discussed in the following sections with a focus on their influence on the design decision-making processes. As argued by Sidaway (2005: 36),

> 'Conflicts are both multi-dimensional and dynamic. Indeed, in seemingly similar situations, examples can be found of both cooperation and conflict, when the issues are the same but the differences lie in the relationships, or lack of them, between the interest groups.'

- As mentioned before, although legislators set the constraints within which other stakeholders have to work, they only communicate indirectly with other stakeholders at intervals throughout the design processes. Nevertheless, unlike any conventional design objective, sustainability requires the knowledge transfer between different stakeholder groups to be not only flexible but also frequent. Therefore, either legislators' poor understanding of this principle or their limited experience in likely approaches may lead the decision-making process out of their control in terms of practice. In other words, due to its special characteristics in knowledge transfer, the Legislator Group is taken as an *independent variable* in the decision-making process which sets the platform based on which communication between other stakeholders is proceeded.

- The client-designer interrelationship is sometimes described as employment due to their direct economical affiliation. Based on the contract, clients and designers are always tightly banded together during the design process, aiming for consensus of design commission. This provides a compulsory circumstance to facilitate knowledge transfer. Some scholars argue that there is an inherent tension between clients and designers since both of them are dependent of each other while, in their own ways, both are also anxious of the other exerting too much control (Lawson 1997: 88). However, as Lawson (1997: 85) points out, the constraints between these two dependent variables can frequently be solved creatively through an ideal interaction or enhanced communication.

- Interrelationship between clients and users can be illuminated in a similar way as the one between clients and designers, though their economical affiliation is not that straightforward. To seek more profits through the free market, intelligent and capable clients often carry out a market survey before making any further decisions. Although this kind of investigation is normally designed for potential purchasers, the results mainly come from their peer views – current occupant group. Since this procedure aims to help clients understand marketing orientation, opinions from users may more or less contribute to the design brief later. In other words, marketing research provides a general platform for knowledge transfer between clients and users. However, there is a bias in their interactions in that clients are always in a dominant position while, in contrast, users have few choices. Due to this bias, it becomes necessary to enable more effective and fair communication between these two dependent variables.

- Communication between designers and users is both indirect and weak. As mentioned earlier, generally knowledge transfer between these two stakeholder groups can only be carried out through clients. However, as a dependent variable, clients themselves are also involved in this knowledge transfer process and likewise, they have their own standpoints for this communication. Thus it is questionable whether clients could guide the knowledge transfer between designers and users faithfully or to a way in favour of themselves. Moreover, since clients actually work on behalf of other dependent, nobody can guarantee knowledge transferred from them would be accurate and in time. Therefore, it is suggested that a third party be introduced into this knowledge transfer procedure as a medium, which aims to ensure justice for symbiosis. However, this is difficult to carry out in practice and often creates unintended results. As Page points out, interaction between designers and users is filtered by organisational politics, through which 'people barriers' are erected to prevent too much disruptive users' feedback reaching designers (Page 1972, cited in Lawson 1997: 85). For instance, local authorities, like politicians or administrators, may attempt to replace the Client Group and establish themselves as the communication channel between designers and users in discussions regarding sustainable design. However, rather than ensuring a faithful knowledge transfer between designers and users, this procedure largely aims to help the authorities force through policy or maintain a powerful position in the system (Lawson 1997: 85). Obviously, no matter who is working as the mediator, be it sympathetic and motivated clients or powerful and candid authorities, this kind of indirect interaction always leads to increased remoteness – a gap between designers and those whom they design for. Sadly, in a recent empirical study, Cairns not only demonstrates the existence of the gap in architectural design, but also implies that neither architects nor users are always aware of them (Cairns 1996, cited in Lawson 1997: 86). This makes the communication between them become even more difficult (see Figure 2.6).

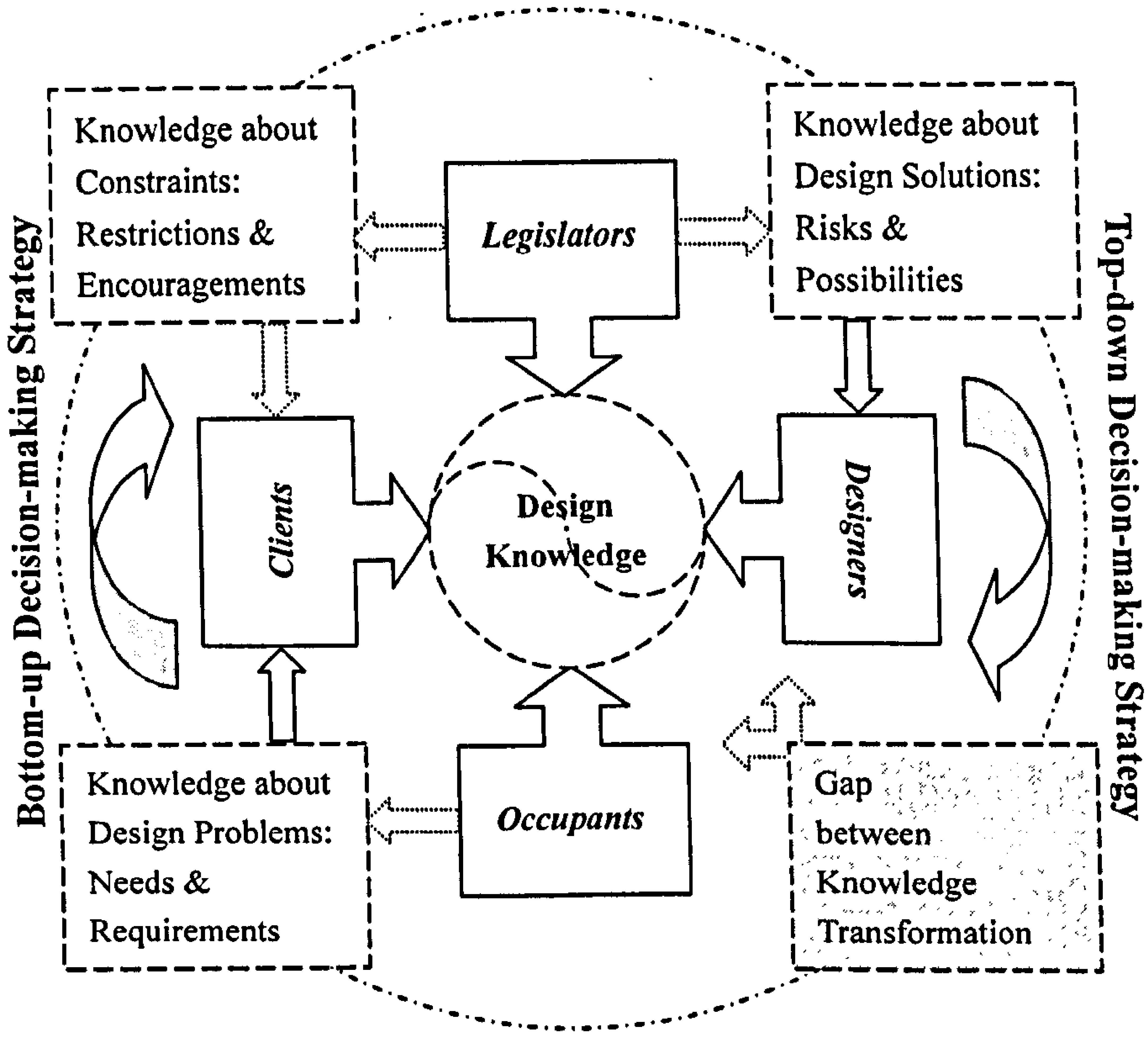

Figure 2.6: Design as a process of knowledge transfer between different stakeholder groups (legislators, clients, designers and occupants)

Although some other stakeholders, such as manufacturers, constructors, contractors, and other specialists, may also influence quality of the final buildings, they are not discussed here as this research focuses on the simplified design processes. It is proposed that the communication gaps between these four stakeholders result in major barriers for knowledge transfer in the decision-making processes (also see Sayce *et al.* 2007). Gap between designers and users probably results in the unsatisfactory outcome during the operational phase of house occupation. This view is further explored in the following sections, which contributes to the principal hypothesis of this research.

2.6 RESEARCH HYPOTHESIS

Housing design processes used to be formulised mainly based on vernacular culture or the conventional procurement routes when living environment is comparatively stable and moderate. Under this circumstance, knowledge gaps between different stakeholder groups in the design processes are concealed in some senses. However, with rapid technological development, today's society is changing rapidly and some scholars even argue that 'designed technology is now one of the most significant aspects of contemporary social order' (Lawson 1997: 114). The tendency for rapid changes also influences conventional housing design processes, broadening the cognitive gaps between different stakeholder groups, especially those between designers and users, and making the communication problems arising in the decision-making processes explicit. On one hand, architects have much more freedom for their creative behaviours, which may allow them to become subconsciously overconfident about their professional knowledge and make it difficult to communicate with other stakeholders in the design processes. On the other hand, users have more satisfactory living conditions yet, as the general public has little or no specialist knowledge, their opinions about lifestyle changes or sustainable living issues become less influential on housing design processes.

However, since energy consumed and carbon dioxide emitted during the operational phase of house occupation are far more than those in procurement phase, housing users have an imperative responsibility for energy saving and carbon reductions. In fact, it is proposed that **communication gaps in knowledge transfer may lead to an unsatisfactory outcome during the operational phase of house occupation, unless**

- **Preferences/understanding of sustainability issues, especially those related to energy saving and carbon reductions, between architects and occupants are identical or one group could completely satisfy the other; or**

- **One of the groups is likely to adjust its priorities according to the other's voluntarily, or one of them could successfully educate the other into more genuinely collaborative roles.**

To verify this hypothesis, an early investigation and some empirical studies are carried out prior to commencing the major research work.

2.6.1 AN EARLY INVESTIGATION

This early study is an investigation conducted in the housing market of Shanghai, China. It is originally designed to analyse the feasibility of enacting zero energy/emissions housing development in China. However, the primary results show some interesting but unanticipated findings.

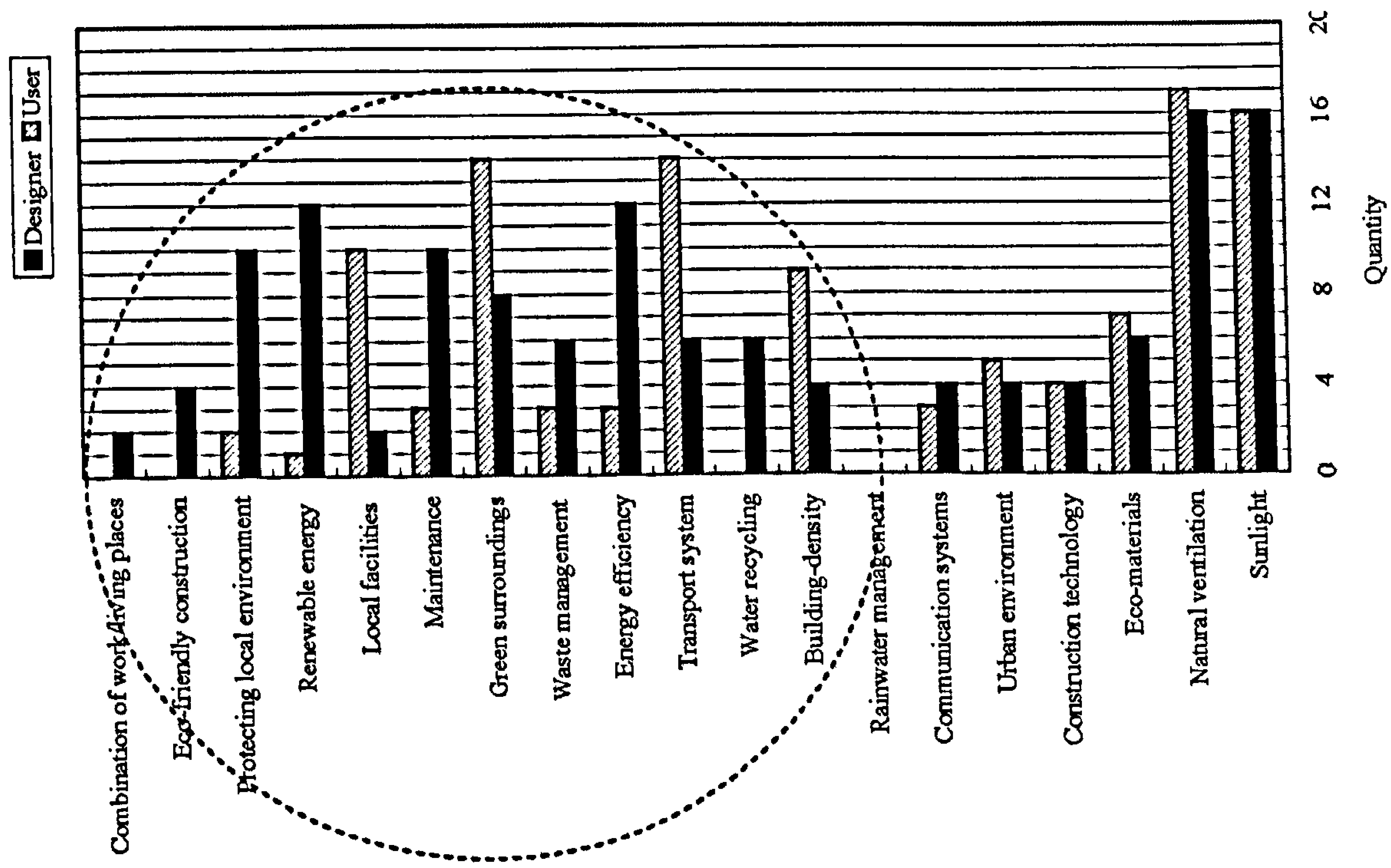

Figure 2.7: Preference of main features for sustainable housing by designers and users: *significant cognitive difference* for issues in the dashed circle (Data source: Chen 2004)

As shown in Figure 2.7, although there is a general agreement on sustainability principles between designers and housing occupants, their priorities for some major issues are significantly different (as shown in the dashed circle). In other words, although both are required to change their attitudes towards sustainability, designers' intentions for possible design measures do not match up with occupants' potential concerns about their daily lifestyle change – their preferences are not identical. Since this difference is led by various cognitive styles of different stakeholders, where gaps always exist considering their widely differing backgrounds and intrinsic motives in the housing market, it is believed that a similar situation also exists in the UK comparably. Moreover, from this early study, it can be found that neither of these stakeholder groups is completely satisfied with the other's contributions to the current housing market (for details, see Chen 2004).

To achieve a better outcome, it is important to reach a shared understanding between different stakeholders. This will only happen if the message lying behind design could be delivered to its intended audience well. Certainly the message (purposes of sustainable design and principles of sustainable lifestyle) itself must be understood and accepted by all stakeholders first.

2.6.2 EMPIRICAL STUDIES

Since preferences of sustainability issues between housing designers and users are not identical (although data from the early investigation in China is not sufficient to make a statistical analysis, the tendency is obvious), some empirical studies are then carried out to verify whether one group is likely to adjust its priorities according to the other's voluntarily, or whether one could successfully educate the other into more genuinely collaborative roles. Unfortunately, however, this objective is also difficult to achieve in practice.

- *Architects – professionals*

On one hand, the term 'architecture' has no legal protection as 'architect' does. Thus, architects often try to maintain their elevated status in practice by 'jealously guarding a specialised area of knowledge which they alone are in a position to define and thereby control' (Till 1996, cited in Parnell 203b: 58). To define the boundaries beyond which the public may not step in, the architectural profession uses its own 'language' and sometimes even develops its own 'taste' (Parnell 2003b: 58-59, Lawson 2001). Take sustainable architecture as an example. Some architects argue that sustainability should only be handed to those who fully understand this term and possess the professional skills to implement it (see Chen and Pitts 2005). In other words, architects, to a great extent, still prefer to be 'on top' rather than 'on tap' in the design processes (Carley and Spapens 1998, cited in Layard *et al.* 2001: 56). As Stansfield Smith Report points out,

> '[This tendency encourages] the view that architectural discourse is inherently esoteric and limited in use for communication, thus isolating architecture from the public and admonishing the vitality of the discourse itself.' (Sara 2001: 2)

Lack of communication may lead to misunderstanding, which then breeds distrust at times, for different stakeholders in the decision-making processes. Because of the absence of communication, the relationships between architects and other stakeholders tend to break down. In terms of practice, therefore, architects always resist two intrusions: 'one into the body of their profession, and the other into the body of their architecture' (Hill 1998: Preface). From this perspective, it seems sensible why people with little specialist knowledge might arrive at a negative view of the professionals. As a result of the vicious circle, architects are then described by people as 'arrogant, poor listeners' and their education has also been blamed (Sara 2001: 2).

- *Housing Occupants – with little specialist knowledge*

On the other hand, as architecture itself becomes 'increasingly specialized and divided', the common base on which designers and users interact becomes eroded (Vale 1991a: 7). In practice, building users are often excluded from the decision-making processes and their opinions also become less influential. However, if they cannot acknowledge building design features, especially those sustainability characteristics addressed by architects in this case, the fault is attributed to their own education or poor understanding. Perhaps this is the main reason 'why ordinary people sometimes feel a little intimidated by professional designers' (Lawson 1997: 263).

As a result, house occupants often spend time and money in the operational phase of house occupation without gaining any functional benefit, but purely to identify and individualise their homes. This re-design action is seen as an insult to the original design by some alleged creative, professional architects. Yet to the occupants, it forms a part of the process of creating 'a sense of belonging' (Lawson 1997: 262) and represents 'the basic human desire to exercise control over the making of one's environment' (Grindley 1972: 9, cited in Kaatz *et al.* 2005: 444). As Herzberger points out (Herzberger 1971, cited in Lawson 1997: 260),

> 'Everyone is doomed to be the one he wants to be seen by the others: that is the price the individual pays to society in order to remain an insider, by which he is simultaneously possessor of and possessed by a collective pattern of behaviour. Even if people built their houses themselves, they could not escape from this, but instead of having to accept the fact that there is only one place to put the dining table, every one would at least be enabled to interpret the collective pattern in his own personal way.'

Obviously the main source of users' satisfaction is not so much about the degree to which their needs have been met but the feeling of having contributed to the decisions and self realisation through this influence (Sanoff 1990: 1). Since these householders are often excluded from the housing design processes in person, it seems reasonable why they expect and seek to express their self-identity through their preferred living manners in the operational phase of house occupation. In addition, the more coherent their lifestyle is, the more credible their identity becomes (Parnell 2003a: 95).

- *Collaborative decision-making processes*

As there is a lack of communication between architects and housing users, their individual requirements for sustainability cannot be completely satisfied. Moreover, they are unlikely to change their priorities to accommodate the other's requirements. On the contrary, both of them tend to be anxious of exerting their control in different phases of housing development – architects in the housing design processes and residents in the housing occupying processes. This, however, might lead to significant problems.

On one hand, following rapid social development, today's design circumstance is more uncertain to architects. Thus, solutions provided by these designers, who perhaps do not properly understand the whole problem, might prove to be wrong. On the other hand, for housing occupants, especially those with little specialist knowledge, their concerns about lifestyle are derived from dynamic aspirations and can sometimes be ill-defined (Jerome 2001: 365). For them, environmental considerations could also become lost in a whole wish list of broader concerns (Layard *et al.* 2001: 12).

To minimise the conflicts mentioned above, a more collaborative decision-making procedure is suggested, considering the increasingly democratic progresses in present social and political climate (Till 1996). As argued by Kaatz *et al.* (2005: 445), arguably, the implementation of a collaborative approach in the building process is validated 'not only in terms of satisfying the aspects of equity and fairness, but also by the necessity to develop critical awareness within the society about responsible lifestyles and choices.'

Sustainable housing design still requires residents to change their conventional lifestyles during the operational phase of house occupation and always be aware of energy use, carbon reduction and other relevant issues. Hence it makes no sense if these ultimate users are excluded from the decision-making processes. Kaatz *et al.* (2005: 443) suggest that collaborative approaches may shape public perception of the possible issues related to sustainability and increase their willingness to take a responsible action over individual interests. To get the message across, therefore, the collaborative design process needs to involve not only housing designers and users but also other relevant stakeholders. In the case study of BedZED, it can be found that the project is the result of coordinated efforts from all participants, even the local authority. The Peabody Trust and BioRegional (the co-developers of BedZED) received the tenure, though they did not bid the highest price, because Sutton Borough Council judged they could provide the best value to local development with their sustainability proposal, although not all benefits of ZED development could be calculated. This is one of the first occasions in which a UK local authority accepts sustainability benefits as additional value (BioRegional 2002).

Through the impartial collaborative decision-making processes, varying perspectives from different stakeholder groups may be integrated to create a united solution, and stakeholders themselves should also be re-educated into more genuinely cooperative roles. To achieve this objective, a variety of trans-disciplinary education programmes are proposed to facilitate the transfer of relevant knowledge and allow key stakeholders to make informed decisions. First and foremost, an open communication platform needs to be established, based on which views, perceptions, interests, values and needs of different interested and affected parties (stakeholder groups) can be integrated into project decision-making. This communication platform needs to emphasize the cross-currents between housing design, theory and use. More focus discussion related to this point, how to broaden participation through a modified building sustainability assessment (also see Kaatz *et al.* 2005), will be carried out in Chapter 4. In the following sections, the architect's role in collaborative decision-making processes is discussed.

2.7 MAIN RESEARCH SCENARIO & QUESTIONS:

Lack of communication among different stakeholders in the housing design processes and its serious consequences are addressed in some recent research work, such as Roaf *et al.* (2004), Shipworth (2005) and so on. However, due to the separation between research and design (see Figure 1.1), it is still questionable that, in terms of design procedure, whether architects, or architectural students, realise the importance of trans-disciplinary knowledge transfer and are likely to take more responsibility for collaboration. In the following sections, the architect's role in sustainable housing design processes is discussed, which leads to the main research scenario and the sub-question: if there are cognitive gaps (priority variances), what are the most significant ones?

2.7.1 ARCHITECT'S ROLE IN COLLABORATIVE DESIGN PROCESSES

As argued above, many architectural researchers realise the problem in the design processes and suggest that architecture should act as the relation between an object and its occupants (Hill 1998: Preface). As Markus (1972, cited in Lawson 1997: 26) points out, there are generally three broad views which designers today might hold in social development. All of them are inevitably linked to the direction in which society should go in future (ibid: 26-28).

- The first role is essential conservation where designers remain isolated with other design elements. In this role architects always respond to the problems coming from the design process passively. Thus, when the conventional role of architects is threatened by any procedural change, like setting sustainability as the ultimate objective in this case, architects may either seek to redefine themselves as leaders of a multi-professional team or fall back into the earlier territory of aesthetic and functional designers.

- The second role is completely opposite to the conservative one. In this revolutionary approach, architects would like to associate with users directly, which may result in the termination of professionalism. Moreover, since architects no longer see themselves as leaders but as campaigners or spokespeople, they deliberately abandon their independence and power in the design processes. Although this activity can be seen as embodiment of democracy, the designers lose all influence over others except by the power of example. This results in significant difficulty in decision-making processes since the collective members are unlikely to control any resources valued outside their limited societies.

- The third one lies between these two extremes. In this vague role, designers retain their professional status but try to involve users in the design processes. This approach may include a whole range of relatively new design techniques, such as public inquiry through game or survey, simulation through computer-aided design and so on. As argued by Lawson (1997: 28), all these techniques embody 'an attempt on the designers' part to identify the crucial aspects of the problem, make them explicit, and suggest alternative action' for comment by the non-professional participants. Designers following this approach are likely to abandon the traditional idea that individual designers are dominant in the design processes. Rather, as active facilitators of the design processes, they should have some specialised decision-making skills to offer (multi-dimensional rather than purely technical).

It is argued that the third role is the one today's architects should adopt. However, the practical circumstance is not that optimistic. Few housing designers are likely to accept their alternative role or take new responsibility in the design processes. On the contrary, to achieve an impact on the solution as a whole, architects firmly hold the power to select the aspects of the problem he or she wishes to consider in order, and are often distinctly 'defensive' about their solutions and 'possessive' about their preferences (Lawson 1997: 126). To a great extent, it is the architects' personal subjective value judgement that decides the ultimate solutions as well as the problems they would like to consider in the design processes. In other words, although it is important to make the designers' decisions and value judgements more explicit and allow other stakeholders to participate in the decision-making processes, decisions made in the design processes are often an embodiment of architects' personal characteristics. As argued earlier (see 2.6.2), since architects use these personalities to identify themselves in their professional domain, it is obviously very difficult for them to give up their vested interests or voluntarily change them, even in a stakeholder-oriented collaborative decision-making process.

In summary, decision-making in housing design processes becomes an individual call by architects who are unlikely to adjust their proprieties according to occupants or other stakeholders. Consciously or not, their partial choices among alternative options play a key role within the building sector, with a greater or lesser impact to future occupants' daily lives (Anink 1996: 8). Further, although it is widely acknowledged that sustainable practice should go beyond the minimums (i.e. Vale 1991b, Mendler and Odell 2000, Clarke 2009, etc.), few architects are likely to meet the minimal standards due to various constraints in practice, such as time, budget and so on. Thus, autocratic behaviour by these architects often leads to a serious enquiry – 'how could a few hours or days of effort on the part of a designer replace the result of centuries of adaptation and evolution embodied in the vernacular product?' (Lawson 1997: 25). In other words, it is very questionable whether the final outcome deriving from an architect's perspective *alone* could really meet all stakeholders' requirements, or achieve the ultimate intention of the design processes – a sustainable living manner.

To make informed choices, it is essential that these professionals have sufficient knowledge in sustainability issues and, at the same time, have insight into the relative impact of options available. To determine whether architects and architectural students are fully equipped with all relevant knowledge, architectural students are set as the main research scenario. Their attitudes on different design measures and alternative lifestyles are going to be discussed.

2.7.2 RESEARCH SCENARIO: ARCHITECTURAL STUDENTS & STUDENT VILLAGES

Although the original idea of this research is to study housing design processes towards sustainability, this scope is narrowed down as the research progresses. University students, especially those studying in relevant disciplines (i.e. Architecture, Landscape, Town and Regional Planning, etc.), are often considered the *key* people in the vast campaigns against climate change, and are accordingly put to the forefront of any related educations, debates or public participations. Since the built environment affects how people feel and perform (Talbot 2003, cited in Kaatz *et al.* 2005: 444) and may also reinforce people's consumptive lifestyles (Van Wyk 2004, cited in ibid: 444), Friedman argues (Lancaster University 2008: Foreword),

> 'The university campus and the physical environment in which the students are placed during the formative years of their adult lives can affect later years and

instil good citizenship practices. The UPP Eco Residences possess many of the attributes that support sustainable student living and it is hoped that students living in the accommodation will adopt sustainable living habits that will see them avoiding unnecessary consumption of resources. Living in a "healthy environment" and adopting appropriate lifestyles can be a long lasting lesson.'

Hence in this research, university students studying architecture or built environment related disciplines are selected as the focus group and their lifestyles in university student accommodation are accordingly taken as the main research scenario for further study. It is believed that student accommodation designed based on sustainable principles could demonstrate that academia can lead by example in the campaigns against climate change. Further, sustainable residences can also be regarded as part of the educational offering: 'by encouraging students to embrace and reside sustainably, the University will lead the way to creating better future citizens and a better planet' (Friedman, cited in Lancaster University 2008: Foreword).

As a special type of accommodation, student villages have not been fully explored in the approach to sustainable design as the vast majority of the artefacts are always created for particular groups of users. However, since these student houses, especially those located in the open campus[xviii], share many important design features with social housing, it is believed that some results from this study can be fed back into future housing environmental policy or relevant researches such as responsible property investment (RPI) criteria (see Sayce *et al.* 2007, Pivo 2008) and energy consumption in higher education institutions (HEIs) (see Ward *et al.* 2008).

Rather than the symbolic quality or the method of construction, it is 'the lives of those who live within the dwelling' that make it a suitable subject for study (Vale 1991a: 12). As shown in Figure 2.8, there are wide differences on electricity consumption observed from 2005 to 2007 in an identical student accommodation (the Mappin Court, a self-catering student accommodation at the University of Sheffield). Given the fact that student residents of Mappin Court change every year, it is believed that energy consumption in this student accommodation is closely related to the occupants' lifestyles. A similar situation may also apply to other student accommodation comparably. In order to save energy and reduce

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xviii The term 'open campus' means that there are no identified boundaries between the university campus and its located city – they are mixed together (e.g. University of Sheffield and Sheffield city). In this kind of city-located open campus, many students are actually living together with other citizens. Therefore, their preference for alternative living modes will be more valuable to study since their lifestyle runs alongside the general people.

carbon dioxide emissions in the operational phase of accommodation occupation, therefore, it is important to encourage student residents to change their lifestyles towards greater environmental sensitivity.

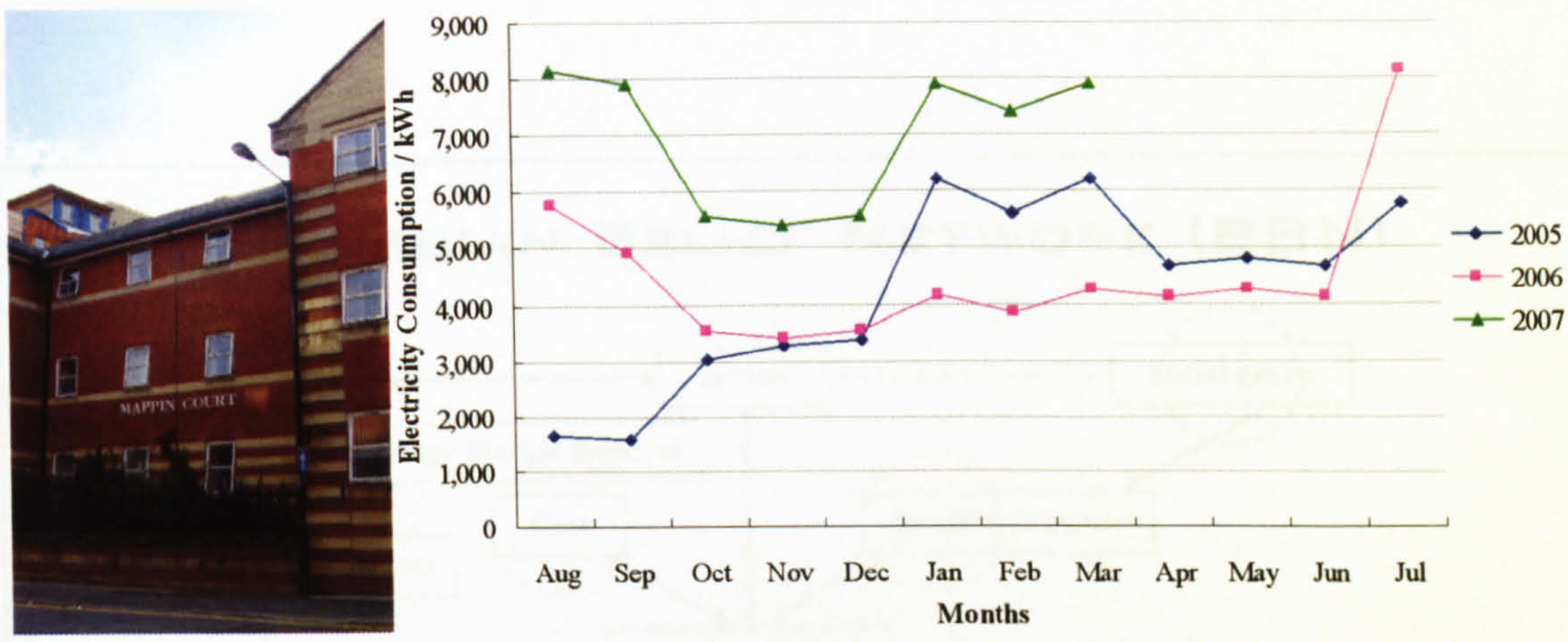

Figure 2.8: Monthly Electricity Consumption in the Mappin Court (Data source: Mr. PR – Energy Manager in the University of Sheffield)

Since university students in the Faculty of Architecture (subjects include Architecture, Landscape, Town and Regional Planning and so on) are always trained to be future decision makers in the way towards sustainable development, they are supposed to have more related knowledge than students in schools or students from other departments. Moreover, there are two potential advantages by setting these students and their living manners in university accommodation as the main research scenario:

First, these students constitute a specially focused group that represents a revised dualism, as current housing occupants and future housing designers, though affiliation between their two roles is also mutual dependent (Hill 1998: 3). Therefore, issues about designers' intention and occupants' awareness on sustainability issues (sustainable design and sustainable living) can be raised at the same time.

Second, since there are many varying human-related factors that jointly decide energy consumption and carbon emissions during the operational phase of house occupation (e.g. different issues addressed in the Bayesian Belief Network (BBN) by Carbon Reductions in Buildings (CaRB), as shown in Figure 2.9), analysis of their interrelationship can be too complicated for an independent research project. Therefore, it is helpful to set a particular social group (university students studying architecture or built environment related disciplines) as the main research scenario, so this research can focus on the question – whether current educational programmes have equipped future decision-makers with sufficient environmental knowledge and awareness. In other words, this procedure helps simplify the research variables.

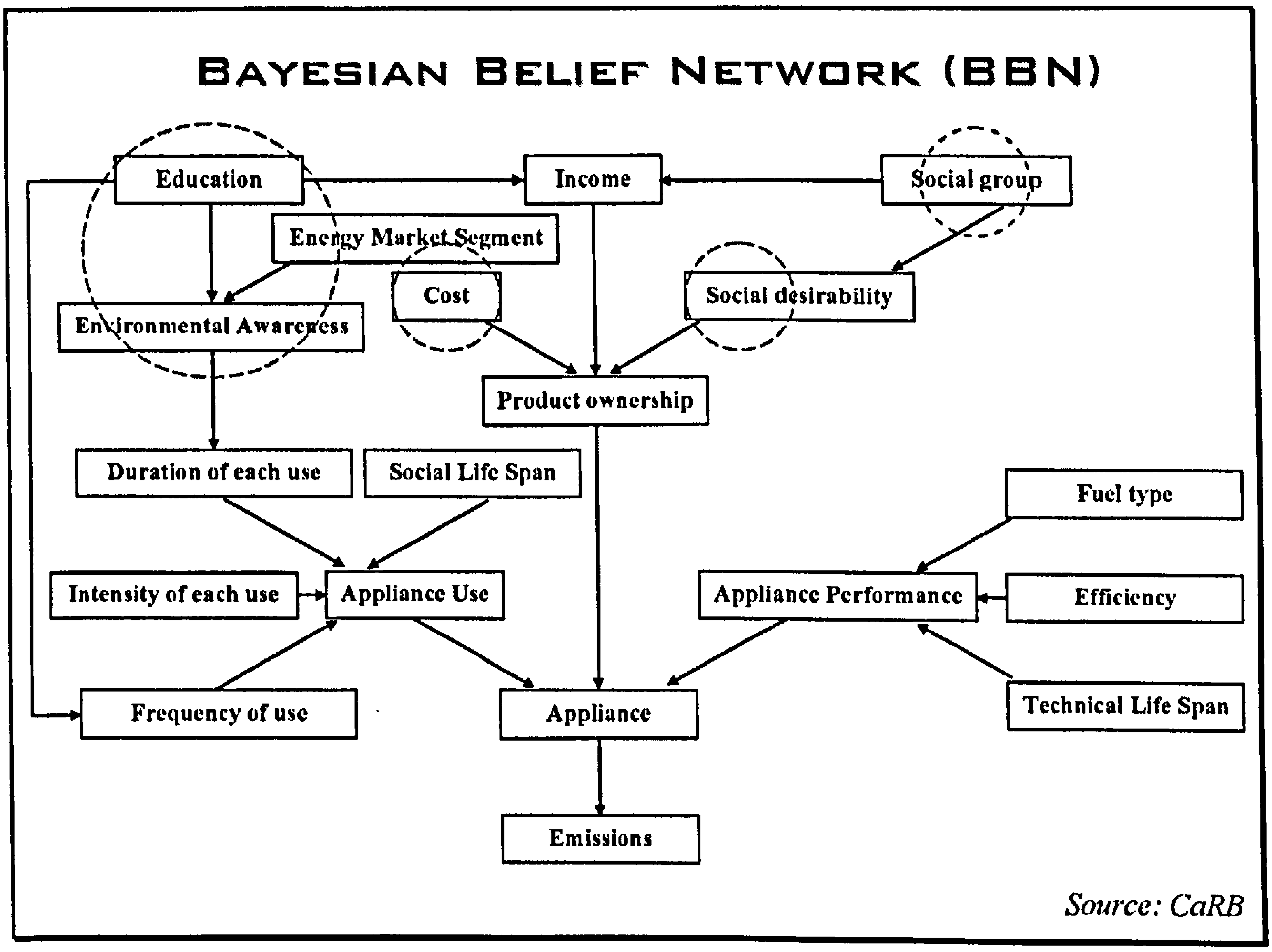

Figure 2.9: Proposed Bayesian Belief Network (BBN) model by CaRB (Shipworth 2005)

Although there are many factors that jointly decide the final energy consumption and carbon emissions during the operational phase of house occupation, this research simplify the variables by setting a particular social group (university students) as the main research scenario. The centre of gravity of this research can accordingly be focused on the interrelationship between education and peoples' environmental awareness. Actually, it is also important to note that 'education' and its effects over 'environmental awareness' and 'social desirability' have been addressed as important factors which contribute to the bottom line of this model. Therefore, it is worth duplicating this kind of investigation widely in different social groups in the future.

However, it has to be confronted that, although this focus scenario can be helpful to narrow down the research scope, it does create some limitations to this research work. Design issues for student accommodation are not completely the same as those for social housing. Hence the experience from this study needs to be re-validated before being applied to the housing market. Another reason why social housing is not identified as the main research scenario is that data from public residents are difficult to access (the researcher attempted to carry out the investigation among public residents, however, the response rate was very low – less than 10%). Further discussion related to research limitations can be found in Chapter 11.

2.7.3 RESEARCH QUESTION: WHAT IS THE SIGNIFICANT COGNITIVE GAP

As argued above, it is assumed that there is a significant cognitive difference on sustainability issues between architects and housing (student accommodation) occupants, which might lead to the considerable variation between designers' intention and building's performance-in-use. However, although many scholars (e.g. Hill 1998, Proops and Wilkinson 2000, Redclift 2000, Kaatz *et al.* 2005, Bakens *et al.* 2005, etc.) realise the importance of including ultimate users in the housing design processes, many local authorities admit freely that tapping into this resource is something 'easy words but difficult to do' (Roney 2005). Until now, householders still have little impact on the supply chain that delivers a building for their own use (Blutstein and Rodger 2001: 139). To address this kind of issues in the housing design processes and close the loop, some detailed study are being carried out, both experimental and experiential.

Some trans-disciplinary research work and relevant modelling processes are proposed towards this approach. For instance, in a recent discussion about influences on domestic energy consumption, a Bayesian Belief Networks[xix] model is constructed as a 'landscape' to examine knowledge synthesis across the 'social, economic and behavioural sciences' (Shipworth 2005: 1389). Imaginary models can be built based on the conceptual ideas, as shown in Figure 2.9 and Figure 2.10. As an assistant media, this 'live model' is proposed to be widely applied in future to analyse the interdependent socio-technical influences on home energy consumption, such as attitudes, social values, and inspirations and so on (Shipworth 2005). Moreover, this model also helps housing design programmes be developed towards

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[xix] 'Bayesian Belief Networks (BBNs) are an intuitive method for reasoning under uncertainty, combining different data types, and learning from new observations as they become available (Jensen 1999).' ... 'In Bayesian Methods: A social and behavioural science approach Gill (2002) lists advantages of Bayesian methods as including: the ability to learn as new information is received or population variables change; the capacity to systematically integrate a wide variety of data types and any prior available knowledge; overt and clear model assumptions and straightforward sensitivity testing.' ... 'The interest in applied Bayesian Belief Networks lies principally in their use as decision support systems. They offer the opportunity to capture expert knowledge in the field as well as structure this in a way that supports programme development and implementation. Their capacity to integrate data of varying quality and type, as well as synthesising relevant factors in social, economic, ecological and technical fields, makes them particularly useful in the complex socio-economic/socio-technical environments of sustainable development.' (Shipworth 2005: 1384-1385)

sustainability from the very start.

However, although it is the architects' responsibility to communicate what lies behind sustainable housing design and how occupants can best use it, it is still questionable whether architects, or architectural students, fully realise the difference between making design and living as general people by themselves, referring to the sustainability criteria. Furthermore, it is proposed that, as future experts, they should be educated to have a proper system for value judgement when considering different sustainability issues in the design processes, ideally according to the priority systems of compulsory regulations or assessment systems (such as the one used in EcoHomes or the Code for Sustainable Homes) (also see Fowles *et al.* 2003). This will facilitate the market transfer and help architects put their design products into practice, though it might not be sufficient to lead to sustainable building designs (see 4.6 and 5.3.1).

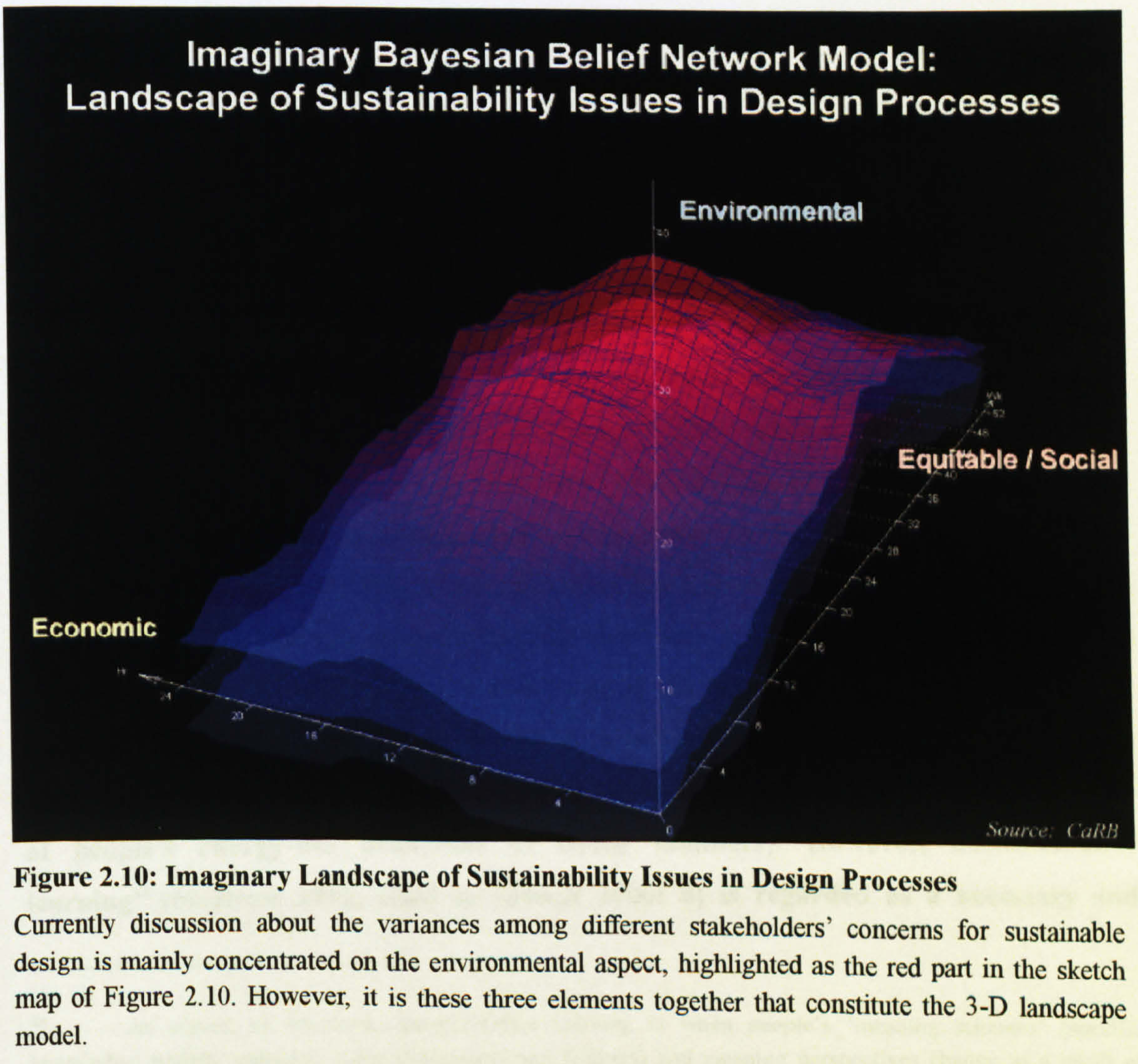

Figure 2.10: Imaginary Landscape of Sustainability Issues in Design Processes
Currently discussion about the variances among different stakeholders' concerns for sustainable design is mainly concentrated on the environmental aspect, highlighted as the red part in the sketch map of Figure 2.10. However, it is these three elements together that constitute the 3-D landscape model.

