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A Framework Model for Assessing Sustainability Impacts of a Built Environment

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ABSTRACT

Urban assets have impacts not just on those who develop, build and operate them, but on people who may be quite remote from them. The impact of a building on greenhouse gas emissions arising from energy use, pollution caused by travel to work patterns, employment opportunities and reductions in crime may be far removed from its immediate locality. There is a growing recognition of the need to internalize these external costs in accountancy frameworks, but this presents major challenges in identifying, evaluating and allocating whole life costs and the external environmental and social costs of a building project. This paper reports progress on the development of a holistic sustainability accounting framework which allows decision makers to identify building sustainability indicators (economic, environmental and social) for different assessment contexts and select the appropriate mechanisms for monetising their impacts so that the holistic, whole life costs and benefits can be evaluated. It builds on a Sustainability Accounting Model (SAM) developed originally in the oil industry covering four major issues: environmental, social, economic and natural resources. The paper describes why the Sustainability Accounting Model was chosen for further development from the many others that have been proposed as candidates. It describes how it has been tailored for the construction industry, how the many sustainability indicators have been prioritised and simplified, and the techniques that have been used for monetising what are regarded by many commentators as intangibles.

Key words: Sustainability assessment; Full cost accounting; Built Environment

1 INTRODUCTION

There is a growing requirement of the construction sector in the UK and in other countries to adopt the principles of sustainability in their activities and polices (Augenbroe and Pearce, 1998; Brandon, 2005; Curwell et al., 1999; DTI, 2006; OECD, 2002, 2003; USGBC, 2003; Walton et al., 2005). Thus environmental and societal aspects are increasingly being considered alongside functional and economic issues by architects, surveyors, engineers, project managers and others responsible for making key decisions throughout the different stages in delivering a construction project. There is consequently a rising demand for tools to support those decision-makers in finding more sustainable solutions. For example, in the United Kingdom, some 25% of the new office buildings acquire an environmental assessment and labels (Hasegawa, 2002). Although assessment criteria are available, there is no single, robust methodology that can quantify and assess all three dimensions (economic, social and environmental) of the built environment.

Sustainability accounting is a useful tool which has been applied at the corporate level. Some work has already been undertaken (Bebbington and Gray, 2001; Bent and Richardson, 2003; CIRIA, 2003; Gray, 1992), but none so far can offer a viable solution. The problem is twofold. First, most financial work is directed at the corporate level rather than the urban development level. At the corporate level, there is little incentive to consider those cash flows which have no direct impact on the performance of the corporation, even though they may well have a significant impact on society at large. Second, complexity of sustainability assessment - both in terms of scientific uncertainty and ideological diversity - requires a multi-dimensional approach (e.g. a plurality of decision criteria) (Bebbington et al., 2007).

The aim of this paper is to present the development of an integrated framework for assessment of economic, environmental and social impacts of building in the context of urban development, representing one of the first full cost accounting-based models for buildings assessment. This paper includes the following sections: a methodological framework, main components of the proposed framework, impact categories in the model, externalities valuation and a conclusion.

2 A METHODOLOGICAL FRAMEWORK

The framework model - Construction Sustainable Assessment Model (CSAM) draws upon advances of two streams of sustainability assessment methods: Building Whole Life Performance Assessment and Sustainability Accounting.

Recently much attention has focused on environmental impacts assessment. There are currently several methods available and in use for evaluation of environmental impacts of buildings (BRE, 2004) , including ENVEST (UK), Bousted (UK), ATHENA (Canada), EcoPro (Germany), TEAM (international), Gabi 4 (Germany), and Ecoquantum (NL/EU). The issues covered are related to materials use, land and pollution created. Much less attention has been paid to social impact assessment. Therefore, they are not holistic tools in term of sustainability assessment. Difficulties also arise in comparing alternatives and options across different projects and communicating assessment results across difference disciplines and different groups of stakeholders. In order to develop a comprehensive building sustainability assessment model, the authors created a framework to integrate building whole life performance methods and sustainability accounting techniques (for recent published reviews see (Bebbington et al., 2001; Lamberton, 2005)).

Theories and practices in whole life performance assessment and sustainability accounting for buildings are integrated and consolidated through a holistic approach by incorporating international, national, local, sustainability indicators, national strategies for sustainable construction and the built environment, major sustainable building assessment tools and other sustainability assessment schemes. The integrated system will be able to analyse the environmental, social and economic costs and benefits in monetary terms at different stages in the life cycle of a built environment. Figure 1 illustrates the methodological framework for the "Construction Sustainability Assessment Model – (CSAM)".

