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### **Social Life Cycle Assessment for Housing in the New Zealand Context**

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#### **Abstract**

There is a growing trend to quantify and reduce impacts during the life cycle of housing as part of the life cycle management process. So far the accent has been on environmental impacts based around the ISO 14040 and 14044 framework standards for life cycle assessment. Work has been going on internationally for the last decade to quantify social impacts in parallel with the work on environmental impacts. In 2009 an attempt was made to define a baseline for social life cycle assessment through the publication of 'Guidelines for Social Life Cycle Assessment of Products' from a task force under the UNEP-SETAC Life Cycle Initiative programme.

This paper examines the applicability of the Social Life Cycle Assessment of Products guidelines to the New Zealand housing sector as a tool to assist the life cycle management of New Zealand's housing stock. Consideration is given to the impacts on the three major stakeholder groups: the workers throughout the life cycle; the society in which the life cycle is embedded; and the housing users. Recommendations are made on the how these guidelines

could be adapted to better assess the true social consequences of decisions made under the conditions that prevail in New Zealand.

## Introduction

Life Cycle Management (LCM) is an integrated framework for managing the life cycle performance of goods and services. The framework aims to minimise the environmental social and economic burdens associated with an organisation's product or service during its entire life cycle and value chain. LCM is not a single tool or methodology but a flexible, integrated framework of concepts techniques and procedures (Jensen & Remmen, 2005).

New tools to improve sustainability are being developed on a regular basis. These tools can be compiled into groups from facilitating a change in paradigm to systems thinking through to the specifics of developing products and services with reduced environmental impacts. A summary of some of the better known tools is provided in alphabetical order under the headings showing diminishing business change thinking in Table 1.

**Table 1: Existing approaches assessed relevant to developing sustainable products and services.** Adapted from (Maxwell, Sheate, & van der Vorst, 2006 and Seadon, 2010)

|  |  |
|--|--|
| ORGANISATION LEVEL   |  |
| SHIFT TO SYSTEMS FOCUS   |  |
| Sustainable Consumption and Production (SCP)<br>Product Service Systems (PSS)  | Eco-efficient services<br>Eco-effectiveness  |
| IMPROVING TBL SUSTAINABILITY PERFORMANCE OF INDUSTRY   |  |
| Sustainable development<br>Triple bottom line/quadruple bottom line<br>Sustainable production<br>Natural capital, five capital model<br>The Natural Step (TNS)   | TBL Sustainability methods and tools for industry, e.g. SIGMA and Corporate Social Responsibility (CSR)<br>Social responsibility, e.g. AA1000, SA8000 and Ethical Trading  |
| IMPROVING THE ENVIRONMENTAL PERFORMANCE OF INDUSTRY  |  |
| Biomimicry<br>Clean technology<br>Cleaner production<br>Eco-efficiency<br>Ecological footprinting<br>Ecological rucksack<br>Environmental auditing<br>Environmental Impact Assessment (EIA)<br>Environmental Management Systems (EMS)<br>Environmental Performance Indicators (EPI)<br>Environmental reporting/Global Reporting Initiative (GRI) | Environmental supply chain management<br>Factor X (Factor 4, 10, 20)<br>Full cost accounting<br>Green marketing<br>Green procurement<br>Industrial ecology<br>Integrated Pollution Prevention and Control (IPPC)<br>Material Intensity Per Service Unit (MIPS)<br>Zero emissions |
| PRODUCTS AND SERVICES LEVEL  |  |
| DEVELOPING SUSTAINABLE PRODUCTS AND SERVICES   |  |
| Sustainable Product Development (SPD)<br>Sustainable product development and design  | SPD approaches   |
| DEVELOPING PRODUCTS AND SERVICES WITH REDUCED ENVIRONMENTAL  |  |

| IMPACT                                  |                                      |
|---|--------------------------------------|
| Carbon footprinting                     | Life Cycle Assessment (LCA)          |
| Cradle to cradle                        | Life Cycle Costing (LCC)             |
| Cradle to grave                         | <i>Life Cycle Management (LCM)</i>   |
| Ecodesign/Design for Environment (DfE)  | Life Cycle Thinking                  |
| Environmental Product Development (EPD) | Product Orientated EMS (POEM)        |
| Extended Producer Responsibility (EPR)  | Product stewardship                  |
| Green Chemistry (GC)                    | Social Life Cycle Assessment (s-LCA) |
| Green Engineering (GE)                  | Total Cost of Ownership (TCO)        |
| Integrated Product Policy               | Water footprinting                   |

LCM is part of the development of products and services that reduce the environmental impact category. The relationship between the tools is shown in Figure 1.