Therefore, the sub-question of this research (see 1.3) is further developed as: **whether people in this focus group (university students studying architecture or built environment related disciplines) have been well educated on sustainability issues. In terms of housing (student accommodation) design, is there any significant cognitive gap between architectural students' awareness on sustainability disciplines (the order in which they consider different sustainability issues as designers and housing users) and the knowledge background they are supposed to possess (the priority system in EcoHomes)?** And if there is, what is it? Although the early study in China shows that generally there exist cognitive gaps in different stakeholder groups regarding sustainability principles, it is still uncertain what the significant ones are. To fully understand this, a detailed investigation is carried out in Chapter 5. It mainly focuses on architectural students' concerns for sustainability issues and related causes, such as their **knowledge** (which leads to people's attitudes towards the environmental behaviour), **motives** and **values** (both of which are related to people's subjective norms) (Gluch and Stenberg 2006: 107), from a solution-focused perspective and a problem-focused one.

Recently there is a clear trend towards a multi-disciplinary approach to energy-use behaviour research, as part of the wider study of environmentally responsible behaviour (ERB) (Parnell 2003a: 79). Some scholars (see Kaiser *et al.* 1999, cited in Gluch and Stenberg 2006: 107) argue that there is only a weak or absent relationship between attitude and environmental behaviour. Further, it is argued that, in terms of predicting ERB, 'competence (Corral-Verdugo 1997), and the situational factors supportive of competence', can often override the effects of personal dispositions such as general environmental attitudes (De Young 1989; Guagnano, Stern *et al.* 1995; Corraliza and Berenguer 2000) (cited in Parnell 2003a: 86). On the other hand, based on 'Ajzen and Fishbein's (1980) Theory of Reasoned Action (TRA)' and 'a process theory of communication (as originated by Shannon and Weaver 1949)' (Gluch and Stenberg 2006: 105), some opponents (see Kaiser *et al.* 1999, cited in ibid: 107) argue that people's 'attitude towards the behaviour' and 'subjective norms' determine their behavioural intention which 'in a certain way is the immediate antecedent of actually behaving in that way'. **In this research, it is acknowledged that change of people's attitude and subjective norms is probably not able to lead to immediate actions (change of people's energy-use behaviour or living manners). However, transformative learning[xx] (Mezirow 1991, cited in Blewitt 2006: 6) is regarded as a necessary and**

[xx] As argued by Mezirow, transformative learning is when people's 'meaning schemes' (specific knowledge, beliefs, attitudes, value judgements and feelings) and meaning perspectives change as a result of

important supplement in order to take the first step in UK society's transition to sustainability (at least these well educated people will feel less reluctant when they are asked to change their lifestyles towards greater environmental sensitivity).

Other factors underlying behaviour in the discipline of environmental psychology, such as mood (Garling *et al.* 1997), self-identity (Manetti *et al.* 2004), effort (Schultz and Oskamp 1996), behavioural experience (Ebrero and Vining 2000), and perceived behavioural control (Ajzen 1985) (cited in Gluch and Stenberg 2006: 108), and some of the issues outlined by Parnell (2003a: 76-114), are also acknowledged important for behavioural patterns. However, they are beyond the scope of this research.

2.8 CHAPTER SUMMARY: RESEARCH PROBLEMS, BOUNDARIES & HYPOTHESIS

Based on a wide spectrum of literature review, housing, as a special domestic approach in the architectural domain, is identified as the main boundary of this research as it contributes significantly to today's climate change. Then through an open-ended debate on the attitudes that architects should adopt to achieve sustainable housing design, a socio-technical perspective is suggested to be used to enable the collaborative design processes. In this stakeholder-oriented decision-making process, it is argued that the variation between housing designers' concerns for sustainability issues and occupants' awareness of their lifestyle issues, together with the lack of communication between them, can lead to substantial discrepancies in estimated and actual energy consumption and carbon emissions in the design processes and later use. This is regarded as a major research problem which contributes to the principal hypothesis of this research. To better understand the problem and close the design loop, architectural students and their accommodation are chosen as the main research scenario. In this focus group, issues about designers' intention for and occupants' awareness of sustainability issues (sustainable design and living) can be raised and discussed at the same time and the research questions can also be simplified. By making the deductive process explicit, the researcher's attitude of research for design is clearly demonstrated and the research framework can be openly inspected and critically evaluated. The analysis of the context within which this research is developed can also make the further work meaningful.

experience and self-reflection. It is also argued that transformative learning will gradually lead to 'perspective transformation' whereby people 'become critically aware of how and why their assumptions constrain the way they perceive, understand and feel about the world'. This process also involves 'the changing of more or less habitual expectations, making possible more inclusive or integrative perspectives and the capability of making choices to act upon these new modes of understanding.' (Blewitt 2006: 6)

From this early study, it is found, though there is a general awareness of sustainability, that it has so far made only limited impact on peoples' lifestyle changes. Therefore, there is an untapped opportunity in social interventions to influence human attitudes and behaviours towards greater environmental sensitivity. Interrelationship between designers' and occupants' priorities for energy use, carbon reduction and climate change is the first step to explore.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGIES

3.1 CHAPTER OUTLINE

This chapter describes the main methodology[xxi] that is used in this research. Since there is no one method that can accommodate all competing problems encountered in the research processes alone, a multi-strategy research framework is proposed. Different research methods are introduced to key stages of the hierarchical framework according to their specific features and desired outcomes. It is important to note that an integrated perspective is permeating throughout the framework design processes.

3.2 MULTI-STRATEGY RESEARCH

Generally two research strategies are widely acknowledged and used in social sciences: quantitative and qualitative. As argued by Bryman (2004: 4), although these two strategies represent different approaches to social research, often being discussed and applied distinctively as shown in Table 3.1, researchers should not drive a wedge between them too deeply. Hence in this study, the distinction between the quantitative and qualitative strategies is only discussed as a useful means to classify different social research methods.

Table 3.1: Differences between quantitative and qualitative research strategies (Source: Bryman 2004: 20)

Fundamental differences between quantitative and qualitative research strategies		
	Quantitative	*Qualitative*
Principal orientation to the role of theory in relation to research	Deductive; testing of theory	Inductive; generation of theory
Epistemological orientation	Natural science model, in particular positivism	Interpretivism
Ontological orientation	Objectivism	Constructionism

In terms of practice, qualitative and quantitative researches have their own advantages and disadvantages. However, neither can accommodate all competing problems encountered in the research processes alone. In contrast, many researchers view these two strategies as complementary (e.g. Greene, Caracelli and Graham 1989, cited in Strauss and Corbin 1998: 28). To create a meaningful picture of the investigated scenario from the perspectives of key stakeholders, therefore, the researcher adopts an integrated perspective in this study and

xxi 'Methodology: A way of thinking about and studying social reality' (Strauss and Corbin 1998: 3). Further, it 'provides a sense of vision, where it is that the analyst wants to go with the research' (ibid: 8).

counterbalances these two strategies by combining them. It is believed that this *multi-strategy research* approach (term borrowed from Layder 1993, cited in Bryman 2004: 452) is more appropriate to this research area than if just any one of them is used. The application of multi-strategy research approach can provide a better understanding of the phenomenon by allowing researchers to study different aspects of it: qualitative data allows researchers to gain access to perspectives of the people they are studying (offering a representative and generalisable picture), while quantitative data allows them to explore specific issues in which they are interested (adding depth and richness) (Bryman 2004: 459; Parnell 2003a: 32). Although it is acknowledged that this incorporated approach is not 'intrinsically superior' to a mono-strategy approach (Bryman 2004: 464), it seems to 'allow the various strengths to be capitalised upon and the weaknesses offset somewhat' (ibid: 452).

As argued by Hammersley (1996, cited in Bryman 2004: 455), there are three approaches to multi-strategy researches: triangulation, facilitation and complementarity[xxii]. Based on a technical version, the multi-strategy approach is appropriate to this study mainly due to the latter two benefits, considering feasible and desirable techniques for data collection and analysis.

3.3 RESEARCH DESIGN

As argued by Bryman (2004: 27), research design aims to provide 'a framework for the collection and analysis of the data'; while a research method is only 'a technique for collecting data'. There are five prominent types of research designs: experimental design, cross-sectional design, longitudinal design, case study design and comparative design (Bryman 2004: 33). Their relationships with quantitative and qualitative research strategies are summarised by Bryman (2004: 55), as shown in Table 3.2.

As argued earlier, this research is designed to be a multi-strategy project. In terms of data collection and analysis, therefore, different research methods in these two research strategies are combined.

[xxii] 'Triangulation: this refers to the use of quantitative research to corroborate qualitative research findings or vice versa. Facilitation: this approach arises when one research strategy is employed in order to aid research using the other research strategy. Complementarity: this approach occurs when the two research strategies are employed in order that different aspects of an investigation can be dovetailed' (Hammersley 1996, cited in Bryman 2004: 455).

Table 3.2: Relationship between research strategies and research designs (Source: Bryman 2004: 56)

Research strategy and research design		
Research design	**Research strategy**	
	Quantitative	***Qualitative***
Experimental	*Typical form.* Most researchers using an experimental design employ quantitative comparisons between experimental and control groups with regard to the dependent variable.	No typical form. However, Bryman (1988a; 151-2) notes a study in which qualitative data on school children were collected within a quasi-experimental research design.
Cross-sectional	*Typical form.* Survey research or structured observation on a sample at a single point in time. Content analysis on a sample of documents.	*Typical form.* Qualitative interviews of focus groups at a single point in time. Qualitative content analysis of a set of documents relating to a single period.
Longitudinal	*Typical form.* Survey research on a sample on more than one occasion, as in panel and cohort studies. Content analysis of documents relating to different time periods.	*Typical form.* Ethnographic research over a long period, qualitative interviewing on more than one occasion, or qualitative content analysis of documents relating to different time periods. Such research warrants being dubbed longitudinal when there is a concern to map change.
Case study	*Typical form:* Survey research on a single case with a view to revealing important features about its nature.	*Typical form.* The intensive study by ethnography or qualitative interviewing of a single case, which may be an organization, life, family, or community.
Comparative	*Typical form.* Survey research in which there is a direct comparison between two or more cases, as in cross-cultural research.	*Typical form.* Ethnographic or qualitative interview research on two or more cases.

The choice between alternative research designs in a flow of work reflects decisions about the priority given to a range of dimensions of a particular stage of the research processes. In this case, particular attention is paid to cross-sectional design, case study design and comparative design. Different research methods associated with these three designs are used to collect data in the key research phases according to their specific features. The decisions are also made in terms of main research questions in which the researcher is interested at a time, and the criteria (reliability, replication and validity) for evaluating research findings.

To better understand these three research designs, their specific features are briefly introduced in the following sections:

- Cross-sectional design: 'a cross-sectional design entails the collection of data on more than one case and at a single point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables, which are then examined to detect patterns of association' (Bryman 2004: 56).

- Case study design: 'the basic case study entails the detailed and intensive analysis of a single case' (Bryman 2004: 48). It is supposed to be concerned with the complexity and particular nature of the case in question, and to provide an in-depth elucidation of its own right.

- Comparative design: 'a comparative design entails the study using more or less identical methods of two contrasting cases' (Bryman 2004: 53). Based on the logics of comparison, this research design aims to provide a better understanding of social phenomena by comparing them in relation to two or more meaningfully contrasting cases or situations.

In terms of implementation, it is important to note that cross-sectional and case study designs are the two main strategies for data collection and analysis in key phases of this research. These two research designs are applied together most of the time, though one or the other may become dominant in a particular circumstance. In contrast, comparative design is only considered as an extended procedure, an extension of cross-sectional design in quantitative research or of case study design in qualitative research. The application of these three research designs is described in the following sections, where particular attention is given to their association with the principal research phases.

3.4 PRINCIPAL RESEARCH PHASES

Although the research framework is described in Chapter 1, the principal research phases are examined in detail here, associated with embodied research methods at a time. As argued by Strauss and Corbin (1998: 34), the interplay between qualitative and quantitative techniques and procedures can be enabled at every research phase. In this case, the research framework is divided into five principal phases.

Research Phase 1:

In the previous chapter, the context of this research, based on which later work was carried out, was described in detail. As an exploratory research phase, it started out with a general research area that interested the researcher, deriving from several sources: personal interest and experience, prevailing theories, research literature and puzzles and so on. Then through a process of progressive focusing down (as shown in Figure 3.1), this research moved from a general research area to specific research questions in response to the emerging concepts and discovered relationships (Strauss and Corbin 1998: 41). Furthermore, a non-probability sampling[xxiii] method (or non-random sampling method) was planned to be used for data collection in later phases. Although the deductive approach was mainly based on critical literature review, a simplified case study of BedZED was carried out. As a study for the revelatory case, it aimed to provide deep insight into the socio-technical perspective for sustainable housing design. Inspiration drawn from this case study, the idea of ZED's lifestyle, also helped formulate the main research questions and facilitate later work. Furthermore, this qualitative research approach facilitated the interpretation of the relationship between variables (different stakeholder groups in the design processes).

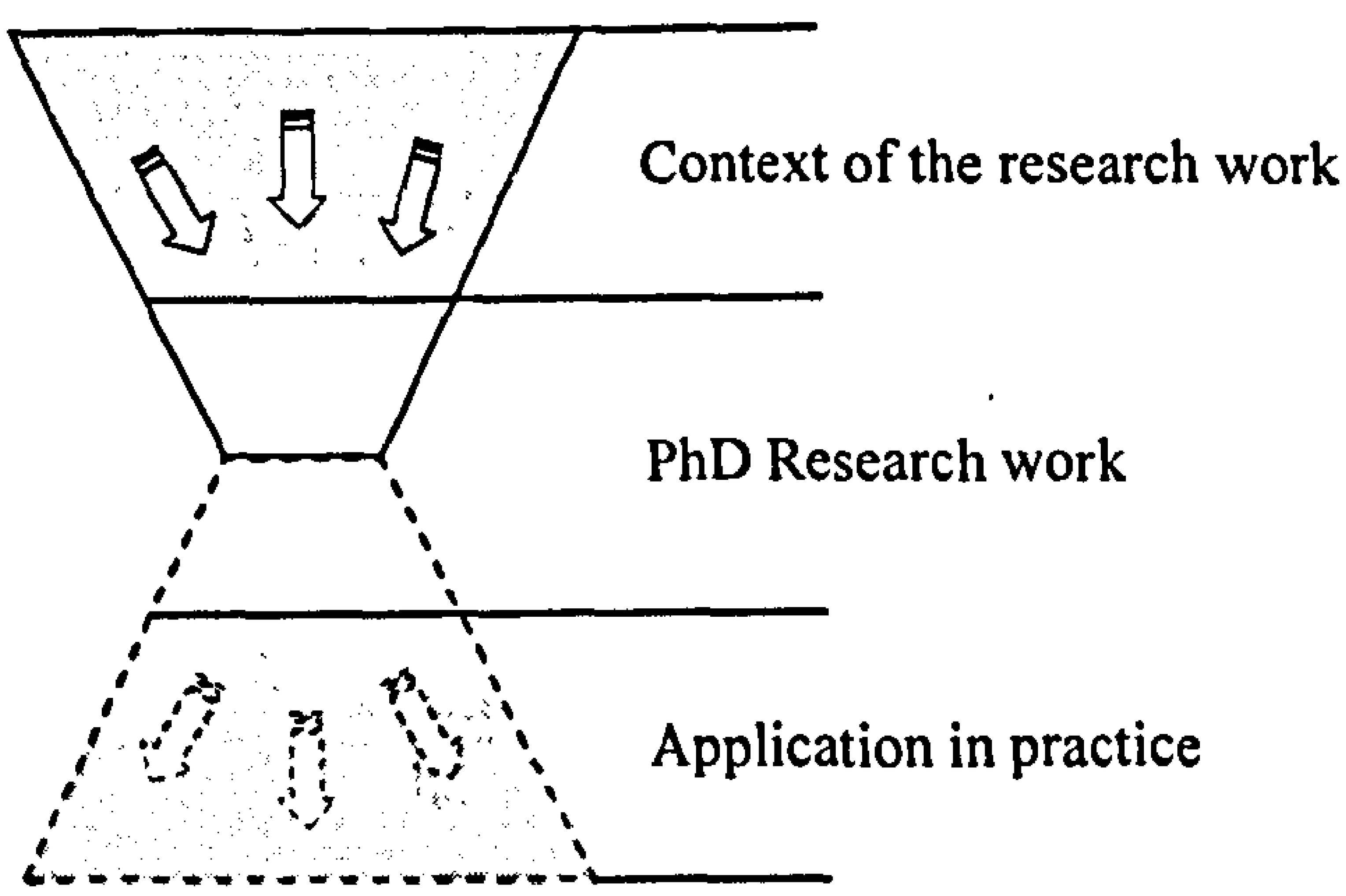

Figure 3.1: Research processes

Since this research is based on some supporting statements and suppositions rather than experimental hypotheses, it is important to observe the suppositions in a proper context. Therefore, by making the research context explicit, the whole research work can be easily followed and replicated.

Research Phase 2:

In Chapter 4, cross-sectional design becomes dominant. Qualitative content analysis is used to interpret a set of official documents related to sustainable housing assessment. This qualitative research approach tends to not only provide further specific hypotheses for this study but also aid measurement. More specifically, although the research objective has already been defined in earlier chapters, which is to explore knowledge gaps between

xxiii 'Non-probability sample – a sample that has not been selected using a random selection method. Essentially, this implies that some units in the population are more likely to be selected than others' (Bryman 2004: 87). Two types of non-probability sampling methods will be further introduced and applied later: the *convenience sampling* and the *snowball sampling*.

different stakeholder groups, Chapter 4 continues this discussion by using EcoHomes as the benchmark for later work. Based on this comprehensive document study, key themes and concepts arising from previous studies in this research area are identified, and the conceptual framework for the development of a communication platform for sustainable housing design is further developed. Furthermore, this qualitative procedure facilitates the follow-up quantitative research and informs the design of data collection methods for phase 3 and 4. To some extent, it also provides data from the Legislator Group.

Research Phase 3:

Based on criteria of EcoHomes, two questionnaires are designed in Chapter 5 to investigate the research questions in a focus group. In this research phase, cross-sectional design (survey design) and case study design tend to be combined. A group of high-level architectural students are selected as the critical case. Within this circumstance, the hypothesis about architecture students' dual nature, future housing designers and current housing users as specified in earlier phases, can be examined from longitudinal and comparative perspectives. The questionnaires can also be modified through this pilot investigation. It is important to note that qualitative and quantitative research strategies are applied together in this phase in order to ensure data being collected is solid. Specifically, although the questionnaires are designed to be self-completed, they are distributed to the participants with clear instructions and are completed under supervision. Furthermore, follow-up discussions and observations are also carried out at the same time to collect qualitative data. This principle is also kept in later procedures of data collection and analysis.

Research Phase 4:

This is the main phase for collection and analysis of data in the research framework. Cross-sectional design (survey design) and case study design tend to be combined in this phase again, followed up with a comparative design. From an integrated perspective, data from key stakeholder groups is collected and analysed in order to investigate potential priority variances between them. This research phase can be divided into three key sub-stages based on data sources and relevant research instruments.

- Students from Faculty of Architecture in the University of Sheffield are selected as an exemplifying case, based on purposive sampling method, to collect data from users (the Occupant Group) of student accommodation. It provides a suitable context for certain research questions to be examined. To allow for comparisons, information from students outside of the faculty is also collected in a follow-up procedure. Supervised self-completion questionnaires are used for the collection of data.

- Likewise, people working in the University's Accommodation Campus Service (the Client Group) are selected for another case study. Semi-structured interview is used to collect qualitative data from this focus group. In the mean time, structured interview is conducted to collect quantitative data. Both procedures of data collection are done strictly under the researcher's supervision.

- Postal self-completion questionnaire is used to collect information from voluntary experienced architects (the Designer Group). However, the survey procedure is not supervised by the researcher. In contrast, it is free to admit that this procedure of data collection has less intervention from the researcher compared with the other two. Furthermore, since participants in this stage are not designers of the Sheffield student village project, this procedure reduces the degree of consistency of the whole research. Also because of this, this research cannot be considered as a case study as a whole.

Based on data available and hypotheses built in previous research phases, a statistical analysis programme SPSS is used to analyse quantitative data and see whether there are any statistically significant findings. On the other hand, qualitative data is analysed based on principles drawn from the grounded theory[xxiv] (Strauss and Corbin 1998). Findings from the qualitative approach are used to verify findings from the quantitative one, or to bring new theoretical hypotheses to future work. However, it is important to note that techniques and procedures from the grounded theory, as set by Strauss and Corbin (1998), are not followed rigidly since Strauss and Corbin's methodology allows flexibility and creativity. In the application of both qualitative and quantitative procedures and techniques, the principal researcher blends some techniques described by his own.

Research Phase 5:

Based on the concept of comparative design, consultation responses (both quantitative and qualitative) from different stakeholder groups are cross-compared in this research phase. Then process view is applied to discover how its qualitative principles can be applied in practice. Based on such theoretical explanatory system, a communication platform is designed to impartially determine the priority view within and between different stakeholder groups in collaborative design decision-making processes.

[xxiv] 'The grounded theory approach is a qualitative research method that uses a systematic set of procedures to develop an inductively derived grounded theory about a phenomenon' (Strauss and Corbin 1998). For further information about the application of this method, please refer to Chapter 7.

It is important to note that, rather than providing an explanation, the emphasis of this research lies on *understanding* human attitude and their intrinsic system for value judgement. Therefore, this study is built upon 'the interpretivist tradition (and its intellectual influences, hermeneutics and phenomenology) rather than the positivist' (Parnell 2003a: 30). Where the researcher attempts to provide causal explanations, it is done in terms of *interpretive understanding*. Furthermore, since this study is designed to be multi-strategy research, the research process is both inductive and deductive. It tends to be guided by and also lead to middle range theories[xxv] which attempt 'to understand and explain a limited aspect of social life' (Bryman 2004: 6). Based on this principle, therefore, the linear research process adopted in this study is expected to be iterative[xxvi]. At least in some phases data collection and analysis is conducted in tandem, repeatedly referring back to each other.

In summary, the hierarchical research framework is designed (see Figure 1.2). To some extent, the whole research framework can be seen as an exemplifying case study, which aims to provide a suitable context for certain research questions to be answered. However, it is important to note that, within this study, the case is not just an object of interest in its own right and the researcher no longer aims to provide an in-depth elucidation of it. In contrast, this study intends to entail a discussion on the basis of theoretical analysis, the quality of which is the central issue of concern.

Although the generalisation of this study is still arguable, which might lead to restricted contributions beyond the case, this study provides an intensive examination of the key themes. Furthermore, as a revelatory case, this study also provides an opportunity to observe and analyse a phenomenon previously inaccessible to scientific investigation – the priority variances between different stakeholder groups in sustainable housing (student accommodation) design processes. Therefore, further work can be expected in the future from both longitudinal (by tracing the same group of students after graduation) and comparative (by comparing with other student accommodation designs) perspectives.

[xxv] This kind of middle range theories often 'operates in a limited domain, falling between grand theories and empirical findings' (Parnell 2003a: 31). Further, compared with grand theory, 'middle-range theories are much more likely to be the focus of empirical enquiry' (Bryman 2004: 7).

[xxvi] Iterative analysis is a process where the researcher moves back and forth through data in order to find, compare, and verify the patterns, concepts, categories, properties and dimensions of the phenomena. (Kwortnik 2003)

3.5 PRACTICAL CONSIDERATIONS AND RESEARCH LIMITATIONS

As a social research project, this study is influenced by a variety of factors, such as theory, epistemology, ontology, values and practical considerations (for further information about these factors, see Bryman 2004). These five key factors are inter-related in practice, influencing and being influenced by each other. Some issues relating to theory, epistemology, ontology and values have been extensively discussed in the previous chapter, and will be discussed further in the following chapters. In this chapter, however, the researcher tends to focus on issues related to 'practical considerations'.

It is always important to address the significance of practical issues in the decision regarding how social research should be carried out. As argued by Bryman (2004: 23)

> 'All social research is a coming together of the ideal and the feasible. Because of this, there will be many circumstances in which the nature of the topic or of the subjects of an investigation and the constraints on a researcher loom large in decisions about how best to proceed.'

This is particularly true for independent research projects led by PhD students, regarding time, budget and some other external constraints. Practical issues may also lead to problems in implementing other factors. In this study, for example, although methods for data collection and analysis are decided at the very beginning, quality of the data being collected based on ethical principles is far from expected. Specifically, in the qualitative approach, only a few people participate in the interviews voluntarily. In the quantitative approach, although the questionnaire distribution receives support from course tutors, sample sizes of different groups are not equal, or even fairly similar. Moreover, some respondents feel reluctant to complete the questionnaires if they have had other similar requests recently. These kinds of practical issues encountered in the real research process lead to a fact that some theories cannot be followed rigidly in this study, which might then result in limitations in reliability, replication and validity. For instance, if consultation participants are all people who are interested in this research topic, their opinions on sustainability issues cannot be claimed to be representative of genuine feedback from the general public. As argued by Weisberg *et al.* (1996),

> 'The people that volunteer for questionnaires and interviews may not be typical. Volunteers generally are more interested in the topic of the study than are other people, so this could be not representative of the larger population.'

Furthermore, this research is designed to be conducted at a single point in time so that opinions of all respondents are comparable. However, exposure to a particular external influence at that time can bias feedback from the sample. Therefore, it would be helpful to confirm the hypothesis and demonstrate that the findings are not an accident or coincidence by replicating the research with different samples in the future (Bailey 1994, cited in Dejesus 2002: 108).

Certainly the researcher also takes the practical issues caused by himself into account in the research design processes. For instance, although both quantitative and qualitative strategies are used in this research, methods from quantitative approach are more preferred. Besides collecting quantifiable data from a large number of people (Bryman 1996), quantitative research strategy can keep researcher-related error to a minimum, especially when the researcher is from abroad and English is not his first language.

All these issues will be discussed in detail as related problems are confronted in the research process. Limitations of this research will be summarised in the final chapter of this thesis, in which the whole research procedure will also be reviewed. However, despite the limitations, the researcher concludes that this study contains useful information about the case being examined. The research framework can also be widely applied for further investigation in the future.

3.6 CHAPTER SUMMARY

In this chapter, different research methods used in this study, selection criteria, biases and limitations of this research are explained. The hierarchical multi-strategy research framework is designed, where different research methods are applied in different phases according to their specific features and desired outcomes. It is acknowledged in this research design that the application of a variety of methods and techniques for data collection and analysis allows inference drawn from one data source to be corroborated or followed up by another (Bryman 1996: 454).

CHAPTER 4

THE APPLICATION OF ECOHOMES TO SUPPORT DECISION-MAKING PROCESSES

4

4.1 CHAPTER OUTLINE

Based on the review of existing building sustainability assessment methods, this chapter aims to introduce a communication platform to the housing market. A wide spectrum of debate is considered to identify the essential themes that an effective communication platform should address. Furthermore, to facilitate knowledge transfer between different stakeholder groups, it is extensively discussed whether and how the existing assessment tools can be transferred into an appropriate communication format to support decision-making. This chapter also defines the research background for later work and sets the boundary and criteria for social survey in the next chapter.

4.2 BUILDING SUSTAINABILITY ASSESSMENT METHODS

As sustainability is widely acknowledged as an important issue in the construction market, many building assessment methods have been developed to introduce sustainability values and principles into mainstream practice and to foster the agenda of sustainable building design or even sustainable community development. Currently potential interventions that might increase the effectiveness of building assessment methods are mainly concerned with completed products and their performance in use, e.g. Post-Occupancy Evaluation (POE) (Bordass 2001) and Design Quality Indicators (DQI) (Gann 2003).

However, more attention is now also paid to the processes that created them (Kaatz *et al.* 2005, 2006) and knowledge transfer and the communication between different stakeholder groups in the decision-making processes (Cole 2005). To help stakeholders improve their sustainability values and principles, building sustainability assessment methods have been required to 'transform the culture of the construction industry to accommodate sustainability as a common, consistent and integral part of its decision-making' (Cole 2005: 464). Therefore, relevant researches, implicitly or explicitly, have been directed towards a collaborative decision-making process in order to better understand important communication issues in practice, especially non-technical ones (sometimes called 'soft' issues) (Kaatz *et al.* 2006: 310).

To enhance the effectiveness of building sustainability assessment methods, both on a conceptual and an operational level, 'Environmental Assessment' and the 'Process Protocol' have been proposed as two valuable complementary sources by Kaatz *et al.* (2005: 450-451, 2006: 311) to allow for further studies at a project level.

4.2.1 ENVIRONMENTAL ASSESSMENT

Environmental Assessment, such as Environmental Impact Assessment (EIA) of projects and Strategic Environmental Assessment (SEA) of policies, plans and programmes, 'provides insights on addressing sustainability at a project level' and 'reveals the potential value and benefits of stakeholder participation for building assessment' (Hill 2004, cited in Kaatz *et al.* 2006: 312; also see Kaatz *et al.* 2005: 450). It employs a scoping procedure to facilitate a collaborative, efficient, integrated and timely decision-making process. As a communication platform, it offers an open forum for different stakeholders, not only for knowledge transfer but also for collective learning (Saarikoski 2000, cited in Kaatz et al. 2005: 450; Webler *et al.* 1995, cited in Kaatz *et al.* 2006: 312).

The key challenge for Environmental Assessment can be examined from two aspects. From a long-term perspective, the challenge is to provide measures to determine whether or not an initiative is sustainable (George 2001). From a short-term perspective, the most important aspect is the integration of various issues – different knowledge backgrounds, different cognitive styles, different perspectives, values and objectives in decision-making (Kirkpatrick and Lee 1999). To help decision-makers to improve their judgement, building environmental assessment should be viewed as 'a process dynamically integrated with the building project cycle rather than a single activity' (Kaatz *et al.* 2006: 312). Further, to achieve a 'robust, simple and yet comprehensive' result, the assessment methods should also allow for flexibility and adaptability (ibid: 312). Hence 'scoping' has been suggested by Mulvihill and Jacobs (1998, cited in ibid: 313) to produce a generic framework to inform the assessment process by addressing and customizing issues of content, philosophy and methodology. This should comprise the following activities (Kaatz *et al.* 2006: 313):

- 'Establishment and refinement of a project vision and objectives based on the principles of sustainable development and stakeholders' needs,
- Establishment of common project values,
- Determination of all contextual issues, factors and values that cannot be agreed upon, which influence problem-definition (to incorporate environmental and social objectives and constraints into proposal formulation),
- Identification of significant assessment issues based on social values and professional judgement,
- Development of terms of reference for subsequent stages of the assessment process, i.e. the methodology or assessment procedure,
- Scheduling of all critical decision-points in the project life cycle and the identification of the nature of information needed'.

Furthermore, to achieve mutual adjustment (Hill 2004, cited in Kaatz *et al.* 2006: 313), a broader collaborative building sustainability assessment process has been proposed based on the ethics of sustainability (also see 2.3.1). It is expected that this process, by addressing social and collaborative learning, would help stakeholders adjust to each other's interests and preferences in establishing project values, and subsequently engage themselves to balance all these competing parameters to reach an agreement on a course of action (Kaatz *et al.* 2006: 313).

4.2.2 PROCESS PROTOCOL

The Process Protocol, sometimes called the Generic Design and Construction Process Protocol, 'offers a structured way of communicating a shared understanding of the building process' and 'provides a template for delineating a process of building assessment that is integrated into the project cycle' (Kaatz *et al.* 2006: 311; also see Kaatz *et al.* 2005: 451). As a framework, the Process Protocol reflects the aspiration towards the process view of construction promoted by Egan (1998) and addresses the importance of establishing a means of 'streamlining' design and construction activities (Kaatz *et al.* 2006: 313-314). Based on this principle, several strategies have been suggested to facilitate more effective cooperation between different organisations, such as 'Activity Zones'[xxvii], 'Process Mapping' and 'Legacy Archives' (Kagioglou *et al.* 1998, cited in ibid: 313) and so on.

From the study of the Process Protocol, it can be found that transparency and accessibility should be taken as 'critical qualities of any building assessment method in terms of the communication strategy (i.e. exchange of information among participants) and the process itself (i.e. methodology)' (Kaatz *et al.* 2006: 314). Consequently a common '*lingua franca*' is suggested to allow the relevant sustainability information to be widely shared and understood by all stakeholders, including both professional and lay stakeholders (Fowles 2000, cited in ibid: 314; Kaatz *et al.* 2005: 447). Moreover, based on the understanding of the flow of information in a project life cycle, a close and dynamic link between the sustainability assessment process and the project construction programme should be built up to correspond with and facilitate the decision-making process, not only for information collection but also for its timely dissemination (Kaatz *et al.* 2006: 314).

[xxvii] The PP (Process Protocol) 'groups project stakeholders into nine Activity Zones: Development Management; Project Management; Resource Management; Design Management; Production Management; Facilities Management; Health and Safety Statutory and Legal Management; Process Management; and Change Management (Kagioglou *et al.* 1998)' (Kaatz *et al.* 2005: 451).

4.2.3 KEY ROLES OF BUILDING SUSTAINABILITY ASSESSMENT

By reviewing Environmental Assessment and the Process Protocol, Kaatz *et al.* (2006: 315-318) argue that three key themes should be addressed in order to increase the effectiveness of building sustainability assessment methods. These are **integration**; **transparency and accessibility**; and **collaborative learning** (besides those broad capabilities, such as 'a common and verifiable set of criteria and targets', 'the basis for making informed design decisions' and 'an objective assessment of a building's impact on the environment' and so on (Cole 1999: 231)). To better understand these three main themes, more studies have been carried out:

- Integration (sometimes called 'dynamic integration') comprises three main approaches. The integration of sustainability principles requires the assessment to be capable of promoting inter- and intra- generational equity through a broad collaborative decision-making process and preserving the carrying capacity of the natural environment by applying a flexible framework (Cooper 1999; Dresner 2002; Kaatz *et al.* 2004). The integration of stakeholders' values requires that the related information from assessment tools can be fed back into the building process at key decision-points in terms of effective information flow. And the integration of stakeholder knowledge addresses the viewpoints from both professional and lay stakeholders during collaboration aligned with the building life cycle. Moreover, a job-sharing approach is suggested by Lutzkendorf and Lorenz (2006: 351) to avoid the information delay and to achieve a better and further integration between the building sustainability assessment and actual project activities and any other specialised instruments. This approach, a close integration of assessment tools, design measures and any other instruments or strategies for sustainable construction, is expected to enable building sustainability assessments from 'appraisal solely' to 'support the decision-making' (ibid: 337).

- Based on the implementation of a process view and the advocacy of broadening stakeholder participation, the issues of transparency and accessibility comprise two main aspects – access to information and communication. To foster accessibility, it is important to eliminate potential barriers to participation, where the technical language barriers between professional and lay stakeholders and the information needs (i.e. timing, form, content and source) have become the emphasis. On the other hand, to facilitate communication, some visual aids have been suggested, such as a graphical interface and process mapping. Since there is always a need to re-examine the premises of building sustainability assessment methods to identify the desired qualities and outcomes (Kaatz *et al.* 2006: 315), such characters will engage the decision-makers to adopt a longitudinal role (Lutzkendorf and

Lorenz 2006: 352) and know what tools should be applied, to what extent the tools should be integrated and to which decision-point their work should be focused. Further, due to the wide array of different demands for assessment results during the building life cycle, the extension of assessment tools should allow the results within different communication formats and in different levels of aggregation to facilitate the information exchange between different stakeholder groups (ibid: 351). As argued by Lowe (2006: 413), 'humility and transparency' are the 'only sustainable attitude' in the face of uncertainties in the decision-making processes.

- According to Robinson (2004, cited in Kaatz *et al.* 2006: 317), a joint process should be utilised for any building sustainability assessment since the principle of sustainability itself is fostered primarily through social and collaborative learning. Thus, the educational capacity is regarded as a key functionality of building sustainability assessment. Moreover, to facilitate collaborative learning in different levels of aggregation, 'transfer of knowledge' and 'enhancing commitment and learning' are taken as two vital characteristics for this kind of educational and empowerment medium (Kaatz *et al.* 2006: 317). Transfer of knowledge requires the collaborative decision-making process to be capable of enabling the generation and transfer of explicit and tacit knowledge and improving the organisation of information flow (Lutzkendorf and Lorenz 2006: 339). It aims to help stakeholders better understand sustainability principles and then allow them to be engaged to re-adjust their values and attitudes accordingly. Enhancing commitment and learning, as another fundamental element of any trans-disciplinary activity, requires the promotion of active interrelations between professional and lay stakeholders. Through the process of learning from each other and about each other, this approach is expected to help invoke a shift from a collective duty towards individual responsibility among all participants (Kaatz *et al.* 2005: 445, Lutzkendorf and Lorenz 2006: 338).

In summary, a successful building sustainability assessment method should be capable of working as a communication platform, help different stakeholders to optimize the processes of information exchange and knowledge transfer in (and between) decision-making processes in a more open and integrated manner. Moreover, stakeholder-oriented and participation-based perspectives should always be addressed as two key features to efficiently develop and effectively implement any building sustainability assessments. All the issues described above formulate a good prototype of building sustainability assessment method, which allows more detailed discussion to be carried out in the following sections. Some of these features will also contribute to the questionnaire design in Chapter 5 and the proposal of a code for sustainable student accommodation (CSSA) in Chapter 10.

4.3 EXISTING SUSTAINABILITY ASSESSMENT TOOLS

To help different stakeholders better understand their responsibility and appropriately address the relevant issues, many design, assessment and decision-support tools already exist. They have been widely described, evaluated and analysed in several reports, e.g. IEA (2001); Altan (2004); Cole (2004; 2005; 2006); ODPM (2004); Liu *et al.* (2006); Lowe (2006); Lutzkendorf and Lorenz (2006), Fowler and Rauch (2006), and so on. As argued by Kirkpatrick and Lee (1999, cited in Kaatz *et al.* 2006: 312), in the short term, the most significant aspect of building sustainability assessment tools is still focused on 'the integration of issues, different ways of knowing, different perspectives, values and objectives in decision-making'. Taking account of their diverse features, assessment tools and supporting instruments available in the market can be classified in the following way (Lutzkendorf and Lorenz 2006: 335):

- Lists of building projects and construction materials;
- Recommendations and exclusion criteria for tendering purposes;
- Element catalogues including assessment results for building components;
- Labels for building projects and construction works;
- Checklists to support the design and planning process;
- Guidelines, case studies and examples of best practice;
- Codes, regulations and standards;
- Energy certificates, building passports and documentation.

This classification is made according to important methodology-based elements such as: 'dimensions of sustainable development; phases of the building life cycle; integration of design and assessment issues; nature of the assessment; level of detail or the extent of aggregation, respectively; nature and breadth of assessment results; applicability for the assessment of existing buildings; etc.' (For more detail about assessment tools' typologies, see IEA 2004; cited in Lutzkendorf and Lorenz 2006: 336). However, it is also important to note that the relationship between assessment methods and assessment tools are not always one to one. In contrast, many integrated tools can often include several methods while it is also possible that different tools draw upon identical methods (Cole 2005, Lutzkendorf and Lorenz 2006: 349).

To better understand some important issues and allow for a critical comparison, a general review of the variety of assessment schemes currently available in the UK construction sector (especially those for the housing market) is given below.

- BREEAM: Building Research Establishment Environmental Assessment Method (BREEAM) consists of a series of assessment techniques and rating systems for new, converted or renovated buildings. It covers a wide range of building types: offices, homes, industrial buildings and retail buildings and so on. To allow BREEAM to work properly at different stages of the construction process, some third-party assessment tools or programs have been incorporated, such as Life Cycle Assessment (LCA), the Green Guide to Specification, Envest 2, SMARTWaste, A Sustainability Checklist for Developments (Brownhill and Rao 2002), etc. (BRE 2006a)

- GBTool: The Green Building Challenge is an international collaborative effort that aims to develop a common language for describing 'green buildings'. The software implementation of the Green Building Challenge (GBC) assessment method, GBTool, has been under development since 1996 and is currently managed by the International Initiative for a Sustainable Built Environment (iiSBE) (iiSBE 2005a). Compared with BREEAM or LEED, GBTool has been tailored towards a regional approach, thus reflecting the relative importance of performance issues in a particular region, and also containing regionally relevant benchmarks (iiSBE, 2005b). Issues assessed by GBTool include Site Selection, Project Planning and Development; Energy and Resource Consumption; Environmental Loadings; Indoor Environmental Quality; Functionality; Long-Term Performance; Social and Economic aspects (iiSBE 2005b, Gowri 2004, Fowler and Rauch 2006).

- SPeAR®: The Sustainable Project Appraisal Routine (SPeAR) is a methodology framework developed and implemented by Ove Arup. It aims to bring sustainability principles into the developmental decision-making process, prompt innovative thinking and inform decision-making at all stages of design and development. In this framework, sustainability issues have been structured against a four-quadrant model: environmental protection, social equity, economic viability and the efficient use of natural resources. (Abley 2004, Arup 2007)

- SAP: The Government's Standard Assessment Procedure (SAP) aims to provide energy rating for dwellings based on energy costs and CO_2 emissions associated with space heating, water heating, ventilation and lighting, the application of energy generation technologies and so on (DCLG 2007a). The current version of SAP (SAP 2005 version 9.80) has been adopted by government as part of the UK national methodology for calculating the energy performance of buildings. It is incorporated into the Building Regulation Part L in line with the EU Energy Performance of Buildings Directive (EPBD) (BRE 2005, DCLG 2007a). Based on the original manual worksheet, the basic calculation procedure can be transposed to a computer program or spreadsheet (Pitts 2004: 92).