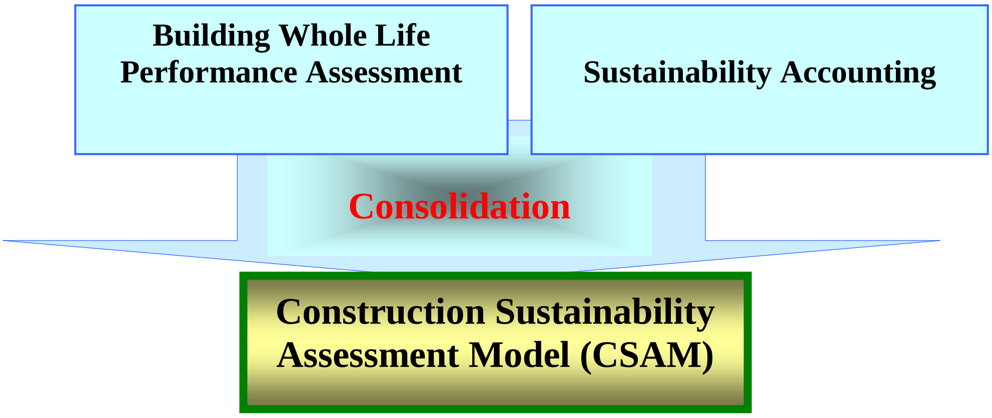

Figure 1: Methodological framework for CSAM

In order to develop a rigorous theoretical background in monetising sustainability impacts, existing sustainability accounting models have been reviewed (Xing et al., 2006). Model applications, tools, findings and problems identified in each model have been discussed and analysed. The development of sustainability accounting models is currently fragmentary in nature and targeted on different issues and business domains. The existing models can be broadly categorised into the following four groups: project evaluation models (Antheaume, 2004; Baxter et al., 2004; Bebbington and Gray, 2001; CIRIA, 2001; Lamberton, 2000); organisational models (Bent, 2004; BSO/Origin, 1990, 1991, 1992, 1993, 1994, 1995; Taplin et al., 2006; USEPA, 1996); sectoral models (Atkinson, 2000; Jones, 1996, 2003; Macaulay, 1999; Rubenstein, 1994); other ideas and frameworks (Birkin, 2000, 2001; Castro and Chousa, 2006; Ekins and Simon, 1998, 1999; Ekins and Simon, 2001; Geibler et al., 2006; Lamberton, 2005; Perrini and Tencati, 2006; Schaltegger et al., 2006). There are few practical mechanisms for managers to use to translate a strategic sustainability vision into operational reality (HRH, 2006). The Sustainability Assessment Model (Baxter et al., 2004) has been identified as one of the most comprehensive models which has been practically used for sustainability assessment (Xing et al., 2006). The Sustainability Assessment Model – (SAM) originated in BP in 1999, after a two year development phase. It was then extensively networked in the UK and presented worldwide. In SAM, the impacts of a project are categorised into the following four groups: economic impacts, environmental impacts, natural resources consumption and social impacts. Sustainability indicators are traditionally categorized in three categories, namely the economic, environmental and social impacts. In the Sustainability Assessment Model, natural resource depletion and environmental impacts are separated as different impacts. Natural resource is the input and the environmental impacts are the possible outcome of using natural resources. Natural resources such as water, fossil fuel reserve, land and other materials are amongst the most important factors to consider in sustainability assessment. Therefore, in the SAM, natural resources depletion is separated from environmental impacts. The SAM assesses those impacts of a project over its full life cycle including product use. These impacts include the direct environmental and social impacts as well as broader social costs and benefits. It also helps address the remediation and restoration options. SAM generates a sustainability "signature," (figure 2), which includes a measurement of costs and benefits for social, environmental, economic and resource effects. The Sustainability Assessment Model has been selected as one of the most appropriate models to be tailored for the context of sustainable built environment assessment because the literature review suggested that it is comprehensive, covers whole life performance, and is relatively simple conceptually (Xing et al., 2006).

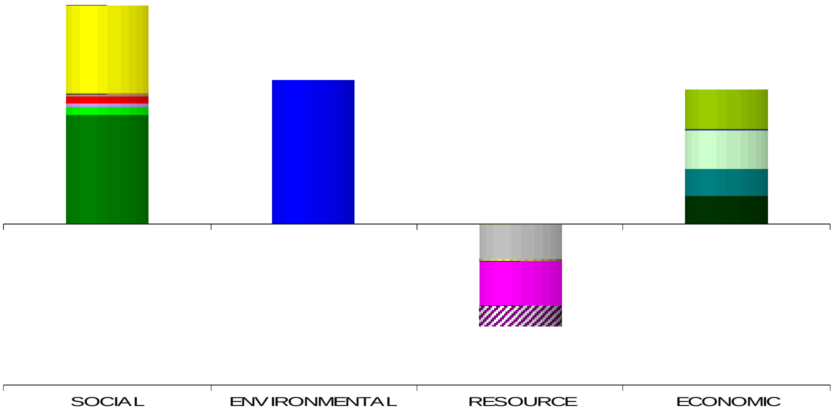

Figure 2: Signature of sustainability performance of an oil field development (reproduced from (Baxter et al., 2004))

3 MAIN COMPONENTS OF THE CONSTRUCTION SUSTAINABILITY ASSESSMENT MODEL

3.1 The construction sustainability assessment model

A structure for the CSAM has been developed (figure 3). Sustainable development indicators were reviewed in order to develop the impact categories in the CSAM, and a range of monetisation tools has been investigated. A spread sheet for detailed data analysis and comprehensive graphical representation will be produced to support building design, policy analysis and decision making.

3.2 The closed loop of the building life cycle in the context of urban development

The traditional building life cycle starts from materials extraction. Local conditions are often overlooked in the design of the built environment. The authors argue that local urban conditions are fundamental factors to consider in assessing whole life performance of a built environment. In this research, the building life cycle is enhanced by incorporating the urban planning stage in the closed loop of a building life cycle in the context of urban development (figure 4). It starts from urban planning stage, through building and infrastructure design, construction, operation and maintenance, to demolition. Significant impacts generated throughout the life cycle are assessed. The impacts of buildings have a significant influence (shown in dotted lines) on resources and social inputs during their whole life. This closed loop is contrary to the linear thinking in building life cycle analysis and aims to develop innovative design options and vertically and horizontally integrated urban development (Lee, 2006).