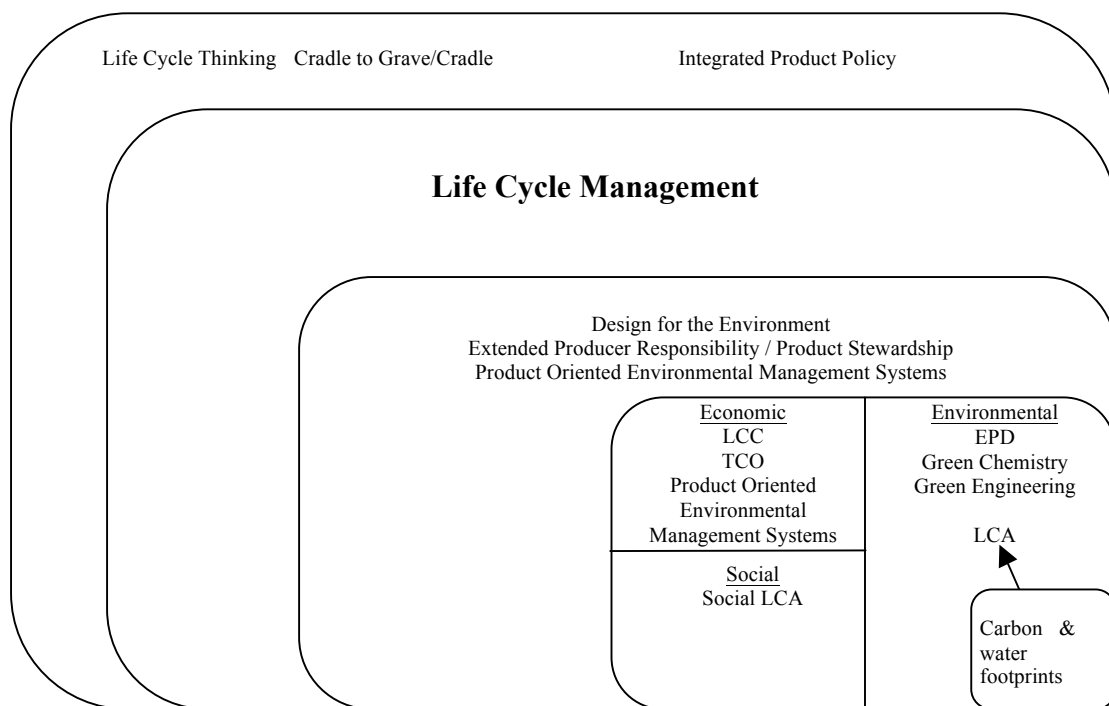


Figure 1: The relationship between tools in the development of products and services to reduce environmental impact

A central focus over the last decade for LCM has been Life Cycle Assessment (LCA). LCA is a tool that can contribute to making improvements in resource efficiency and sustainable development. It is a methodology that considers the whole life cycle of a product from its extraction from the earth until it is disposed back to the earth – the “cradle-to-grave” approach that considers waste to be the final outcome (ISO, 2006). The current trend of cradle to grave thinking is progressing to “cradle-to-cradle” thinking devised by McDonough and Braungart (2002). With the cradle-to-cradle concept every product is reformed into another product resulting in zero waste, thus everything is reused, recycled or recovered. The cradle-to-cradle approach changes the focus from a product to the service it is providing (Senge *et al.*, 2007). The comprehensive scope of LCA ensures that problems are not shifted from one part of a life cycle to another, one medium to another or one region to another.

LCA quantifies the potential impacts associated with a product or service by compiling an inventory of inputs and outputs of a system, evaluating the potential environmental impacts and interpreting the results of the inventory analysis and impact assessment phases using a

standard framework and guidelines developed by the International Standards Association (ISO, 2006). The ISO14040:2006 framework consists of four phases: goal definition and scope; inventory analysis; impact assessment and interpretation (ISO, 2006).

The goal definition and scope are particularly important as they define what is contained within the study and the objective of the study clarifies the expected use of results and the receiver of the study.

