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Comprehensive life cycle assessment by transferring of preventative costs in the supply chain of products. A first draft of the Oiconomy system

Pim R. Croes*, Walter J.V. Vermeulen

Utrecht University – Copernicus Institute of Sustainable Development, Utrecht, Netherlands

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ABSTRACT

A major part of global unsustainability is embedded in consumption and the processes involved in the lifecycle of products, but there is currently no comprehensive and objective method for product sustainability measurement, including both environmental and social issues. This requires a life cycle approach. Current life cycle assessment (LCA) systems, developed to compare environmental performance of products and production alternatives, have many shortcomings if used to comprehensively measure product sustainability. The most important shortcomings are: the lack of a measuring standard, the top-down approach, the weighting of different issues, the very laborious procedures of addressing specific supply chains, limitation to environmental aspects, the very complex nature of impact based data, and difficult database maintenance. This article presents a new type of "bottom-up" and "product-specific LCA" for the comprehensive measurement of the hidden environmental and social costs of products. Every supply chain actor collects the upstream supply chain hidden costs, calculates and adds its own contribution and transfers the result to the next link by means of a monetary unit, the "Eco Social Cost Unit" (ESCU). Every ESCU allocation is the product of a quantitative factor for an issue and a price factor. The uniform measurement of the quantitative factor, their transfer through the supply chain, and the creation of a self learning database of the price factors is achieved by means of a standard.

The price factor represents the marginal preventative costs for the relative impact category of sustainability issues. For initial determination of the price factor this article extends the EcoCost/Value ratio system, developed by Vogtländer et al., to social issues, discusses implications of the system, its principles, advantages, research challenges and limitations and proposes system boundaries for application of the system and future research contributions to the project.

1. Introduction

Issues like climate change, pollution, depletion of biodiversity, mineral resources and fresh water, land degradation, poverty, corruption, inequality, human population growth and financial irresponsibility present serious threats to humanity. Because these issues are strongly interrelated to the economy and the current way of producing, selling and using of products, there is an increasing need for a comprehensive method for the measurement of the sustainability of products. In the current version of the free market mechanism, considerable costs of damage to the environment and people are not included in the economy and therefore, are called "externalities".

A frequently proposed solution is the internalization of the externalities, e.g. by taxation, already proposed by (Pigou, 1920, p.129–179; Mishan, 1967). Recent authors, (e.g. Bithas, 2011; Van den Bergh, 2010) argued that internalization is indeed effective. Bithas, like Pigou before, based his arguments on damage based externalities and made the observation that monetary externalities are time and location dependent and therefore, are extremely difficult to determine.

To date, some form of Environmental Tax Reform (ETR) is already widely practiced (OECD, 2011), although mostly limited to energy use and carbon emissions. In the Netherlands and in the UK, some consulting companies are specializing in promoting "true costs" (True Price, 2015; Trucost, 2015). But also large financial

* Corresponding author.
E-mail address: p.r.croes@uu.nl (P.R. Croes).

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advisers like Price Waterhouse Cooper, Deloitte and Ernst& Young are involved (Sipkens et al., 2014). The World Business Council for Sustainable Development envisions business based on true prices for 2050 (WBCSD, 2010), and the CEO's of companies like Patagonia and Blu Skye argue that successful business is synonymous with sustainable business, leading to true pricing (Chouinard et al., 2011).

The idea of internalization is that, in a free, full price economy, consumers and producers will automatically make sustainable choices and create a sustainable economy. Internalization actually is nothing other than a correction of the malfunctioning of the free market regarding currently excluded goods and services. Therefore, the magnitude of the externalities, representing the cost distance to sustainability, provides a perfect measure of unsustainability. However, to date, no system exists for the comprehensive measurement of the externalities related to the world's millions of products.

In this article we present the “Oiconomy project”. Its objective is to develop a new type of “bottom-up” and comprehensive LCA, for measuring the distance to sustainability of specific products by their currently externalized preventative costs. A long-term goal is to provide the data for potential future internalization of product related externalities.