- NHER: Owned and operated by National Energy Service (NES), the National Home Energy Rating (NHER) scheme provides 'software, training and accreditation; research and consultancy services; energy ratings and energy efficiency support; and advice on future technological and legislative changes' to help individuals or organisations to improve the energy efficiency of their domestic properties (NES 2007). It gives an energy label based upon total annual running costs per square metre under standard occupancy conditions. Further, the NHER software package provides a nationally recognised SAP rating to allow for direct comparison between different dwelling types in different locations in terms of energy efficiency. Compared with SAP, however, the NHER includes various location-specific elements and so better reflects actual running costs (NEF 2007).

- BREDEM: The Building Research Establishment Domestic Energy Model (BREDEM) is a model for the calculation of the annual energy requirements of domestic buildings, which provides the estimation of potential savings resulting from energy conservation measures (BRE 1985). As a domestic energy rating model supported by the Government, it has been used as the basis for both the SAP and NHER scales (NEF 2007). This model shows that the physical characteristics of a dwelling and the lifestyles of the occupants are about equally important in determining energy consumption (Altan 2004).

- Envest: Envest 2 is a web-based software tool that can help designers estimate the building environmental impact and whole life cost at the early design stage (EERE 2006). Currently two versions are available online: Envest 2 estimator and Envest 2 calculator. All environmental impacts in Envest 2 are measured against a single scale – the UK Ecopoints system. Hence this software allows designers to make direct comparisons between different solutions or different specifications within one design, and then to identify those aspects that have the greatest influence on the building's overall impact instantly. Trade-offs can be evaluated between the embodied and operational Ecopoints of the building, and higher Ecopoints values indicate greater negative environmental impact (Dickie and Howard 2000). This software also allows clients to optimise the concept of best value according to their own priorities as both environmental and financial credentials have been made explicit in the early decision-making process. (BRE 2006d, 2006e)

- Green Guide to Specification: As part of the BREEAM programme, the Green Guide to Specification works as an easy-to-use handbook to provide guidance on the relative environmental impacts of over 250 building materials and components (including roofs, walls, floors, windows, paints, insulation, etc.). The environmental rating of these specifications are based on Life Cycle Assessment from a widely-accepted Environmental Profiles methodology and its Addendum (Anderson and Shiers 2002: Preface). Moreover, this guide provides data on 'cost and durability' to ensure that environmental issues are considered 'in the wider context of specification choices' and therefore help 'determine the appropriate balance between these sometimes conflicting requirements' (ibid: 4). Thus, many other assessment tools, such as BREEAM, often use this guide to provide basic input for further analysis.

It can be found that, to improve building energy efficiency and reduce carbon dioxide emissions, many assessment schemes, such as SAP, NHER and so on, have already been implemented in the building construction market for a number of years. However, they have a bias towards building physical fabric design or indoor appliances improvement, as well as an assumption of *standard* occupancy. As a result, strategies and technologies have not been effectively transferred to the building operational phase, and the profile of the existing housing stock has little changed since 1996 (Altan 2004). Actually, it is very questionable whether housing occupants, often with little relevant knowledge, will run the dwelling buildings in an optimum way without further education.

In Table 4.1, a comparison is made of certain features, where different sized bullets are used to highlight the specific aspects or purposes of different assessment schemes. At the present time, there is no one building sustainability assessment tool in the market that can truly accommodate all competing parameters in the design decision-making processes or be applied to all circumstances of building construction (also see Jamison 2001: 27). Hence it is important to identify the specific characteristics of different assessment schemes, select the most suitable ones and optimise the application according to their relevance.

This leads to a further discussion in recent research about alternative implementations, such as green building or sustainability, mandatory or voluntary, quantitative or qualitative, complex or simple and so on.

Table 4.1: Comparison of assessment schemes co-existing in the UK

A comparison based on certain features, where different sized bullets are used to highlight the specific aspects or purposes of the assessment tools.

		BREEAM	GBTool	SPeAR	SAP	NHER	BREDEM	Envest 2	Green Guide to Specification
Dimensions of sustainability	Environment	●	•	•	•	•	•	•	•
	Economics		•	•				•	•
	SocioEquity		•	•					
Nature of assessment	Voluntary	•	•	•		•	•	•	•
	Mandatory				●				
Target buildings	Individual	•	•	•	•	•	•	•	•
	Communities	•	•	•					
Phases of building life cycle influenced	Pre-design	•	•	•	•	•	•	●	•
	Planning	•	•	•	•	•	•	•	•
	Design	•	•	•	•	•	•	•	•
	Construction	•	•	•					
	Operation	•	•	•	•	•	•		
	Demolition			●					
Integration of design and assessment issues	Energy/CO_2	•	•	•	●	●	●	•	
	Water	•		•					
	Materials	•	•	•				•	●
	Waste			•					
	Pollution	•		•					
	Management	•	•	•					
	Transport	•		•					
	Health and well-being	•	•	•					
	Land use and ecology	•	•	•					
	Functionality		●						
	Appliances	•			•	•	•	•	
Web-based information	Free access	•	•	•	•	•	•	•	•
	Free download	•			•				
Software available	Yes		•		•	•		•	
	No	•		•			•		•
Regional approach	Yes		•	•		●			
	No	•			•		•	•	•
Related to users' lifestyle	Yes						●		
	No	•	•	•	•	•		•	•

4.3.1 GREEN BUILDING OR SUSTAINABILITY

Due to varying dimensions when addressing the principle of sustainability, the question about whether the building assessment tools should be designed towards green building standards (addressing environmental issues only) or sustainability standards (from a multi-dimensional perspective) has been widely discussed (for more information about the difference between 'green building' and 'sustainability', see Chen and Pitts 2005). Some related questions have been raised: should the tool solely focus on environmental aspects as a green building assessment; or should it additionally assess economic, social, technical and functional aspects as an integrated sustainable building assessment?

Kaatz *et al.* (2006: 310) argue that it is possible to distinguish between green building assessment tools and sustainable building assessment tools by telling whether the assessment method is 'predominantly concerned with the assessment of building performance against a declared set of environmental criteria' (green building assessment) or 'addressing an even broader set of environmental, social and economic building-related issues' (sustainable building assessment). According to this declaration, some existing assessment tools, which measure improvements in environmental building performance in relation to typical practice or requirements (Cole 1999), have been categorised as Green Building Assessment Tools. These include the Building Research Establishment Environmental Assessment Method (BREEAM), Leadership in Energy and Environmental Design (LEED) and so on. On the other hand, some emerging assessment tools, which are set with the participation of the client and the design team (CSIR 2001), have been categorised as Sustainable Building Assessment Tools, including the Sustainable Project Appraisal Routine (SPeAR), Green Building Tool (GBTool), Sustainable Building Assessment Tool (SBAT) and so on. Moreover, Kaatz *et al.* (2006: 310) also point out, in terms of the assessment 'philosophy', green building assessment tools tend to focus on 'a building in terms of its performance standards and physical characteristics' while sustainable building assessment tools on 'the processes and transformations that occur within a building system'.

To achieve a common and consolidated vision of sustainability, as proposed in the *CIB Agenda 21 for sustainable construction: why, how and what* (Sjostrom and Bakens 1999), it is argued that the application of building assessment tools should be capable of facilitating the integration of full multi-criteria sustainability considerations (Ding 2005). Compared with merging or aggregating the results from a number of different single tools subsequently, the intrinsic integration at an earlier stage would avoid the risk of neglecting the overall context or mutual interdependencies in the assessment process (Lutzkendorf and Lorenz 2006). Further, it is also argued that the shift from green building to sustainable building approaches and the linkage of assessment results with far-reaching financial or social aspects will ultimately help impose stricter requirements in terms of the 'traceability, liability, comparability, certainty and extent of building assessments' (ibid: 336).

As Cole (1999) points out, however, with the technical knowledge and human capacity available, it is too complicated to model the socio-technical system across the spectrum of criteria of a building project. Further, since the emphasis on different aspects of sustainability might differ widely across different project designs, it seems to be effectively impossible to define an absolutely precise target (or an out-and-out winner) that can push the boundaries of sustainability in all respects and at the same time (Gething and Bordass 2006: 417; Lowe 2006: 412). In other words, the measurement of a building's sustainability or the attempt to cover all dimensions of sustainability appears to be a mission impossible in real construction practice. To solve this problem, some conceptual frameworks, such as 'Triple Bottom Line' (Office of Sustainability 2005) and the 'Sustainability Matrix' (Blair *et al.* 2005, Gething and Bordass 2006: 417) have been proposed to help with the scheme plan and management. Since they allow the economic, environmental and social impacts of building design to be organised, considered and evaluated separately, these frameworks can be helpful to facilitate team discussions, record scheme progress and structure project reports as the design develops.

Obviously, to achieve a better outcome and enhance the effectiveness, it is important to address flexibility and adaptability when integrating the appropriate assessment tools in the decision-making processes. Particular attention should also be paid to the communication between different levels and across a variety of dimensions.

4.3.2 MANDATORY OR VOLUNTARY

The question whether the building sustainability assessment tools should remain a voluntary activity or become a mandatory exercise required by legislators or other powerful parties in the market depends on the various local 'cultures of decision-making' (Lutzkendorf and Lorenz 2006: 339). These cultures, predominantly rely on governmental influence or market forces, will significantly impact on the 'procedural sequence' in collaborative decision-making process, known as the top-down or bottom-up decision-making strategies (for details, see 2.3.2). However, Lutzkendorf and Lorenz (2006: 340) also point out that both models currently tend into very similar directions – a trend towards strengthening consumers' rights. To increase their capacity for responsibility and thereby overcome information asymmetries and the interconnected problems of adverse selection, these stakeholders and other market participants should be vested with appropriate information and decision support

(Lutzkendorf and Speer 2005, Lutzkendorf and Lorenz 2006).

In the UK, since the construction and property industry is traditionally developed based more on market forces, the principle of building sustainability values has been introduced mainly on a voluntary basis (Lutzkendorf and Lorenz 2006: 340). Nevertheless, the UK government acknowledges that it has a leading role to get the message across concerning the implementation of sustainability principles. From an integrated perspective, many positive efforts have been made by the Government to communicate this concept to the public and to the construction market. On a voluntary level, detailed guidelines have been provided to encourage more stakeholders to participate in the decision-making processes by signalling the advantageous characteristics of sustainable buildings. On a mandatory level, sustainable measures have been applied in government projects, firstly to demonstrate their competitive advantage to the market and then to enact relevant legislations. Social and ethical responsibilities have also been addressed to allow for more informed decisions.

Recently an increasing demand for sustainability assessment and decision support is being created in the market, regardless whether the sustainable model is constructed based on governmental influence (mandatory basis) or market forces (voluntary basis). In fact, although some specific assessment tools in the market might allow for a voluntary harmonization based on bottom-up criteria, 'the development of a variety of tools with significant differences in terms of basic assessment procedures, indicators and communication formats' have instead required the mandatory imposition of harmonization powered by top-down standardization (Lutzkendorf and Lorenz 2006: 343). The competition between coexisting voluntary and mandatory tools in the market can potentially 'enhance the quality of building performance assessment both technically and operationally, and can offer a powerful driver for excellence and ease of use' (Cole 2006: 367).

4.3.3 QUANTITATIVE OR QUALITATIVE RATINGS

The discussion of whether to use quantitative or qualitative ratings is focused on the nature of the assessment – whether the toolkit predominantly uses qualitative or quantitative information, or a balanced combination of the two (Lutzkendorf and Lorenz 2006: 336).

In the current market, many stakeholders would prefer assessment tools that are predominantly based on qualitative information since they are easy to use (saving cost and time) and their results can be easily applied or transferred for marketing purposes (Lutzkendorf and Lorenz 2006: 338). Moreover, environmental demands, based on these qualitative measures and principles, are easier to evaluate and handle in collaborative decision-making processes where some stakeholders may have less detailed knowledge (Dammann and Elle 2006: 396). However, the problem is that they do not provide building owners, occupiers or decision-makers with appropriate information on the impacts of their 'actions and decisions on the environment' (Lutzkendorf and Lorenz 2006: 338). This might restrict the possibility of increasing the building users' motivation (their willingness and ability) to take individual responsibility (ibid: 338). Likewise, some of these concrete qualitative requirements might leave less space for creativity and innovation for designers or planners at times (Dammann and Elle 2006: 401).

Thus, life cycle analysis (LCA) based tools, which mainly use quantitative information, have been acknowledged as a means to demonstrate the impacts of individual stakeholder's decision and actions on the environment by using appropriate reference values. Unlike those assessment tools based on qualitative information or methods, these LCA based tools 'do not encroach on design freedom as they leave it up to the designer *how* to achieve the quantitative goals' (Dammann and Elle 2006: 401). Further, since there are problems caused by the inconsistent use of assessment criteria and indicators within existing tools, there is also a need for the standardization and transparent description of quantitative information to substantially 'increase the tools' comparability and allow for more robust benchmarking of assessment results' (Lutzkendorf and Lorenz 2006: 339). Yet to some extent, the implementation of LCA-based results for marketing purposes has been hampered due to its cumbersome nature and the conflict between researchers' claims and market demands (Dammann and Elle 2006, Lutzkendorf and Lorenz 2006: 338).

Obviously, neither qualitative assessment from a subjective perspective nor quantitative assessment from an objective perspective can accommodate the competing issues arising in the market alone. The integration between 'feelings' and 'figures' will be the key to enact sustainability in the property and construction sector. However, although many attempts have been made to integrate qualitative insights and quantitative criteria, few tools exist in the market that allow for a combined determination. This is mainly caused by the complexity of aggregation, lack of algorithms available or the uncertainty of normalisation (Lowe 2006, Lutzkendorf and Lorenz 2006).

However, it is also worth noting that, although the intrinsic integration of quantitative and qualitative assessment is difficult to achieve in practice, extending collaboration between various assessment methods by different stakeholders and in different levels might help enable more widely shared motivations towards sustainable living.

4.3.4 COMPLEX OR SIMPLE

The issue of 'complex or simple' is mainly concerned with the level of detail or the extent of aggregation, respectively. Since the desires from different stakeholders are varying, these two approaches do not necessarily conflict with each other in practice.

Within researchers, consultants and assessors (working on a scientific frame basis), there is a desire for more robust assessment tools to mirror the complex and manifold causal interrelations between diverse issues and subsequently help professionals optimise the alternative options from an integrated perspective. For developers, clients and building occupants (thinking from an aesthetic-holistic or layperson basis, sometimes even from a public-relations basis), on the other hand, there is a need for a simpler assessment procedure and more straightforward presentation of results to allow these lay stakeholders to understand the difference between various options available in the market and then make their choices accordingly. Therefore, the manner of portraying the assessment procedure, complex or simple, depends heavily on different communication formats being applied in collaborative decision-making processes and different stakeholders' requirements (Dammann and Elle 2006, Lutzkendorf and Lorenz 2006).

However, discussion about the issue between 'complex or simple' has not been concluded. Experts and professionals have discussed standardization in the context of whether it is obligatory to have 'a minimal list of indicators' (Lutzkendorf and Lorenz 2006: 343) for assessing a building's environmental performance. Although a basic consensus has been achieved that 'an obligatory minimal list of assessment indicators must be agreed' in the decision-making process (ibid: 343), an open mind, referring to flexibility and adaptability, should be adopted to allow for further adjustment at any point in time. Moreover, as the principle of sustainability becomes more all-embracing, it becomes important, though also difficult, to know where to stop.

4.3.5 SUMMARY

In summary, it can be found that all issues related to the assessment tools are somewhat ambiguous – **when evaluating building sustainability issues, different stakeholders often prefer to address the underlying problems from different dimensions, by different procedures, through different formats and to different extents, taking into account their intrinsically varying incentives.** Therefore, Malmqvist and Glaumann (2006: 324) suggest, based on the problem-related cause-and-effect chains, that particular attention should be given to some characteristics of these indicators during implementation – validity, reliability and accuracy from a theoretical perspective; and costs, competence, intelligibility and influence from a practical perspective. The choice of environmental indicators for building management in the decision-making processes is always a dynamic balance 'between what is theoretically possible and what is practically most desirable' though it needs to be directed intrinsically 'towards problem orientation' (ibid: 332).

It is emphasized that decision-makers should always keep an integrated view on these dilemma issues by taking them into account as two sides of the same coin rather than making any deliberate segregation in the decision-making processes. Moreover, although the existing environmental assessment tools do not take into account mutual inter-dependencies and interrelations between different design issues (e.g. environmental, economic, social, technical, etc.), multi-dimensional optimization and comparison of building concepts should be addressed in terms of implementation (Lutzkendorf and Lorenz 2006).

In the shared market, many building environmental assessment tools coexist, being influenced by and subsequently influencing each other. As Cole (2006: 357) points out, with regard to their complementary or competitive roles in practice, 'the organizational and market context in which the systems operate, the financial and political support they receive, and personal interests and biases are all complicit in their market acceptance and influence'. Once the assessment tools 'have fairly clearly defined and distinct roles', the market can easily make discerning choices (ibid: 368).

Based on the critical review and the comparisons above, some important issues relating to building sustainability assessment have been discussed in detail. Although a close consensus has not been reached, this review procedure provides insight into the background of building sustainability assessment methods and therefore allows for a further study on the advantages and disadvantages if the existing tools are to be applied as communication platforms in collaborative decision-making processes. Some issues addressed in terms of alternative implementations provide methods to improve the effectiveness of communication. Some of them will contribute to the proposal and implementation of the Code for Sustainable Student Accommodation. This will be further discussed in Chapter 10.

4.4 HOUSING DEVELOPMENT

Since this research is about sustainable design for student accommodation, which has been seen as a particular type of domestic building, the study on building sustainability assessment tools in this section is going to be concentrated on those relating to the housing sector accordingly.

4.4.1 ASSESSMENT FOR HOUSING AND STUDENT ACCOMMODATION

BREEAM (2005) acknowledges that some multi-residential homes, such as student halls of residence, sheltered housing for the elderly (but not care homes), supported housing for mentally or physically disabled persons and hostel type accommodation, might not fit into the standard EcoHomes version. As an alternative, a bespoke version of EcoHomes, BREEAM Multi-Residential, is developed. In addition to issues covered by EcoHomes, BREEAM Multi-Residential looks at 'communal services and the management of communal areas within the building such as catering facilities, lounges, dining rooms, health and leisure areas, offices, meeting rooms and other support areas (e.g. laundries)' (BREEAM 2005).

In practice, however, many types of new student accommodation are likely to be designed and assessed under the standard EcoHomes scheme. For instance, the Eco Residences in Lancaster University, which was developed by University Partnerships Programme (UPP), achieved the BREEAM EcoHomes 'excellent' rating recently (Lancaster University 2008). This is probably because, as a bespoke environmental programme, the criteria of BREEAM Multi-Residential have not been fully released (cannot be freely accessed) and the assessment procedures can vary from case to case. To allow for competitive comparisons and maximum market benefits, more attention is paid to the assessment methods for sustainable housing design (i.e. BREEAM EcoHomes) in this research.

Actually, in a recent survey (see Chapter 6), it is found that university students (out of 467 responses) prefer living in 'private rented properties' (63%) and 'personally or family owned properties' (6%) to 'University or University Partnership properties' (31%). Therefore, there is a potential trend to design houses, and their assessment methods, to be more adaptable to allow them to be used for student accommodation if necessary.

4.4.2 ASSESSMENT FOR SUSTAINABLE HOUSING DEVELOPMENT

It has been acknowledged in the consultation document, *Proposals for Introducing a Code for Sustainable Homes* by the Office of the Deputy Prime Minister (ODPM 2005), which initiates the public review process of building sustainability assessment tools, that a single and isolated review, especially for energy performance standards in some cases, will 'be insufficient to move the construction industry of a major industrial country across the chasm to a sustainable state' (Lowe 2006: 413). Recently a considerable amount of information, primarily focusing on 'the individual systems and side-by-side comparisons of their technical features' (Cole 2006: 358) for existing sustainability assessment tools, have been published in order to define the next stepping stone and enable the industry to move towards it. To have a deeper insight into evaluating the performance of environmental management systems for housing development, some researchers have even proposed a procedure that 'contains more environmentally relevant indicators for assessing environmental impacts' (Malmqvist and Glaumann 2006: 331), such as indicators built on problem-related basis. However, since it is assumed that there is always an 'incumbent' system before the introduction of a new one, political sensitivity typically limits 'an open, critical debate' (Cole 2006: 358). Therefore, little information is available on the coexisting assessment tools' potentially conflicting roles 'within a common context or on opportunities for complementary, rather than parallel, system development' (ibid: 358). Lowe (2006: 405) even argues that there is 'a pervasive concern that environmental performance targets in use at the beginning of the 21st century are more arbitrary, more subjective, than one would like'.

To solve this problem, Lutzkendorf and Lorenz (2006: 351) suggest that design and assessment tools should be complemented by the use of 'case studies, best-practice programmes, guidelines, labels, checklists, codes and regulations, building/energy passports, valuation reports, post-occupancy evaluation studies, consumption benchmarks, etc.'. However, this complementary procedure needs to be carried out consciously to avoid unnecessary constraints or unexpected consequences. Take the relationship between regulatory development and environmental performance assessment schemes in use in the UK as an example, which is argued by Lowe (2006: 413) as an instructive case:

> 'The unexpectedly rapid development of Part L since the publication of the Energy White Paper[xxviii] caused it to overtake environmental performance assessment schemes such as BREEAM, particularly in the housing sector (Rao *et al.* 2000; Office of the Deputy Prime Minister (ODPM) 2005). This in turn is now undergoing rapid development to ensure that it can continue to fulfil their most important original function – to provide guidance for and means of recognizing developments that go beyond minimum regulatory requirements.'

Furthermore, Lowe (2006: 413) also points out that this is a clear 'empirical demonstration of the developmental and pragmatic nature of these environmental performance schemes'. Specifically, this kind of developmental approach will depend on the view that not all issues can be dealt with by such decision-making, that many decisions are better taken over shorter

xxviii 'Part L went through a radical overhaul in 2006, which meant that all new buildings now have to be modelled to assess their likely CO_2 emissions per m^2 in use. Essentially, the onus is now on building designers to show that new buildings will have CO_2 emissions 20 per cent lower than an identical building that met the previous Part L (2002)' (CIRIA 2009: 4) cycles and that the complexity of the factors and processes determine energy use in the built environment renders it unable to harness and promote learning within relatively short review cycles (ibid: 413). Obviously, there is a trend in the current housing market that, disregarding the political context, conscious consideration of and open discourse about 'goals, contents and demands' of the indicators or assessment tools are likely to lead to 'a socially and environmentally more accountable handling of the trade-offs between conflicting demands' (Dammann and Elle 2006: 400).

4.4.3 LEED FOR HOMES AND BREEAM ECOHOMES

To understand this situation better, LEED (Leadership in Energy and Environmental Design) for Homes in USA and the EcoHomes by BREEAM (Building Research Establishment Environmental Assessment Method) in the UK are extensively examined and discussed in this research. Each of them has been implemented in its national housing market and has proven to be successful to some extent.

By comparing the range of key issues addressed in these two assessments, it can be found that a general consensus seems to have been reached. Some important issues, such as energy, materials, water saving and recycling, ecological improvement onsite, etc. have been addressed in both assessment tools (as shown in Figure 4.1). To a great extent, these issues constitute a template of 'minimal list of indicators' (standardization) that is helpful for benchmarking purposes (Lutzkendorf and Lorenz 2006: 343, ODPM 2004).

However, since these two assessment tools were initially designed to accommodate different national conditions, their focuses are varying. LEED for Homes (USGBC 2005) is more concerned with detailed design issues for single housing projects, such as 'Indoor Environmental Quality'. On the other hand, EcoHomes (BRE 2006b, 2006c) looks more like an assessment tool for sustainable community development, where particular attention has been paid to communication issues, such as 'Transport'.

Besides adopting a developmental approach as described above, the ultimate success of environmental indicator will also depend on if, and to what extent, a consensus on environmental indicators for buildings can be reached among the key stakeholders in the construction sector (Dammann and Elle 2006: 400). Since this research is focused on housing development in the UK, BREEAM EcoHomes has been selected as the design criteria to investigate how a consensus can be reached among the key stakeholder groups. This will be discussed in the following sections.

Figure 4.1: Comparison of issues addressed in EcoHomes 2006 and LEED for Homes

4.5 ECOHOMES (BREEAM FOR HOMES)

Since its first launch in 1990, BRE's Environmental Assessment Method (BREEAM) has been extensively applied in the UK to assess building environmental performance. It covers a wide range of environmental issues within one assessment and aims to present the measures and results in a way that can be widely understood by those stakeholders involved in property procurement and management (BRE 2006a). Up to 2007, this scheme has been regarded by the UK's construction and property sectors as 'the criterion of best practice in environmental design and management', covering a range of building types such as offices, houses, schools, retail buildings, etc. (ibid).

As the housing version of BREEAM, EcoHomes aims to provide an authoritative rating for the property sector. On the official website of BREEAM EcoHomes (http://www.ecohomes.org), two important documents are available: a Pre-Assessment Estimator (BRE 2006c) with related simplified information to allow for guidance on likely rating, and the EcoHomes Guidance (BRE 2006b) with full information on the credit requirements to allow for detailed evaluation.

According to Lowe (2006: 412), the key factors in a successful developmental target of any environmental performance assessment schemes are likely to include: to be 'fairly related to regulation and other systems; properly related to currently available technologies; pragmatic, dynamic and devising targets; taking account of the lead times of the systems and industries that they affect; framing regulation in a way that maximizes tendency for integration; taking consultation as part of a process for building consensus; including an overarching long-term environmental agenda; etc.'. To see how well EcoHomes has satisfied all these factors, a related discussion is raised in the following sections.

4.5.1 INTEGRATION THROUGH PARTICIPATION

To make consistent and holistic judgements about the environment, the system for value judgement that underpinned BREEAM (or more precisely – BREEAM '98) was initially developed through a series of focus groups discussion with industry representatives and academics in the UK (Lowe 2006: 406). As argued by Lutzkendorf and Lorenz (2006: 344), 'the description and assessment of a *single* building's contribution to sustainable development must focus on social aspects of the characteristics and attributes of the building'. Hence the purpose of the focus groups method is to 'establish a broad consensus on the weighting of different environmental impact categories' between all levels of decision-makers (Howard 1998, cited in Lowe 2006: 406), and 'reconcile different expectations of an assessment tool' among a variety of different cultural viewpoints (Cole and Larsson 2002, cited in Dammann and Elle 2006: 388).

To obtain a weighting system against which different impacts can be compared based on a single scale or score (such as BRE's Ecopoints in this case), research was conducted by the Centre for Sustainable Construction at BRE based on earlier studies into the impacts of construction. Key people from a wide range of interest groups were asked for opinions[xxix] (Rao *et al.* 2000: 5, Dickie and Howard 2000), which included:

- Government policy makers and researchers
- Construction professionals
- Local authority policy makers and planners
- Construction materials producers and manufacturers
- Property and institutional developers and investors
- Environmental activists and lobbyists
- Academics and researchers

According to these *professionals'* opinions, the results (as described in Dickie and Howard 2000) have been tailored into a checklist-based indicator to help users of this system to estimate the likely score of different building environmental issues, which is the EcoHomes Pre-Assessment Estimator. This checklist involves assigning credits within each sub-area and establishes a weighting system between all areas that can be used for scoring. Although the number of credits available in each category does not necessarily reflect the relative importance of the issues in the whole system (credits do NOT have the same value between different categories), the point score for each issue does[xxx] (Rao *et al.* 2000: 4). To allow for

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xxix In all, some 60 participants from the expert panels scrutinised the sustainability-related theme (environmental, economic and social), sub-themes and detailed issues establish their meaning. The investigation procedure can be described as *two phases*. 'Firstly, the issues were assessed theme by theme. The participants were asked to "spend" 20 points between all the issues within each theme, giving more points to issues that they considered more important to sustainability. There were more issues than points to force some prioritisation, but the groups were given independence to determine how they should judge their priorities. In a second exercise, participants were asked to score the relative importance of the themes and sub-themes, thus ensuring a test of consistency and enabling evaluation of the overall importance of the themes relative to each other. A high degree of consistency between responses was apparent when comparing the summary results with the detailed results. Overall an objective method was used to collate the expert panels' subjective weighting decisions.' (Dickie and Howard 2000)

xxx There are eight main categories in EcoHomes. 'These categories have different numbers of credits, but these simply reflect the number of factors within each category, rather than the relative importance of the a full evaluation, more details about how to achieve the related credits for different issues have been clarified in the EcoHomes Guidance.

As argued by some researchers (e.g. Bentivegna *et al.* 2002, Brindley 2003, Baines and Morgan 2005; cited in Lutzkendorf and Lorenz 2006: 343), since uncertainties and substantial gaps still prevail for the assessment of social aspects, 'a consensus on appropriate indicators that are *directly applicable for single buildings* has not been reached' (Lutzkendorf and Lorenz 2006: 343). Therefore, many other rating systems have been applied, complementarily or directly, as subsystems in the EcoHomes Guidance, such as the Standard Assessment Procedure (SAP), DCLG's (Department for Communities and Local Government, used to be ODPM) Housing Quality Indicators (HQI), Life Cycle Assessment (LCA), and Building Regulations Part L and so on. To a great extent, this integrative measure, especially mirrored by the use of 'LCA-based' indicators as subsystems in the 'checklist-based' BREEAM EcoHomes, implies a potential trend of recent development – from 'mutual criticism between stakeholders in different technological frames' into a more 'constructive dialogue' (Dammann and Elle 2006: 399).

However, since lay stakeholders seem to have been excluded from the decision-making processes for the weighting system, it is very doubtful whether the results have truly demonstrated all stakeholders' opinions and can be well communicated between all of them. It is argued that building environmental assessments, such as BREEAM EcoHomes or the Code for Sustainable Homes, will only be fully accepted and successfully implemented when interest groups (including stakeholders classified as the 'layperson-sensualist frame' by Dammann and Elle (2006: 393)) 'understand and are involved in determining the solution to mutually recognized problems' (Sidaway 2005: 118). Delli Priscoli (1980, cited in ibid: 118) supports this view and argues that 'a further advantage of public involvement is that it can affect the way an agency carriers out its mission and adapts to changing social values by redefining problems and considering a broader range of alternatives'.

4.5.2 FLEXIBILITY AND ONE STEP AHEAD

In the latest version EcoHomes 2006, issues that have been agreed as the most significant in the context of housing development (Kaatz *et al.* 2006: 315) have been identified and grouped into eight main categories: energy with 22 credits, transport with 8 credits, pollution

different categories. Scores from each category are combined into an overall rating by applying the BREEAM weightings; these reflect the relative importance of the different categories.' (Dickie and Howard 2000)

Point score for each issue = (credits achieved / total credits available in the category) * 100% * related weighting factor for the category with 10 credits, materials with 14 credits, water with 10 credits, land use and ecology with 12 credits, health and well being with 14 credits, management with 10 credits (BRE 2006a). Since all issues are optional, the scheme itself is relatively flexible, which enables developers to address the most 'appropriate' and 'beneficial' issues for each particular development (Rao *et al.* 2000: 1).

Some issues relevant to housing and the environment might not be included in this version of EcoHomes according to Rao *et al.* (2000: 16):

- 'no clear improvement on current regulations or normal practice can be defined to help designers/developers reduce their impacts on the environment;
- there is no satisfactory way to assess a particular issue at the design stage;
- our understanding of the issue is not sufficiently advanced to devise robust assessment criteria; or
- the issue is not universally applicable to different developments.'

Meanwhile, however, misunderstanding or misuse of this maximum flexibility might lead to a serious problem in the decision-making processes. Since the 'excellent' rating in EcoHomes only requires 70% of the total credits (BRE 2006b), it becomes possible for developers to achieve the highest rating without taking into account some specific issues, such as transport, pollution or water etc. Since no category assessment in EcoHomes is mandatory, key stakeholders' decisions become vitally important in achieving successful sustainability. Actually, EcoHomes attempts to encourage developers to 'be one step ahead of legislation' and 'go beyond the statutory requirements' by taking effective action through this voluntary scheme (Rao *et al.* 2000: 1-4). While it becomes a more open and important question about how to persuade and engage those developers, with fewer incentives and less specialist knowledge, to do this.

4.5.3 TRANSPARENCY AND ACCESSIBILITY

Looking towards the biggest market opportunity, EcoHomes allows for a coexisting status of different knowledge levels, from general to detailed. This aims to allow the related information to be widely shared among stakeholder groups with different knowledge backgrounds and various incentives.

- For professional assessors who are trained and licensed by BRE, or those researchers, consultants and regulators who have more detailed knowledge (classified as the 'scientific frame' by Dammann and Elle (2006: 393)), detailed indicators and robust calculation methods in the EcoHomes Guidance can be used for a formal assessment, a precise and quantitative comparison or a related protocol evaluation. Moreover, since detailed information in the credit requirements promote a series of design measures, the potential for creative integration might lead to a desire for more collaborative decision-making.

- For professional clients, administrators and local authorities (classified as the 'public-relations frame' by Dammann and Elle (2006: 393)), or architects and planners (classified as the 'aesthetic-holistic frame' by ibid: 393), the implicit measures, with regard to the environmental issues addressed in the EcoHomes Pre-Assessment Estimator, can be applied as guidelines to allow for more informed decisions, though the estimated score can not be used to demonstrate compliance with BREEAM (BRE 2006b, 2006c). Moreover, some case studies have demonstrated the competitive advantages in the market of using EcoHomes (Wilson and Smith 2006).

- For those occupants, residents or non-professional clients who have less detailed knowledge (classified as the 'layperson-sensualist frame' by Dammann and Elle (2006: 393)), EcoHomes provides credible and transparent labels as the final results to inform these consumers about the environmental credentials of housing – Pass with 36 credits, Good with 48 credits, Very Good with 58 credits and Excellent with 70 credits, in EcoHomes 2006 (BRE 2006b, 2006c). To make the results easy to be understood and communicable to these lay public, EcoHomes tends to boil down its complicated quantitative analysis process to a simple qualitative indicator.

As environmental issues become more important in the housing market, EcoHomes is proposed to be widely applied as an Eco-labelling scheme in the market. Further, since EcoHomes provides much online free-access information to facilitate knowledge transfer, it might also be able to engage different stakeholders into a more collective dialogue.

4.5.4 FROM ECOHOMES TO THE CODE FOR SUSTAINABLE HOMES

Based upon BRE's EcoHomes, the Department for Communities and Local Government (DCLG 2006c) developed the *Code for Sustainable Homes* (CSH), which was launched in December 2006 to encourage zero carbon development. As it is closely linked to building regulations, this new code contains mandatory performance levels in nine key categories (though the later four topics do not have minimum standards): Energy efficiency / CO_2; Water efficiency; Use of Materials; Surface water run-off; Waste; Pollution; Health and well-being; Management; Ecology (BRE 2007, DCLG 2008a).

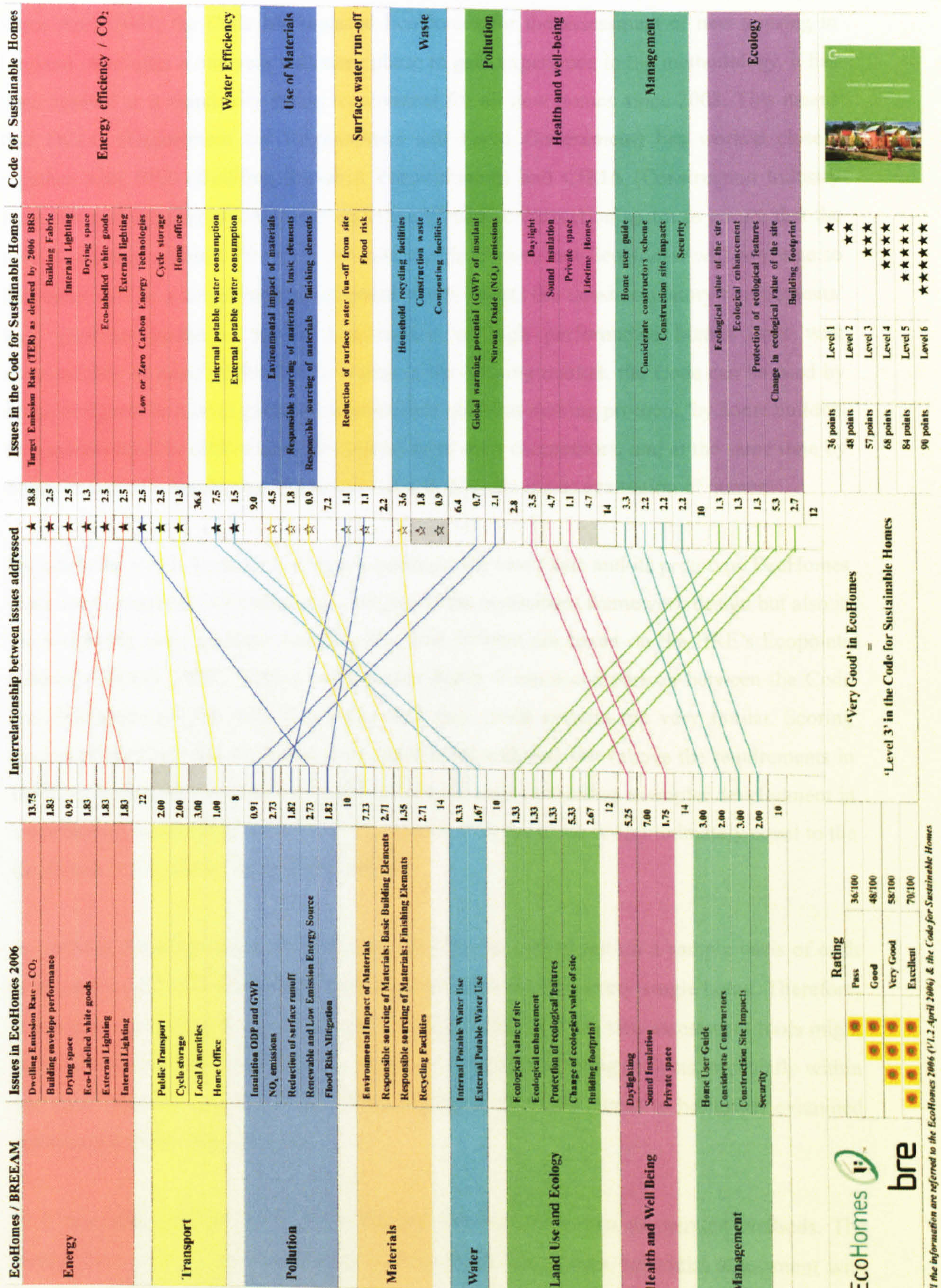

Figure 4.2: Comparison of EcoHomes and the Code for Sustainable Homes

Since April 2007, the Code has replaced EcoHomes for the assessment of new housing in England. And after a one year voluntary phase to gain experience in the methodology, it has been applied as a mandatory rating requirement for all new homes since 2008. This means that DCLG (Department for Communities and Local Government) has worked closely together with BRE (Building Research Establishment) and CIRIA (Construction Industry Research and Information Association) in the housing construction sector to ensure that the new assessment scheme, *The Code for Sustainable Homes*, and EcoHomes will converge so that there will be a single national standard which 'meets the latest regulatory requirements' and 'provides guidance on the construction of high performance homes built with sustainability in mind' (BRE 2007). Hence in the housing market, the Code can be used by home designers as a brief guideline to steer their decision-making protocol, by home builders as a market label to differentiate themselves from their competitors, and at the same time by home-buyers as a purchasing manual to assist in their choice or evaluation of homes.

By rating the whole home as a complete package, the new Code and its prototype EcoHomes share many important characteristics, not just in the assessment framework design but also in the weighting score protocol (specifically, both of them are based on the BRE's Ecopoints scheme) (DCLG 2007b, Dickie and Howard 2000). From a comparison between the Code and EcoHomes (Figure 4.2), it is found that their credit systems are very similar. Scoring system of the Code has six levels, from entry level with one star (above the requirements in Building Regulations) to the highest level with six stars (reflecting exemplar development in sustainability terms) (DCLG 2008a). The 'Level 3' in the Code is approximately equal to the EcoHomes 'Very Good' score (BRE 2007).

In practice, EcoHomes and the Code only need to be carried out on a sample basis of each home type within the multi-home development rather than on every single home. Therefore, it is argued by the government that the implementation of these two assessment tools might help achieve success in reducing the impact of affordable housing projects, especially within the social housing sector (DCLG 2006c). However, this view needs to be further examined during their marketing processes.

It is also important to notice the difference between these two assessment methods. The compliance of the Code needs to be carried out in two phases, an initial assessment with interim certificate being issued at the design stage (Design Stage Review) and the final assessment with verified certificate being issued based on a post-completion check after construction (Post Construction Review). Compared with EcoHomes which pays attention to the assessment in the post construction phase, the Code tends to assess the building design processes from a more integrated perspective and start the guiding procedure at the very beginning. Further, the post-completion check on the energy and CO_2 emissions performance required by the Code demonstrates a significant improvement from those design-based assessment tools. Moreover, the Code uses the same calculation methodology for energy efficiency and carbon performance as the one used in the Energy Performance Certificate which has been introduced in June 2007 under the Energy Performance Building Directive (EPBD)[xxxi] (DCLG 2006c). Thus, the application of the Code can help complement the system of Energy Performance Certificate and avoid the need for duplication in the market. The implementation of the Code has been fully supported by the Royal Institute of British Architects (RIBA 2006). Responding to the release of the Code for Sustainable Homes, RIBA President Jack Pringle suggests that the Government should move further to 'tackle the energy performance of existing building stock' based on this early achievement (ibid).

Other differences between the Code and EcoHomes are known as the varying issues being separately addressed in these two assessment tools. As shown in Figure 4.2, the new Code adds some new sustainability issues into the assessment scheme, such as 'Lifetime Homes' and 'Inclusion of composting facilities' and so on. While other sustainability issues that used to be addressed in EcoHomes have been removed, such as 'public transport', 'local amenities' and so on. Compared with EcoHomes, which pays particular attention to issues relating to community development as a whole, the new Code tends to concentrate on the individual housing building itself and assess the design processes from a more integrated perspective, from building pre-design phase to building demolishment phase.

Moreover, different levels in the Code are made up by achieving both 'the appropriate mandatory minimum standards' together with 'a proportion of the flexible standards' (BRE 2007), which differs from the voluntary rating procurement of EcoHomes. For example, as a mandatory requirement, specified minimum standards in key resource efficiency criteria, such as 'energy', 'water', 'materials', 'surface water run-off' and 'waste', must be reached before even the poorest rating can be achieved in the assessment processes (minimum standard at Code entry level, with ★ or ☆ in Figure 4.2) and higher standards for both 'water' and 'energy' must be met to reach a higher level of the Code (minimum standards at each level of the Code, with ★ in Figure 4.2) (DCLG 2008A). To a great extent, this

xxxi 'Following publication of the European Energy Performance of Buildings Directive, from June 2007 it will be necessary for all houses to have an Energy Performance Certificate as part of the Home Information Pack to be made available to purchasers and these certificates have to be renewed at regular intervals.' (Banfill and Peacock 2007: 428) integrated perspective, with both mandatory requirements on essential elements (those with stars next to their ratings in Figure 4.2) and voluntary requirements on optional elements, can be helpful to solve the potential problems caused in the EcoHomes assessment procurements (see 4.5.2). However, this also makes it impossible to make a direct comparison between these two schemes.