Most of the building assessment tools consider site selection in terms of land use and environmental impacts (Forberg and Malmborg, 2004; Graham, 2003; Junnila et al., 2006; Llewelly and Edwards, 1998; OECD, 2002, 2003; Roaf et al., 2004; Venables et al., 2000). Urban planning considerations, such as social capital and public infrastructure development are often overlooked and research into the social impacts of the built environment throughout its whole life is still in its infancy. The authors argue that both natural resources and social inputs supporting the operations of the building throughout its whole life cycle need to be analysed. The main components of local conditions have been identified as local natural resources, local labour force availability, regional economic structure, public utilities and infrastructure, leisure facilities and social conditions.

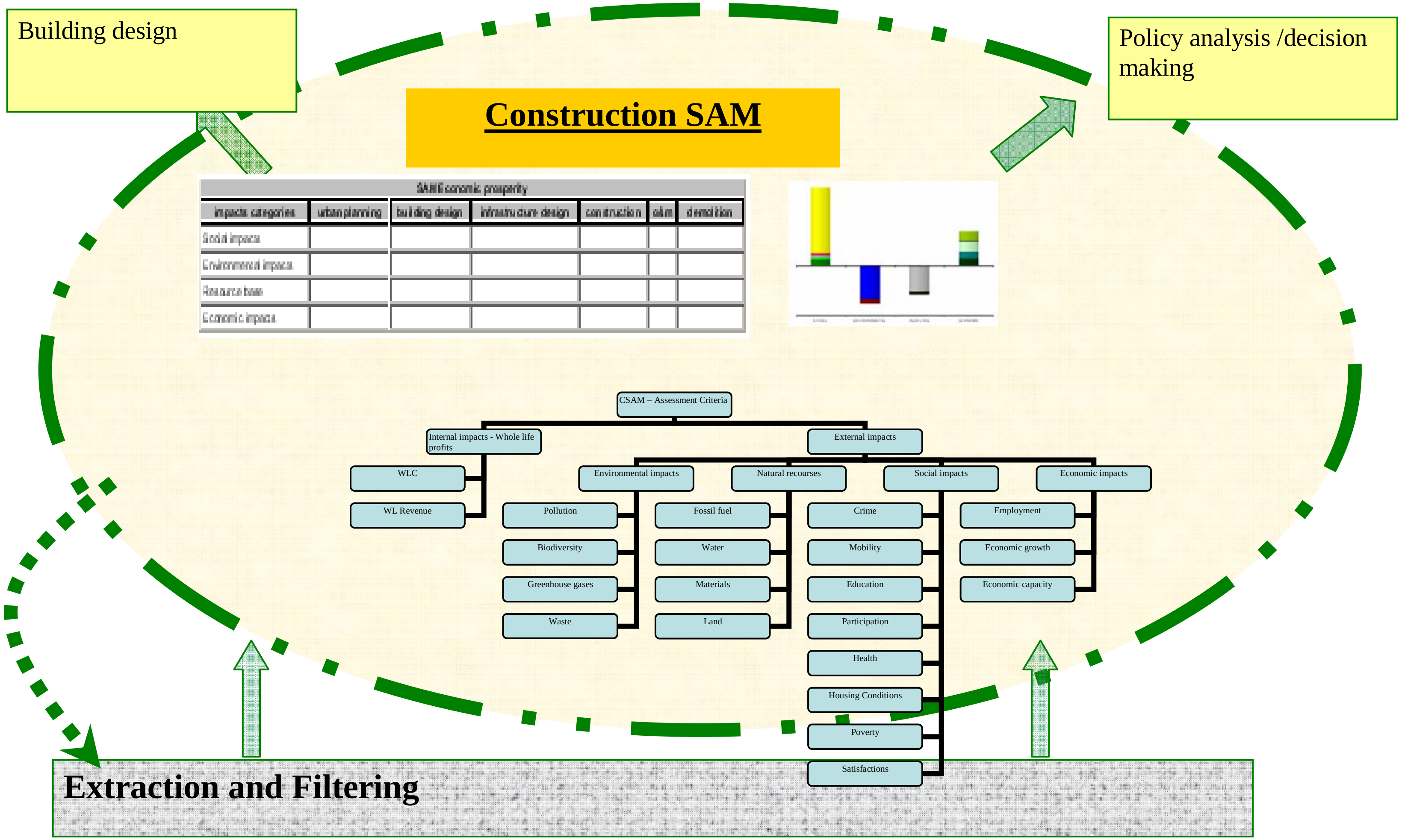

Figure 3: The Construction SAM

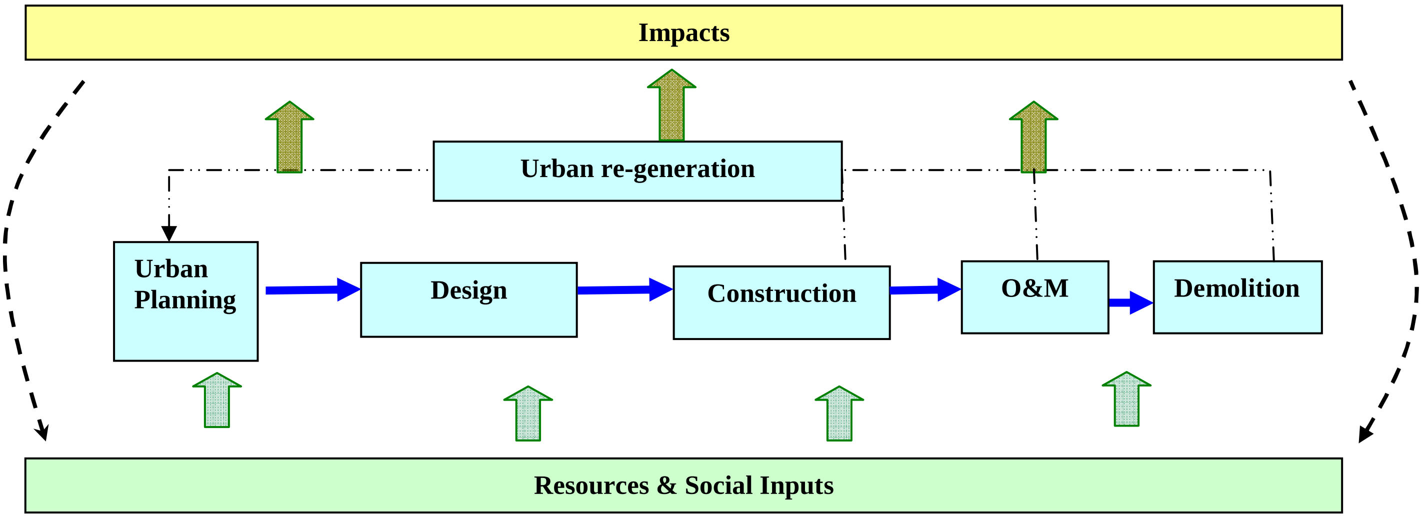

Figure 4: A building life cycle in the context of urban development

3.3 A Framework model for assessing sustainability impacts of the built environment – a system structure

The system structure for the framework model is illustrated in Figure 5. The Construction SAM serves to specify the requirements on data extraction and filtration. The data extraction and filtering process consists of two major tasks: the first task is to identify the most important generic sustainable development indicators; the second task is to select the most relevant indicators for assessing the built environment. All data available for a building will be filtered into the CSAM. The most significant impacts will be monetised. The monetised data can be formalised as spreadsheets and graphical presentations for future use in more sustainable building design and urban development policy making. In turn, decisions/policies and building designs will have impacts on the resources and social inputs which are shown by dotted lines. This framework enables the decision/policy makers to identify and analyse key elements and feedback influences in assessing the sustainability impacts of the built environment.