In this article “Oiconomy” is used for “a sustainable full price economy, “comprehensive” refers to integrating environmental, social and economic aspects, “product” is defined in its widest sense; it may be tangible or a product-service, intended for consumers or for organizations. “Specific products” refers to the end products as they are presented to the consumer/user. “Preventative costs” are defined by the precautionary costs necessary to prevent damage. “Bottom-up” refers to data determination and transfer through the supply chain from cradle-to-grave by the supply chain actors themselves, and “top-down” refers to a LCA where the practitioner takes the initiative to investigate the supply chain”. Note that our concept of “top-down” is very similar to the more common LCA concept of “background systems”, but “bottom-up” is not exactly the same as “foreground systems”, that refers more to the nature of the data than to the route of transfer (JRC, 2010, p.97).

Taking preventive measures brings both costs and benefits. The systems of eco-efficiency (Schmidheiny and Zorraquin, 1998) and environmental management accounting (e.g. Jasch, 2006) have been developed to measure and base decisions on a balance of costs and benefits. There are many examples where even the internal benefits equal or even exceed internal costs (Henson, 2008). A quarter of a century of experiences in pollution prevention practices has shown that systematic attention to environmental impacts in the design of products and processes generate savings rather than additional costs (Allen and Rosselot, 1994; Ochsner et al., 1995; Durfee, 1999; Miller et al., 2008; Bartholomew et al., 2008; Granek, 2011; Sam, 2010). Often these benefits are analysed from the perspective of a single firm and they are limited to environmental impacts. Internal costs and benefits are easier to measure by single companies involved in improving their sustainability performance. As we will show in this article, accurate measuring of external costs and benefits throughout the value chain is far more difficult or even impossible, surely for the involved company itself. In Section 5.5 we will address how to deal with the benefits of preventative approaches.

2. Methods and structure of this article

To date, the methods closest to the proposed comprehensive measuring system of product sustainability are life cycle assessment methods (LCA) and life cycle sustainability assessment (LCSA) (UNEP & SETAC, 2011).

We therefore, extensively reviewed the literature, based upon searches via Google Scholar, Picarta and Scopus. We extensively used previous reviews, and bi-directionally followed references and citing of papers on the strength and weaknesses of current methodologies of LCA and LCSA and assessing these on their use for the comprehensive sustainability measurement of specific products.

We found that current damage assessments based LCA and LCSA have major shortcomings if used for this purpose, including: their damage based character, the lack of considering social issues, the lack of standardization of the system boundaries, measurement and methods of transfer of verified data through the supply chain.

Because successful global certification systems exist on a wide spectrum of issues, which can support the standardization, verification and transfer of data through supply chains, we proceeded to develop a model for a product sustainability measuring standard and system (Croes, 2013). For this purpose we searched literature for existing conventions, standards, guidelines and initiatives for the creation of a comprehensive selection of sustainability criteria. We used the issues found in LCA system boundaries for supporting our proposed approach for standardized system boundaries.

In Section 3 the strengths and weaknesses of current LCA, if used for the comprehensive sustainability measurement of specific products are discussed. In the Sections 4 And 5 we presented a new type of LCA, which is designed to overcome most of the found shortcomings and discuss the system properties and boundaries. In Section 6 we discussed the next steps of the project and reflected on its research challenges and limitations.

3. Strength and weaknesses of current LCA

Currently LCA is widely used by companies, governmental bodies and scholars. The ISO standards 14040 and 14044 present a framework for LCA systems (ISO, 2006b; ISO, 2006a). LCA was developed as an assessment tool to compare the environmental impact of different alternatives and has proven to be a useful tool for assist in making management decisions. It is also useful for helping to provide a life cycle focus and to increase scientific knowledge on the environmental impact of products and processes.

However, for the purpose of seeking to achieve comprehensive sustainability measurement of specific products, current LCA systems suffer from some fundamental shortcomings, which are discussed in the following sections. Subsequently, we described how the proposed system might help to overcome those shortcomings.