Although the Code for Sustainable Homes has been seen as a step forward by the UK Government, EcoHomes still plays an important role in the housing market, especially for sustainability assessment of the existing housing stock. Further, most ideas in the Code were derived from its prototype, EcoHomes (ODPM 2005). In this research, particular attention is paid to the housing environmental issues and sustainable design measures addressed in EcoHomes rather than those in the new Code. This decision is also due to the fact that this research started in 2004 while the Code was released in 2007.

4.5.5 SUMMARY

Since the UK has 'separate systems' for regulating planning and building (Banfill and Peacock 2007: 428), the implementation of EcoHomes or the Code needs the close collaboration between different departments in local authorities. Compared with sustainability legislations often remote from the design processes (Meacham *et al.* 2005: 93), EcoHomes seems to be a more 'straightforward, flexible and independently verified environmental assessment method' (BRE 2006b). To a great extent, it meets the key requirements of a successful assessment scheme as argued by Lowe (2006, see 4.5). Moreover, periodic updates and amendments have been issued to ensure EcoHomes remains current (Rao *et al.* 2000: 7).

However, based on the three significant themes argued by Kaatz *et al.* (2006), 'integration; transparency and accessibility; and collaborative learning' (see 4.2.3), some constraints that might restrict the further implementation of EcoHomes as a communication platform in the design decision-making processes are discussed in the following sections:

- In terms of integration, it can be found that, since BREEAM EcoHomes is not capable of measuring the performance of the built environment against the principle of global carrying capacity, its 'ability to contribute to the sustainability or environment debate is likely to remain limited' (Cooper 1999: 323). Furthermore, since lay stakeholders have been excluded from the weighing exercise, it is very questionable whether the so-called 'broad consensus' on environmental issues can be ultimately achieved. Credits relating to provision of a 'Home User Guide' have been introduced to the latest version of EcoHomes 2006 (BRE

2006b, 2006c) for the first time, which aims to provide instructions for non-technical occupiers on how to obtain maximum benefits by using the controls properly. However, whether stakeholders in other focus groups can truly represent or consider the likely knowledge, values and concerns from those lay or non-technical stakeholders is still open to question. To solve this problem, a 'job-sharing approach', which is suggested by Lutzkendorf and Lorenz (2006: 351), needs to be addressed to allow for a broader participation. In the implementation of EcoHomes, this trans-disciplinary collaboration aims to allow the related information from assessment to be fed back into the building process at key decision-points in terms of more effective information flow.

- In terms of transparency and accessibility, although the web-based database allows related information to be accessed and shared among all stakeholders in the early stages, the technical language barriers prevent further communication. Due to its intrinsic commercial motive, the information and the scheme of EcoHomes are primarily tailored for those professional assessors trained and licensed by BRE or external rating specialists (classified as the 'scientific frame' by Dammann and Elle (2006: 393)). Hence many other stakeholders, such as clients and administrators (classified as the 'public-relations frame' by ibid: 393), architects and planners (classified as the 'aesthetic-holistic frame' by ibid: 393), occupants and residents (classified as the 'layperson-sensualist frame' by ibid: 393), etc., cannot easily use detailed information to guide their decision-making in collaborative processes. Meanwhile, although different indicator levels in EcoHomes seem to meet the information needs from different stakeholders, no visual interface or process mapping has been provided to facilitate information exchange. Roles and responsibilities of different stakeholders in collaborative decision-making processes are also not clear. To solve this problem, more attention should be paid to the process protocol to tie down a manageable agenda with agreed levels of aspiration among all stakeholders in a visible way.

- Compared with the above two factors, the development of EcoHomes pays little attention to collaborative learning issues. Although BRE applies a participatory procedure to decide the weighting system of EcoHomes, its independent assessment process and the voluntary implementation in the housing market are less trans-disciplinary than expected. This is because the existing versions of EcoHomes do not have related educational capability to engage stakeholders to adjust their values and attitudes in a positive way. Hence the basis of participation, the complicated social interrelationship between professional and lay stakeholders (Cicmil and Marshall 2005), tends to break down. To solve this problem, the capabilities of 'transfer of knowledge' and 'enhancing commitment and learning' need to be addressed in EcoHomes within a more socio-inclusive campaign.

EcoHomes / BREEAM	Issues in EcoHomes	2006	2005	2003	2002/2001
Energy	Dwelling Emission Rate – CO_2	13 75	10 71	10 42 (20)	10.64 (20)
	Building envelope performance	1 83	5.36	5 21 (10)	5.32 (10)
	Drying space	0 92	1.07	1.04 (2)	1.06 (2)
	Eco-Labelled white goods	1.83	2 14	2 08 (4)	2.13 (4)
	External Lighting	1.83	2 14	2.08 (4)	2.13 (4)
	Internal Lighting	1 83			
		22	21.42	20 83 (40)	21.18 (40)
Transport	Public Transport	2.00	2.14	2 08 (4)	2 13 (4)
	Cycle storage	2.00	2.14	2.08 (4)	1.06 (2)
	Local Amenities	3.00	3.21	3 13 (6)	3.19 (6)
	Home Office	1.00	1.07	1.04 (2)	1.06 (2)
		8	8.56	8 33 (16)	7.45 (14)
Pollution	Insulation ODP and GWP	0.91	2 14	4.17 (8)	8 51 (16)
	NO_x emissions	2.73	6 43	6.25 (12)	6 38 (12)
	Reduction of surface runoff	1.82	4.28	4 17 (8)	
	Renewable and Low Emission Energy Source	2.73	2 14		
	Flood Risk Mitigation	1 82			
		10	14 99	14 58 (28)	14 89 (28)
Materials	Environmental Impact of Materials	7.23	7.73	8 33 (16)	8.51 (16)
	Responsible sourcing of Materials: Basic Building Elements	2.71	2 90 (Timber)	3.13 (6 – Timber)	3.19 (6 – Timber)
	Responsible sourcing of Materials: Finishing Elements	1 35	1.45 (Tunber)	1.56 (3 – Timber)	1.60 (3 – Timber)
	Recycling Facilities	2.71	2 90	3.13 (6)	3 19 (6)
		14	14 98	16 15 (31)	16 49 (31)
Water	Internal Potable Water Use	8.33	8.33	7.81 (15)	10.64 (20)
	External Potable Water Use	1.67	1.67	1 56 (3)	
		10	10	9 38 (18)	10 64 (20)
Land Use and Ecology	Ecological value of site	1.33	1.67	1.56 (3)	4 79 (9)
	Change of ecological value of site	5.33	6.67	6 25 (12)	6.38 (12)
	Building footprint	2.67	3.33	3.13 (6)	3 19 (6)
	Ecological enhancement	1.33	1.67	1.56 (3)	
	Protection of ecological features	1.33	1 67	1.56 (3)	
		12	15.01	14.06 (27)	14 36 (27)
Health and Well Being	Daylighting	5.25	5.64	6.25 (12)	4.26 (8)
	Sound Insulation	7.00	7.52	8 33 (16)	8 51 (16)
	Private space	1.75	1.88	2.08 (4)	2.13 (4)
		14	15.04	16 67 (32)	14 89 (28)
Management	Home User Guide	3.00			
	Considerate Constructors	2.00			
	Construction Site Impacts	3.00			
	Security	2.00			
		10			
Total		100	100	100 (192)	100 (188)
EcoHomes bre	Rating	Score (%)			
	Pass	36	36	36	36 (68)
	Good	48	48	48	48 (90)
	Very Good	58	60	60	60 (113)
	Excellent	70	70	70	70 (132)

Figure 4.3: Developmental progress of EcoHomes since 2001

To summarise, these are interim findings from the study of EcoHomes, but provide a sound basis for analysing environmental effects and setting priorities for further action. It seems that there is still a long way to go to develop EcoHomes in terms of increasing its effectiveness. As argued by Cole (2006: 363),

> 'Most of the focus in the development of LEED has been on the continued refinement of the credit and submittal requirements and, more recently, at reducing documentation burdens on design and construction teams and on LEED assessors.'

From the view of progress of EcoHomes since 2001 (as shown in Figure 4.3), it can be found that a similar situation also applies to the development of EcoHomes. More sub-categories and further separation within each category have been developed according to attributes in the areas of 'building performance, design and procurement assessment, and management and operation assessment' (Pitts 2004: 88). It is important to note that, although 'Management' has been introduced as a new category in the version EcoHomes 2006 to encourage assessors and other stakeholders to pay more attention to issues which occur in the building construction and operational phases, less information is available to enable the related communication or knowledge transfer between different stakeholder groups (see BRE 2006b). To apply EcoHomes to broaden project participation and support the related decision-making, some further analysis work needs to be carried out to transfer this existing assessment version towards a stakeholder-oriented outcome.

It is also important to note that, although a general consensus has been reached about the palette of environmental issues that should be addressed in the housing design processes, assessment schemes in different times are likely to address them in different order of relative importance. For instance, as shown in Figure 4.4, all the housing environmental issues have been re-arranged in the order of relative importance as addressed in EcoHomes 2006. Compared with this system for value judgement, the one adopted in the Code for Sustainable Homes, which was released in 2007, pays more attention to some issues, such as 'daylighting' and 'household recycling facilities' and so on, besides those nuances between some adjacent issues. From this longitudinal study, it can also be found that there is a potential tendency that technology-dependent issues have become less important in the scheme year after year due to the technological improvement (e.g. 'NOx emissions', 'building fabric or building envelop performance' and 'reduction of surface runoff', etc.). On the other hand, human-related issues, especially personal attitude or behaviour related to energy saving and carbon reductions during the operational phase of house construction and occupation, have gradually become more important (e.g. 'home user guide', 'household recycling facilities' and 'construction site impacts', etc.).

Issues in EcoHomes & the Code for Sustainable Homes	2007	2006	2005	2003	2002/2001
Dwelling Emission Rate – CO_2 (TER)	18.8 ★	13.75	10.71	10.42 (20)	10.64 (20)
Internal Potable Water Use	7.5 ★	8.33	8.33	7.81 (15)	Shared 10.64 (20)
Environmental Impact of Materials	4.5 ☆	7.23	7.73	8.33 (16)	8.51 (16)
Sound Insulation	4.7	7.00	7.52	8.33 (16)	8.51 (16)
Change of ecological value of site	4.8	5.33	6.67	6.25 (12)	6.38 (12)
Daylighting	5.3	5.35	5.64	6.25 (12)	4.26 (8)
Lifetime Homes	4.7				
Local Amenities		3.00	3.21	3.13 (6)	3.19 (6)
Home User Guide	3.3	3.00			
Construction Site Impacts	2.2	3.00			
Renewable and Low Emission Energy Source and Technologies	2.5 ★	2.73	2.14		
NO_x emissions	2.1	2.73	6.43	6.25 (12)	6.38 (12)
Household Recycling Facilities	3.6 ☆	2.71	2.90	3.13 (6)	3.19 (6)
Responsible sourcing of Materials: Basic Building Elements	1.8 ☆	2.71	2.90 (Timber)	3.13 (6 – Timber)	3.19 (6 – Timber)
Building footprint	2.7	2.67	3.33	3.13 (6)	3.19 (6)
Public Transport		2.00	2.14	2.08 (4)	2.13 (4)
Cycle storage	2.5 ★	2.00	2.14	2.08 (4)	1.06 (2)
Considerate Constructors	2.2	2.00			
Security	2.2	2.00			
External Lighting	2.5 ★	1.83	2.14	2.08 (4)	2.13 (4)
Building envelope performance / fabric	2.5 ★	1.83	5.36	5.21 (10)	5.32 (10)
Eco-Labelled white goods	2.5 ★	1.83	2.14	2.08 (4)	2.13 (4)
Internal Lighting	2.5 ★	1.83			
Construction waste	1.8 ☆				
Reduction of surface runoff	1.1 ☆	1.82	4.28	4.17 (8)	
Flood Risk Mitigation	1.1 ☆	1.82			
Private space	1.1	1.75	1.88	2.08 (4)	2.13 (4)
External Potable Water Use	1.5 ★	1.67	1.67	1.56 (3)	Shared 10.64 (20)
Responsible sourcing of Materials: Finishing Elements	0.9 ☆	1.35	1.45 (Timber)	1.56 (3 – Timber)	1.60 (3 – Timber)
Ecological value of site	1.3	1.33	1.67	1.56 (3)	4.79 (9)
Ecological enhancement	1.3	1.33	1.67	1.56 (3)	
Protection of ecological features	1.3	1.33	1.67	1.56 (3)	
Home Office	1.3 ★	1.00	1.07	1.04 (2)	1.06 (2)
Drying space	1.3 ★	0.92	1.07	1.04 (2)	1.06 (2)
Composting facilities	0.9 ☆				
Insulation ODP and GWP	0.7	8.91	2.14	4.17 (8)	8.51 (16)

bre · Communities and Local Government

Rating by score (%)

			2006		2005		2003		2002/2001	
★	Level 1	36 points	Pass	36/100	Pass	36/100	Pass	36/100	Pass	36 (68)
★★	Level 2	48 points	Good	48/100	Good	48/100	Good	48/100	Good	48 (90)
★★★	Level 3	57 points	Very Good	58/100	Very Good	60/100	Very Good	60/100	Very Good	60 (113)
★★★★	Level 4	68 points	Excellent	70/100	Excellent	70/100	Excellent	70/100	Excellent	70 (132)
★★★★★	Level 5	84 points								
★★★★★★	Level 6	90 points	*All the data information are based on EcoHomes and the Code for Sustainable Homes by BRE or DCLG*							

Figure 4.4: Relative importance of housing environmental issues (the Legislator Group)

In this research, the weighting system by EcoHomes 2006 is used as the appraisal standard. Based on the order of relative importance as addressed in this benchmark, a close comparison can be carried out to investigate designers' intention and householders' awareness of different housing environmental issues. Relevant issues will be further discussed in the next chapter, respectively from a designer's perspective (Design Stage Review) and an occupant's perspective (Post Construction/Occupancy Review).

The release of the Code did not have a significant impact over this research as it happened after the data collection phase of this research. Actually, the principal attitude of the new Code, an integrated perspective from both Design Stage Review and Post Construction Review, has already been highlighted in this research throughout the analysis and application of EcoHomes scheme.

4.6 USING ECOHOMES TO SUPPORT DECISION-MAKING PROCESSES

Typically, assessment tools are not ready to be integrated into the decision-making process since they often adopt a retrospective perspective and cannot be easily applied in the design or building construction phase. Due to the competition among different professionals (architects, assessors, rating experts, property valuation professionals, consultants, etc.) in the medium-term, there is often a differentiation between tools 'that can accompany the design stage' and those 'that can be used within the scope of external rating for already completed designs or buildings' (Lutzkendorf and Lorenz 2006: 345). For most assessment tools existing in the current market, they are normally used by external specialists towards the end of the design in order to evaluate the final results only, though this procedure often raises an 'information delay' (ibid: 337) that hampers the optimisation of design solutions. Obviously, there is a need to shift the emphasis 'from reactive (or scrutinizing) assessment to a proactive (and integrated) project appraisal' by incorporating the philosophy of sustainability (Kaatz *et al.* 2006: 318). Moreover, Lutzkendorf and Lorenz (2006: 345) also point out, tools cannot be discussed or treated in isolation from those stakeholders 'who use the tools' and those 'who use the assessment results within their decision-making process'.

To achieve a win-win result, this research aims to enable key stakeholders (developers, architects, engineers, occupiers etc.) to use the assessment tools to compare alternative options and optimise the application of a variety of measures in collaborative decision-making processes. Among these stakeholders, the majority of architects, as core decision-makers in the building procurement process, clearly play an important role to introduce this discipline (Dammann and Elle 2006). Although it is acknowledged that some issues in EcoHomes are not under the control of architects, architects have an important responsibility to conduct and lead the negotiation-based communication and to handle the trans-disciplinary trade-offs between different demands from other stakeholder groups. Moreover, with probably more specialist knowledge due to their professional background, architects also need to introduce different assessment tools into the related design phases at a proper time since these tools generally provide building-related information only at 'selected points' in time (Lutzkendorf and Lorenz 2006: 352).

Then the question has been identified as **how to apply EcoHomes to help architects make more informed decisions, enable them to rapidly assess different design options and select the most appropriate ones in terms of their relative importance (embodied sustainability values)**. To allow this happen, some expectations of the assessment tools are required (Lutzkendorf and Lorenz 2006: 345):

- 'Readily available
- Well-documented and explained
- User-friendly and deliver interpretable results
- Supported with education and training courses
- Able to optimize design sketches by providing case study facilities
- Capable of generating documents and reports (e.g. energy passports, etc.)
- Adjustable to the designer's / planner's working methods
- Capable of processing information available within different design stages'

EcoHomes meets most of these conditions. However, since assessment tools do not build houses, the decisions taken on the basis of indicators lying behind them remain decisive. Therefore, whether informed decisions can be ultimately made depends heavily on to what extent the key stakeholders accept and use these tools. This broad acceptance is especially important when implementing EcoHomes in the housing market since it is to be used based on voluntary bottom-up initiatives. However, since EcoHomes, as with many other existing assessment tools, is not designed according to *architects'* (or developers', occupants', etc.) specific demands, the consensus 'across different groups of decision-makers in different phases of a building's life cycle' (Dammann and Elle 2006: 387) is not easy to achieve.

Cited in Dammann and Elle (2006: 396), the chief architect of a major housing association points out:

> 'We don't have time for that. If life cycle assessments and results of the different materials are not already available so that one immediately can compare them with one another we don't have the possibility to carry out the calculations ourselves. And we cannot assign a technician to it either. This would cost a fortune. ... We cannot carry out basic research just because we are building a house!'

Moreover, to maintain their elevated status as competent generalists in practice (Till 1996), architects also worry about the potential restrictions introduced by these environmental indicator-based benchmarks, either on their design freedom or on their power to define the principles of 'green building' (Dammann and Elle 2006: 396). As a result, the concept of 'transparent, well-documented, consistent' environmental indicators for building is often seen sceptically by architects (ibid: 395). Likewise, they would prefer to use 'implicit indicators based on environmental issues mixed with general functional and aesthetical aspects' in a 'holistic view' (a more subjective judgement) rather than 'operate with clearly defined environmental notions' directly (Dammann and Elle 2006: 396, Andreu and Oreszczyn 2004). To them, there is a need to integrate the building's benefits or 'output' (functionality, aesthetical serviceability categories) and the building-related expenses or 'input' (costs, energy and mass flows, and environmental impacts, etc.) (Lutzkendorf and Lorenz 2006: 345). Since the assessment of building performance-based issues and sustainability issues (environmental issues in particular in this research) are normally discussed and assessed separately, these two approaches do not need to be in conflict in practice. In contrast, concerning sustainable development or building environmental design, the description of building performance is 'a precondition for safeguarding the comparability of building concepts, and for validating the fulfilment of building users' needs' (ibid: 345).

To enhance the efficiency of the decision-making process, formulate possible project goals for investors and communicate possible solutions for planners and designers, EcoHomes scheme needs to be modified to accompany the planning phases as a hands-on guidance. In this research, therefore, it becomes extremely important to adjust EcoHomes scheme towards typical design workflows, transfer its context to respond to those questions within different decision-making stages and facilitate related information exchange between different stakeholder groups. Although it seems that the *Plan of Work* by the Royal Institute of British Architects (RIBA *ed.* 1999; as shown in Figure 4.5) provided a perfect workflow to allow EcoHomes to fit in, this is not the case.

This is mainly because, to obtain the maximum benefits and the most efficient decision-making, environmental issues within EcoHomes need to be addressed at the very early phases of design decision-making (Rao *et al.* 2002: 6), such as briefing and sketch plans (Figure 4.5). Hence in this research, a more general procedural sequence, which is usually employed by architects' thinking, has been applied to allow for more potential flexibility, categorised as: project scheme and management; master plan and landscape; plan, elevation, section, interior design; energy and water supply; other details (as shown in Figure 4.6).

Outline Plan of Work				
Stage	**Purpose of work and decisions to be reached**	**Tasks to be done**	**People directly involved**	**Commonly used terminology**
A Inception	To prepare general outline of requirements and plan future action	Set up client organisation for briefing. Consider requirements, appoint architect.	All client interests, architect	Briefing
B Feasibility	To provide the client with an appraisal and recommendation in order that he may determine the form in which the project is to proceed, ensuring that it is feasible, functionally, technically and financially.	Carry out studies of user requirements, site conditions, planning, design, and cost, etc., as necessary to reach decisions.	Clients' representatives, architects, engineers and QS according to nature of project.	
Stage C begins when the architect's brief has been determined in sufficient detail.				
C Outline Proposals	To determine general approach to layout, design and construction in order to obtain authoritative approval of the client on the outline proposals and accompanying report.	Develop the brief further. Carry out studies on user requirements, technical problems, planning, design and costs, as necessary to reach decisions.	All client interests, architects, engineers, QS and specialists as required.	Sketch plans
D Scheme Design	To complete the brief and decide on particular proposals, including planning arrangement appearance, constructional method, outline specification, and cost, and to obtain all approvals.	Final development of the brief, full design of the project by architect, preliminary design by engineers, preparation of cost plan and full explanatory report. Submission of proposals for all approvals.	All client interests, architects, engineers, QS and specialists and all statutory and other approving authorities.	
Brief should not be modified after this point.				
E Detail Design	To obtain final decision on every matter related to design, specification, construction and cost.	Full design of every part and component of the building by collaboration of all concerned. Complete cost checking of designs.	Architects, QS, engineers and specialists, contractor (if appointed).	Working drawings
Any further change in location, size, shape, or cost after this time will result in abortive work.				
F Production Information	To prepare production information and make final detailed decisions to carry out work.	Preparation of final production information i.e. drawings, schedules and specifications.	Architects, engineers and specialists, contractor (if appointed).	
G Bills of Quantities	To prepare and complete all information and arrangements for obtaining tender.	Preparation of Bills of Quantities and tender documents.	Architects, QS, contractor (if appointed).	
H Tender Action	Action as recommended in relevant NJCC *Code of Procedure for Selective Tendering*	Action as recommended in relevant NJCC *Code of Procedure for Selective Tendering.*	Architects, QS, engineers, contractor, client.	
J Project Planning	To enable the contractor to programme the work in accordance with contract conditions; brief site inspectorate; and make arrangements to commence work on site.	Action in accordance with RIBA *Plan of Work*	Contractor, sub-contractors.	Site operations
K Operations on Site	To follow plans through to practical completion of the building	Action in accordance with RIBA *Plan of Work*	Architects, engineers, contractors, sub-contractors, QS, client.	
L Completion	To hand over the building to the client for occupation, remedy any defects, settle the final account, and complete all work in accordance with the contract.	Action in accordance with RIBA *Plan of Work*	Architects, engineers, contractor, QS, client.	
M Feedback	To analyse the management, construction and performance of the project.	Analysis of job records. Inspections of completed building. Studies of building in use.	Architect, engineers, QS, contractor, client.	Feedback

Figure 4.5: Outline Plan of Work by RIBA (Source: RIBA *ed.* 1999)

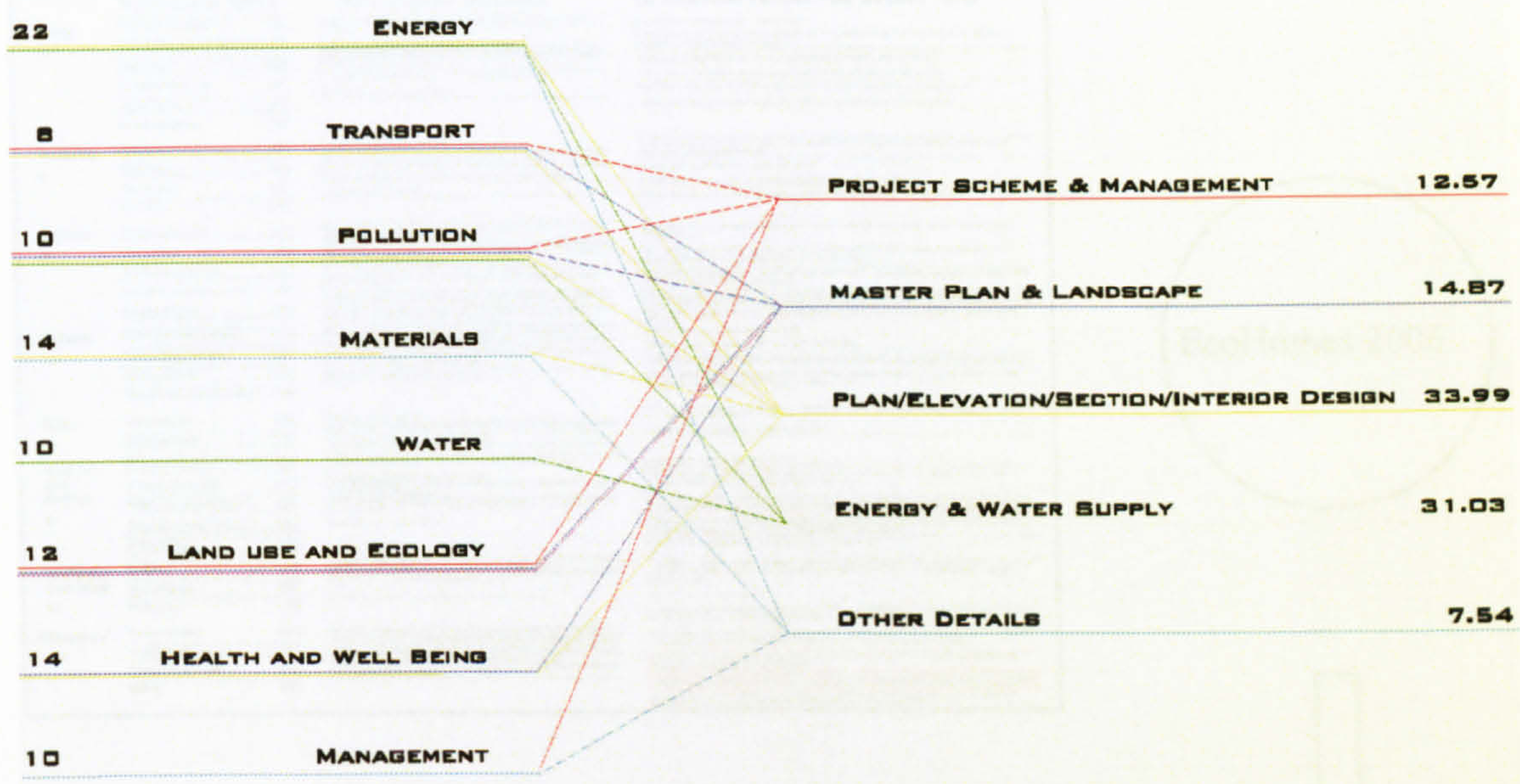

Figure 4.6: Process Mapping – link issues in EcoHomes with related design phases

From an architectural outset, all competing parameters in EcoHomes are re-arranged with regard to those questions that mainly occur in different design stages (as shown in Figure 4.7). Compared with the technical fashion in which issues are structured in EcoHomes (energy, transport, pollution, materials, water, land use and ecology, health and well being, management as categorised in Figure 4.8), this new mapping procedure (Figure 4.10) reorganises these issues to be more related to the sequence of design decision-making in an architectural project.

Besides providing designers with strategic direction to improve building environmental performance as a qualitative checklist, this new procedure (Figure 4.10) provides a potential opportunity to allow architects to convert their decision-making process from a qualitative procedure into a quantitative one (Chen *et al.* 2006, 2008a).

Since the weighting system in the *Pre-Assessment Estimator* provides a related score for each design measure together with detailed criteria in the *Guidance*, architects may use them as quantitative checklists and make decisions between alternative design options based on the principle of trade-off. By comparing the merits of different design measures across an agreed set of topics and obtaining a picture of their relative importance, this rapid but structured strategy can help summarise complicated environmental data to reach practical decisions. Further, it can increase efficiency and address flexibility in the decision-making processes, especially under some unlikely constraints such as limited time, budget and so on.

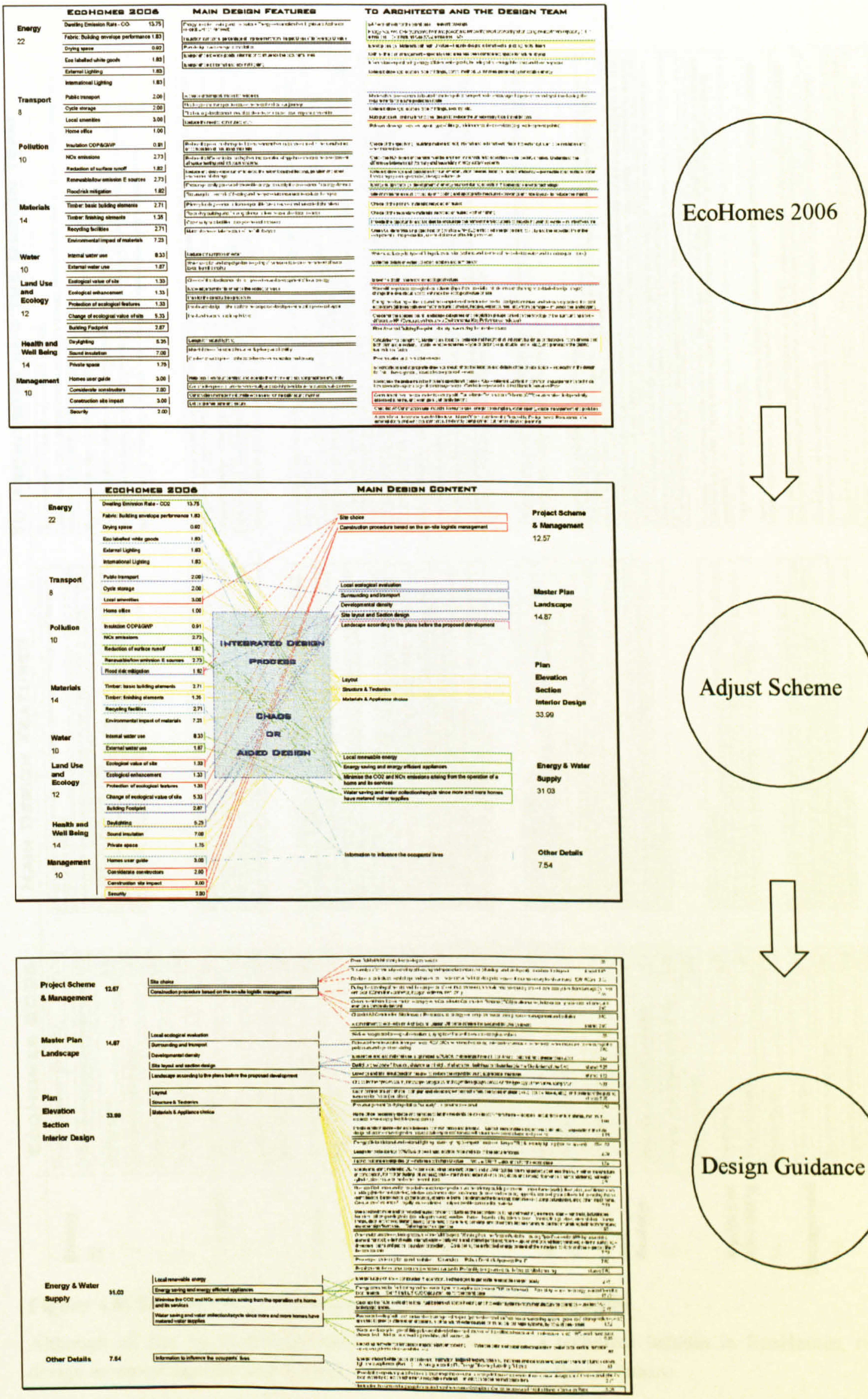

Figure 4.7: Adjust EcoHomes scheme to guide the design process (from Figure 4.8 to 4.10)

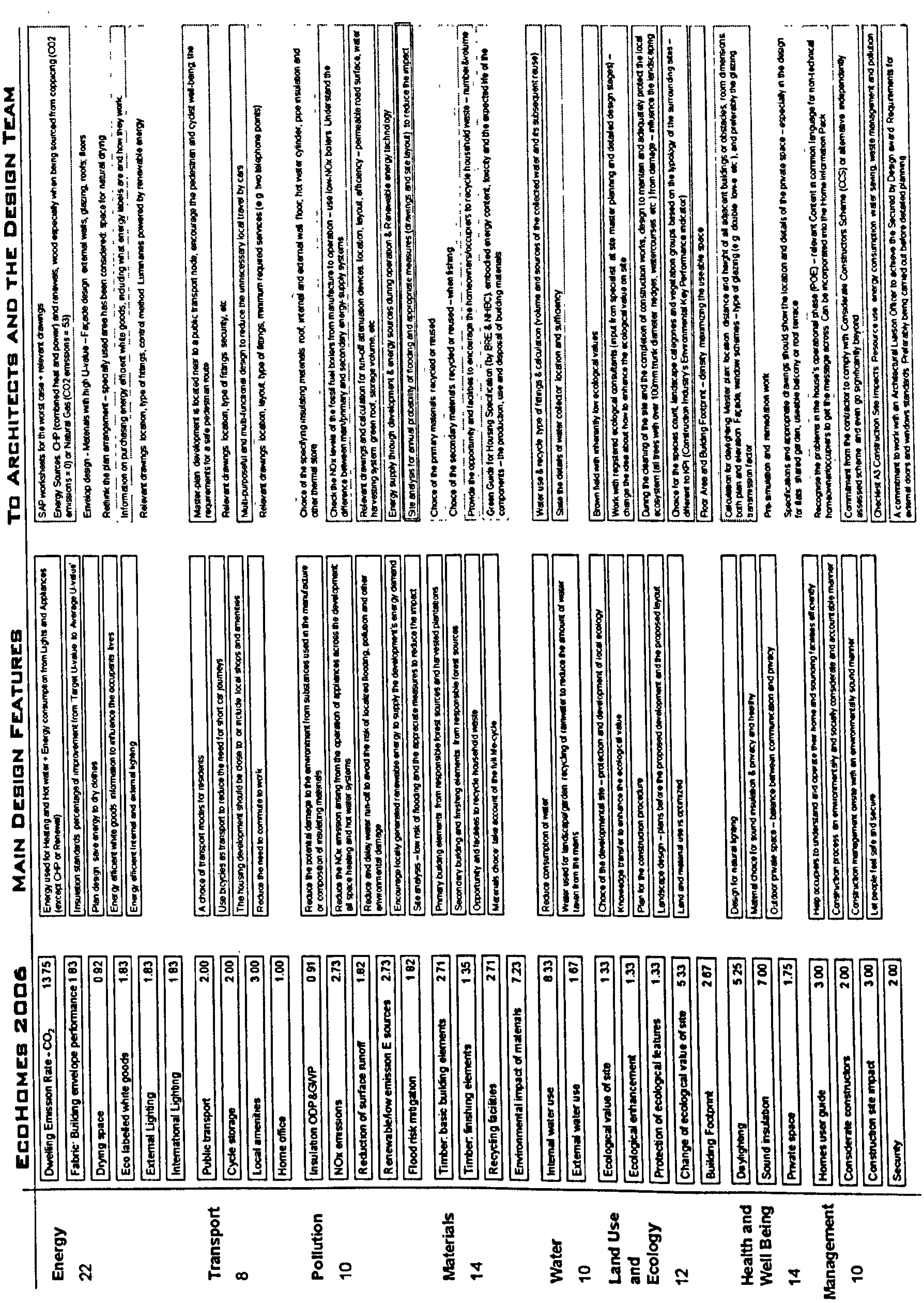

Figure 4.8: Environmental issues addressed in EcoHomes 2006

Although all the environmental issues are structured in a technical fashion in EcoHomes, related design measures and detailed criteria are briefly described in the *Guidance*.

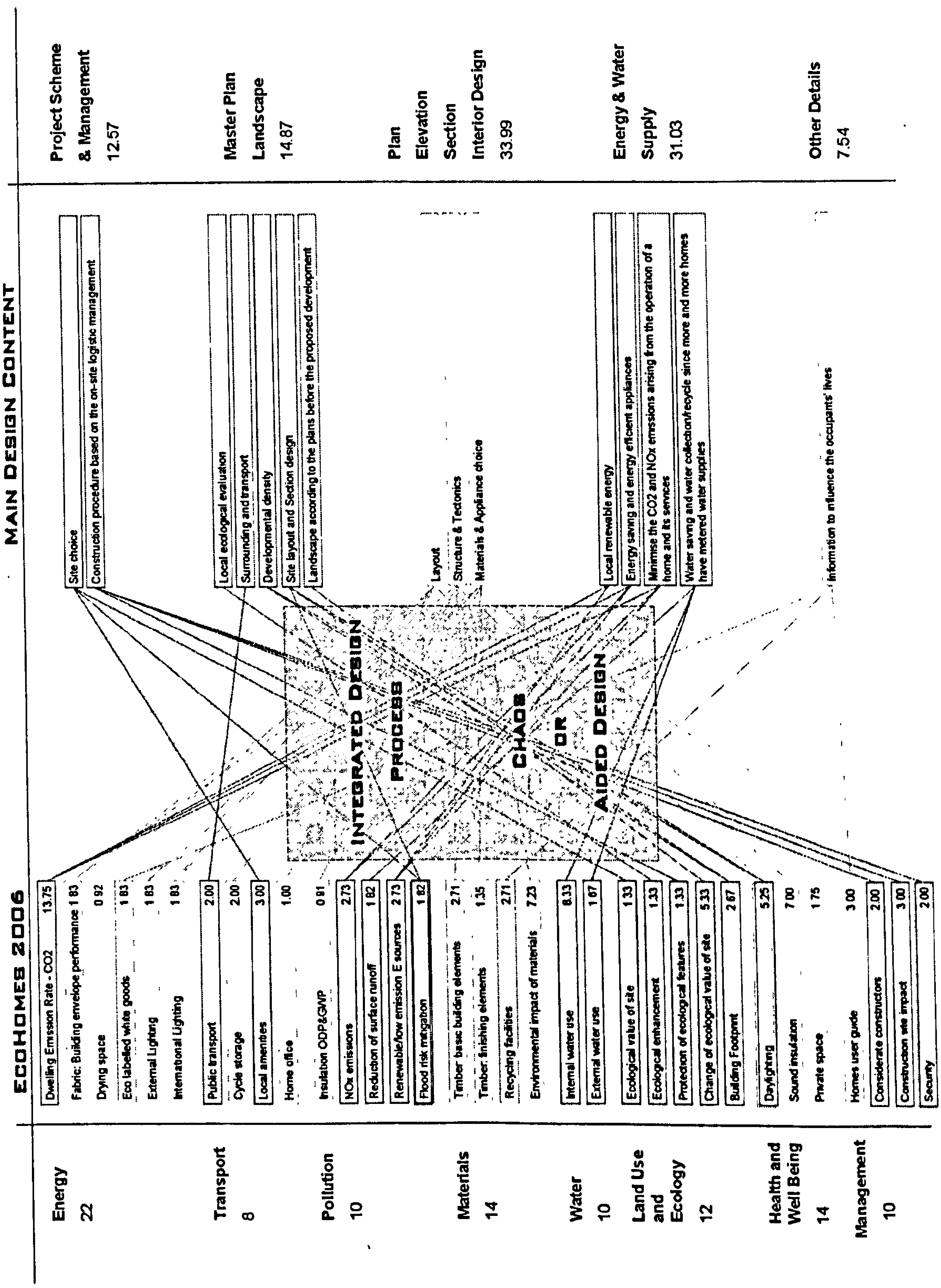

Figure 4.9: Adjust EcoHomes scheme towards typical design workflows

It is necessary to adjust EcoHomes scheme towards typical design workflows, transfer its context to respond to those questions within different decision-making stages. Otherwise, it will not be able to improve the efficiency of the plan of work but lead to chaos.

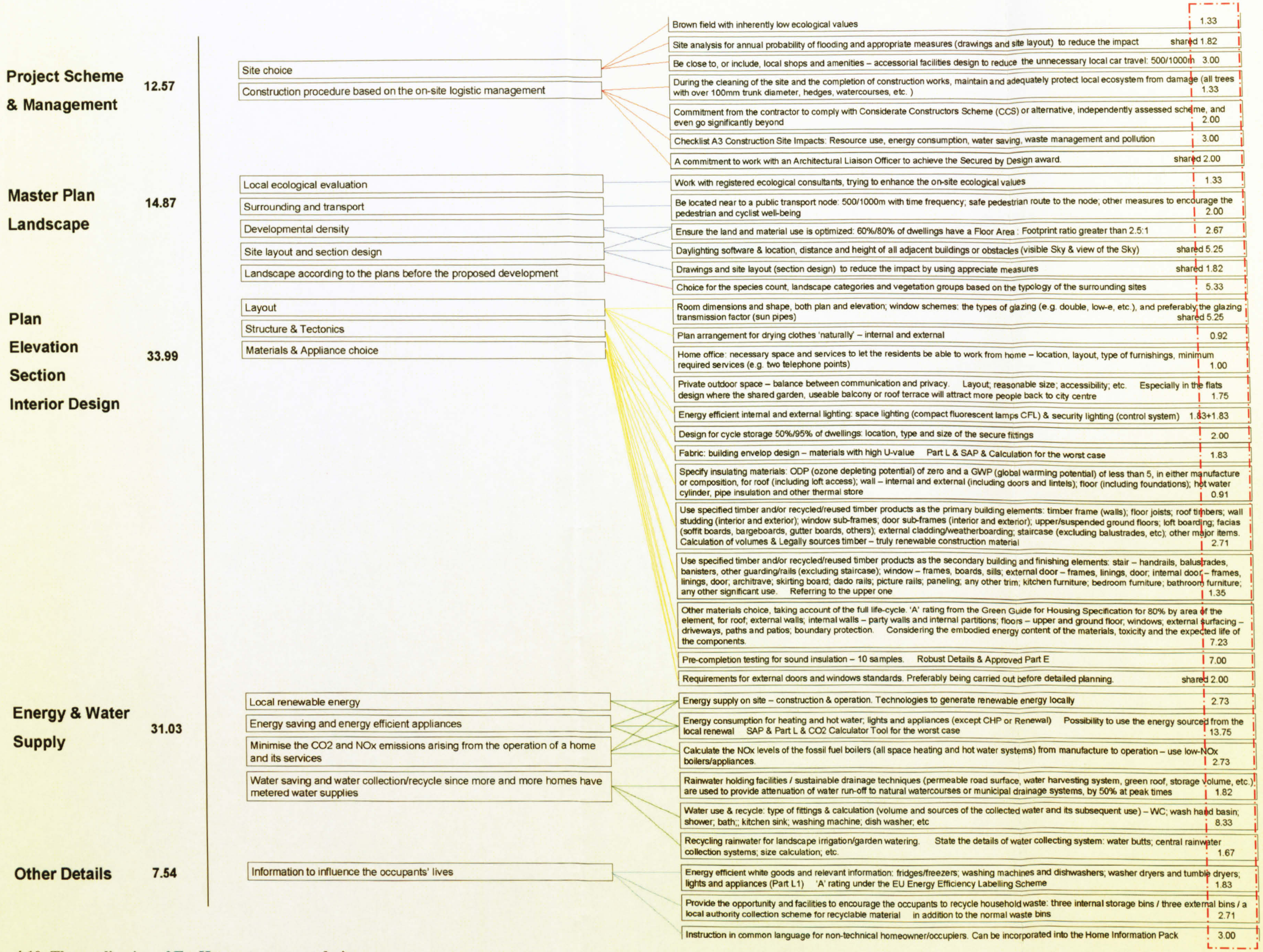

Figure 4.10: The application of EcoHomes to support design processes

Since weighting system in the *Pre-Assessment Estimator* provides a related credit for each design measure together with detailed criteria in the *Guidance*, architects may use them as quantitative checklists (*transparent graphical interface*) and decide to accept or reject a particular design measure according to its corresponding credit as well as how easy to meet the specific requirements in real-life projects.