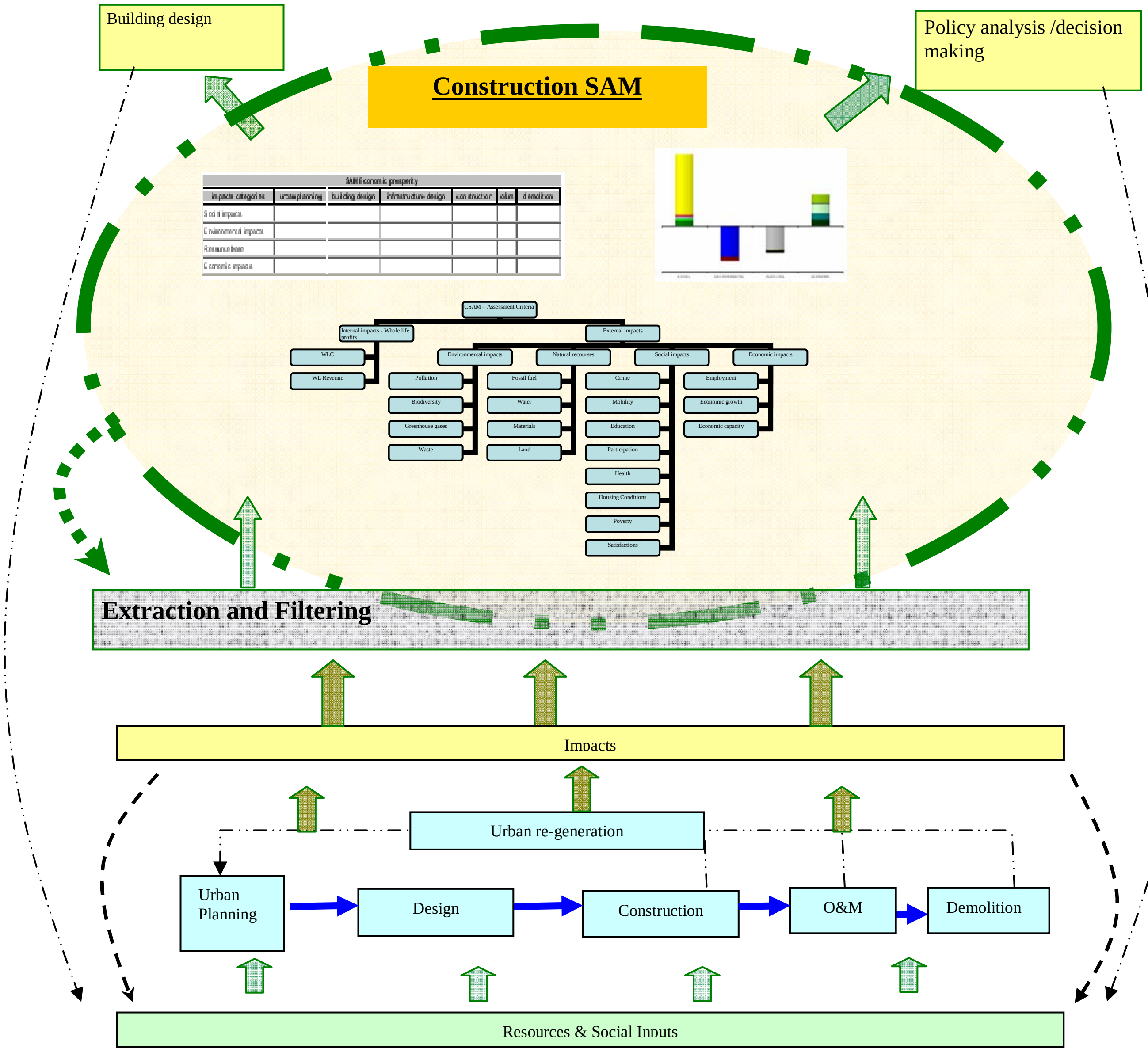

Figure 5: A system structure for the FCA-based construction SAM

4 IMPACT CATEGORIES IN THE CONSTRUCTION SUSTAINABILITY ASSESSMENT MODEL

4.1 A systemic review of existing sustainable development indicators

This review was undertaken in three parts. An initial section reviewed international, national and local initiatives to develop sustainable development indicator systems. This was followed by a review of SDIs for the construction sector and built environment. The last part was a review of wellbeing, happiness and other SDIs. In total, 24 sets of indicators have been chosen based on an analysis of over 600 sets of SDIs (Bourdeau and Nibel, 2004; BRE, 2004; Levett-Therivel, 2004) in several sustainability-related categories.

The review provided an understanding of how these systems work and informed the development of a sustainability assessment tool. The principal purpose of the analysis was to determine what impact should be included in the Construction-SAM. Only the SDI systems with detailed assessment criteria were selected; other schemes with merely generic principles were not included at this stage. The following SDIs were reviewed;

4.1.1 International/national/local sustainable development indicators

The 1992 Earth Summit (UNCSD, 1993) recognized the important role that indicators can play in helping countries to make informed decisions concerning sustainable development. The UNCSD indicators system (UNCSD, 2001) provides a detailed description of key sustainable development themes and sub-themes and the CSD approach to the development of indicators of sustainable development for use in decision-making processes at the national level. The Division for Sustainable Development has now begun to review the 2001 set of indicators (UNCSD, 2006). The European Common Indicators (ECI) were launched in 1999 for monitoring sustainability progress in urban contexts. ECI has 10 generic indicators ranging from global climatic change to ecological footprint (Tarzia, 2003). The UK Strategy for Sustainable Development published in March 2005 (Defra, 2005) identifies four shared priorities across the UK. They are: Sustainable Consumption and Production; Climate Change and Energy; Natural Resource Protection and Environmental Enhancement; and Sustainable Communities. Accordingly, the Scottish Executive developed a similar set of indicators for Scotland (SE, 2006). The Australian Department of the Environment and Heritage (EnvironmentAustralia, 2001) and a private organisation in Japan (JFS, 2007) have also developed systems for measuring national sustainability performance. Local sustainable development indicators (Bristol-City-Council, 2005; Plymouth-City-Council, 1995) have been developed since 1990s based on local Agenda 21 (UNCSD, 1993).

National SDIs are fairly consistent in term of themes and sub-themes. Compared to local SDIs, indicators for measuring national performance are very aggregated in order to give a general idea of the current state and the evolution of trends (e.g. economic development, education, health), and local SDIs are less aggregated to allow them to be understood by their users (e.g. the number of noise complaints received by the City Council each year, or the number of fixed penalty fines and prosecutions for dog fouling offences).