The inventory analysis involves gathering data relative to inputs and outputs at each stage of the product life cycle, while the aim of impact assessment is to interpret these data in terms of environmental impacts (ISO, 2006). This stage involves classification into impact categories and evaluation of the level of impact. A key feature of the impact assessment is the detailed data provided for each stage of the life cycle aggregated into impact categories. Common impact categories are:

- acidification potential;
- energy consumption;
- eutrophication potential;
- freshwater aquatic ecotoxicity;
- global warming potential;
- human toxicity potential;
- marine aquatic ecotoxicity;
- ozone depletion potential;
- photochemical ozone creation potential; and
- terrestrial ecotoxicity.

Assessment models may include normalisation, grouping and sorting or weighting procedures to facilitate interpretation. However, none of these procedures are mandatory according to ISO framework and guidelines (ISO, 2006). Finally, the results are interpreted and evaluated, according to goal definition and scope; thus taking an iterative approach for the completion of a LCA study.

The concept of aggregation of the impact categories to produce a single figure has been replaced by single indicators to represent areas of concern. For example, the global warming potential is represented by the measurement of carbon dioxide equivalents (CO<sub>2</sub>-e) whereby everything is converted to the equivalent warming of one tonne of carbon dioxide (e.g. methane is 25 times more potent than carbon dioxide ( UNFCC, 2007)). In a similar way, acidification is represented by sulfur dioxide equivalents and eutrophication in phosphate equivalents.

## **Social LCA framework in comparison to environmental LCA**

A desire for sustainable development has encouraged many initiatives that aim to produce a method for the assessment of the environmental, social and economic impacts of consumption. Accordingly, there is growing interest in the inclusion of social metrics into the LCA of products and systems that feature environmental metrics. Despite a similarity in name, environmental and social LCA studies differ markedly. The following sections consider the main phases of a LCA study using ISO14040:2006 (ISO, 2006) and highlight some key differences in the framework between a LCA study that has an environmental or a social focus. The purpose of this is to highlight the current issues and methodological differences between environmental and social LCA.

### **Goal and Scope**

According to ISO14040:2006, the first step in a LCA study is to identify and define the goal and delimit the scope of the assessment (ISO, 2006).

Commonality exists between environmental and social LCA studies in the overall purpose of the study. Like environmental LCA studies, social LCA studies can be used to compare products, processes or companies (Schmidt *et al.*, 2004, Spillemaeckers *et al.*, 2004) and identify hotspots to identify areas where improvements can be made (Dreyer *et al.*, 2006, Flysjo, 2006, Manhart and Griesshammer, 2006). However, neither environmental nor social LCA would claim or stipulate whether a product or service is produced or not, and neither will necessarily provide a breakthrough solution (Andrews *et al.*, 2009).

Allocation is the partitioning of investigated metrics to a reference flow; and it is a perennial issue in LCA studies (Reap *et al.*, 2008a). The allocation of emissions to a product is clearly defined in an environmental LCA but in social LCA studies it is not clear. Dreyer *et al.*, (2006) and Spillemaeckers *et al.*, (2004) argue that most of the social impacts of a product have no relation to the product but rather are a symptom of the conduct of the company producing the product. However it is noteworthy that in one study a common approach with environmental LCA protocol is achieved (Schmidt *et al.*, 2004)

LCA uses a cut off rule to exclude minor contributors to keep the size of a study practical and reasonable (Baumann and Tillman, 2004). An experienced LCA practitioner will probably have a good idea of suitable system boundaries for an environmental LCA study before the study starts, but because of the different impacts investigated and the influence of value judgements involved in social LCA study, such estimation of system boundaries may be impossible.

### **Life cycle inventory**

The objective of the life cycle inventory is the compilation of all the relevant information for the LCA study that's defined in the goal and scope phase.

The data collection phase of a LCA is well recognised as the most time consuming step of a LCA (Baumann and Tillman, 2004). Accordingly, the data collection period is expensive and can produce a large volume of data which needs to be handled by experts. There is a lot of emphasis on obtaining a mass balance in a LCA investigation that focuses on environmental metrics but this is unattainable in a social LCA (Andrews *et al.*, 2009). Furthermore, the social impacts are linked to company behaviour and this makes social impacts location and time specific. The consequence is that generic data (e.g. the Ecoinvent database (Frischknecht and Rebitzer, 2005)) is no longer applicable. This makes the data collection phase even more time consuming (Jørgensen *et al.*, 2008).