However, whether this procedure, a combined determination with both qualitative and quantitative perspectives, will lead to a truly 'green building' is a more open question. As argued by Dammann and Elle (2006: 401),

> 'As the limited impact of already existing indicator systems shows, indicators as "a common language for green building" among the relevant actors are a *necessary*, but not a *sufficient* condition for green building.'

From an empirical study of construction effectiveness, Lowe (2006: 412) also implies that architects often pay attention to assessment tool's 'impacts on innovation', rather than the degree to which they 'embody an absolute external measure of sustainability'.

However, it is still worth noting that, although this initial attempt might not be sufficient to bring forth green housing immediately, this review process of EcoHomes will help architects increase their familiarity with a systematic consideration of environmental aspects by means of indicators. Moreover, by 'identifying', 'quantifying' and 'incorporating' environmental issues into the decision-making processes (Ding 2005: 6), these kinds of indicators may help decision-makers 'create the option of taking stock, setting targets and measuring progress, be it in voluntary agreements or binding demand in building regulations' (European Environment Agency 1999, cited in Dammann and Elle 2006: 401). Therefore, they have potential power to engage architects to undertake analysis of alternative design or construction practices consciously, especially when they consider those measures that might introduce new costs or time requirements to the development process, such as building energy simulation, commissioning and so on.

To better understand knowledge transfer and cogitative gap between architects and professional assessments or regulations, a questionnaire is designed to investigate architects' intentions concerning environmental issues addressed in EcoHomes. This is described in the next chapter (*Questionnaire for Future Designers* in Chapter 5). It is also planned to review how well the environmental issues addressed in EcoHomes will match up with those issues regarded important by architects.

4.7 COMMUNICATION PLATFORM BASED ON A COMMON LANGUAGE

As argued by Dammann and Elle (2006: 388), environmental indicators for buildings have the potential to 'make the environmental impacts (and possibly benefits) of buildings visible to all relevant actors' and then to 'facilitate the consideration, management and communication of an array of environmental issues in the relevant decision-making phases'. Therefore, the implementation of integrated building-related environmental tools (such as EcoHomes), where the relevant indicators are located, might facilitate further communication and collaboration in a collaborative decision-making process – 'improve the organization of the information flow as well as the basis for sharing information and knowledge between different professional groups, between profession groups and stakeholders, and between regulators and professionals' (Lutzkendorf and Lorenz 2006: 352). However, Dammann and Elle (2006) also point out that this will only happen if these environmental indicators for buildings are perceived as *fit-for-purpose* by the relevant stakeholders and a consensus can be achieved among them. Obviously, this is not easy in real-life practice.

Although there is a general awareness about building-related environmental issues between different stakeholders, the consensus is rather weak since they often have 'different environmental priorities' and talk about environmental issues in 'different languages' (Dammann and Elle 2006: 397). Different environmental priorities might be adjusted through related participation-based negotiation at times. Yet the absence of a common language will lead to an unfortunate communication gap, which might then result in misunderstanding and breed distrust between different participant groups. This is the major barrier for knowledge transfer. Also because of this, the interrelationships between these stakeholders tend to break down. Questions then arise about whether the early efforts to apply such regulation-related assessment methods with the wording proposed would represent the most effective way of achieving the sustainability objectives (Banfill and Peacock 2007: 434). This phenomenon has been observed not only between professional and lay stakeholders, but also between different professional stakeholder groups at the level of integration of green technologies where:

> 'The delegation of assignments to specialists weakens essential linkages between tasks that are indeed interrelated. Some parts of the system may be optimized or sized at the expense of others and to the detriment of the overall building design, but the trade-offs are seldom made explicit. Instead, each successive designer's product is tossed over the wall to the next designer, as if the effort were part of a relay race rather than a team process. Even when the specialists do meet and try to

communicate, they may not succeed because each of the two dozen or so players in the building-design process may have different incentives, a different outlook, and worst of all, a very different technical language'. (Stein *et al.* 1998, cited in Dammann and Elle 2006: 388)

This situation, lack of a common language, leads to the 'Green Building Challenge' initiative (Curwell *et al.* 1999, Cole and Larsson 2002) in the construction sector. However, Dammann and Elle (2006: 402) also point out, by applying the theory of social construction of technology (SCOT[xxxii]), mapping and analysis of the observed areas of consensus and lines of conflict between the demands from different stakeholder groups, it can be found that a complete consensus across all stakeholders is unlikely to be reached in the near future. To accommodate the initiative, Dammann and Elle (2006: 398) suggest three likely scenarios for the future study instead:

- Scenario 0: '*Post-modern relations*', in which the present situation with a multitude of indicator systems used in parallel with each other continues
- Scenario 1: '*Science goes public*', in which the SF (scientific frame), the PRF (public-relations frame) and the LSF (layperson-sensualist frame) agree upon indicators based on LCA
- Scenario 2: '*Keep it simple*', in which the PRF (public-relations frame), the LSF (layperson-sensualist frame) and the AHF (aesthetic-holistic frame) agree on simple, concrete measures-based checklist indicators

Between these three approaches, Dammann and Elle have a preference towards the second (Scenario 1) where a method of multi-level aggregation has been implied. This method allows for close debate and communication between different stakeholder groups while maintaining a certain degree of 'interpretative flexibility' which allows different stakeholders to still maintain their understanding and views on environmental issues at their own knowledge level '*in parallel*' (Dammann and Elle 2006: 399). In other words, the implementation of multi-level knowledge aggregation in the communication procedure explores the possibility that close knowledge transfer can be achieved between different stakeholder groups *without* a ***complete consensus*** (Luxenburger and Asmussen 2001, cited

xxxii 'The central idea of SCOT (social construction of technology) is that the 'working' of a technological artefact such as of a set of EIFOB (environmental indicators for buildings) is socially constructed by the artefact's relevant social groups and is not an immanent characteristic of the artefact itself. Accordingly, one and the same technological artefact can in its societal embedding be seen (or 'interpreted') by several different relevant social groups as several different socio-technological artefacts. SCOT calls this the 'interpretative flexibility' of the artefact'. (Dammann and Elle 2006: 390) in ibid: 400). This view has also been supported by BRE's sustainability checklist for developments (Brownhill and Rao 2002: v):

> 'Considerable ongoing research (at BRE and elsewhere) has found it difficult to define appropriate indicators due to the broad and complex nature of sustainability. However, this research shares a common view that in order to be meaningful, indicators must act at the appropriate level.'

Since this approach allows different stakeholders to use mainly their own level of aggregation, the uneven distribution of environmental knowledge will lead to potentially differing degrees of 'literacy' across different stakeholder groups in the communication process (Dammann and Elle 2006: 400). For knowledge transfer, it is actually not necessary to let stakeholders with less environmental knowledge speak the language exactly like those stakeholders with more knowledge. But it will be required that stakeholders with more environmental knowledge should be capable of not only speaking the language of stakeholders with less knowledge but also understanding implicit meanings of specialist knowledge (i.e. the likely technical strategies or design measures). In other words, the so called '***common language***' does not need to comprise all levels of knowledge aggregation, but only the level understood by all, including 'the stakeholder group with the least environmental knowledge' (ibid: 401).

To get the message across, a communication platform based on a common language is proposed to facilitate knowledge transfer between the corresponding levels of different stakeholder groups and 'verify their diverse perceptions and perspectives when challenged with framing problems in the context of sustainability' (Kaatz *et al.* 2005: 447). This trans-level negotiation is sometimes called 'functioning communication' (Dammann and Elle 2006: 401).

Dammann and Elle (2006: 402) also argue that the overlapping knowledge shared between professional and lay stakeholders will increase along with the twofold increase of knowledge: 'the increase of environmental knowledge among non-professional stakeholders' and 'the increase of socio-technical knowledge among professional stakeholders'. Based on this argument, Cole (2006: 368) implies that there might be an as yet untapped potential for a scheme to be framed in a combination of socio-technical terms to address building environmental issues in a more holistic way.

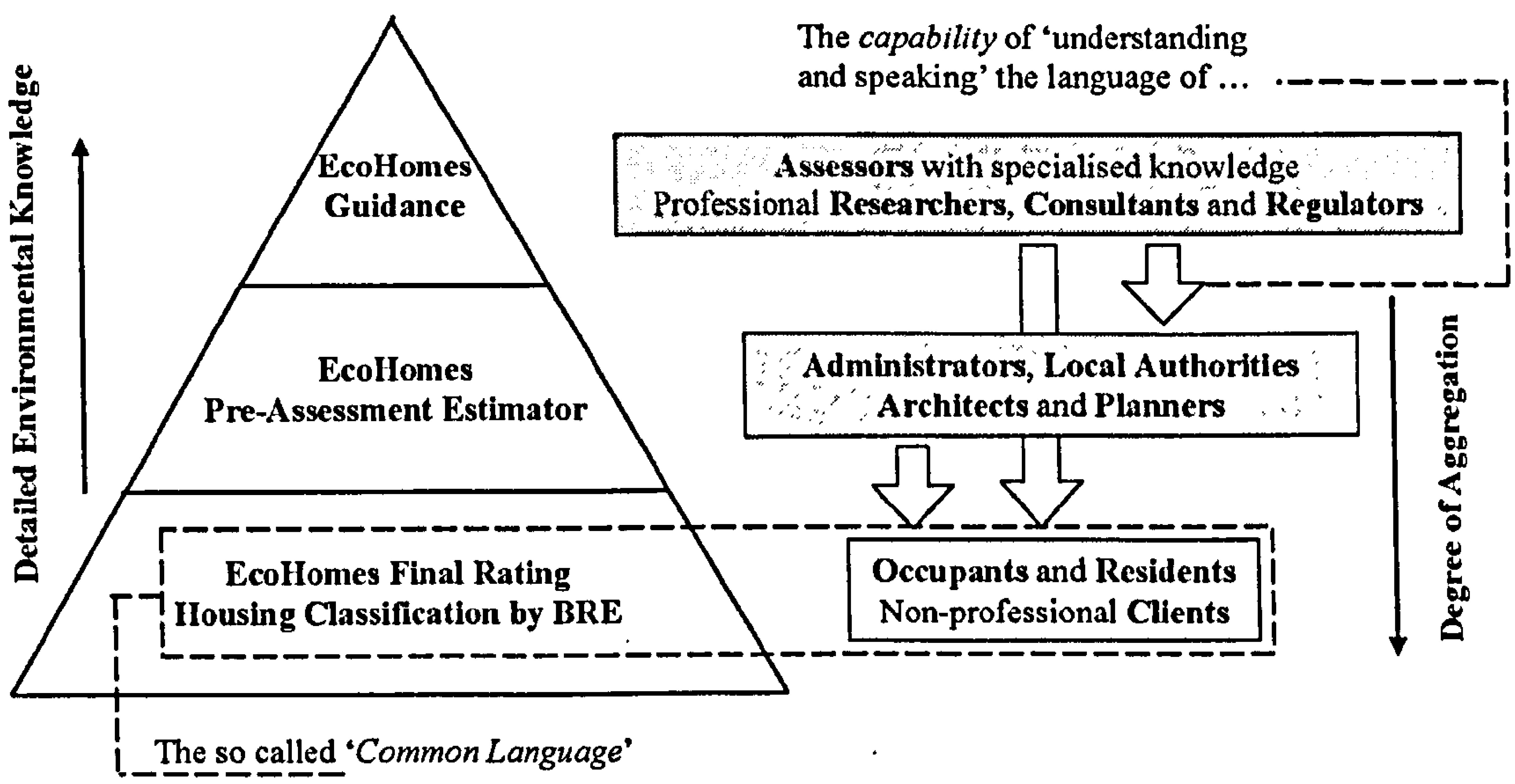

Figure 4.11: Aggregation of multi-level knowledge based on a common language

As shown in Figure 4.11, the concept of trans-disciplinary aggregation has been well demonstrated during the formalization of EcoHomes. With respect to requirements of different stakeholder groups, the formats of communication and presentation have been appropriately adjusted where the 'Pre-Assessment Estimator', the 'Guidance' and the 'Final Rating Score' constitute a frame with all three knowledge levels and with all related environmental criteria structured in 'an organized fashion' (Cole 2006: 369) (for details, see 4.5.3). Moreover, it provides a level of building environmental knowledge (the final rating score) as common language to share the related information within all stakeholders. To a great extent, therefore, EcoHomes has the potential to work as a communication platform in the housing market (comprising all different levels of knowledge aggregation and being formalized based on a common language). Likewise, it is also argued that the framework of EcoHomes might be capable of accommodating the principle of dialogue as 'a common, consistent and integral part' (Cole 2005: 464; 2006: 369) of the decision-making process.

However, the unfortunate thing is that few consumers (lay stakeholders) in the housing market have awareness of this existing common language or the potential function of the 'entry-level' knowledge in EcoHomes (also true for some professional stakeholders though they might have different causes). Moreover, their awareness of building environmental issues also lags far behind where it should be. This might become a significant barrier to implement a communication platform as a green labelling scheme in the future since the housing market is shifting from predominantly 'supply-push' to 'demand-pull' (Lutzkendorf and Speer 2005). Thus, to reach a ***close consensus*** between different stakeholder groups, besides using common language to facilitate the communication, it is important to enable a joint decision-making procedure to allow for a broader integration of opinions and to facilitate the potential possibilities of collaborative learning.

Although legislators (classified as the 'scientific frame' by Dammann and Elle (2006: 393)) have frequently not been involved in the actual design process, they create 'rigid and mandatory' constraints and boundaries within which designers and clients must work. Likewise, according to the *Plan of Work* by RIBA (RIBA *ed.* 1999), the communication between clients (classified as the 'public-relations frame' by Dammann and Elle (2006: 393)) and designers (classified as the 'aesthetic-holistic frame' by ibid: 393) is assumed to be well conducted due to the contract effect though architects might need to work more positively to engage the clients who might have less concerns about environmental issues in the related negotiation (also see 2.5.2). However, the lay stakeholder group (classified as the 'layperson-sensualist frame' by ibid), with less detailed environmental or technical knowledge, has often been excluded from the 'participation-based' decision-making process, either for housing assessment or development (for details, see 4.5.1).

This exclusion results in a significant problem in the housing market that non-professional stakeholders see environmental assessment tools for buildings as 'an incomprehensible but in some ways useful *expert tool* (e.g. when they address indoor climate aspect that are difficult to capture for laypersons)', but also as 'an *untrustworthy* challenge of their own pet solutions' (Dammann and Elle 2006: 396). In a collaborative decision-making process, therefore, particular attention should be paid to the concerns from these lay stakeholders' perspectives. As a result, besides environmental or energy-related design and assessment tools, the communication platform should allow other (non-environmental) toolkits or design tasks to be integrated (see Lutzkendorf and Lorenz 2006: 346-351). As argued by Dammann and Elle (2006: 396), lay stakeholders in ecological settlements will often prefer to use '(implicit) qualitative' building environmental indicators as a lifestyle label to create social cohesion and a 'green' identity. Hence some important non-professional or non-technical features should be addressed to allow the communication platform to be further modified. These might include some aspects, such as reflecting the lay stakeholders' critical views on environmental issues, focusing directly on certain features (such as 'local circulation systems and technical measures of symbolic significance'), and highlight ultimate building performance especially indoor climate and so on (ibid: 396).

In summary, this broader collaborative 'developing, implementing and propagating process', based on a common language, is helpful to 'avoid the mismatch of information supply and demand' (Lutzkendorf and Lorenz 2006: 336). Obviously, these two approaches, a common language and a more stakeholder-inclusive collaborative decision-making process, will also be the key for the development of a communication platform in the future.

To better understand the knowledge transfer and cogitative gap between lay householders and professional assessments or regulations, another questionnaire is designed to investigate housing occupants' awareness of environmental issues addressed in EcoHomes. This is described in the next chapter (*Questionnaire for Current Housing Occupants* in Chapter 5). Based on a communication platform, it is also planned to investigate how well the environmental issues addressed in EcoHomes will match up with those issues regarded important by occupants with little specialist knowledge.

4.8 DISCUSSION AND CONCLUSION

As argued by Lutzkendorf and Lorenz (2006: 346), there is a potentially 'growing (market-, regulatory- and industry-driven) interest' for building assessments and their results, though the implementation of building assessments has not yet been seen as a mainstream activity in the construction sector. Therefore, the process that allows related building environmental knowledge to be shared widely across different stakeholder groups becomes the focus of this research. Based on the analysis of existing building environmental assessment tools, the concept of a communication platform has been perceived as an important method for use in the future housing market. Moreover, two approaches have been addressed to introduce the principle of trans-disciplinary communication: a **common language** and a **broader collaborative decision-making process.**

To facilitate knowledge transfer, a common language should be agreed between different levels of knowledge aggregation. This 'entry-level' language aims to initiate further concerns about detailed environmental strategies or measures. In this research, the framework of EcoHomes has been applied as a communication platform and the 'Final Rating Score' of EcoHomes has been regarded as the common language. However, since this research discusses environmental issues on the basis of architect's knowledge level, particular attention is paid to the application of the Pre-Assessment Estimator of EcoHomes.

Although the Pre-Assessment Estimator, as a minimal list of indicators (standardization), will be helpful for benchmarking purposes, whether this simplified procedure will result in the neglect of some particular aspects of different buildings is a more open question.

Moreover, due to the rationale that 'a less expensive, broad-based, entry-level method would influence market transformation by increasing the demand for more energy efficient and environmentally benign (sustainable) buildings (ECD 2002: 1)' (cited in Cole 2006: 366), it is still arguable whether EcoHomes, which is mainly based on commercial incentives, can lead the housing market towards better environmental design. In any case, to avoid the unnecessary negative aspects, building assessment tools need to be regularly revised as knowledge evolves and 'today's certainties can become tomorrow's uncertainties' (Dammann and Elle 2006: 402, Till 2007).

Besides a common language, a broader collaborative decision-making protocol starting from the early design phase will be another key to allow the information to be widely shared between different stakeholder groups and consequently to reach a closer consensus through collaborative learning. This is especially important to avoid some unexpected results caused by the mismatch of information supply and demand, such as the frequent 'significant differences' between the predicted, simulated performance of many new buildings during their design phase (by professional stakeholders) and the actual energy consumption in their operational phase (by stakeholders with less environmental knowledge) (Roaf *et al.* 2004: 9, CIRIA 2009: 5). However, since housing occupants have not been included in the decision-making of EcoHomes and architects in practice show less initiative on environmental issues, it will be important to find answers to the following questions (referring to the sub-question in 2.7.3):

- Will architects and non-professional occupants be concerned with the same issues of environmental friendly housing design?
- Can architects truly consider the likely environmental requirements from a non-professional occupant's perspective?
- Will opinions from architects and occupants correspond with view from legislators (referring to the criteria of EcoHomes or the Government's Code); if not, what is the significant knowledge gap?

Rather than providing detailed solutions (how to make up this gap, such as detailed design measures or guidelines), this research aims to identify the main problem (where is the communication gap: major mismatch between architects' intentions, clients' interests, occupants' awareness and legislators' constraints bearing on housing environmental issues), and so have the cognitive gap explicit whilst leaving more room for creative innovation from architects or other decision makers. As argued by Lowe (2006: 412), details of this kind of research are required both to 'support strategic decision-making' and to 'challenge a prevailing climate of opinion'.

It is also necessary to investigate how the understanding from the lay stakeholders can be fed back into the decision-making process; also how this procedure will influence peoples' everyday attitudes and behaviour, especially lifestyle change relating to energy saving, carbon reductions and waste recycling in the operational phase of house occupation. Some potential initiatives to persuade and engage householders to participate in the decision-making process will be discussed in later chapters, mainly concerned with how the assessment results can be transferred into appropriate communication formats to support the compilation of required documentation (e.g. energy and building passports, repair and servicing manuals, maintenance plans, and building user's guide and so on) (Lutzkendorf and Lorenz 2006: 352) (examples also given by Parnell 2003a, the Sellers'/Buyers' Home Energy Report in the Home Information Pack).

It is important to note that the high rating by any existing building environmental assessment tools is a *necessary*, but **not** a *sufficient*, condition for green building. The challenge of implementing green building practices therefore remains and it is worth adopting a more open mind to consider issues arising in the decision-making process from a more integrated socio-technical perspective.

Since 'without learning there is no communication' (Dammann and Elle 2006: 403), relevant education and further training possibilities in terms of interpreting building assessment results should be offered for decision-makers to implement the assessment tools in the market, besides demonstrating economic profits (Lutzkendorf and Lorenz 2006). This social campaign is based on two educational approaches, which requires professional stakeholders (architects and engineers) to learn more about social science and non-professional stakeholders (householders or tenants) to learn more about environmental science. This should also accelerate the overlapping process for knowledge shared between them (Dammann and Elle 2006: 402). This initiative has two parallel approaches: educational curricula needs to 'teach graduates an awareness of the relevance, or even better the skills, of trans-disciplinary communication'; while professional organisations needs to 'build or improve capabilities in the different actor groups to create a commonality of understanding' (ibid: 402). More relevant demonstration cases (such as Student Accommodation projects by the University Partnerships Programme (UPP), Carbon Reduction in Buildings (CaRB), etc.) should be provided as examples in the 'social laboratory' to allow these trans-disciplinary communication skills to be principally acquired in 'off-line' training scenarios and in real-life projects (Dammann and Elle 2006: 402).

4.9 CHAPTER SUMMARY

Based on the study of building sustainability assessment methods, it is argued in this chapter that, in order to increase the effectiveness of collaborative decision-making, three key themes should be addressed for constructing a successful communication platform: integration, transparency and accessibility, and collaborative learning.

Some assessment schemes coexisting in the UK housing market are reviewed and compared. The results (see Table 4.1) can help future decision makers identify the specific features of different assessment schemes, select the most suitable ones and optimise the application according to their relevance.

The environmental issues addressed in BREEAM EcoHomes are reorganised towards typical design workflows (see Figure 4.6). By comparing the merits of different design options across an agreed set of topics and obtaining a full picture of their relative importance, this new mapping procedure (see Figure 4.10) provides a potential opportunity to allow architects to convert their decision-making process from a qualitative procedure into a quantitative one. It is argued that the application of EcoHomes to support decision-making processes, by shifting the emphasis 'from reactive (or scrutinizing) assessment to a proactive (and integrated) project appraisal' (Kaatz *et al.* 2006: 318), can help architects increase their familiarity with a systematic consideration of environmental aspects.

Actually, when evaluating building sustainability issues, different stakeholders would prefer to address the underlying problems from different dimensions, by different procedures, through different formats and to different extents, taking into account their intrinsically varying incentives. To avoid the mismatch of information supply and demand, therefore, a communication platform needs to be designed to get the message across. There are two important factors that should be taken into account in this design procedure: a common language and a broader collaborative decision-making process. Due to its capability of multi-level knowledge aggregation, it is suggested by the researcher that the framework of EcoHomes be used as a template to form the communication platform and facilitate knowledge transfer. However, the ultimate success of this proposal depends on if, and to what extent, a consensus on environmental issues can be reached among the key stakeholder groups in the construction sector.

Hence in the next chapter, the system for value judgement used by EcoHomes will be used as an appraisal standard, based on which architects' intentions and householders' awareness of environment issues can be studied in a pilot investigation. Other relevant work, such as the potential cognitive gaps between different stakeholder groups, will also be discussed based on the criteria in later chapters.

CHAPTER 5

QUESTIONNAIRE DESIGN AND A PILOT INVESTIGATION FOR DESIGNER'S INTENTION AND OCCUPANT'S AWARENESS

5

5.1 CHAPTER OUTLINE

This chapter describes the design procedure of two questionnaires and a pilot investigation carried out in a focus group of postgraduate architectural students. It is argued in this chapter that students in the target group should be educated that they are contributing to both problems and solutions in tackling climate change.

Based on the study in Chapter 4, two questionnaires are designed from a socio-technical perspective, one to test architects' understanding (the stakeholder group with more environmental or technical knowledge) and the other to investigate occupants' awareness (the stakeholder group with less environmental or technical knowledge) of housing environmental issues. Since issues addressed in these two questionnaires are both drawn from EcoHomes, they are interrelated to some extent. Based on this communication platform, consultation responses, opinions from different stakeholder groups (i.e. architects, occupants, clients and regulators), can be used for cross-comparisons and trans-disciplinary studies. This survey also explores the untapped opportunity in social interventions that can lead housing development to move towards sustainability in the future.

As argued in Chapter 2 (see 2.7.2), the research scenario is identified as university students studying architecture or built environment related disciplines and issues about their understanding of sustainability principles, relating to sustainable design and sustainable living manners. The second part of this chapter describes a pilot study which is carried out within a focus group of postgraduate architectural students. It aims to determine whether these students are likely to address different housing environmental issues, both in the design processes as designers and in the accommodation seeking processes as end users. This is set out based on the system for value judgement used by EcoHomes. The pilot study also provides an opportunity to determine whether these students have realised that their dual status of both future housing designers and current housing occupants will make them contribute to both problems and solutions in tackling climate change.

5.2 QUESTIONNAIRE DESIGN BASED ON ECOHOMES

As argued in Chapter 2 (see 2.7), there is a clear need to explore the cognitive gaps between different stakeholder groups in the design decision-making processes. In this research, particular attention is paid to the variances between stakeholder groups normally with more environmental or technical knowledge (e.g. the Legislator Group and the Designer Group) and stakeholder groups often with less environmental or technical knowledge (e.g. the Client

Group and the Occupant Group). To allow for a cross-comparison, it is first necessary to set an appraisal standard.

Through the study of EcoHomes and the Code for Sustainable Homes (see 4.5.1), it is found that the relative importance of each of the environmental impact categories is adjusted by applying a set of consensus-based environmental weighting factors. These weighting factors are derived from an extensive study[xxxiii] carried out by Building Research Establishment (BRE), in which a wide range of stakeholder groups are asked for opinions on different environmental issues covered within the housing assessment method. As declared by BRE, feedback from the interest groups are broadly similar and a close consensus has been achieved (DCLG 2007b). Moreover, responses from two earlier consultations (DCLG 2006d; 2007c) also show that the way in which EcoHomes and the Code address housing environmental issues is positively supported by a variety of different cultural viewpoints (as shown in Figure 5.1 and Figure 5.2). Therefore, it is reasonable to believe that the level of relative importance of different housing environmental issues used by EcoHomes (or the system for value judgement used by EcoHomes) can be applied as a benchmark for further study, as shown in Figure 5.3. Since different environmental impacts are compared against a single scale or score (BRE's Ecopoints (Dickie and Howard 2000)) in this benchmark, a more consistent and holistic analysis of housing environmental issues can be carried out on the basis of it.

Based on this assumption, two questionnaires are designed, one to examine architects' knowledge and willingness to address housing environmental issues in the design processes, and the other to investigate occupants' awareness and willingness to adopt sustainable living principles in their everyday lives. In the pilot investigation, these two issues can be raised at the same time since architectural students (both future housing designers and current housing users) are identified as the main research scenario. Close comparisons between designers' consciousness, end users' awareness and regulators' constraints (referring to the criteria of EcoHomes or the Code) are made later. Further, since the Code has been applied as a

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[xxxiii] The original weighting factors from the Centre for Sustainable Construction at BRE in 1998 have recently been reviewed in the light of a second study carried out be BRE as part of the Green Guide 2007 development (BRE IP, The BREEAM Guide Environmental Weighting System). An international panel of experts have been surveyed and an open consultation exercise focused on industry representatives has been carried out. The results from the two survey groups were broadly similar and those from the expert group were then used to inform the revised environmental weightings used in the Code taking account of: the contribution that new housing in the UK makes to the impact category concerned; and the opportunity that exists to influence the impact at the design and construction stage. However, there are also some aspects of the Code were not covered by the recent survey. And the weightings for these areas have been taken from previous consensus studies carried out to support BRE's EcoHomes method. (DCLG 2007b)

mandatory rating requirement for all new housing development since 2008 (BRE 2007), it becomes a central issue of this research to see whether current architectural education has equipped these students with sufficient **knowledge** and appropriate subjective norms (including '**motives**' and '**values**', see Gluch and Stenberg 2006: 107), for the purposes of both sustainable design and lifestyle choice.

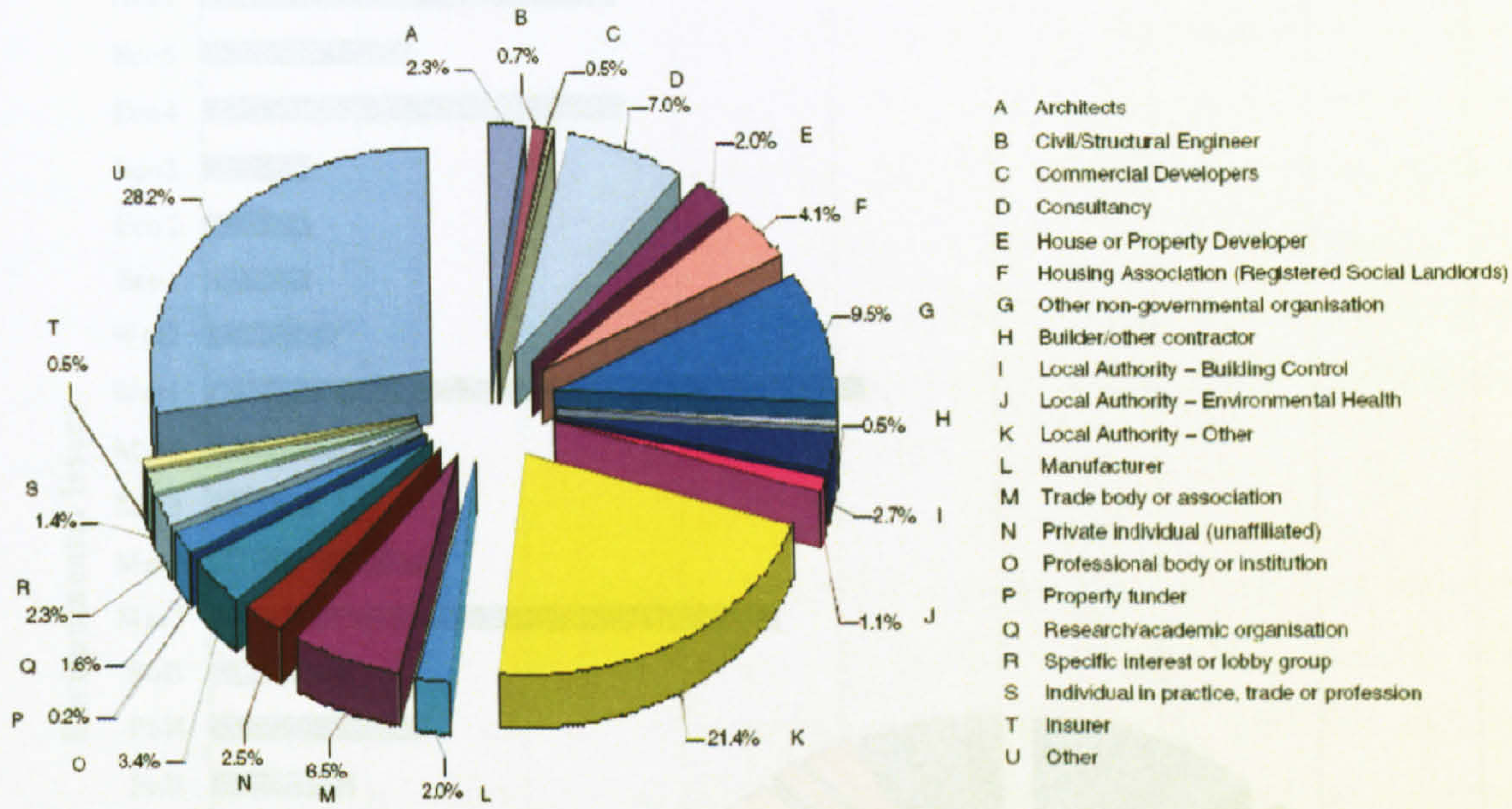

Figure 5.1: Pie chart of respondents by organisation type (on the proposals for introducing a Code for Sustainable Homes). (DCLG 2006d: 6)

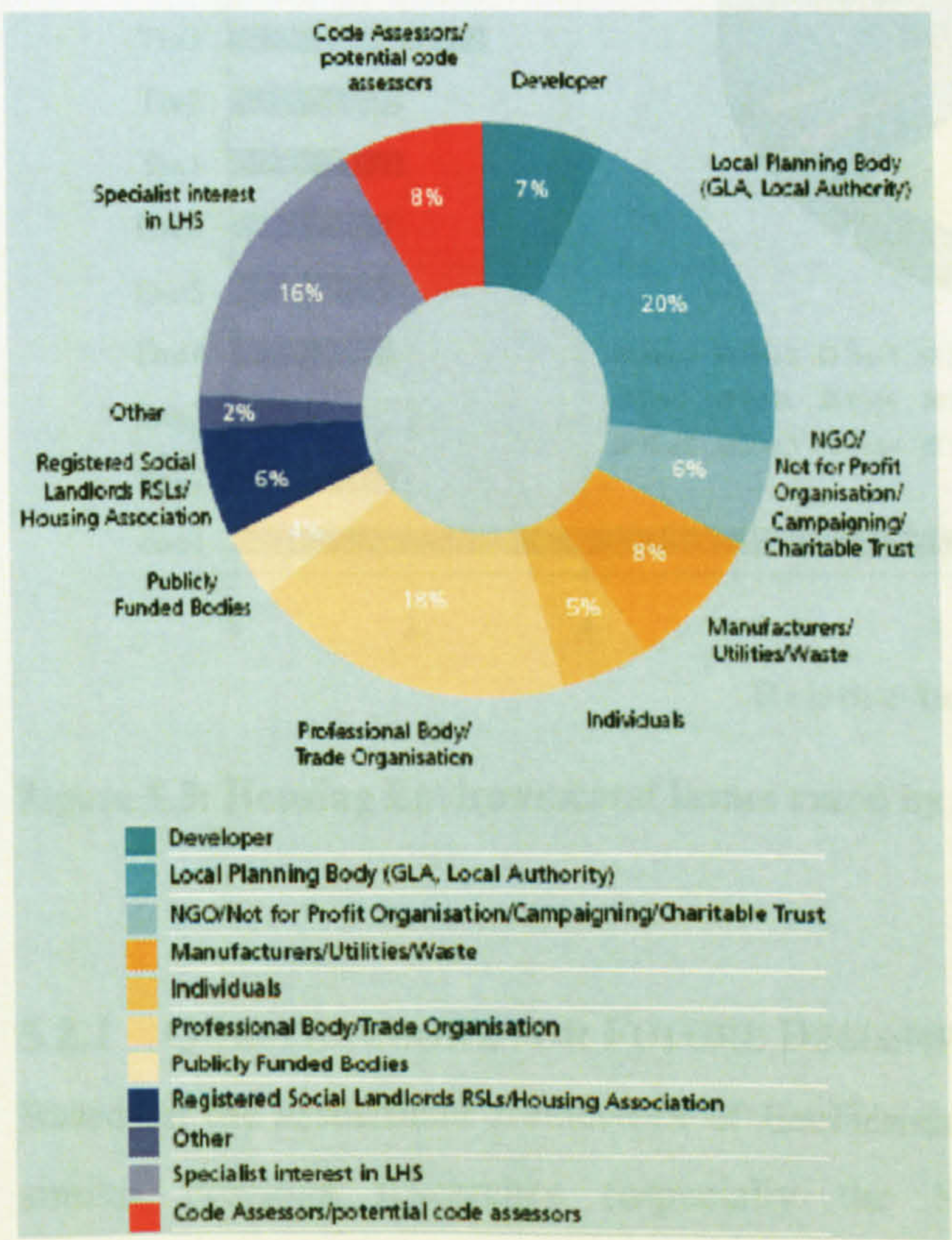

Figure 5.2: Breakdown of respondents by organisation type (on making the Code for Sustainable Homes mandatory) (DCLG 2007c: 8)

Figure 5.3: Housing Environmental Issues rated by EcoHomes 2006

5.2.1 QUESTIONNAIRE FOR FUTURE DESIGNERS

Based on the assessment framework of EcoHomes 2006 and empirical studies from some similar previous researches (especially the Sustainable Property Development &

Construction Survey carried out by BRE online in 2005), a questionnaire is prepared to examine architectural students' knowledge of housing environmental issues and their consciousness of applying related design guidelines. The questionnaire design procedure is reviewed in the following sections (Q – Question) and a sample of *Questionnaire for Future Designers* can be found in Appendix 2.5.

Since this study focuses on a group of postgraduate architectural students, it is believed that their knowledge of sustainable design issues mainly comes from their related educational background and previous professional experience. Therefore, QA1 and QA2 are used to categorise the variables and allow for a longitudinal study[xxxiv] in the future. QA3 investigates architectural students' interest in sustainability issues. As argued in Chapter 2 (see 2.2.3), among various building types, housing holds an important position in the approach of sustainable architectural design. Hence it is important to see whether architectural students are informed about this in current architectural education.

In the housing design processes, different designers may prefer to make decisions based on varying tools or standards. QB1 is designed to explore the prevailing methods that architectural students normally use. QB2 furthers the investigation in QB1 and explores students' awareness and experience of some prevalent housing design standards. Certainly some of these questions overlap. For example, EcoHomes includes information from Standard Assessment Procedure (SAP), Building Regulations Part L and Green Guide to Specification as part of its content (BRE 2006b; also see 4.5.1).

Questions in QC1 constitute the most important part of the questionnaire. All environmental issues addressed in EcoHomes are re-arranged according to a simplified design process (see Figure 4.6). Some related design strategies are drawn based on the study of *the Guidance of EcoHomes* (BRE 2006b), as shown in Figure 5.4. Then students in the target group are asked to evaluate their knowledge and use of these design guidelines. Feedback from QC1 can be used to see whether current architectural education has equipped students with sufficient knowledge of sustainable housing design. It also attempts to examine students' consciousness of studying and applying these design guidelines to improve efficiency of their design processes and make their products close to the higher ratings in EcoHomes.

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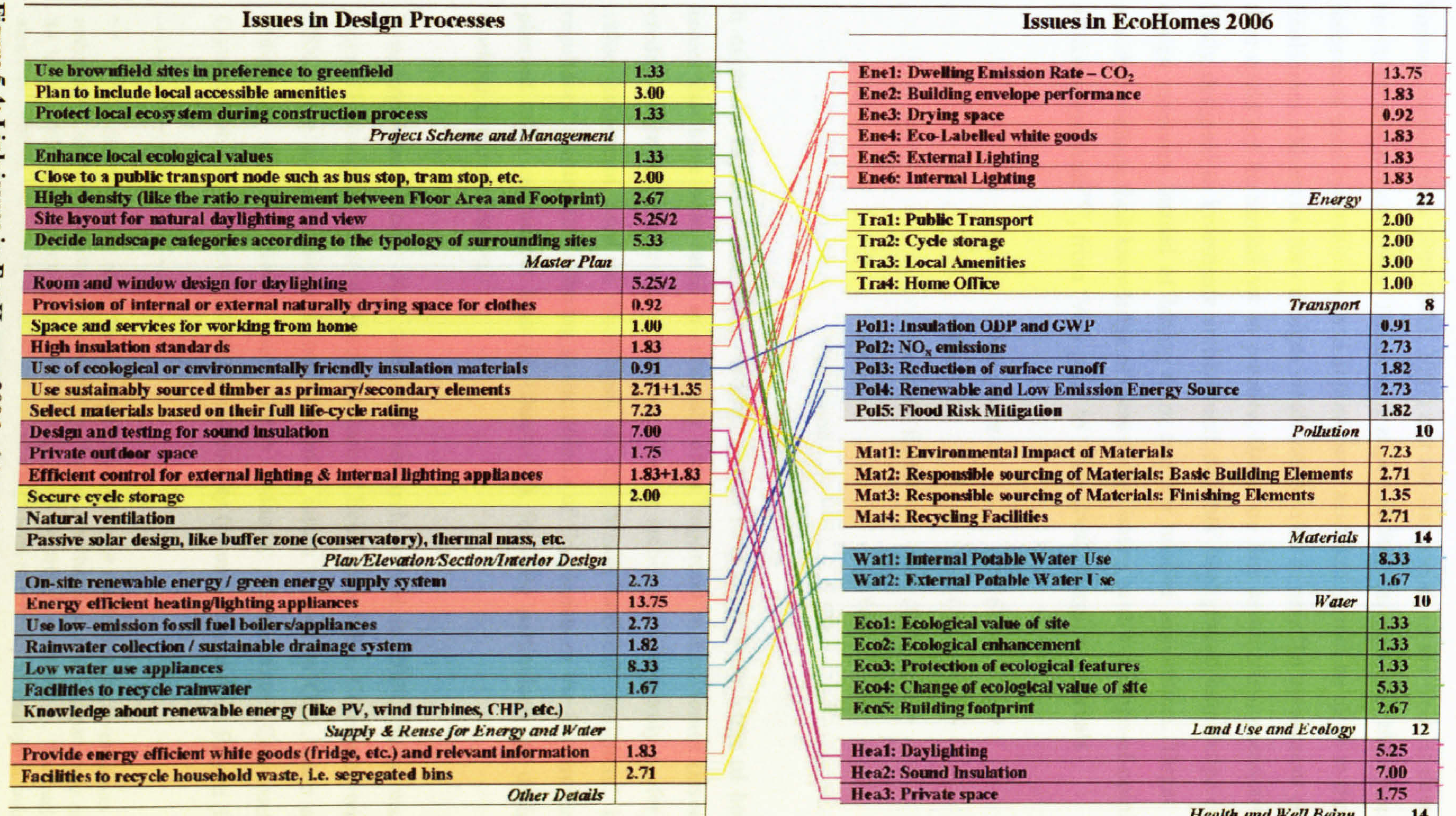
xxxiv It is good to see whether the target students' knowledge of sustainability principles will be improved in current education programmes from a longitudinal perspective. Although a further step (the follow-up study based on the same group of students) has not been carried out in this research due to time constraints, it is expected to be done in the future.



Although the environmental issues and their order of importance have been updated up to the EcoHomes version 2006, the questionnaire for the future designers was mainly designed based on the EcoHomes version 2005.

Figure 5.4: Link issues in EcoHomes 2006 with related design strategies

The Code for Sustainable Homes has been applied as a mandatory requirement in the housing market since 2008 (BRE 2007) and the framework of the Code is developed based on its prototype EcoHomes. Hence it is expected that, theoretically, the system for value judgement used by architects (and architectural students) should be close to the one used in EcoHomes. Otherwise their designs would not be able to pass the assessment procedure and then could not be carried out in practice. Based on this assumption, questions in QC1 are firstly designed to investigate architectural students' background knowledge of sustainable design measures instead of letting them rate the relative importance. Target students are asked to evaluate their knowledge of these design issues, with 1-5 range-of-opinion based on a Likert-type scale[xxxv], from 'Very poor' to 'Very good' at regular intervals.

o	Very poor	1 (-2)
o	Poor	2 (-1)
o	Neutral / Equal	3 (0)
o	Good	4 (1)
o	Very good	5 (2)

It might be expected that these students should have more knowledge of housing design issues that have been rated as relatively more important in EcoHomes (issues with more credits available). However, to find out whether architects would truly prefer to adopt the value judgement used in EcoHomes, a comparison between designers' intention and regulators' constraints (referring to the criteria of EcoHomes or the Government's Code) is planned to be carried out later (in Chapter 8), focusing particularly on designers already working in the profession.