4.1.2 Construction related sustainable development indicators

There are several sustainable building assessment systems that have been implemented around the world (Bourdeau and Nibel, 2004; BRE, 2004). The best-known systems are undoubtedly BRE’s Environmental Assessment Method – BREEAM (BRE, 1998, 2006) , a system primarily used in the UK, and The Leadership in Energy and Environmental Design Green Building Rating System – LEED (USGBC, 2007) which was created by the U.S. Green Building Council (USGBC). Their use is now growing at a very rapid rate and they have undoubtedly been responsible for a major shift in industry attitudes.

There are two dominant assessment systems currently present in Hong Kong, HK-BEAM and CEPAS. HK-BEAM was initiated in 1996 by using BREEAM UK as a template. The overall structure and detailed criteria were modified to suit the Hong Kong context, for example, the compact city form. However, the influence of LEED is evident, e.g. recognising site aspects and using similar certification levels to LEED. The Comprehensive Environmental Performance Assessment Scheme (CEPAS) is positioned as a new tool to fill in some of the gaps not fully addressed by HK-BEAM. It addresses human factors and their surroundings. However, many similarities between these two tools have been noted (Cole, 2006).

The GBTool has been under development since 1996. Launched by Natural Resources Canada, responsibility was handed over to the International Initiative for a Sustainable Built Environment (iiSBE) in 2002. It contains regionally relevant benchmarks. Regional authorities can ensure that the system will be relevant to their unique local conditions. BEES (Building for Environmental and Economic Sustainability) (Lippiatt, 2002) measures the environmental performance of building products by using a life-cycle assessment approach specified in the ISO 14040 series of standards. In BEES (Building for Environmental and Economic Sustainability) was developed by the US National Institute of Standards and Technology with support from the U.S. EPA Environmentally Preferable Purchasing Program (Lippiatt, 2002). It includes actual environmental and economic performance data for nearly 200 building products. In BEES, environmental and economic performances can be aggregated into a score for overall performance by weights defined by the users.

In the UK, another two indicator systems are widely used: DQI™ and SPeAR®. The Design Quality Indicator (DQI™) (CIC, 2004) assesses the following issues: functionality (access, space and use), build quality (performance, engineering, construction) and impact (place, form & material, character & innovation). Questionnaires and a facilitation process are used to collect scores for the DQI™. The Sustainable Project Appraisal Routine (SPeAR®) (ARUP, 2007; Raman, 2005) focuses on the key elements of environmental protection, social equity, economic viability and efficient use of natural resources.