### **Life cycle impact assessment**

In the impact assessment phase raw data associated with a product or service is related to an impact or consequence. This is achieved through the characterisation of flows and emissions, where the characterisation is proportional to the effect.

The characterisation of emissions on an environmental impact is achieved through a validated clear cause and effect chain (Guinee, 2002). The cause and effect chain needs to be detailed and validated in accordance to well-organized criteria such as International Life Cycle Database handbook (ILCD, 2010). The cause and effect models of the social metrics are different to those normally associated with environmental metrics and there is no consensus regarding the cause and effect relationships or characterisation approaches (Jørgensen *et al.*, 2008).

Characterisation factors for an environmental LCA are mostly decoupled from location, and this may reduce the accuracy of the assessment (Seppaia *et al.*, 2006), but the separation encourages standardisation and credibility. The characterisation of social indicators cannot be achieved without taking into account the local conditions e.g. political landscape, population density and the time of the assessment (Andrews *et al.*, 2009, Jørgensen *et al.*, 2008) and as such generic characterisation factors are of limited use. Furthermore, there is a lack of consensus of what to include as a social indicator and published studies differ markedly.

The social indicators to date are disparate, use qualitative data and rely heavily on value judgements. These features mean the social indicators will be difficult, maybe impossible, to standardise in the same way the environmental impact categories have been established.

### **Interpretation**

In the interpretation phase of a LCA study the data and project outputs are compiled and possibly utilised.

The ISO14040:2006 encourages peer review to verify the credibility of the study. The review should ensure that:

- The methods used to carry out the LCA are scientifically and technically valid;
- The data used are appropriate and reasonable in relation to the goal of the study;
- The interpretations reflect the limitations identified and the goal of the study; and
- The report resulting from the study is transparent and consistent.

The focus of a review for an environmental LCA study would be on the implementation and robustness of the assessment (Baumann and Tillman, 2004). In a social LCA more focus would be on the level of stakeholder engagement (Barthel *et al.*, 2005, Jørgensen *et al.*, 2008), completeness of social impact covered (Hunkeler, 2006, Nazarkina and Le Bocq, 2006) and a relevance to the key issues at hand (Dreyer, 2006, Nazarkina and Le Bocq, 2006).

Uncertainty and variability are key issues in LCA studies (Reap *et al.*, 2008b, Weidema and Wesnaes, 1996). In an environmental LCA study objective data rooted in scientific endeavour is used, whereas in a social LCA it is more commonplace to use subjective data. While this may have limitations to its applicability, it is likely that the use of subjective data means that there is less variability in a social LCA compared to an environmental LCA. However, both social and environmental LCA studies are subject to significant uncertainties. Therefore, there are similarities in acting on the data from an environmental and social LCA. Indeed, because of the issues to do with data uncertainty and variability both social and environmental outputs lend themselves to a LCM approach rather than a stand alone footprint declarations.

The final step in a LCA study is an application of weighting to the results. This is often done in order to synthesise different results into a single figure. As previously mentioned the perception of the nature and severity of social LCA results are likely to differ greatly and consequently generic weight schemes might be unsuitable (Andrews *et al.*, 2009, Jørgensen *et al.*, 2008). A common use of weighting in LCA studies is to relate midpoint indicators to endpoint 'Areas of Protection'. There are three key Areas of Protection: Human Health, Damage to the Environment and Damage to Resources. Several studies have argued that these areas of protection do not suffice (e.g. Dreyer, 2006) and (Weidema, 2006) proposes a fourth area of protection 'Human dignity and wellbeing' that is designed to bring together midpoint social indicators.

### **The contribution of Social LCA**

Social LCA encourages the principles of life cycle thinking to be applied in the social sphere. The synthesis of any positive and negative social impacts may improve consumers' ability to evaluate products and services. For the social impact evaluation to be meaningful, information on the social metrics needs to be gathered for foreground and background supply chains. The utilisation of this approach can result in the promotion of transparency and ethical business practice in hitherto nebulous supply chains. The information gleaned from a social LCA study may result in the individuals and companies challenging their preconceptions and opinions about their businesses. Additionally, if a social LCA is conducted alongside an

environmental LCA or an economic evaluation then the reconciliation of these indicators may encourage a less unilateral decision making protocol.