It is important to note that, since this research started in 2004, questions in QC1 are originally designed based on the framework of EcoHomes 2005. Compared with EcoHomes 2006, there are some housing environmental issues missed in QC1, such as Flood Risk Mitigation (Pol5), Home User Guide (Man1), Considerate Constructors (Man2), Construction Site Impacts (Man3), and Security (Man4) (as show in Figure 5.4). However,

[xxxv] Likert scale is one of the most common techniques for conducting the investigation of attitudes. It is essentially 'a multiple-indicator or -item measure of a set of attitudes relating to a particular area'. 'The goal of the Likert scale is to measure intensity of feelings about the area in question'. ... 'Normally since the scale measures intensity, the scoring is carried out so that a high level of intensity of feelings in connection with each indicator receives a high score (for example, on a 5-point scale, a score of 5 for very strong positive feelings about an issue and a score of 1 for very negative feelings)'. ... 'Variations on the typical format of indicating degrees of agreement are scales referring to frequency (for example, 'never' through to 'always') and evaluation (for example, 'very poor' through to 'very good')'. (Bryman 2004: 68)

this does not influence the follow-up data analysis processes in which all issues are still analysed based on weighting system of EcoHomes 2006. In other words, each housing environmental issue addressed in the design processes (QC1) is given credits according to the latter EcoHomes version, with total scores of all issues in QC1 adding up to 88.17.

In order to make comparison between designers' intention and regulators' constraints (referring to EcoHomes) possible, it is assumed that all environmental issues should be considered from a compulsory and balanced perspective. This is different from the way in which EcoHomes truly works (for details, see 4.5.2).

Since this research aims to explore knowledge gaps between different stakeholder groups, it is important to understand their varying information sources. QD1 is designed to investigate such issues. QD2 and QD3 explore incentives for designers to take sustainable measures into account in the decision-making processes, from both positive and negative perspectives.

As argued earlier (see 2.6.2 and 4.8), to achieve sustainability, a collaborative decision-making procedure should be used to facilitate knowledge transfer between different stakeholder groups in housing designs. In collaborative design processes, architects have the responsibility to offer their specialised decision-making skills rather than being dominant (see 2.7.1). Therefore, it is important to determine whether architects have realised their new duty, which is to get the message across to different stakeholder groups, and are likely to encourage other stakeholders to take sustainability principles into account at an earlier stage. QE1 and QE2 are designed to investigate such related issues. Further, it is also argued in Chapter 2 (see 2.4.2) that a housing occupant's lifestyles (including purchase and use patterns for housing and energy) are important for energy saving and carbon reductions, especially during the operational phase of house occupation. QE3 is designed to examine architects' awareness of this issue and their willingness to encourage housing occupants to make changes.

QF1 is an open-ended question which allows participants to provide comments on sustainable design issues or the survey.

5.2.2 QUESTIONNAIRE FOR CURRENT HOUSING OCCUPANTS

As claimed in *Our Common Future* (Bruntland 1987: xiv), sustainable development needs to change peoples' 'attitudes', 'social values' and 'inspirations', which will rely heavily on 'vast campaigns of education, debate, and public participation'. In Chapter 2 (see 2.7.2), it is argued that university students, especially those studying in relevant disciplines (e.g.

Architecture, Landscape, Town and Regional Planning, etc.), can be considered as *key* professionals in the campaign against climate change. It is believed that, unless they realise their roles in tackling climate change and take steps to change their conventional lifestyle towards greater environmental sensitivity, they would not be able to re-educate other stakeholders in the future. In other words, these stakeholders' awareness of sustainability principles and lifestyle choices will decide how far the world-wide campaign will progress. Therefore, it becomes a central issue of this research to investigate whether these key stakeholders have been well informed about sustainable living issues in current education programmes, besides knowledge related to sustainable design.

To allow for comparisons and potential trans-disciplinary studies, the questionnaire to investigate architectural students' lifestyles (considering them as current housing users and future housing purchasers) is designed mainly based on the same palette of housing environmental issues addressed in EcoHomes. Other issues highlighted in the university information brochures (from the University of Sheffield), such as the Housing Checklist, Where to Live – A Guide to Districts, and Looking for Private Accommodation (Information for New Students and for Returning Students) and so on, have also been taken into account. A sample of *Questionnaire for Current Housing Occupants* can be found in Appendix 2.3.

Questions QA1 to QA6 are designed to categorise the variables. Since this survey aims to discover whether students' awareness of sustainable living issues can be improved in current architectural education, QA1 to QA6 are used to group the responses according to students' gender, courses undertaken, academic year and cultural background.

It is believed that students' future lifestyle choices would be affected not only by university education programmes but also through their day-to-day lives in their current accommodation (see the argument by Friedman in 2.7.2). Questions QB1 to QB3 are designed to examine the relationship between architectural students' current living patterns and their expectation of future sustainability. The indicator 'occupant satisfaction' in QB4 through post-occupancy evaluation represents a key performance indicator that might replace some other partial indicators mentioned earlier (e.g. Leaman and Bordass 1999, Bordass *et al.* 2001; cited in Lutzkendorf and Lorenz 2006: 344). Retrospectively, this indicator reveals a very close relationship between the social aspects of sustainable development (in terms of health, comfort and well-being) and other considerable issues in decision-making processes.

QC1 is designed to investigate the accommodation types that architectural students prefer. Results can be used to guide future student accommodation design. Questions in QC2 constitute the major part of this questionnaire. To a great extent, people's lifestyle choice is decided by the alternative options available during the operational phase of house occupation. Therefore, it is believed that, if participants truly care about climate change and are likely to change their lifestyle towards greater environmental sensitivity, they should be concerned with the possibility and feasibility of energy saving and carbon reductions, and should take such issues into account when they look for a new accommodation. QC2 aims to investigate whether architectural students have been well informed about this in current education programmes and are likely to start considering the related environmental issues, especially those that might influence their future lifestyles, in their accommodation seeking processes. To allow for a comparison between occupants' awareness and regulators' constraints (referring to the criteria of EcoHomes or the Government's Code), housing environmental issues addressed in QC2 are also mainly derived from EcoHomes, as shown in Figure 5.5.

However, compared with the correlation between design strategies and issues addressed in EcoHomes (see Figure 5.4), it is more difficult in this case to decide on alternative issues or ways to assign scores from EcoHomes. Finally, based on the system for value judgement used by EcoHomes (the relative importance of different housing environmental issues) and the logics of association, most issues in QC2 are given the relative credits.

It is important to note that environmental issues arising in students' accommodation seeking processes and those design strategies addressed in EcoHomes do not always correspond. In contrast, some integrated design strategies can often address several issues at the same time, while it is also possible that different strategies create similar environmental benefits. For example, being close to 'supermarket or late shops', 'gymnasium or sports centre', 'pub or bar' and 'café, takeaway or restaurant' all contribute to the credits of 'Tra3 local amenities (3.00)'[xxxvi]. On the other hand, 'energy efficient heating and lighting appliances' needs to be considered from an integrated perspective, which might require connection between 'Ene1 dwelling emission rate – CO_2 (13.75)', 'Ene5 external lighting (1.83)', 'Ene6 internal lighting (1.83)' and 'Pol2 NO_x emissions (2.73)'.

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xxxvi These four options were drawn from the 'Tra3: Local Amenities' being addressed in EcoHomes, which were 'food shop, post facility, bank/cash point, pharmacy, primary school, medical centre, leisure centre, community centre, place of worship, public house, children's play area, outdoor open access public area' (BRE 2006), and were considered as particularly important for students' daily living.

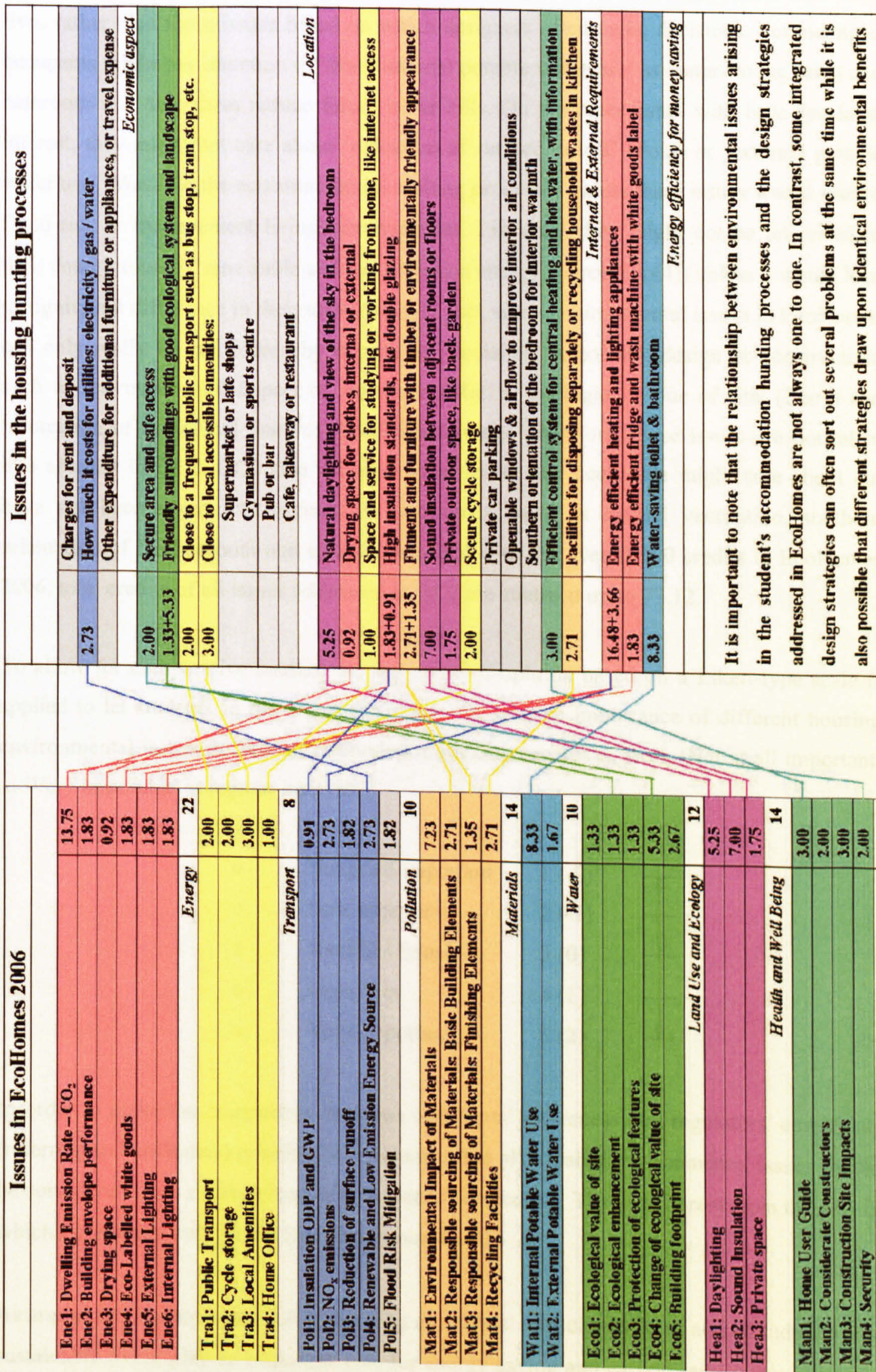

Figure 5.5: Link issues in EcoHomes 2006 with related issues addressed by students in their accommodation seeking processes

As housing end users, occupants often care about design results that might affect their daily lives rather than those issues based on which designers often make decisions. For example, occupants might pay attention to 'Wat1 internal potable water use' as water-saving toilet and bathroom will help them reduce future water bills. On the other hand, with little specialist interest, they might not care about 'reduction of surface runoff' (Pol3) or 'external potable water use' (Wat2) in the accommodation seeking processes unless these issues would lead to flood risk or inconvenient living circumstances. Likewise, they might not be interested in their energy source ('renewable and low emission energy source' (Pol4)) unless it would lead to significant difference in their utility bills. In fact, some environmental issues in EcoHomes can only really be considered by experts or specialists in housing design or construction, such as 'environmental impact of materials' (Mat1), 'ecological value of site' (Eco1) and 'protection of ecological features' (Eco3) and so on. Therefore, these issues are not taken into account in QC2. QC2 also includes some issues that occupants might care about but have not been taken into account in EcoHomes, such as natural ventilation, southern orientation of the bedroom and so on. Compared with the overall 100 credits in EcoHomes 2006, total credits of all issues addressed in QC2 are summed up to 77.12.

To allow for comparative studies, the 1-5 range-of-opinion based on a Likert-type scale is applied to let students in the target group rate the relative importance of different housing environmental issues in their accommodation seeking processes, from 'Not at all important' to 'Very important' at regular intervals.

o	Not at all important	1 (-2)
o	Less important	2 (-1)
o	Neutral / Equal	3 (0)
o	Important	4 (1)
o	Very important	5 (2)

In order to make the comparison between occupants' awareness and regulators' constraints (referring to EcoHomes) possible, it is assumed that all housing environmental issues should be considered from a compulsory and balanced perspective. This is different from the way in which EcoHomes truly works (for details, see 4.5.2).

As argued in Chapter 2 (see 2.4.2), housing occupants' consciousness of and attitude towards sustainable living play an important role for energy saving and carbon reductions during the operational phase of house occupation. Earlier study of environment behaviour also shows that it is the knowledge differences about the specific problems and possible actions that lead to the behaviour variation between people who are actively engaged in environmental issues and those who are not (Gluch and Stenberg 2006: 107). Therefore, QD1 is designed to determine whether architectural students are aware of this and have started to pay attention to related issues in their day-to-day lives. QD2 and QD3 are especially focused on two important issues relating to students' attitudes and beliefs about purchase and use patterns for energy at home and for transport. QD4 is designed to see whether students in the target group are likely to look for information that can lead them to live in a more sustainable way and, if yes, what their primary information sources are. Results from QD4 can be used for a trans-disciplinary study in the future.

QE1 is an open-ended question which is designed to see whether architectural students are likely to take more responsibility in tackling climate change. QE2 allows participants to leave their comments on sustainable living issues or the survey.

5.2.3 SURVEY PROCEDURES

The proposed research procedure has been ethically reviewed and approved by the University Ethics Review Procedure (see Appendix 2.1 and 2.2 for the Cover Letter and the Approval Letter), prior to commencing the survey. Moreover, a pre-testing procedure has also been carried out prior to the pilot investigation in order to modify questions with ambiguity and comprise issues that have not be taken into account in EcoHomes (e.g. 'natural ventilation' and 'passive solar design'). Some survey measures are designed based on previous studies and known facts.

To ensure quality of responses, postgraduate students in the School of Architecture were selected as the first target group of respondents, as most of them had background knowledge and working experience in building-related environmental design. It was expected that these higher-level architectural students should understand building environmental issues better than junior students or students studying in other disciplines. In order to ensure quantity of responses, the questionnaires were distributed to students during postgraduate courses particularly tailored for sustainable building design. It was believed that these students, undertaking sustainability-related education programmes, might be more interested in building environmental issues and more likely to respond to relevant studies.

Moreover, to help participants understand the research topic better and answer the questions properly, a short introduction about the entire research project, together with necessary illustrations, was given to the target students before letting them complete the questionnaires. For example, to allow students to evaluate their knowledge and use of the design guidelines drawn from EcoHomes, the related design guidelines (see Figure 4.10) were distributed to students together with the *Questionnaire for Future Designers*.

Further interpretation of the ranks were also provided: 'Very poor' meant 'only have awareness', 'Poor' meant 'have outline knowledge', 'Neutral / Equal' meant 'fully understand but might not have applied it in design', 'Good' meant 'apply in design', 'Very good' meant 'know how to optimise it with other design measures in the design processes' or students could leave the options blank if they had 'no awareness' of the issue (either in practice or in studio work). Students in the target group could then evaluate their familiarity of a particular environmental design strategy more accurately based on detailed illustrations available. Therefore, it was believed that all responses from the target students were made based on sufficient information.

In terms of practice, these two questionnaires were distributed to the students separately, at an interval of six months, to allow the same group of students to consider the environmental issues respectively from a designer's perspective and from a user's perspective. As a follow-up procedure, focus group discussions were also carried out. Once data was collected, it was filtered and uploaded onto a computer by the principal researcher.

5.3 CONSULTATION RESPONSES

To better understand the responses from the consultation, each response in these two questionnaires is given a breakdown in detail before a cross comparison. All related analyses and findings are summarised in the following sections based on descriptive statistics.

5.3.1 RESPONSES FROM FUTURE DESIGNERS

There were 63 formal responses from the future designer group. Of these, 49 respondents were 5th year architectural students and the rest (14) one-year taught masters students (QA1). Most of them already had some related professional experience (QA2). All respondents had an interest in the topic of sustainability or sustainable design (QA3), except one response missing from the 5th year architectural students.

As shown in Figure 5.6 (QA4), although some students argued that sustainability principles and relevant design measures were important for all building types, there was a general consensus that they should be firstly considered in the design processes of housing projects, including both private (15%) and social (15%) housing, commercial offices (14%) and educational buildings (14%). Moreover, between these three building types, it was acknowledged that sustainable measures were very important for housing development, especially in the approach of social housing development. Since this result was close to the declaration in Chapter 2 (see 2.2.3), it was believed that these architectural students had been well informed about this in current education programmes.

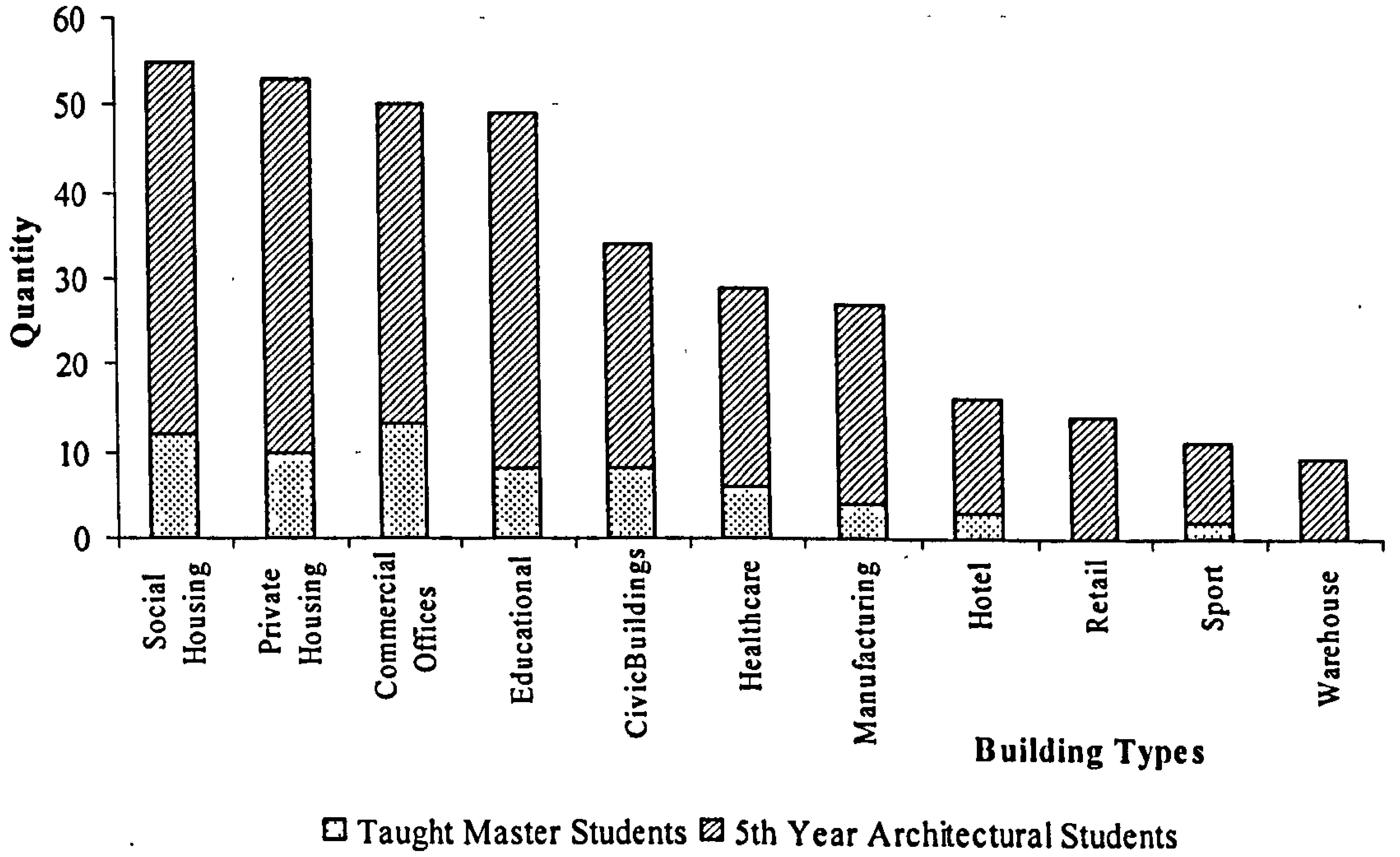

Figure 5.6: Importance of sustainable measures for different building types

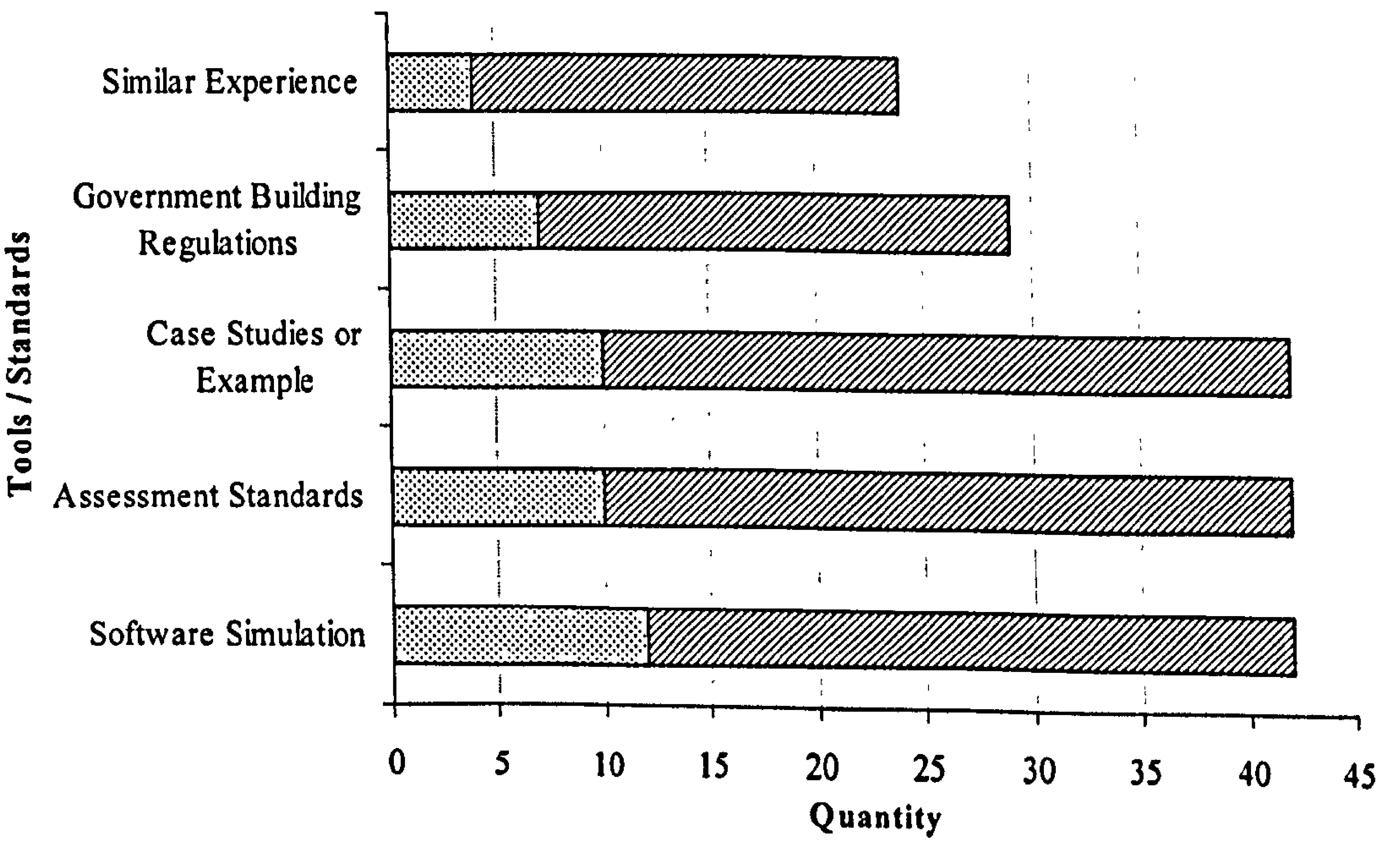

Figure 5.7: Make sustainable design according to the related tools or standards

To achieve higher levels of sustainability, architectural students were often likely to make decisions based on 'software simulations' (23%), 'assessment standards' (23%) and 'successful cases studies or examples' (23%), as shown in Figure 5.7 (QB1). Therefore, it was expected that these future designers should have been equipped with sufficient related knowledge in their education programmes. However, findings from this investigation were not optimistic. Although many students in the target group were aware of the design tools or standards prevailing in the market, there were still some interviewees who had no idea about them (Figure 5.8, QB2). Moreover, since some of the design tools need to be applied together (for instance, BREEAM EcoHomes includes requirements from SAP, Building Regulations Part L and The Green Guide to Housing Specification as part of its content, see 4.5.1), it made no sense that the students rated their awareness of BREEAM EcoHomes much higher than SAP and The Green Guide to Housing Specification (Figure 5.8). The explanation for this was that, through current education programmes, these architectural students had only been taught the general background of these design tools or standards while few of them truly knew how to apply them in practice. This was verified in Figure 5.9 (QB2). Generally less than half of the target students had the experience of applying these design tools or standards in the housing design processes. This was much worse than expected as some of the building standards had already been mandatory in the housing market for many years, such as SAP, Building Regulations Part L and so on.

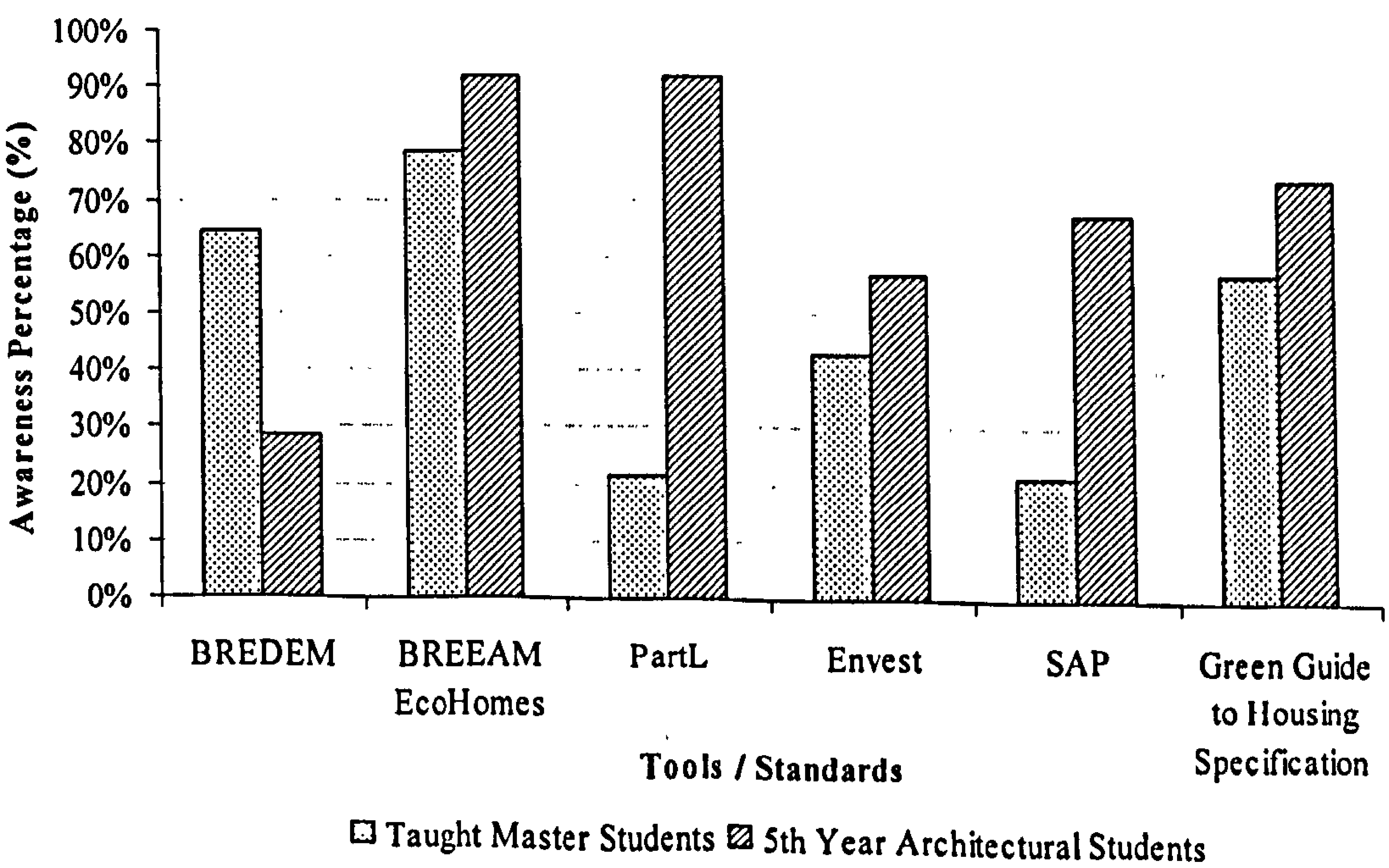

Figure 5.8: Awareness of different tools/standards available in the market

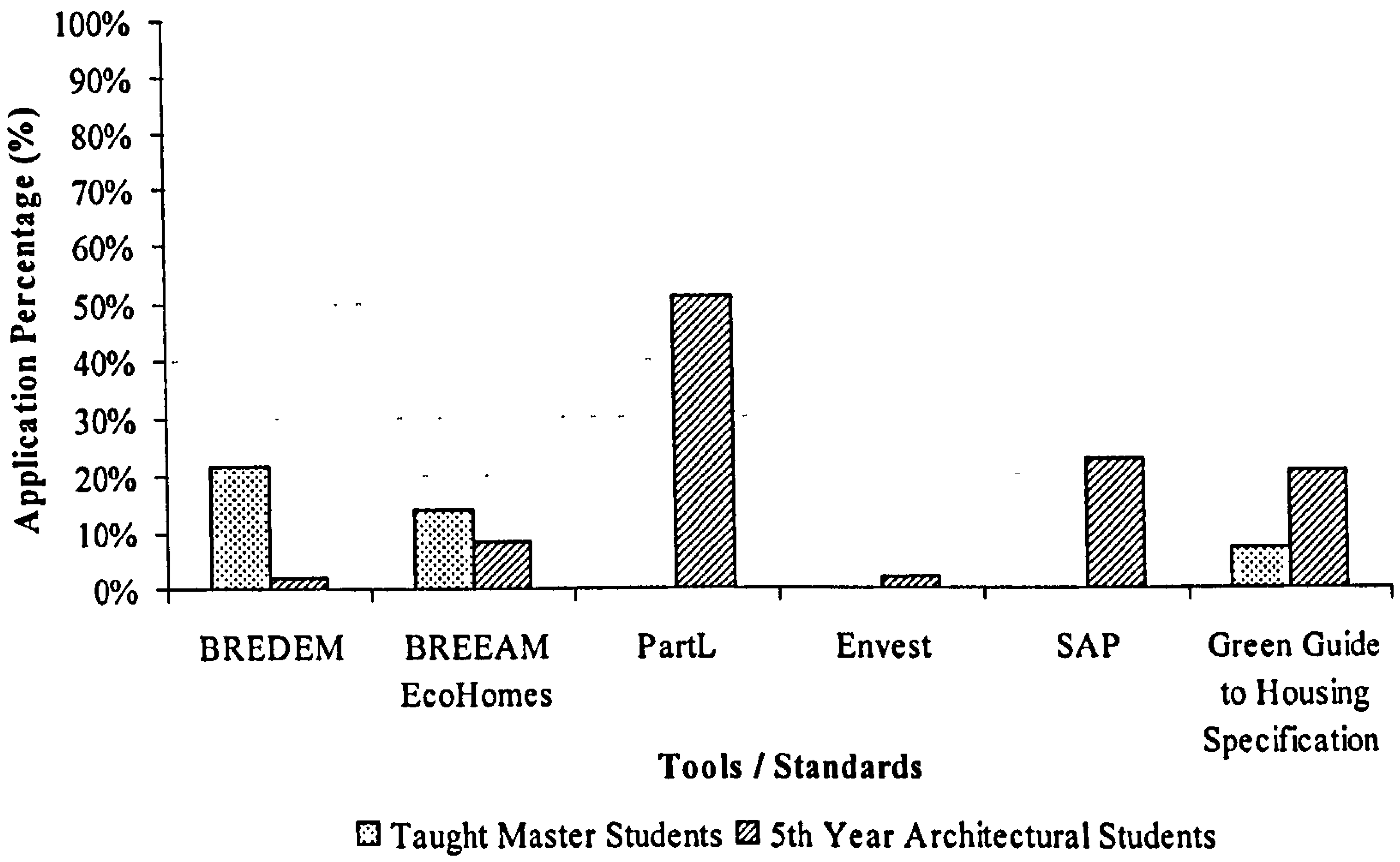

Figure 5.9: Application of different tools/standards in the design processes

Although people may argue that architects can get the technical support from other experts or specialists in collaborative design processes, they need to have enough knowledge to collaborate with others and intervene at key decision-points in terms of information flow. In other words, architectural students need to be trained to understand more about these issues even though they are not necessarily going to become EcoHomes assessors or specialists. This needs to be envisaged in future education programmes.

Within these design tools and standards, BREEAM EcoHomes is discussed in particular as it is the prototype of the Code for Sustainable Homes which has been applied in the housing market mandatorily from 2008. Since EcoHomes provides a credit-based weighting system according to the relative importance of different environmental issues, it can be used as a quantitative benchmark to evaluate the architectural students' knowledge of the related strategies (Figure 4.10, also see 4.6). It was expected that, in order to achieve a better result (higher score rated by EcoHomes), these students needed to know how to achieve the relevant credits efficiently. Thus, more attention should be paid to the environmental issues with more credits in EcoHomes, such as 'landscape' (related to Eco4 in EcoHomes: max 5.33), 'materials with LCR' (Mat1: max 7.23), 'sound insulation' (Hea2: max 7.00), 'energy efficiency' (Ene1: max 13.75) and 'low water use' (Wat1: max 8.33). However, as shown in Figure 5.10, (QC1), generally there was no significant difference between students' understanding of various housing environmental issues, no matter whether the issues had been highly rated in EcoHomes or not.

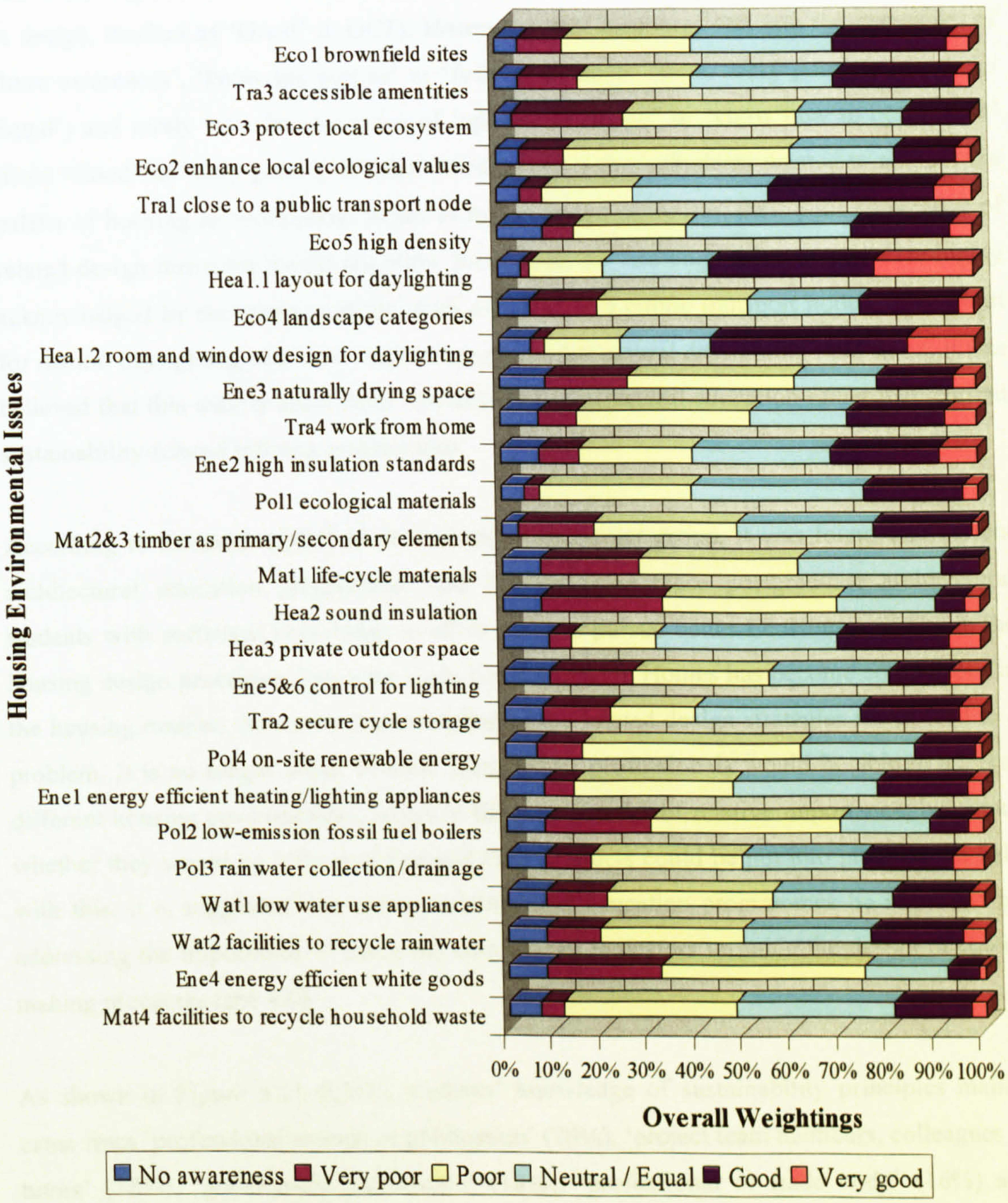

Figure 5.10: Students' knowledge of housing environmental issues (designers)

In fact, students' average knowledge of sustainable housing design issues (from both taught masters students and 5th year architectural students) was much less than expected. Since most of these students already had relevant working experience, they were expected to know the importance of applying EcoHomes to guide their housing design processes better and have more knowledge of the related environmental issues than junior students (for instance, fully understanding all the environmental issues being addressed in EcoHomes and applying them in design, marked as 'Good' in QC1). However, most responses fell into the categories of 'have awareness', 'know the outline' or 'fully understand' (from 'Very poor' to 'Neutral / Equal') and rarely into the categories of 'applied in design' or 'know how to optimize it' (from 'Good' to 'Very good'). In other words, even if these students wanted to address the palette of housing environmental issues in future design processes, their poor knowledge of related design measures would not allow them to do so. Although a few issues were highly acknowledged by the target students, such as 'close to a public transport node', 'site layout for natural daylighting and view' and 'room design for natural daylighting' and so on, it was believed that this mainly arose from conventional architectural education rather than current sustainability-related training programmes.

According to feedback (QC1) from students in the target group, it was found that current architectural education programmes had not equipped these postgraduate architectural students with sufficient knowledge to allow them to pursue better EcoHomes results in the housing design processes. Since the Code for Sustainable Homes has become compulsory in the housing market, their poor understanding of the related design strategies might lead to a problem. It is no longer about whether these future professionals would be able to address different housing environmental issues in the proper order of relative importance, but about whether they would be truly qualified and their products could be put into practice. To help with this, it is suggested that current architectural education programmes be improved by addressing the importance of using the compulsory indicators to guide the design decision-making processes (see 4.6).

As shown in Figure 5.11 (QD1), students' knowledge of sustainability principles mainly came from 'professional journal or publication' (20%), 'project team members, colleagues or tutors' (18%), 'government publication' (18%), 'professional or trade body' (16%) and 'research organisations' (16%), though details might vary because of their different educational backgrounds. As a special general medium, the 'Internet' was also highlighted by the students. Feedback from the target students (QD1) was expected to be compared with information sources of other stakeholder groups later. It is argued that the sustainability-related message would be communicated between different stakeholder groups more efficiently if the communication platform could be constructed in the overlapping area.