To sum up, these tools are similar in term of issues covered, but differ in the level of detail addressed. The tools selected concentrate mainly on environmental issues. Economic and social issues are the major gaps in measuring sustainable performance of a building (BRE, 2004)

The Sustainable Construction Strategy (DTI, 2006) builds on the UK Government’s principles for sustainable development (Defra, 2005). This review aimed to develop a vision for the future highlighting key issues relevant to existing government targets across the spectrum of sustainability. Those issues include cost, facilities management, materials, water (flood risk), climate change/energy, water quality, waste, aesthetics, safety, skills, equity and respect for people. “Sustainable construction: company indicators” (CIRIA, 2001) looks at how to use indicators to set company targets and derive direct benefit from sustainability reporting and benchmarking of company performance, while contributing to industry-wide measurement and progress. It identifies a series of quantitative measures (indicators) against which companies can measure the sustainability of their business (strategic indicators) and the activities they perform (operational indicators). Strategic indicators include environmental (e.g. percentage of projects for which an environmental assessment has been undertaken, percentage of projects for which whole life costs were calculated) social (percentage of projects that include a plan for stakeholder dialogue, average client satisfaction using the KPI approach), and economic (profit before tax and interest as a percentage of sales, profit before tax and interest per employee).

4.1.3 Wellbeing, happiness and other indicators

In the early 1970s, Nobel laureate James Tobin and William Nordhaus highlighted that “GDP is not a measure of welfare” and proposed a Measure of Economic Welfare (MEW) by adding to GNP the value of household services and leisure, subtracting the cost of capital consumption and of “bad effects” such as pollution, and excluding for example police services to combat crime. (Nordhaus and Tobin, 1973). Similar indexes have been developed since the 1990s, the Index of Sustainable Economic Welfare (ISEW) (Cobb and Cobb, 1994) and the Genuine Progress Indicators (GPI) (Venetoulis and Cobb, 2004), use similar methods to correct measures of GDP so that it may be seen to be more akin to a measure of welfare and may, therefore be a measure of relative SD performance. The UK’s “New Economics Foundation” publishes a Happy Planet Index (HPI) (Marks et al., 2006) which looks for countries where people live long and happy lives without damaging the planet. The HPI combines data on life expectancy, surveys on life satisfaction and the consumption of natural resources (energy, land etc.). Measures for happiness and wellbeing have been developed by various international and private institutions (Bruno and Stutzer, 2002; Richard, 2006; Romina et al., 2006). So far, there is no consensus on the best measure. Most of these indices are not used by policy-makers due to measurement, weighting and indicator selection problems (Bartelmus, 2001). However, some of them are popular among different stakeholders. HDI, Ecological Footprint, ISEW and GPI have been computed by researchers for a number of countries under different assumptions due to the variation in data quality and availability.

In general, happiness and wellbeing measure issues in the following three categories: economic well-being: consumption, net investment, leisure, wealth and non-market activities; living conditions: environment, health, education and inequality; and happiness: family, friends, work satisfaction, and community ties.

EU directives on Environmental Impact Assessment (EU, 2001) declared that “The environmental impact assessment shall identify, describe and assess, in an appropriate manner … the direct and indirect effects of a project on: human beings, fauna and flora; soil, water, air, climate and landscape; the interaction between the(se) factors; material assets and the cultural heritage.”

In the UK, Strategic Environmental Assessment (SEA) is mandatory for plans and programmes. In order to embrace wider sustainability objectives in England and Wales, Sustainability Appraisal (SA) is mandatory for Regional Spatial Strategies and Local Development Documents (ODPM, 2005). The Dow Jones Sustainability Indexes are the indexes ranking the financial performance of the individual companies worldwide by using criteria in three areas, namely economic, environmental and social (DJSI, 2006; Hotia et al., 2005; Knoepfel, 2001).

Based on the review of the 24 sets of SDIs, table1 shows the most commonly used SDIs and their frequency.

Table 1: List of the most commonly used SDIs and their frequency**.**

	Headline indicators (8 sets)	**Construction related indicators (9 sets)**	**Others (7 sets)**	**Total (24 sets)**
Internal impacts				
Whole life costs		3	1	**4**
Whole life revenue		1	1	**2**
External Impacts				
Economic impacts				
Economic growth	8	2	6	**16**
Employment	8	3	6	**17**
Economic capacity	8	3	5	**16**
Environmental impacts				
Greenhouse gases emissions	8	9	6	**23**
Pollution	8	9	7	**24**
Waste	8	9	5	**22**
Nuisance	8	9	3	**20**
Biodiversity	8	7	2	**17**
Natural resources depletion				
Materials	8	9	3	**20**
Land	8	9	3	**20**
Water	8	9	3	**20**
Fossil fuel reserves	8	9	4	**21**
Social impacts				
Crime	8	3	6	**17**
Mobility	7	3	2	**12**
Education	8	2	2	**12**
Community participation	8	3	2	**13**
Satisfaction	7	1	3	**11**
Health	7	8	6	**21**
Housing condition	7	2	3	**12**
Poverty	7	2	7	**16**
Family	2		3	**5**
Total	**157**	**115**	**89**	**361**

It is clear that amongst the construction indicators, economic and social indicators are the most neglected, but it should be noted that not all indicators are independent.

4.2 Better prioritisation through simplification and consolidation

An ever-increasing number of environmental, social and economic indicators are being developed (Deelstra and Boyd, 1998; Mega and Pedersen, 1998; Warhurst, 2002; Wong, 1995). Generally, these indicators are either used in isolation to analyse the performance of projects, companies, sectors and countries as they relate to one of the three dimensions of sustainability, or, increasingly, in combination as a means of measuring progress towards or away from sustainability. However, the simple combination of sets of environmental, economic and social performance indicators does not necessarily represent the creation of indicators that are capable of describing the extent to which a construction project is contributing to or detracting from sustainable development goals over time from an inter- and intra- generational equity perspective. In turn, while indicators allow the complexity of events and trends to be reduced, and more easily understood and managed, there is a danger that the proliferation of indicators and different approaches to their development and use could ultimately undermine their effectiveness.