However social LCA is an immature new field where there are a number of fundamental issues that need to be resolved (Andrews *et al.*, 2009, Jørgensen *et al.*, 2008, Weidema, 2006). Foremost is an inconsistent perception of the nature and severity of social impacts. Regardless, the inclusion of social LCA and the associated metrics in high level decision making is a step towards truly sustainable development.

## Social LCA and the housing sector

The International Labour Organisation (ILO) has surmised that the basic features of Decent Work have to be the lowest common denominator. Beyond the minimum fundamental ILO labour rights the literature (Dreyer *et al.*, 2010) suggests that optional measures self-determined by the manufacturer are added to complete a social LCA exercise.

Some key areas within the wider system of housing sector, where social LCA could deliver benefits for workers, housing users and society at large, are outlined in Table 2. The applicability of fundamental labour rights examination in the wealthier nations, and possible optional measures are discussed briefly.

**Table 2: Areas where Social LCA could deliver benefits to workers, housing users and society at large.**

| Area  | Some discussion points   |
|---|--|
| Informing ethical selection of materials, services and products | The growing interest by consumers in the fundamental human rights of workers in the supply network extending to industrially developing countries ideally needs systematic, directly comparable and reliable information provided at point of sale.<br>A social LCA approach could highlight cases of the exporting of unacceptable tasks offshore by NZ companies.  |
| Health and safety of construction workers                       | Most consumers would consider the fundamental human rights of workers to be mandatory in OECD countries, but the widespread workplace deregulation of the last 20 years might mean that that cannot be assumed. Social LCA could be useful in identifying such situations. (Moore, 2009)<br>The Accident Compensation Corporation and Department of Labour data (supplemented possibly by private insurance records) could provide a crude generic database reflecting the respective trades and material sources. |
| Health and safety of home users                                 | Injuries in the home are recognised as one of the top priority areas for action in the NZ National Injury Prevention Strategy. The identification of design and property management features that most contribute to this could usefully be included as optional social LCA categories.  |
| Operating costs of homes  | The usage phase of the building carries the majority of the total life costs. As with the previous area of home injuries, research providing evidence-based checklists of design and management features shown to ‘nudge’ users towards lower cost running of their houses would form useful social LCA measures.  |
| Protecting the export position of NZ                            | As overseas consumers increasingly include sustainability factors in their purchasing decisions, domestic producers in these markets will  |

|               |   |
|---------------|---|
| manufacturers | be quick to seize any advantage over established NZ suppliers that can be gained. Early moves to establish and use social LCA databases and techniques in NZ could be seen to be having benefit in this regard. |
|---------------|---|

### *Limitations*

In principle social LCA clearly has the potential, in the longer term, to enable more informed consumer decisions to be made regarding the NZ housing market. However, in looking at this specific example there are some clear questions raised.

### **The cost of Social LCA**

Our ability to gauge the potential benefit of social LCA is currently limited by the lack of studies that include data on the affordability of the tool for small firms.

Part of the lack of progress may be that the efforts to establish social LCA have been conducted against a backdrop of ‘increasing fragmentation of previously integrated systems of production and service delivery’ (James, Johnstone, Quinlan and Walters, 2007). They suggest that this has led to ‘diffusion of overall management control and responsibilities’. There are many more small and medium sized companies in the chain and more people in non standard work. With networks being global, and standardised data required, can businesses in poorer countries hope to participate?

### **A perverse outcome**

Could a social LCA initiative have the reverse of the desired affect and actually damage quality of life at the poorest corners of the supply network?

As the Guideline explains (Andrews *et al.*, 2009), social LCA requires a huge amount of data. The extent of fundamental data shortage in developing countries is sometimes overlooked by those working in better documented nations. One third of children worldwide are not even registered at birth; and so in these countries data on the characteristics of the labour force will be patchy at best and certainly incomplete. The funds and research expertise to address these data gaps will also be scarcer, and the exercise probably seen as a low priority. The real cost to small workplaces means that having their product assessed as part of a social LCA network study could be out of reach.

The Guideline, in explaining the need for social LCA, gives the example of the consumer being faced with a choice between buying a product from the farmer selling through a farm shop or via a supermarket, but could the farmer alone afford it, and if not would the customer take ‘silence to be an admission of guilt’?