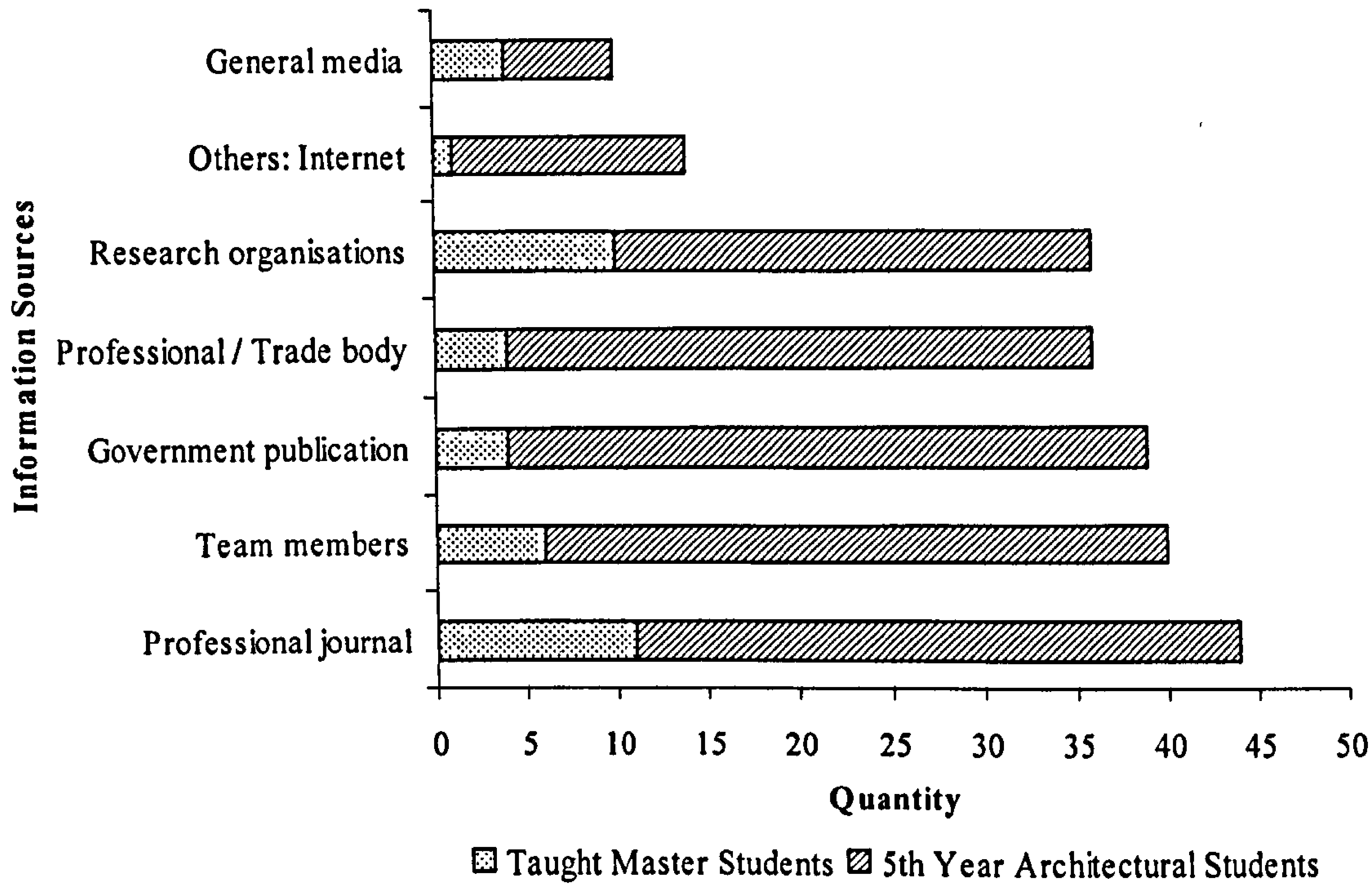

Figure 5.11: Main sources of sustainability information (designers)

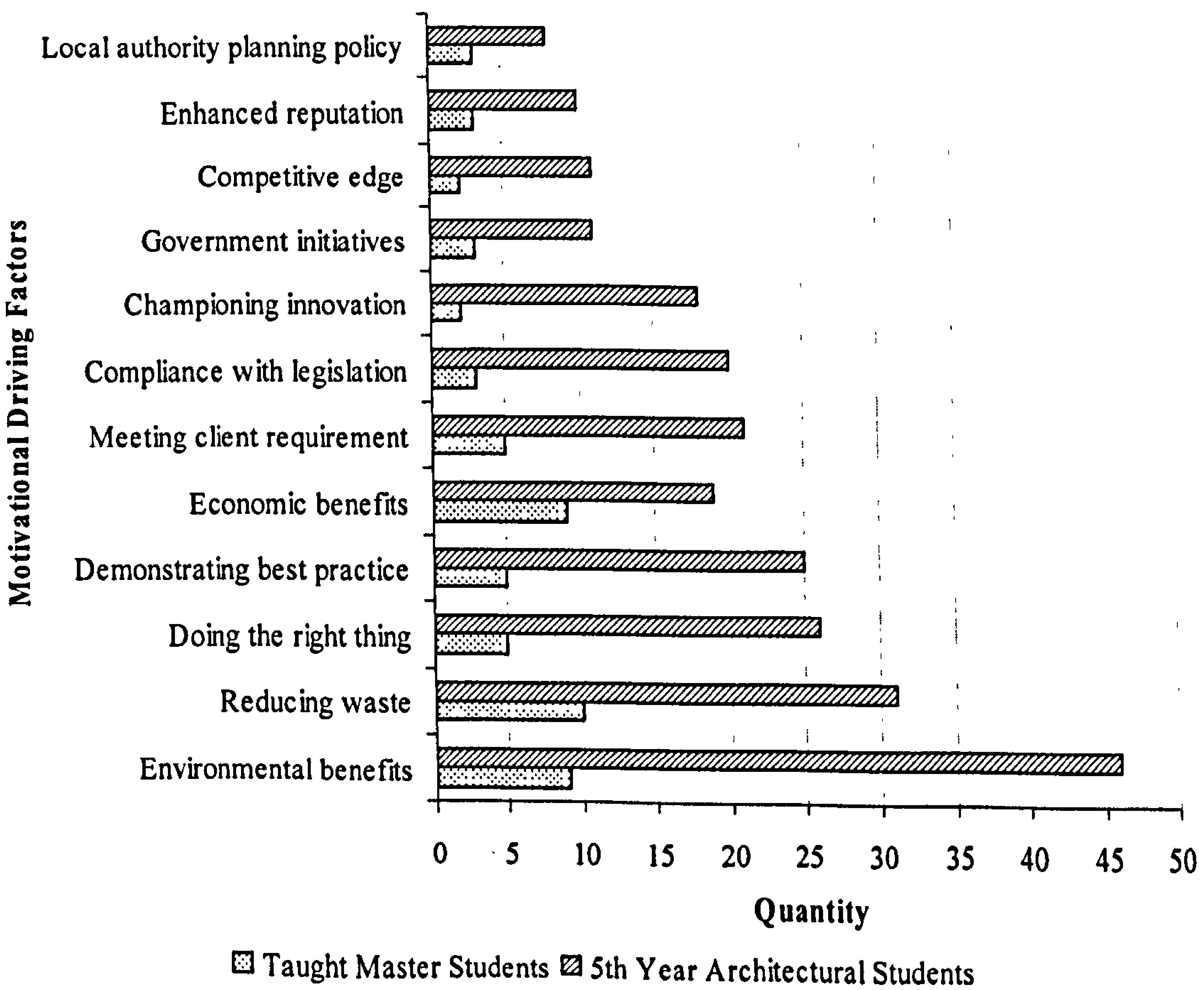

Figure 5.12: Top 5 drivers to take sustainability principles into account (designers)

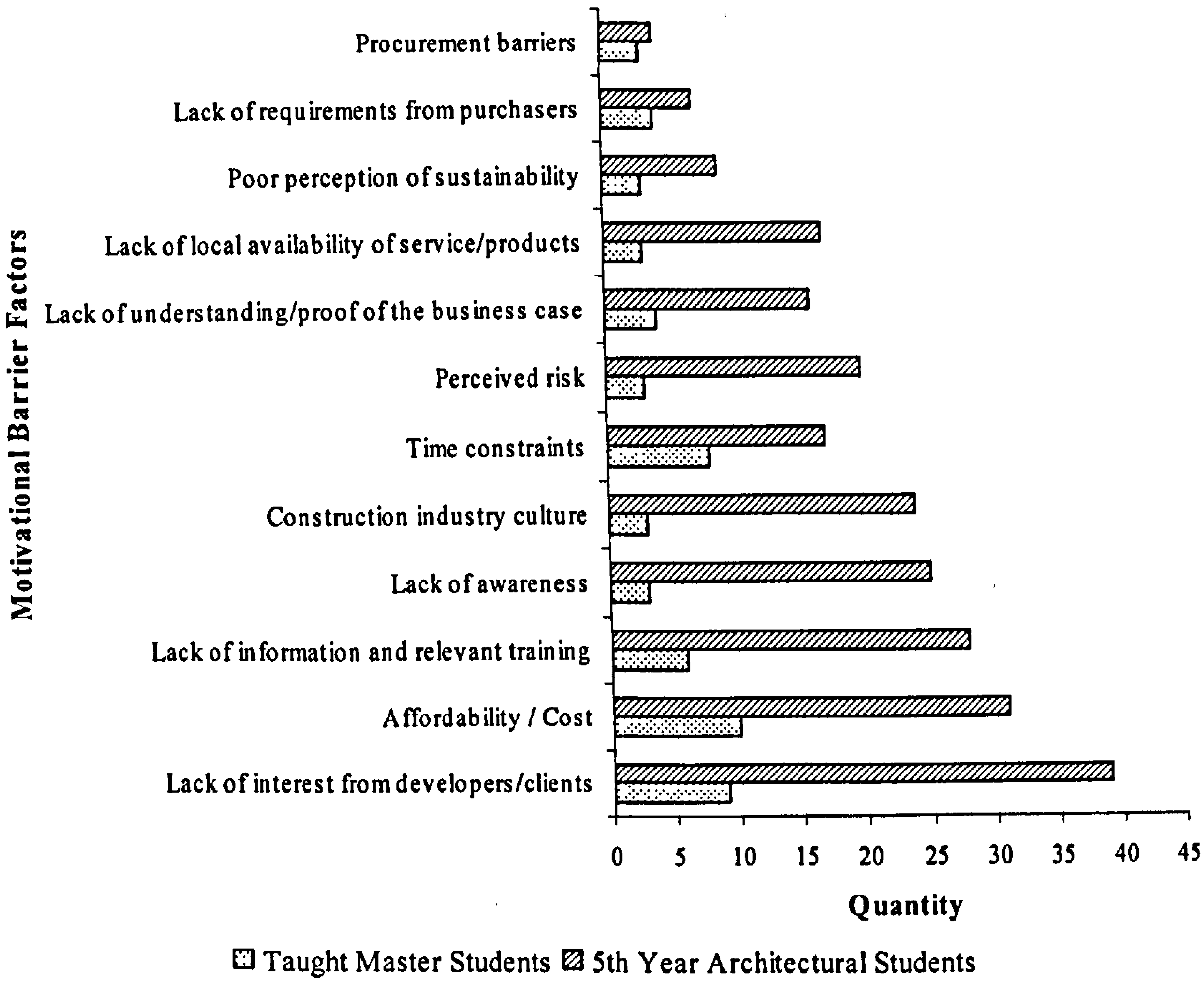

Figure 5.13: Top 5 barriers to take sustainability principles into account (designers)

As shown in Figure 5.12 (QD2), important drivers for 5th year architectural students to take sustainability principles into account in the housing design processes were 'environmental benefits' (19%), 'reducing waste' (13%), 'doing the right thing' (11%), 'demonstrating best practice' (10%) and 'meeting client requirement' (9%). On the other hand, important drivers for the taught masters students were 'reducing waste' (17%), 'environmental benefits' (15%), 'economic benefits' (15%), 'demonstrating best practice' (8%), 'meeting client requirement' (8%) and 'doing the right thing' (8%). It was found that, although students in different groups rated the driver factors in different orders of importance, there was a *general consensus* that 'environmental benefits', 'reducing waste', 'doing the right thing', 'demonstrating best practice', 'meeting client requirement' and 'economic benefits' were the most important drivers for the target students to take sustainability principles into account in the design processes.

Likewise, as shown in Figure 5.13 (QD3), important barriers for 5th year architectural students to take sustainability principles into account in the housing design processes were 'lack of interest from developers or clients' (16%), 'affordability or cost' (13%), 'lack of information and relevant training' (12%), 'lack of awareness' (11%) and 'construction industry culture' (10%). On the other hand, important barriers for the taught masters students were 'affordability or cost' (17%), 'lack of interest from developers or clients' (15%), 'time constraints' (14%), 'lack of information and relevant training' (10%), 'lack of understanding or proof of the business case' (7%) and 'lack of requirements from purchasers' (7%). It was found that, although students in different groups rated the barrier factors in different orders of importance; there was a *general consensus* that 'lack of interest from developers or clients', 'affordability or cost', 'lack of information and relevant training' were the most important barriers for the target students to take sustainability principles into account in the design processes.

As argued in 2.7.1, it was expected that architects would take responsibility to offer their specialised decision-making skills rather than being dominant in collaborative design processes. Therefore, feedback from QE1 and QE2 was used to see whether architectural students, as future designers, had realised the motivational factors that might encourage other stakeholders, for instance their future clients (or developers) and practices, to take sustainability principles into account.

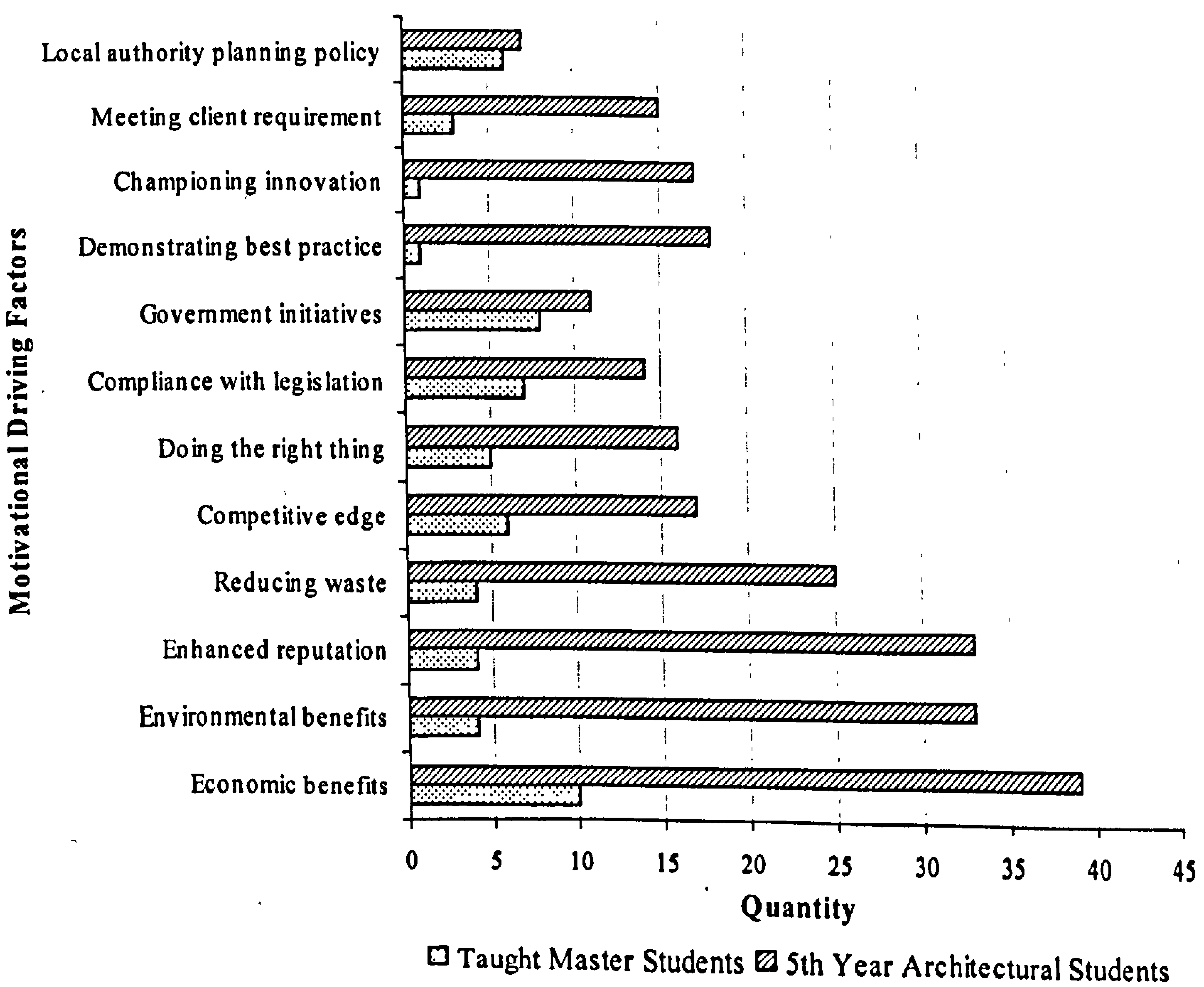

Figure 5.14: Top 5 drivers to take sustainability principles into account (clients/developers)

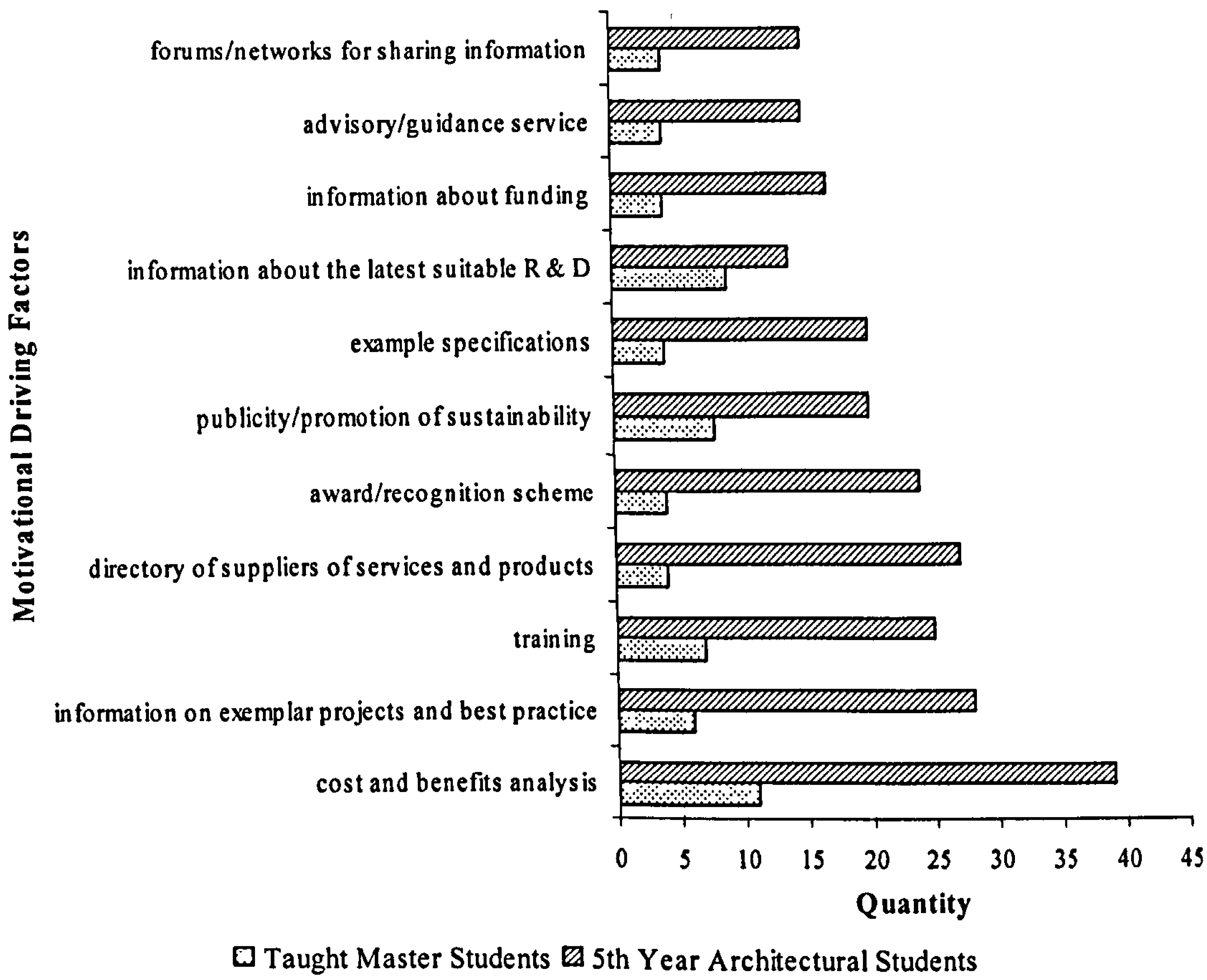

Figure 5.15: Top 5 drivers to take sustainability principles into account (practices)

As shown in Figure 5.14, according to the 5th year architectural students' understanding, important drivers for developers or clients to take sustainability principles into account in the housing design processes were 'economic benefits' (16%), 'environmental benefits' (13%), 'enhanced reputation' (13%), 'reducing waste' (10%) and 'demonstrating best practice' (7%). On the other hand, the taught masters students in the target group believed that important drivers for developers or clients to take sustainability principles into account were 'economic benefits' (17%), 'government initiative' (14%), 'compliance with legislation' (12%), 'competitive edge' (10%) and 'logical authority planning policy' (10%). To some extent, except 'economic benefits', which had been generally regarded by both student groups as the most important driving factor to encourage developers or clients to consider sustainability principles, other driving factors differed between the 5th year architectural students and the taught masters students, and a general consensus could *not* be achieved.

Likewise, as shown in Figure 5.15, the 5th year architectural students believed that important drivers that would encourage their future practices to increase the application of sustainable measures were 'cost and benefits analysis' (16%), 'information on exemplar projects and best practice' (11%), 'directory of suppliers of services and products' (11%), 'training' (10%)

and 'award or recognition scheme' (10%). On the other hand, the taught masters students believed that the top five drivers for their future practices were 'cost and benefits analysis' (17%), 'information about the latest suitable research and design' (14%), 'publicity or promotion of sustainability' (12%), 'training' (11%) and 'information on exemplar projects and best practice' (9%). Therefore, there was a *general consensus* between these two student groups. Drivers such as 'cost and benefits analysis', 'information on exemplar projects and best practice' and 'training' were useful to encourage their future practices to increase the application of sustainable strategies.

In summary, since the consultation responses were collected from two groups, the 5th year architectural and the taught masters students, it was possible to make comparisons between their motivational factors. As discussed above, it was interesting to see that there was a general consensus between these two groups of students on important motivational factors, from both positive and negative perspectives, for themselves or for their future practices to take sustainability principles into account in housing design processes. However, this kind of consensus could not be achieved between these two groups on important drivers to encourage their clients or developers to participate in tackling climate change. In other words, higher-level architectural students in the target group might have a general idea about their incentives, but rarely knew how to educate people from other stakeholder groups into more genuinely collaborative roles. This needs to be envisaged as architects have the responsibility to get the sustainability-related message across to different stakeholder groups in collaborative design decision-making processes.

Most students (84%) in the target group agreed that it was important to engage future housing occupants in the operational phase of house occupation, and would like to do so in the earlier phase of housing design. This might be because these students had been informed in their education programmes that, as a special group of stakeholders, housing occupants' alternative decisions on lifestyle often led to significant difference between the predicted, simulated energy consumption and carbon reductions and the actual ones (as argued in 2.4.2), although these people often had little specialist knowledge related to sustainability.

5.3.2 RESPONSES FROM CURRENT HOUSING OCCUPANTS

To allow for a horizontal comparison[xxxvii], *Questionnaires for Current Housing Occupants*

[xxxvii] Students in the target group can be seen as a special group of people with dual statuses, both future housing designers and current housing occupants. Therefore, their willingness to make sustainable design and awareness of sustainable living can be compared in parallel.

were distributed to the same group of students six months later. This time, however, only six 5th year architectural students (compared with 49 at the first phase) and ten taught masters students (compared with 14 at the first phase) attended the second phase of the pilot investigation. Obviously, students in the target group were more likely to consider housing environmental issues from a designer's perspective and show little interest in research work related to sustainable living manners.

Half of these 16 volunteers were male and the other half were female (QA1). Between them, three students were living in university accommodations (university or university partnership properties), two were living in private rented properties registered with the university and the rest of them (eleven students) were living in private rented properties not registered with the university (QB1). Most of the students did not know the details of their monthly utility bills (including gas, electricity and water) as two of the accommodations had included the utility bills in the rent and ten of the students were not sure whether their utility bills had been included in the rent or not (QB2). Although the student accommodation types were different and only a few of the students had been living in the accommodation for more than one year (three out of 16 according to QB3), most of them were satisfied with their current accommodation conditions (QB4).

As shown in Figure 5.16, 'flat' was considered as the most suitable accommodation type by students in the target group. However, student village design with mixed property types was also welcomed by the students.

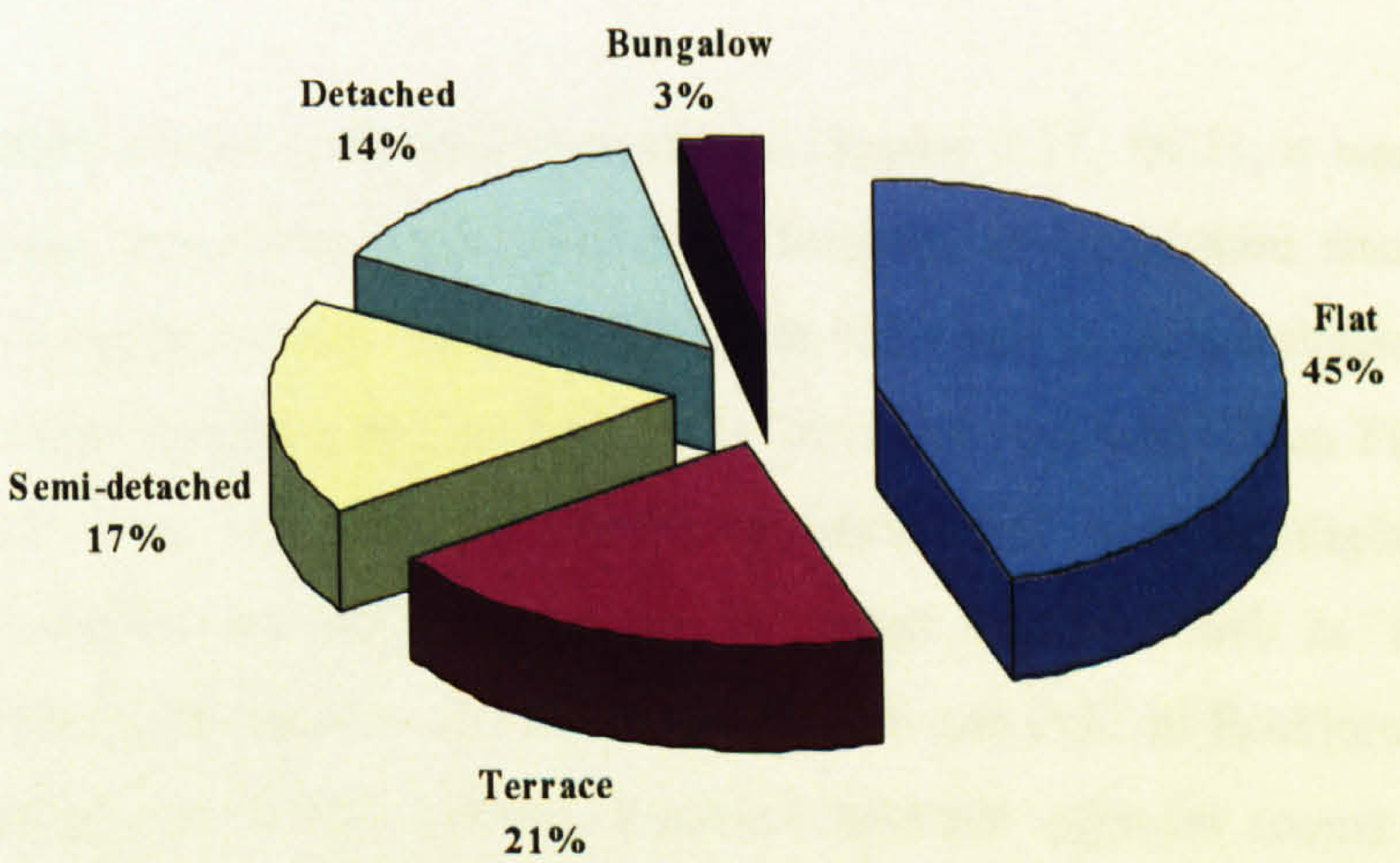

Figure 5.16: Most suitable student accommodation types

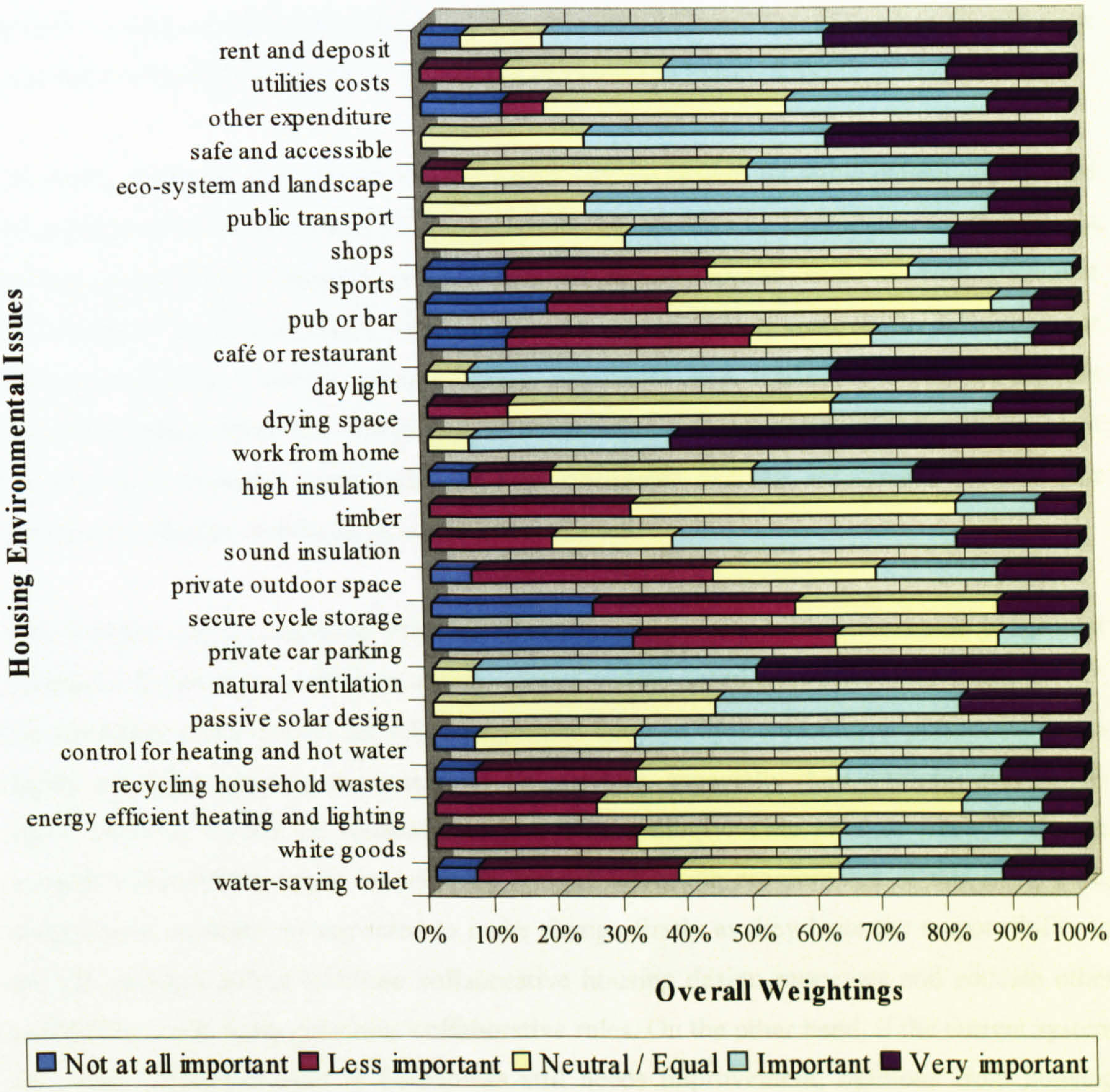

Figure 5.17: Relative importance of housing environmental issues (occupants)

Based on the consultation responses (Figure 5.17, QC2), it was found that students in the target group were concerned with housing environmental issues in their accommodation seeking processes, although this often happened in an unconscious way in which social and economic issues had not been fully taken into account. From Figure 5.17, it was also found that some important environmental issues that were highlighted in EcoHomes were not considered as that important by the target students, such as 'energy efficient heating and lighting appliances' (related to Ene1, 5, 6 and Pol2 in EcoHomes), 'water-saving toilet and bathroom' (Wat1), 'sound insulation between adjacent rooms or floors' (Hea2), 'friendly surroundings with good ecological system and landscape' (Eco2, 4) and 'natural daylighting and view of the sky in the bedroom' (Hea1) and so on (referring to Figure 5.5). On the other hand, some important issues to the target students, such as 'openable windows and airflow to improve interior air conditions', 'space and service for studying or working from home' (related to Tra4 in EcoHomes) and 'secure area and safe access' (Man4) and so on, were not considered to be that important in EcoHomes (referring to Figure 5.5).

Obviously, from this comparison, it can be seen that the system for value judgement adopted by students in the target group was different from the one used by EcoHomes. In other words, current architectural education programmes do not equip the students with sufficient knowledge of EcoHomes-based living issues. As argued earlier, however, to achieve better performance-in-use (energy saving, carbon reductions and waste recycling) during the operational phase of house occupation, it is important to ensure that priorities of different housing environmental issues, addressed by occupants and the assessment systems (for instance EcoHomes in this case), are properly aligned.

This concept can be explored from two perspectives, as the system for value judgement adopted in EcoHomes is also new and developed mainly based on *professional* opinions[xxxviii]. On one hand, if the system for value judgement adopted by EcoHomes is perfect (which is highly unlikely), housing occupants' living manners, especially their attitudes and beliefs about lifestyle, should be somewhat adjusted accordingly. This kind of lifestyle change towards sustainability might be achieved through education programmes. If this is the case, architectural students are expected to make change firstly as they have the responsibility to get the message across in future collaborative housing design processes and educate other stakeholders into more genuinely collaborative roles. On the other hand, if the current system for value judgement used in EcoHomes still needs improvement, opinions from housing occupants (or other stakeholder groups), such as architectural students in this case, should then be taken into account to inform other stakeholders in the weighting exercises and contribute to the final decisions in collaborative decision-making processes. This procedure can be particularly necessary and important when architects try to apply EcoHomes to guide student accommodation design, as EcoHomes is originally tailored for general housing development. In terms of practice, these two aspects should be carried out in parallel, as two sides of the same coin.

As shown in Figure 5.18 (QD1), students' average knowledge of daily living issues, especially those related to energy saving and carbon reductions during the operational phase of house occupation, was rather limited. Further, it was interesting to see that these students

[xxxviii] Opinions from non-professional stakeholders, for instance housing occupants with little specialist knowledge, have not been taken into account in the establishment of EcoHomes. For details, please see 4.5.1.

paid little attention to 'the difference between energy suppliers', 'cost of utility bills' and 'low energy lighting appliance' and so on, although these issues were all related to economic incentives, directly or indirectly. But this feedback seemed to be sensible when compared with the response from QB2.

Although Sheffield is not the most suitable case for investigating student attitude to transport, QD3 helps to remind the students that sustainable lifestyle should always be considered from an integrated perspective. As shown in Figure 5.19, generally most students went to university by environment friendly methods, such as on foot, by bike or on public transport. However, one of them (out of 16) had a private car and many showed a strong interest in private car ownership. This will be further discussed later.

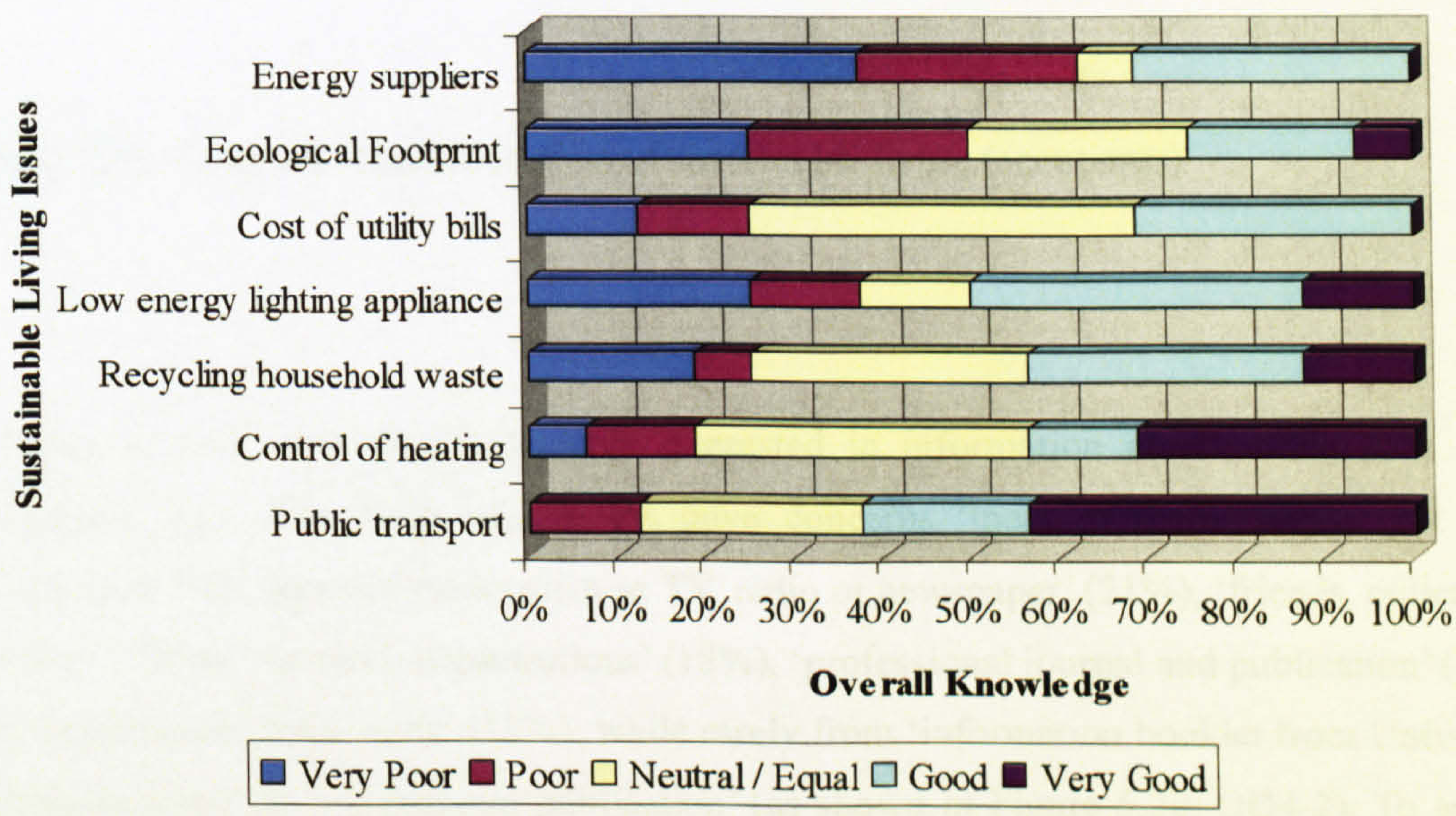

Figure 5.18: Knowledge of different living issues (occupants)

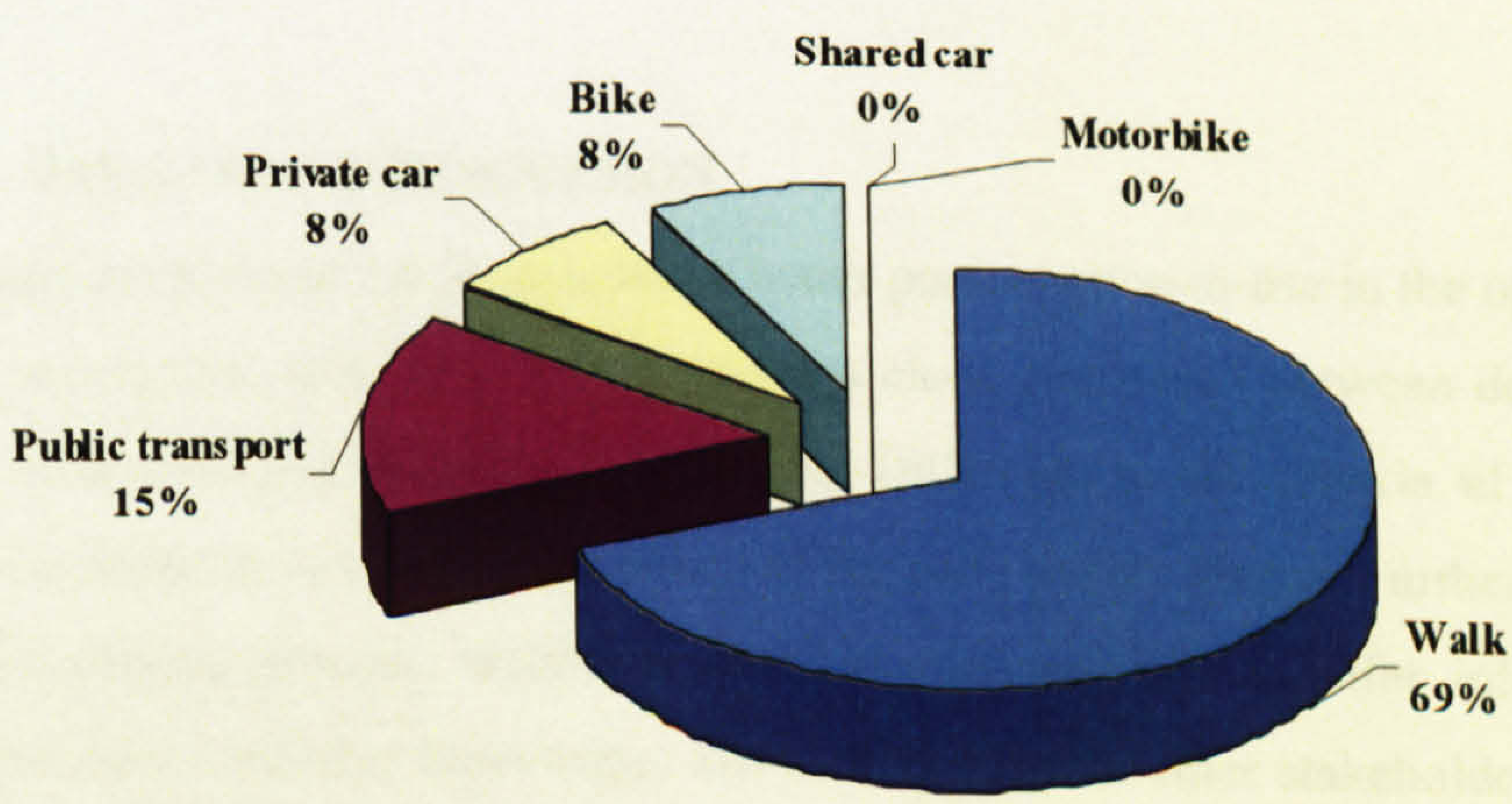

Figure 5.19: Transport methods generally used by students (occupants)

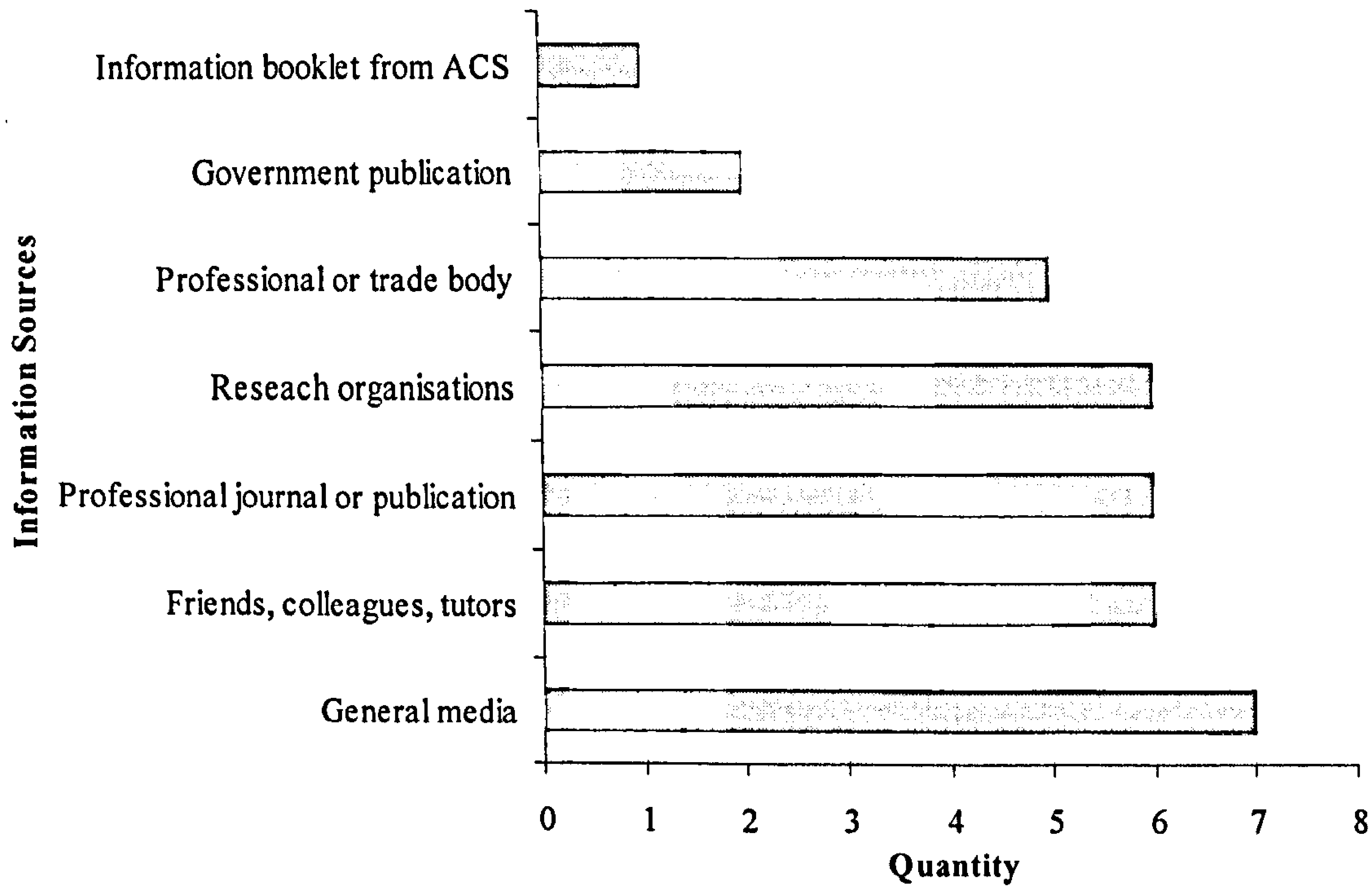

Figure 5.20: Main information sources of sustainable living (occupants)

Actually, not all students (71%) were interested in information about living in a more sustainable way. For those who might have concerns, most of them usually got their information from 'general media such as TV, radio or newspaper' (21%), 'friends, colleagues or tutors' (18%), 'research organisations' (18%), 'professional journal and publication' (18%) and 'professional trade body' (15%), while rarely from 'information booklet from University accommodation' or 'government publication' (as shown in Figure 5.20, QD4-2). To get the message across efficiently, therefore, feedback from QD4-2 can help establish the future communication platform.