Prioritisation of existing sustainability development indicators was carried out through a simplification and consolidation process (figure 6). A generic set of sustainability impact categories has been developed based on consolidation of the impact categories identified through a systematic review of sustainability development indicators and existing full cost accounting models.

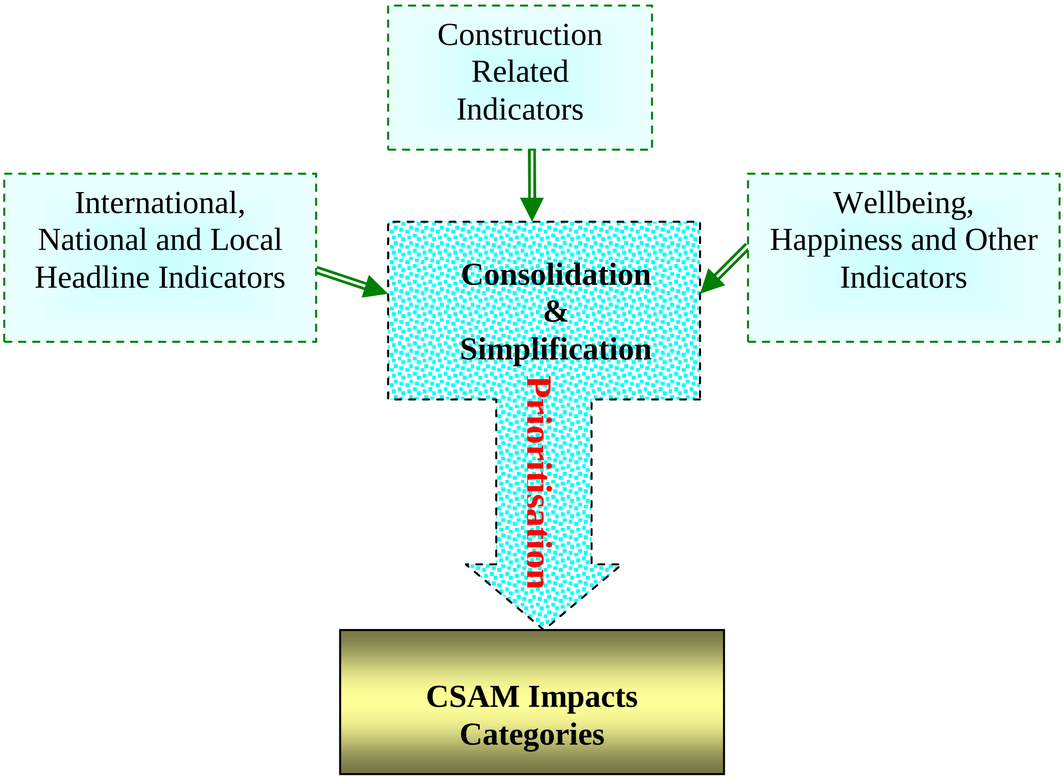

Figure 6: A conceptual structure for the consolidation process

4.3 Sustainability assessment criteria in the construction SAM

It is impossible or very difficult to address all the impacts generated from a building life cycle due to a lack of adequate scientific and technical knowledge. However, a holistic picture of the all possible impacts is essential for the delivery of an integrated assessment tool.

In the CSAM, the performance indicators are grouped into two categories: internal impacts and external impacts. The internal impacts include whole life cost and whole life revenue. The external impacts include economic impacts, natural resources depletion, environmental impacts, and social impacts. In the CSAM, environmental impacts from the activities are split into five elements: greenhouse gases emissions, pollution (e.g. from combusting fossil fuels), waste, nuisance (such as noise, odour and visual impacts) and biodiversity. The natural resources depletion indicators capture resources used including materials, land, water and fossil fuel reserve. The social impacts of a building life cycle assessed including the following elements: crime, mobility, education, community participation, satisfaction, health, housing condition, poverty, as illustrated in Figure 7.

5 EVALUATION OF EXTERNALITIES

Externalities are defined as costs or benefits arising when the activities of one group of people has an impact on another group and when that impact is not fully accounted for by the first group" (Bebbington et al., 2001). Monetary evaluation of intangibles is also often referred to as shadow pricing or non-market valuation. The neoclassical economic theoretical basis of the economic valuation of externalities is welfare economics, which recognizes that the economic value of a resource or service is ultimately a function of individual preferences. The approach for analyzing welfare changes is therefore utility theory (Patterson, 1998). However, it is argued that not all of us think of ourselves primarily as consumers with private preferences. Many of us regard ourselves as citizens with public preferences as well. Our environmental goals derive not necessarily from self-interest, which is priced by markets or willingness to pay in markets, but from the conceptions of human rights and need. It is argued that the fundamental objective of economic evaluation of environmental effects of economic activities is not only the economically efficient allocation of resources but also the achievement of equity or social fairness (Kim, 2007).

In line with the work of others, (Bebbington et al., 2007; Bebbington and Gray, 2001; Bent, 2004), in the CSAM the ultimate goal for externalities valuation is to make external costs more central to decision making and to enable decision/policy makers to pursue wider sustainability objectives. In this respect, a range of monetisation techniques were investigated (Hanley and Spash, 1993; Hunter et al., 1998; OECD, 2006). They are differ in the data demands, assumptions regarding economic agents and physical surroundings, and in the values they are able to capture. Table 2 presents a summary of the research results showing the monetisation tools and the sustainability issues that they try to evaluate.