Ironically therefore, any social LCA system initiated will be placing an additional burden of cost and administration disproportionately on the micro, small or medium businesses (SME). There is already real concern amongst smaller companies that the larger ones will use certification schemes or mandatory reporting requirements to improve their competitive position. The NZ housing sector is based on SME with 50,000 firms with an average of just three staff each (Department of Building and Housing, 2009) and any additional costs need to be clearly justifiable and seen as fairly shared.

### **First steps**

Perhaps as a first step social LCA in New Zealand, given the lack of generic data immediately available, the focus should be on the suggested mandatory measures supported by NZ-specific health and safety sub categories.

Factors captured in the ILO Conventions are widely accepted, and were selected in the first place in a tripartite process that considered them ultimately achievable and measurable in all,

or at least enough, countries. The absence of child labour, forced labour and discrimination, and freedom of association including the right to organise collective bargaining are widely referred to as the fundamental labour rights that social LCA should include at the very least (Dreyer, Hauschild and Schierbeck, 2010).

Nations that are signed up to ILO conventions should in theory have laws, monitoring systems, and support structures to achieve these, and where they are not being achieved to know about it. In the New Zealand housing sector therefore, absence of prosecution should, in principle, suffice as evidence. Individual company data against mandatory measures could include their track records for prosecutions, insurance claims, and serious harm reports.

Where bodies in the supply network are from nations that are not signed up, and/or, have not achieved these standards, then the onus is on that body to provide data. There is a suggestion in the literature that occupational health and safety in developing countries has not been significantly enhanced by corporate social responsibility schemes (Pearse, 2010). This may be partly due to the lack of generic surveillance infrastructure to measure either poor or good performance with enough sensitivity.

The Accident Compensation Corporation have industry and claim type analyses to gauge generic data for the relative performance of individual entities. However, the data is not sensitive enough to provide generic data for housing workers drawn from the non-standard NZ work sector including on-hire staff who may move between sectors.

## Conclusion

The UNEP/SETAC Life Cycle Initiative had multiple aims, but the most important one was “to convert the current environmental tool LCA into a triple-bottom-line sustainable development tool” (Andrews *et al.*, 2009). Although the process has had a long gestation period, there is still insufficient clear agreement on what impact categories to include and how to measure them (Jorgensen *et al.*, 2008).

Worked examples in the Guidelines would be extremely helpful, to stimulate thinking and debate about what these categories should or could be included, and how the system could be designed to make social LCA meaningful, affordable and fair – right across the supply network that it seeks to serve.

The Guidelines make it clear that although ultimately the “*accountability lies with the people (who will be buying the products) and their desire to support a socially responsible corporation*” (Executive Summary) – the outcomes from the method laid out in the Guidelines are “*not for comparative assertion communicated to the public*”. This limits the usefulness of the approach to an in-house study, which also severely limits the marketability of potential studies.

The authors acknowledge that consumer demand for information about wellbeing of the people involved in the supply chain will be the real driver for the companies and governments to facilitate social LCA, but collectively cannot yet envisage the tool that will provide that help.

This raises the question of whether adopting a more user-centred perspective would be beneficial. The voices missing in the development of social LCA to date are the consumers in the marketplace, potential suppliers, social LCA professionals, and researchers outside Western Europe and Canada; especially from our perspective in the southern hemisphere.. Of the 12 UNEP SETAC meetings; 10 were in western Europe and 2 in Montreal. Given the global scale of the supply chains in question this is surprising surely. Practical issues to do with data collection and objective measurement outside OECD may have been under-considered as a result. No parties from Australasia for example are mentioned in the introductory lists of authors and technical specialists involved in the consultations.

The World Business Council for Sustainable Development were contributors to these Guidelines. A user-centred perspective would be a useful contribution for their members to make – given their access not only to consumers but also ability to evaluate actions as well as intentions through objective analysis of purchases. The NZBCSD could be approached as a conduit to the WBCSD and as a pilot sponsor in any major housing sector research exercise being brought together in New Zealand.

The need for a system to provide a more formalised approach to measuring social issues in the supply chain is long overdue. The recent social LCA guidelines are a step in the right direction, but here is still a lot of work to do before they become meaningful for the New Zealand housing market.

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