5.4 FOLLOW-UP DISCUSSION

As argued earlier (see 2.6.1), to achieve better performance-in-use in the operational phase of house occupation, it is important to reach a close consensus between designers' intention, users' awareness and legislators' constrains (referring to the criteria of EcoHomes or the Code) on different environmental issues at the early design stages. Further, in a collaborative decision-making process, architects have the responsibility to offer informed suggestions based on their specialist knowledge, and to help educate other stakeholders to work in more genuinely collaborative roles. In this pilot investigation, a follow-up discussion was carried out immediately after the questionnaires were collected. The application of qualitative research strategy aimed to see whether current architectural education had equipped architectural students, as both future housing designers and current housing occupants, with sufficient knowledge to do so.

5.4.1 ARCHITECTURAL EDUCATION

As one of the oldest professions, architecture and its relevant education can be traced back to the third millennium BC. The form of apprenticeship, as the original educational pattern for architects, has lasted for many centuries thereafter. However, this was changed during the last century. In the UK, the Royal Institute of British Architects (RIBA) was founded during the process of 'professionalisation' in the nineteenth century. Soon this division of occupations led the body of architects to become a 'legally protected and socially respected' elite (Lawson 1997: 21). Almost at the same time, their education evolved into a 'studio-based tutorial environment' (Glasser 2000). This change has often been seen as a tendency of educational centralization that goes along with the development of modern culture and technologies. Nevertheless, its exclusive characteristics also lead to the remoteness of architects from house builders and users afterwards. Currently, although this kind of educational pattern has led to increasingly higher standards of education and examination because of its collective control, it is open to question whether it has or will truly equip the students (future architects) with sufficient knowledge to finally lead to better practice (Lawson 1997: 22).

Today, since the advanced technocratic society is changing more quickly than at any previous time, not just the design but also the world into which the design must fit have become more and more uncertain to architects. Under these circumstances, the design processes have arisen not as the result of careful and wilful planning, but rather as 'a response to change in the wider social and cultural context in which design is practised' (Lawson 1997: 23). To achieve a better outcome in terms of practice, therefore, today's architects can no longer be trained to follow a set of conventional procedures as the rate of social, economic or technological changes would soon leave them behind. Actually, as argued earlier (see 2.7.1), architects today are required to be not just technically capable, but also trained in design decision-making.

Since sustainability has been set as the ultimate objective, particularly focused educational procedures should be built to help architects and architectural students understand this topic and its relevant issues. Some early work in such area has been carried out for many years, by interest groups (see Fowles *et al.* 2003) and by individuals (see Dejesus 2002). Hence this research tends to provide an insight into the outcome of these efforts. In the following sections, relevant education programmes, which contribute to the 'self-conscious professionalised process' (Alexander 1964, cited in Lawson 1997: 22), are examined and discussed from two aspects. One aims to investigate students' specialist knowledge from a solution-focused perspective, trying to find out whether current education programmes have equipped students with related skills for decision-making in the design processes. The other aims to investigate students' personal characteristics from a problem-focused perspective, trying to find out whether current education programmes have instilled good habits into students through their day-to-day lives.

- ***Specialist knowledge from a solution-focused perspective***

As argued by Lawson (1997: 126), design is a prescriptive job rather than descriptive and designers are expected to act. Therefore, unlike scientists who may help people understand the present and predict the future, designers have been asked to prescribe and create these times. Obviously, this is a rather hazardous work which deserves 'not just ethical but also moral scrutiny' (ibid: 127). Any misunderstanding of this job definition, especially in terms of architectural educational procedures, may lead to serious problems.

Normally architectural students learn through a series of design studies and receive criticism about the solutions they put forward rather than the methods. Moreover, they are not always asked to understand the problem or analyse the situations lying behind. Therefore, when they are making design, their thinking seems sensible, related to this kind of cognitive style; 'learning about the problem through attempts to create solutions rather than through deliberate and separate study of the problem itself' (Lawson 1997: 43). In other words, they have often been trained to be obsessed with achieving the desired results rather than really understanding the underlying principles. The result of this is that, in the real architectural world, the solution is everything while the decision-making processes have rarely been examined (ibid: 42). As designers and important decision-makers, architects are also often likely to employ a solution-focused strategy in practice rather than a problem-focused one. In the sustainable housing design processes, however, the solutions provided by these designers, who think the way they do rather than considering the inherent problem they are confronted by, might prove to be wrong or lead to other problems. This is mainly because the concept of sustainability and its related principles are still vague, and are difficult to achieve (see 2.3.1).

In Chapter 4, the application of EcoHomes to support the housing design processes has been extensively studied from a solution-focused perspective. It is suggested that the system for value judgement adopted by EcoHomes could be used as a checklist to help designers increase efficiency and address flexibility in the decision-making processes, especially with constraints such as limited time and budget and so on. It is expected that, through related educational procedures, architectural students would begin to learn how to make informed decisions based on options available, to consider different housing environmental issues in order of relative importance and to adapt their preferences for different design measures accordingly.

To see whether current architectural education programmes have equipped architectural students with sufficient relevant knowledge, the *Questionnaire for Future Designers* has been tailored in this chapter and the related investigation has been carried out within a group of postgraduate architectural students from a solution-focused perspective. However, findings from this survey are not optimistic.

Although the target students have realised the importance of addressing sustainability principles in housing design processes, few of them have been equipped with sufficient knowledge in current educational procedures. Actually, most students in the target group did not truly distinguish housing environmental issues addressed in EcoHomes from conventional design issues. Taking the issue of 'close to a public transport node' as an example, it was found from the follow-up discussion section that students who had marked this issue as 'apply in design (Good)' or 'know how to optimise it (Very good)' knew about the general ideas but barely had any insight into relative impacts of the options, such as the requirements for frequency and distance and so on. In contrast, many students were likely to take the training programmes of sustainable design as a technology-focused extension for their existing tutorials, and saw EcoHomes as a specialised assessment system that should be used by professional consultants *only*. Based on this viewpoint, they often focused their interest and energy on technology-dependent solutions and were likely to leave their final products to be judged by EcoHomes assessors (or their course tutors) passively. Indeed, they often felt obliged to visibly demonstrate commitment to sustainability issues, even if the approaches undertaken were not always the best environmental options – photovoltaics and micro-turbines being two examples (Clarke 2009: 19). This finding somewhat corresponded with the argument which arose in an earlier study (Dejesus 2002: 166):

> 'Architectural students prefer to learn through the design process, because it is practical and gives them the opportunity to experiment and have control over the elements they want to develop. Nevertheless, one of the biggest motivations to learn is *obtaining a degree*. There should be some evaluation mechanisms to ensure they have a solid understanding of issue of sustainability and not a

superficial one designed only to obtain a credit.'

Most students in the target group probably did not realise that their duties in a collaborative decision-making process were to get the message of sustainable design across to different stakeholder groups and offer their specialised decision-making skills. A general consensus could be achieved within the focus group on main motivational factors, including both drivers and barriers, to take sustainability principles into account in housing design processes. However, their opinions on motivational factors to encourage other stakeholders (for instance housing developers or their clients) to consider sustainability issues did not correspond. In the follow-up discussion section, it was found that students in the target group were often likely to take sustainable design measures into account from a *passive* (or reactive) perspective. For example, the issue of 'low water use appliances' was rated by the students as 'fully understand (Neutral / Equal)' but rarely as 'apply in design (Good)'. Some students argued that the application of water-saving appliances would depend heavily on the clients' requirements. However, the problem is that their clients, often with little specialist knowledge, might not understand every sustainable measure, but simply ask for an outcome with better qualities. Therefore, it is the architects' responsibility to consider the various possibilities of integrating different design measures from an *active* (or proactive) perspective and help their clients make informed decisions based on options open to them. This viewpoint is strongly supported by Herzberger who argues that the designers' role should not be taken as purely passive but an active facilitator of the design process (Herzberger 1971, cited in Lawson 1997: 262). Further, Keith Clarke, Chief Executive of ATKINS and Deputy Chairman of the Construction Industry Council (CIC), also argues,

> 'Construction professionals have a role in moving practice forwards and have a responsibility to contribute to current developments that will influence future practices. It is too easy to place responsibility on government or use clients and end users as excuses for inactivity.' (Clarke 2009: 19)

To summarise, from a solution-focused perspective, it can be judged that architectural students in the target group have not been equipped with sufficient specialist knowledge to make sustainable housing design. In order to achieve a better result, it is important to improve current architectural educational procedures by addressing not just detailed criteria of the design guidelines, but also architects' new responsibilities in the design processes. Some discussions in Chapter 4 (see 4.6) might provide an opportunity to improve current architectural education, although they are focused on temporary solutions in particular. Further, it is important to note that the increasingly specialised technological knowledge can also become a strait-jacket for architects' creative thinking, 'directing their mental processes towards a predefined goal' (Lawson 1997: 8). On the other hand, based on solution-focused design measures, houses can probably be designed towards the standards of 'Excellent' in EcoHomes or 'Level 6' in the Code for Sustainable Homes. However, it is questionable whether these highly rated houses will truly lead to the objective of sustainability, especially for energy saving and carbon reductions during the operational phase of house occupation.

- ***Lifestyle change from a problem-focused perspective***

It is widely acknowledged that housing occupants, normally with little specialist knowledge, play an important role in sustainable housing, especially for energy saving and carbon reductions in the operational phase of house occupation. This viewpoint needs to be envisaged from two perspectives. On one hand, as the market protocol moves from industry-chain oriented perspective to consumption-chain oriented perspective (or shifting from predominantly 'supply-push to demand-pull' as argued by Lutzkendorf and Speer (2005)), householders today have more choices for daily living than ever before. On the other hand, it is very rare for architects to choose users for their designs, though some celebrated designers might get the opportunity to select their clients at times. In order to achieve a better result, therefore, architects need to find a way to work closely with housing occupants, educate them into more genuinely collaborative roles and help them make informed decisions based on the options open to them. This objective can only be achieved in collaborative decision-making processes if architects are aware of the nature of housing users and their needs from a problem-focused perspective. Hence this follow-up discussion intended to find out, as a focus group of housing occupants who already had specialist knowledge, whether architectural students were aware of this and had started to consider issues relating to sustainable living in their own day-to-day lives.

As argued earlier, lifestyle can be seen as a combined symbol of culture, social class, consumer choices, behaviour and historical trends (Kempton 1993: 221). Spaagaren and Van Vliet expand this idea and refer it to the process of integration of the various social practices that people experience in their daily lives:

> 'A lifestyle can be defined as a more or less integrated set of practices which an individual embraces, not only because such practices fulfil utilitarian needs, but because they give material form to a particular narrative of self-identity.' (Giddens 1991: 81, cited in Spaargaren and Van Vliet 2000: 55)

According to Lutzenhiser (1990: 108, cited in Parnell 2003a: 94), peoples' lifestyle choices or 'recipes for living' in their everyday lives are influenced by 'the wide variety of, technological, ideational, and behavioural resources'. To help householders, normally with little specialist knowledge of sustainable lifestyle (for instance One Planet Living as argued in 2.4.3), make informed decisions, it becomes partly the architects' responsibility to get the message across. It is proposed that better results can be expected if architects had a sensible system for value judgement in their own lives, based on their understanding of the relative importance of different housing environmental issues.

To determine whether current architectural education programmes have equipped architectural students with sufficient relevant knowledge, the *Questionnaire for Current Housing Occupants* has been tailored in this chapter. The system for value judgement adopted by EcoHomes is set as the appraisal standard to examine the variances in awareness, behaviour and consequent issues among a particular sub-group of society (postgraduate architectural students in the University of Sheffield who are in a position to be informed about climate change). Some issues related to concerns addressed in an individual's Ecological Footprint (referring to One Planet Living as argued in 2.4.3) have also been taken into account.

Although there was an aspiration for sustainable lifestyles among students in the target group, feedback from the pilot investigation showed that, as current student accommodation users, these architectural students considered housing environmental issues in order of relative importance which did not correspond with the one used in EcoHomes. As argued earlier, the system for value judgement used by EcoHomes was developed from extensive consensus-based studies on the basis of BRE's Ecopoints scheme (Howard 1998). Hence the relative importance of different housing environmental issues in EcoHomes was set as the appraisal standard in this research. Based on the comparison, it is believed that, as key stakeholders potentially leading in the way towards One Planet Living, architectural students in current architectural education programmes have not been equipped with sufficient knowledge of sustainable living principles from a problem-focused perspective.

This was emphasised in the follow-up discussion, where the online Ecological Footprint Quiz (Earth Day 2002) was applied to check the students' current Ecological Footprint. As shown in Figure 5.21, most students in the target group needed more than two planets to sustain their existing lifestyles and some of them needed six. A large proportion of resources were consumed not just for housing operation, but also for personal transportation and food or goods miles (also see 2.4.3). Obviously students' consciousness of sustainable living lagged behind the requirements on the basis of One Planet Living.

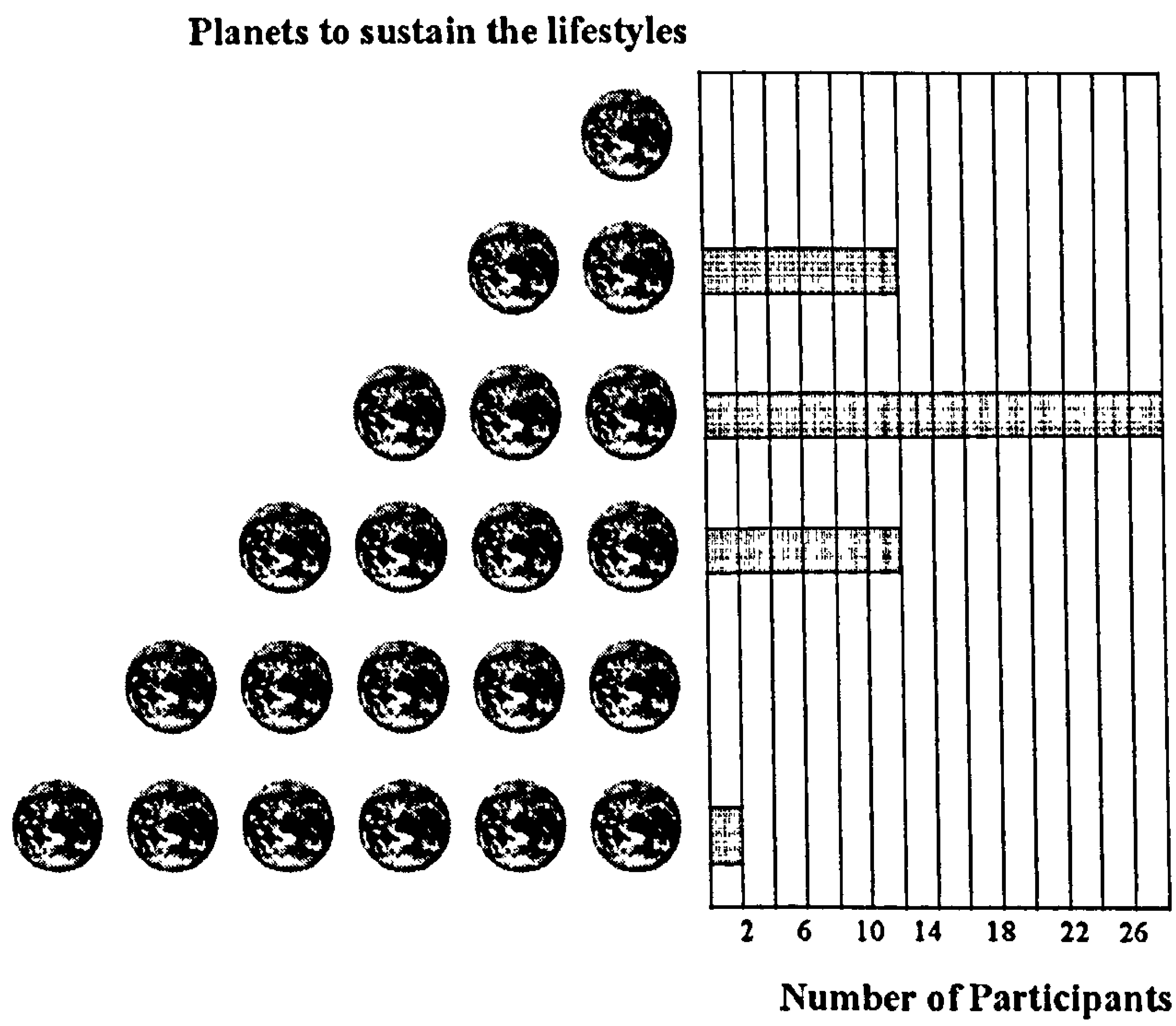

Figure 5.21: Target students' Ecological Footprint

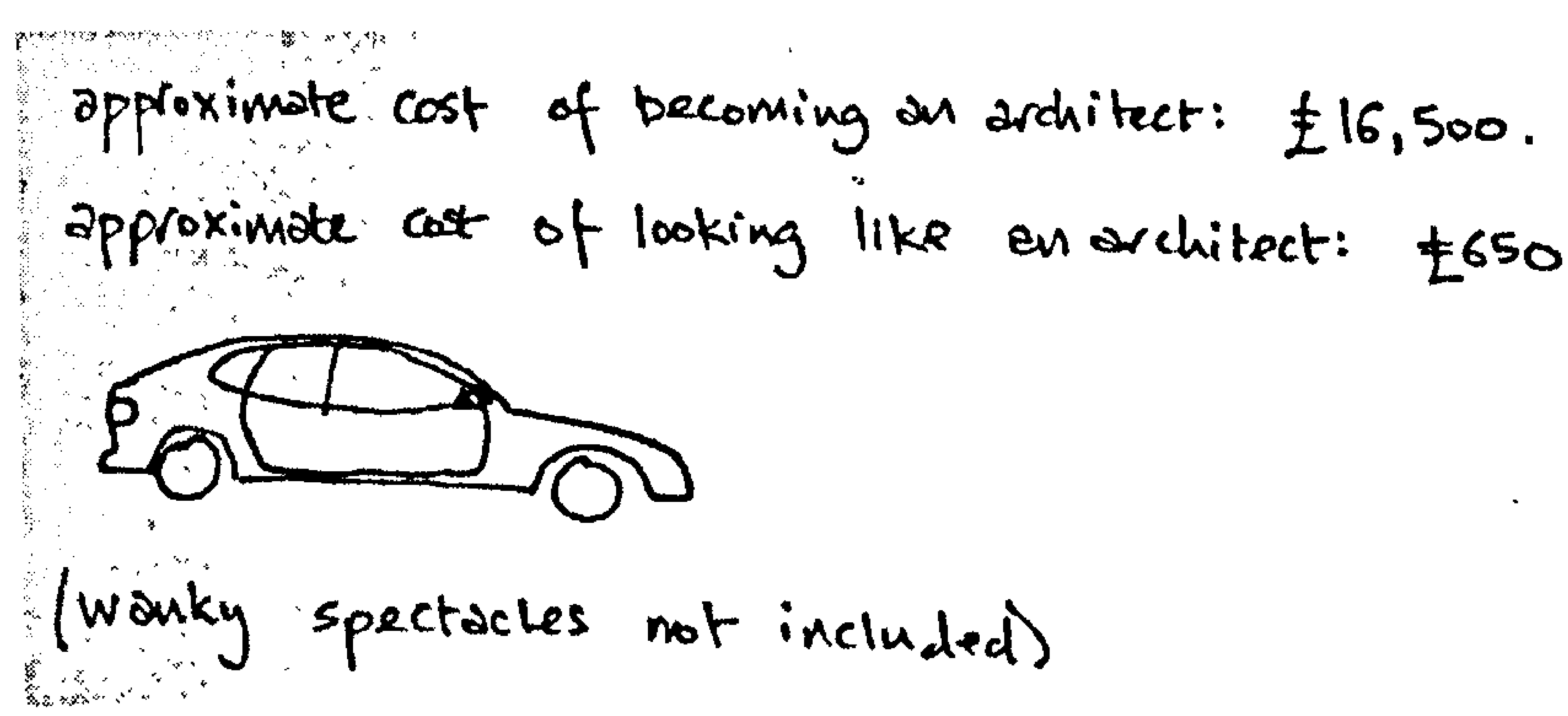

Figure 5.22: Advertisement for a car for sale in the School of Architecture

This situation could be worsened once these students graduated from the university and became more financially independent. As shown by an advertisement for a car for sale in the School of Architecture (Figure 5.22), it stated that,

> 'It will cost you approximately 16,500 pounds to become an architect; but it will only cost approximately 650 pounds to make yourself look like an architect.'

Based on such observation, it was believed that students care more about their short-term interests (e.g. how to look like architects or make their designs look more sustainable in order to achieve better credits) rather than long-term benefits (e.g. becoming part-BEE[xxxix] or considering sustainability principles from an integrated perspective, which often requires them to change their lifestyles towards greater environmental sensitivity). Some of them did not yet realise that, although houses could be designed for energy saving and low carbon dioxide emissions by using technical add-ons, it was the residents' lifestyles that decided whether the long-term objective of sustainability could be truly achieved.

To summarise, from a problem-focused perspective, it can be judged that architectural students in the target group have not been trained to take into account sustainable living issues in a sensible order of relative importance in current education programmes. Therefore, it becomes questionable how these poorly informed key people would be able to lead other stakeholders in changing their attitudes and beliefs about lifestyles in future housing designs. To achieve a better result, it is important to improve current educational procedures by addressing not just awareness of sustainable lifestyles, but also the potential to get the message across in the decision-making processes.

5.4.2 DISCUSSION: PROBLEMS OR SOLUTIONS

As argued by Peter Graham (2003, cited in Roaf *et al.* 2004: 14), all building professionals should be trained as at least part-BEE[xxxix] at a time when so many people need rapid and robust advice. For the necessary changes to take place in time, it becomes important to breed built environmental professionals, who could be trained Home Energy Report or Building Certificate evaluators, designers or managers for the built environment and so on. Related training programmes for such professionals, such as suitable postgraduate courses (examples given by Roaf *et al.* 2004), should be encouraged. As a major university that provides the sustainability-orientated education in the UK, the School of Architecture in the University of Sheffield is selected for further study in this research.

Compared with the general public, university students have many advantages in tackling climate change. Their lifestyles have not been fully formulated and they are about to make decisions independently among available alternative options. Hence the opportunity for lifestyle change exists. Further, since they are taking higher education programmes, it will be easier for them to access information related to sustainability principles. Likewise, their understanding of this concept and its implementation should also be superior to others.

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xxxix In the book *Building Ecology*, Peter Graham calls sustainability experts 'BEEs' – Building professionals who are Ecologically literate and Environmentally aware. This book also explores the problems in the built environment and how the BEE can act to mitigate them. (Roaf *et al.* 2004: 14)

Issues in Design Processes	
Use brownfield sites in preference to greenfield	1.33
Plan to include local accessible amenities	3.00
Protect local ecosystem during construction process	1.33
Project Scheme and Management	
Enhance local ecological values	1.33
Close to a public transport node such as bus stop, tram stop, etc.	2.00
High density (like the ratio requirement between Floor Area and Footprint)	2.67
Site layout for natural daylighting and view	5.25/2
Decide landscape categories according to the typology of surrounding sites	5.33
Master Plan	
Room and window design for daylighting	5.25/2
Provision of internal or external naturally drying space for clothes	0.92
Space and services for working from home	1.00
High insulation standards	1.83
Use of ecological materials or environmentally friendly insulation materials	0.91
Use sustainably sourced timber as primary/secondary elements	2.71+1.35
Select materials based on their full life-cycle rating	7.23
Design and testing for sound insulation	7.00
Private outdoor space	1.75
Efficient control for external lighting & internal lighting appliances	1.83+1.83
Secure cycle storage	2.00
Natural ventilation	
Passive solar design, like buffer zone (conservatory), thermal mass, etc.	
Plan/Elevation/Section/Interior Design	
On-site renewable energy / green energy supply system	2.73
Energy efficient heating/lighting appliances	13.75
Use low-emission fossil fuel boilers/appliances	2.73
Rainwater collection / sustainable drainage system	1.82
Low water use appliances	8.33
Facilities to recycle rainwater	1.67
Knowledge about renewable energy (like PV, wind turbines, CHP, etc.)	
Supply & Reuse for Energy and Water	
Provide energy efficient white goods (fridge, etc.) and relevant information	1.83
Facilities to recycle household waste, i.e. segregated bins	2.71
Other Details	

Based on EcoHomes, there is a potential opportunity to convert the decision making processes from a qualitative procedure to a quantitative one.

Issues in EcoHomes 2006	
Ene1: Dwelling Emission Rate – CO_2	13.75
Ene2: Building envelope performance	1.83
Ene3: Drying space	0.92
Ene4: Eco-Labelled white goods	1.83
Ene5: External Lighting	1.83
Ene6: Internal Lighting	1.83
Energy	22
Tra1: Public Transport	2.00
Tra2: Cycle storage	2.00
Tra3: Local Amenities	3.00
Tra4: Home Office	1.00
Transport	8
Pol1: Insulation ODP and GWP	0.91
Pol2: NO_x emissions	2.73
Pol3: Reduction of surface runoff	1.82
Pol4: Renewable and Low Emission Energy Source	2.73
Pol5: Flood Risk Mitigation	1.82
Pollution	10
Mat1: Environmental Impact of Materials	7.23
Mat2: Responsible sourcing of Materials: Basic Building Elements	2.71
Mat3: Responsible sourcing of Materials: Finishing Elements	1.35
Mat4: Recycling Facilities	2.71
Materials	14
Wat1: Internal Potable Water Use	8.33
Wat2: External Potable Water Use	1.67
Water	10
Eco1: Ecological value of site	1.33
Eco2: Ecological enhancement	1.33
Eco3: Protection of ecological features	1.33
Eco4: Change of ecological value of site	5.33
Eco5: Building footprint	2.67
Land Use and Ecology	12
Hea1: Daylighting	5.25
Hea2: Sound Insulation	7.00
Hea3: Private space	1.75
Health and Well Being	14
Man1: Home User Guide	3.00
Man2: Considerate Constructors	2.00
Man3: Construction Site Impacts	3.00
Man4: Security	2.00
Management	10

	Issues in the housing hunting processes
	Charges for rent and deposit
2.73	How much it costs for utilities: electricity / gas / water
	Other expenditure for additional furniture or appliances, or travel expense
	Economic aspect
2.00	Secure area and safe access
1.33+5.33	Friendly surroundings with good ecological system and landscape
2.00	Close to a frequent public transport such as bus stop, tram stop, etc.
3.00	Close to local accessible amenities:
	Supermarket or late shops
	Gymnasium or sports centre
	Pub or bar
	Cafe, takeaway or restaurant
	Location
5.25	Natural daylighting and view of the sky in the bedroom
0.92	Drying space for clothes, internal or external
1.00	Space and service for studying or working from home, like internet access
1.83+0.91	High insulation standards, like double glazing
2.71+1.35	Fitment and furniture with timber or environmentally friendly appearance
7.00	Sound insulation between adjacent rooms or floors
1.75	Private outdoor space, like back-garden
2.00	Secure cycle storage
	Private car parking
	Openable windows & airflow to improve interior air conditions
	Southern orientation of the bedroom for interior warmth
3.00	Efficient control system for central heating and hot water
2.71	Facilities for disposing separately or recycling household wastes in kitchen
	Internal & External Requirements
16.48+3.66	Energy efficient heating and lighting appliances
1.83	Energy efficient fridge and wash machine with white goods label
8.33	Water-saving toilet & bathroom
	Energy efficiency for money saving

It is important to note that the environmental issues arising in the student's accommodation seeking processes and the design strategies addressed in EcoHomes do not always correspond. In contrast, some integrated design strategies can often address several issues at the same time, while it is also possible that different strategies create similar environmental benefits.

Figure 5.23: Communication platform based on the EcoHomes scheme

It is important to note that all housing environmental issues were discussed based on architects' knowledge level. Although this is not the common language as argued in Section 4.7, it makes the study more related to design decision-making. Architectural students need to understand more about these housing environmental issues even though they are not necessarily going to become EcoHomes assessors or specialists.

Better understanding of these issues will also allow architects to make design in compliance with building regulations. For instance, as stated in the consultation paper *Proposals for introducing a Code for Sustainable Homes* (ODPM 2005): 'Part L 2006 will require calculations based on the potential performance of the building based on standardised occupation and behaviour in relation to space heating, hot water heating and lighting. Compliance with Part L 2006 will require calculation of the home's carbon dioxide emission rate (DER) in accordance with the procedures set out in SAP 2005. This emission rate must not be greater than the target carbon dioxide emission rate (TER) derived according to the procedure published in Approved Document L1A 2006 (AD L1A): Conservation of Fuel and Power in New Dwellings'.

To architects, therefore, the common language of sustainability also embodies the meaning of increased responsibility, social and environmental consideration.

Among these university students, those studying in relevant disciplines (i.e. Architecture, Landscape, Town and Regional Planning, etc.) can be seen as a special sub-group with dual status, related to both future housing design (as housing designers) and current housing occupancy (as residents in student accommodations). In tackling climate change, they contribute to both the solutions and problem. By setting them as the main research scenario, therefore, issues about a designer's willingness to embrace sustainable design and an occupant's awareness of sustainable living can be raised at the same time, from solution-focused and problem-focused perspectives.

As shown in Figure 5.23, based on the appraisal standard (the system for value judgement used by EcoHomes), comparisons have been made to see whether the higher-level architectural students consider different housing environmental issues in a sensible order of importance, in the housing design processes and in their everyday lives.

It is important to note that all housing environmental issues are discussed based on architects' knowledge level. Although this is not the common language as argued in 4.7, it makes the study more related to design decision-making and reflects the researcher's personal values (a researcher with background in architectural design). Further, it is argued in this pilot study that, although architects can get technical support from experts or specialists in collaborative decision-making processes, they need to have enough knowledge to collaborate with others and intervene at the key decision-points in terms of information flow. This should be addressed at the early stage of their education – as architectural students, they need to be trained to understand more about these issues even though they are not necessarily going to become EcoHomes assessors or specialists (also see Dammann and Elle 2006: 402). In other words, to this focus group, the common language of sustainability also embodies the meaning of increased responsibility, social and environmental consideration.

However, findings from the pilot investigation were not optimistic. Compared with the system for value judgement adopted by EcoHomes, students in the target group considered the range of housing environmental issues in a different order of importance, either as future housing designers or current housing users. Some people may argue that this should be tolerable since detailed weighting scores for different housing environmental issues may vary due to personal priorities or the investigation itself. Nevertheless, if a close consensus about the order of relative importance of the issues cannot be achieved between different stakeholder groups, cognitive gaps might lead to problem related to energy saving and carbon dioxide emissions reductions in the operational phase of house occupation (see 2.4.2

and 2.6). Further, if people in the target group, housing occupants with relatively more specialist knowledge, do not realise the importance of changing their lifestyles towards greater environmental sensitivity, it is very doubtful how they would persuade general housing occupants, normally with fewer incentives and less specialist knowledge, to do so.

Current education programmes have only helped architectural students achieve a basic perception of sustainability and rarely taught them how to implement principles in terms of practice. To facilitate knowledge transfer, therefore, an alternative decision-making process is proposed based on the framework of EcoHomes. It is suggested by the researcher that an ongoing interaction between all stakeholders can be achieved throughout the housing development processes based on a shared communication platform (Figure 5.23). Moreover, to get the message across effectively, proper interfaces should be built according to the overlapping information sources used by different stakeholder groups. For instance, from the close comparison of results from QD1 in the *Questionnaire for Future Designers* and QD4 in the *Questionnaire for Current Housing Occupants*, it was found that generally there were four efficient ways to share sustainability-related information (related to both design and living issues) within the group of architectural students. They were 'professional journal or publication', 'people to people' (project team members, colleagues or friends), 'research organisations' and 'professional or trade body'.

However, it is also important to note that architectural students often looked for information about living in a more sustainable way from 'general media such as TV, radio or newspaper', though it was not considered important by the same group of students when they searched for information about standards, services, technologies and products relating to construction and the built environment. This finding was not against the principle of developing a common language as argued in 4.7. On the contrary, it implied that, although sustainability information should be written in a common language for transparent purpose, it could be communicated in a variety of ways to meet the requirements from different stakeholder groups. Since format of communication platform can vary from case to case, there is a need to identify the most efficient one in the future and understand how it will influence green building practice (also see Gluch and Stenberg 2006).

5.5 FINDINGS OF THIS PILOT INVESTIGATION AND FUTURE WORK

To understand architectural students' intrinsic cognitive styles better, two prevalent assessment schemes were applied in this pilot investigation to examine their consciousness of the related issues, EcoHomes from a solution-focused perspective and Ecological

Footprint from a problem-focused one. It is argued that **the application of EcoHomes can probably provide temporary solutions for the current housing market, but it is peoples' awareness of sustainable living (based on their own Ecological Footprints) that decides how far they want to go to do this in tackling climate change.** In other words, the opportunity for change exists but its realisation will depend heavily on these key peoples' initiative, whether they see themselves as contributing to the problem or the alternative solutions. As argued by Roaf *et al.* (2004: 450), '... this is not a one-off exercise. Questions must be asked at inception, during the project, and periodically once the building is occupied'.

Some early findings show that current sustainability-related education programmes have not equipped the target postgraduate architectural students with sufficient knowledge or subjective norms (including motives and values) to allow them to design houses towards higher sustainability standards (as designers) or change their lifestyles towards greater environmental sensitivity (as occupants). Actually, though architectural students have had a general awareness of sustainability, it has so far made only limited impact on their design protocols or lifestyle choices. Therefore, there is a great degree of untapped opportunity to improve current education programmes. As argued by Lawson (1997: 26), the more the whole design process can be openly inspected and critically evaluated, the more architects' work can be replicated and criticised and their methods can be above suspicion. Hence in the future, it is important to make explicit not just the design solutions, but also the decision-making procedures. Skills in communication and trans-disciplinary study should also be addressed in future architectural education programmes, as they help housing designers understand how to collaborate with people from other stakeholder groups, when to intervene at the key decision-points in terms of information flow and where to stop when embracing sustainability. Some discussions relating to this area can be found in Chen *et al.* (2006, 2008b). Furthermore, it is important to note that the development of sustainability-related architectural education should not rely on voluntary input from individuals with 'spare time' (Clarke 2009: 19) as this results in timeframes of five to ten years or even longer. The architectural education sector needs to recognise that this is fundamental work and not a hobby and that change needs to happen more quickly.

Further, as argued by Strauss and Corbin (1998: 205), preliminary field-work can provide concepts for later work, which is better than deriving concepts from literature or experience alone. In this research, therefore, the pilot investigation was used to examine argument raised by BRE that a high degree of consensus on the relative importance of different environmental issues could be achieved between all levels of decision-makers (see Dickie and Howard 2000: 2). Since this pilot study proved that the consistency could not even be achieved within a special focus group (the stakeholder group with more environmental or technical knowledge), it is very doubtful it could be achieved between different stakeholder groups. This formulates **the objective of later work that is to explore the priority variances between different stakeholder groups.**

It is important to note that there were some research limitations in this pilot investigation. Although data analysis was made based on updated weighting system used in EcoHomes 2006, major housing environmental issues addressed in the questionnaires were coming from EcoHomes 2005. Further, to allow for comparisons, all issues were rated by the target students from a compulsory and balanced perspective, which differs from either the voluntary way in which EcoHomes works or the mixed way in which the Code works (both mandatory and voluntary requirements, see 4.5.4). It is also very arguable whether EcoHomes can be seen as regulators' constraints since there are still some differences between this voluntary assessment system and the Code. Other research limits were due to the case study itself. Because of the hilly terrain of the city, the Sheffield Student Village has some particular design requirements compared with student accommodations elsewhere. Hence, feedback from some issues, for instance those related to transport, might not be suitable to guide other student accommodation design.

Although a general summary was drawn from this pilot investigation, it is important to note that data collected in this stage was not eligible for statistical analysis, which would lead to generalisations. Further, not all questions in the questionnaires are discussed. Some of them are left to further studies in the future.

5.6 CHAPTER SUMMARY

In this chapter, two questionnaires are designed, one for future housing designers and the other for current housing occupants. Since both of them are based on housing environmental issues addressed by EcoHomes, a cross comparison can be made to explore the priority variances between stakeholder groups. This research method, using EcoHomes (or other building environmental assessment methods) as a communication platform to gather information from stakeholders at different knowledge levels, has not been fully explored in previous studies.

A group of postgraduate architectural students are selected to make the pilot investigation. Due to their dual status, as both future housing designers and current housing users, priority-related issues about designers' knowledge of and occupants' awareness of housing environmental issues are raised at the same time.

From the pilot study, some sub-questions of this research (see 2.7.3 and 4.8) can be answered. It is found that these postgraduate architectural students do not realise that they are contributing to both problems and solutions in tackling climate change. As a result, though they have a general awareness of sustainability principles, their design protocols or lifestyle choices have had limited impact from it. The systems for value judgement adopted by these students, either as future housing designers or current housing users, do not correspond with the one used in EcoHomes (legislators' or experts' constraints). In contrast, they still see EcoHomes (or other building environmental assessment methods) as a reactive assessment rather than a proactive project appraisal. This is probably led by the separation between design and research in the sustainability-related education (see Figure 1.1). Such issues must be envisaged in current architectural education by addressing designers' role as an active facilitator of the design processes.

Some important motivational factors are also explored, from both positive and negative perspectives. It is found that there is a general consensus within this group of students on the drivers (which are 'environmental benefits', 'reducing waste', 'doing the right thing', 'demonstrating best practice', 'meeting client requirement' and 'economic benefits') and on the barriers (which are 'lack of interest from developers or clients', 'affordability or cost', 'lack of information and relevant training') for them to take sustainable measures into account in the design decision-making processes. Likewise, a general consensus is also achieved on issues that could encourage their future practices to increase application of sustainable strategies (which are 'cost and benefits analyses', 'information on exemplar projects and best practice' and 'training'). However, apart from 'economic benefits', this kind of consensus is not reached on drivers to encourage their clients or developers to participate in tackling climate change. In summary, higher-level architectural students in the focus group might have a general idea about their incentives to make sustainable design, but rarely know how to educate people from other stakeholder groups into more genuinely collaborative roles. Since it is argued that they have a responsibility to get the sustainability-related message across to different stakeholder groups in collaborative design processes, sustainable principles (both design and living issues) must be addressed in current sustainability-related education by means of collaborative learning.

Since the so-called *close consensus* on housing environmental issues, as argued by BRE (DCLG 2007b), cannot even be achieved within the same group of people (for instance, postgraduate architectural students in this case), it is believed that there also might be variances between different stakeholder groups. This contributes to another sub-question of this research (see 1.3). To explore the related issues and validate the earlier findings, further investigations have been carried out between 2005 and 2007. Detailed procedures will be described in Chapter 6, Chapter 7 and Chapter 8.

Some important concepts for sustainable housing design arising from the first part of this thesis are summarised as following:

- It is argued that housing occupants, often with little specialist knowledge, play an important role in energy saving and carbon dioxide emissions reductions in the operational phase of house occupation. Stakeholders from other stakeholder groups (for instance, the Legislator Group, the Designer Group and the Client Group) can probably provide temporary solutions for the housing development. However, it is the housing occupant's awareness of sustainability issues and willingness to change their lifestyles towards greater environmental sensitivity that decide how far they want to go to save energy, reduce carbon dioxide emissions and recycle waste.

- As a special focus group of occupants, university students, especially those studying architecture or built environment related disciplines, should have a positive effect, through changes in their attitudes, social values and inspirations, over the vast campaigns of education, debate and public participation. Therefore, it is argued that these students should be educated on sustainability principles as the first step to making changes. Furthermore, considering their dual status of both future housing designers and current housing occupants, it is important to educate them so they realise they not only contribute to the problem, but also the solutions in sustainable housing (or student accommodation) designs.

- Design is described as a transfer between areas of knowledge bearing on a particular project, aiming for consensus of problem solving. Hence better results can be expected if a close consensus on the alternative options is achieved between different stakeholder groups. In reality, however, stakeholders from different groups often have different systems for value judgement and it is difficult to get the message across in the design processes. To facilitate knowledge transfer, therefore, it is important to design a communication platform based on a common language. Moreover, this communication platform needs to represent opinions from all levels of decision-makers in collaborative decision-making processes through a procedure of multi-level knowledge aggregation.

- It is argued that architectural students should be trained to understand more about housing environmental issues even though they are not necessarily going to become EcoHomes assessors or specialists. This is mainly because architects need to have enough knowledge to collaborate with others and intervene at the key decision-points in terms of information flow, though they can get technical support from experts or specialists in collaborative decision-making processes. Likewise, it is argued that change of people's attitude and subjective norms is a necessary and important supplement in order to take the first step in UK society's transition to sustainability, though this change might not necessarily lead to immediate benefits (such as energy saving, carbon reductions, waste recycling and other actions led by change of people's energy-use behaviour or living manners).