These basic monetisation tools can be flexibly combined to address a variety of issues for example, the contingent valuation method (the hypothesized willingness to pay or willingness to accept) can be combined with the hedonic pricing method to measure impacts of new roads on local residents. Damage cost can be calculated by using current market price methods, the income method, the avoided cost, or the contingent valuation method. The monetisation process can provide a means of generating new insights and improving the quality of discussions leading to the achievement of mutual consensus. Some researchers have argued that our knowledge of the environmental damage and the future is too uncertain to allow reliable estimates of damages to be made. However, damages not valued for whatever reason, are effectively valued at zero. This is the most likely the wrong answer.

Table 2: Monetisation techniques

Monetisation techniques
WLC (Boussabaine and Kirkham, 2004; BSI, 2002; Edwards et al., 2000; El-Haram et al., 2002; WLCF, 2004)
Wealth distribution (Baxter et al., 2004)
Current market price method (Bebbington and Gray, 2001; Rubenstein, 1994)
Cost method value by components (Rubenstein, 1994)
Income method (Voorhees et al., 2001)
Non-utilization value Remediation cost value (Jones, 1996, 2003)
Rehabilitation value (Garrett, 1995; Rubenstein, 1994)
Capitalized earnings of alternative sustainable economic uses (Jones, 1996, 2003)
Compensation value (Rubenstein, 1994)
Future scarcity value, Infinite value (Rubenstein, 1994)
Hedonic pricing (Gilchrist and Allouche, 2005; Nijlanda et al., 2003; Pearce, 1993)
Travel cost method (Nijlanda et al., 2003)
Dose response function (Silvander and Drake, 1989)
Production function techniques (Garcia et al., 1986)
Human capital / human health approach (Antheaume, 2004; Gilchrist and Allouche, 2005; Voorhees et al., 2001)
Avoided or replacement cost approach (Baxter et al., 2004; Bebbington and Gray, 2001; BSO/Origin, 1990)
Averting or preventative expenditure approach (Abdulla et al., 1992; Antheaume, 2004; Baxter et al., 2004; Bent, 2004)
Contingent valuation method (Alberini and Chiabai, 2007; Antheaume, 2004)

6 CONCLUSION AND FUTURE WORK

It is argued that accountability of socio-economic policies for their impacts is at the heart of sustainable development. Accounting for economic performance and its environmental effects is the first step towards integrating environmental concerns into economic policies (Bartelmus, 1992). This paper introduced a holistic approach for assessing sustainability impacts of the built environment, one of the first FCA-based models for built environment assessment. In this representation, a refined building life cycle in the context of urban development has been developed. It starts from urban planning, through materials, construction process, occupancy, operation and maintenance, demolition leading to urban re-generation. This is a closed loop focusing on informing planning practices. A systematic review of sustainable development indicators and monetisation tools has been carried out in order to determine the most significant impacts and how they can be measured. By addressing these issues, the CSAM provides the means for proactive project enhancement (Kaatz et al., 2006) for developing a more sustainable built environment. CSAM links together separate impact assessments which are undertaken at different stages in the policy, planning and project cycle and brings together different types of impacts - economic, environmental and social - into a single, overall assessment at one or more stages in the planning cycle.

Building projects may have a number of impacts on the environment and society which are not reflected by the market. This is for two reasons. Firstly those effects may be imperfectly valued by the market. Secondly, no market may exist which reflects those effects. Therefore shadow pricing is required to estimate the value of an impact. This determines the social value of those effects either in terms of modifying existing market prices and/or estimating the value where no market exists. It has been argued that the current dominant accounting and economic systems do not reflect environmental and social issues and hence encourage environmental and social degradation and social inequity. One of the solutions is to get the prices right. Prices carry valuable information that can be used to give a supportive argument for more sustainable projects. Monetary values are easily understood by most stakeholders (e.g. contractors, clients, occupants, citizen, politicians and civil servants etc). It is argued that the monetary value can reflect the strength of feeling for the complex sustainability issues in question, e.g. value of urban green, urban heritage, and local family support schemes. Calculations of non-tradable goods, e.g. to estimate the benefit of keeping someone alive or the social cost of someone dying might seem repugnant to many. However, the valuation of life turns out to be crucial for projects as diverse as insurance, the construction of a new motorway, or medical research. On the other hand, monetised values which are used as a common unit in the CSAM are merely a device for convenience, rather than an implicit statement that money is all that matters.

Valuing policies and programmes requires substantial science and technology input and, ideally, interdisciplinary collaboration among natural scientists, social scientists and engineers. In view of the growing complexity of managing the rapidly evolving built environment and cities in Europe, there is a definite need for integrated approaches that assist city planners, developers and councillors in this undertaking (Rotmans and Asselt, 2000). Development of a sustainability assessment model has to be guided by a rational, participatory evaluating process wherein values, goals, and requirements are determined with the help of the best-available knowledge from more intensive, interdisciplinary holistic scientific research.

A case study will be carried out to test and improve the CSAM in terms of its usability and practicality. It is argued that sustainability issues can most valuably be addressed through the development of more transparent and dialogic model (Bebbington et al., 2007). Based on the CSAM framework, a subsequent system for group decision support and learning will be created to assist social learning to promote societal change and changes in beliefs, values, governance, theories and practices in building design, management, and urban planning for a more sustainable built environment (Kemp et al., 2007; Polani, 1944; Rotmans et al., 2001).

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