3.1. *Inadequate consideration of social issues*

LCA is currently limited to environmental sustainability issues. Social LCA is under development (Benoît and Vickery-Niederman, 2011), but thus far a functional system is not available (Guinée et al., 2011). Without considering social issues, LCA's may lead to seriously incomplete conclusions, because many environmental and social issues are causally interrelated. E.g. neglecting social issues means that a seemingly environmentally sound product may be made using child labour or inadequately remuneration of members of the supply chain. Such a product may cause poverty and illiteracy, a social sustainability issue by itself, but also one that may cause future land degradation and climate issues, e.g. by unsustainable harvesting of timber and home biomass cooking emissions (Smith et al., 2000). On the other side, decreasing poverty may, result in increased meat consumption and consequently have impacts upon land use and upon climate related issues.

3.2. Lack of certainty and objectivity in damage based LCA

Most current LCAs are damage- or impact-based, but sustainability impact is extremely complex to determine, it needs a long-term scope, and "large uncertainty is general to any model that relies on long-term forecasting" (Weidema et al., 2009, p.23); damage may occur at considerable spatial and time distance from the cause, and one cause may have an impact on several aspects. End-of-life assessment of long lifetime products with inherently uncertain future disposal technologies is especially difficult (Höjer et al., 2008, p.1964).

Many of the required damage data are unknown (Reap et al., 2008, p.294). Social impacts are not easily quantifiable (Udo de Haes et al., 2004, p.4). The impact of health-related issues is usually characterized by the "disability-adjusted life years (DALY)", the calculation of which uses subjective and time- and location-dependent assumptions. DALYs not only lack objectivity and depend on time and location, but also change, e.g. because they depend on a people's development (Goedkoop et al., 2009, p.7).

An advantage of a damage-based measurement is that it relates to the consumer-oriented "polluter pays" principle, but industry thinks in terms of the balance of their internal required preventative costs and their internal benefits, which together make their actual extra costs needed for a sustainable product. Increasingly companies become aware of the external benefits, but can only base their decisions on these if they can be really internalized and incorporated in their products' prices.

The problems of subjectivity and of updating difficulties even increase if different issues are compared or aggregated and a weighting step is used for the severity of the issues, even if that weighting is based on research on the opinion of large groups. The fast changing results of national elections present evidence of individual's and people's different and changing opinions. Also monetary weighting by preventative costs, the method that is proposed in this article, is a choice giving equal severity weight to all issues. However it objectively represents the hidden distance to the price of an issue free product and can be easily understood by consumers. See (Finnveden, 1999) for an extensive review of weighting issues and related problems in LCA.

3.3. The lack of standardization

There is no comprehensive standard for the measurement and verification of comparative 'product' sustainability, nor for defining the functional unit and scope, the choice of impact categories and the system boundaries (Reap et al., 2008, p.292–293). Without a standard for what and how to measure and for the system boundaries, the objectivity and comparability of LCA results may be seriously questioned. Because both functional unit and scope are the LCA-practitioner's choice, without a modelling standard this first step already leads to differences and incompatible results (Thorn et al., 2011, p.5). Allocation of damage to a product or process, defined as the functional unit, is especially difficult if the product or process has multiple functions (Reap et al., 2008, p.292). Although taking the functional unit as a starting point is logical for the decision-taker, it is less so for the consumer, who usually takes far more than one type of functionality into consideration. The ISO standard requires flows to be related to a reference flow, but provides no standard for how to do so (Heijungs et al., 2012, p.2). Therefore, although it is a step in the right direction, it lacks standardized system boundaries.

3.4. Quality and availability of data

Current LCAs are either generic data-dependent or are very laborious to perform because there is no standardized way to transfer reliable data through the supply chain. Every link in the chain must be developed by the researcher via her/his top-down LCA, without the possibility to use verified data of its specific supply chain actors bottom-up (Guinée et al., 2001, p.6), unless the practitioner has complete control over the supply chain her/himself. Because current LCAs are based on generic databases, it is difficult to measure the specific sustainability performance of an individual product at a specific location at a specific time (Udo de Haes et al., 2004, p.2). E.g. a LCA database may contain data on the average GHG emissions involved in processing cocoa beans to cocoa powder, but miss that these emissions depend on the specific processing of a specific type of cocoa powder. Similar examples are present in all industrial sectors. For more upstream links in the supply chain it is virtually impossible to include specific downstream consequences.

The databases are seldom up to date (Thorn et al., 2011, p.5). The generic data that are used for current LCAs are subject to continuous changes and are therefore, difficult and expensive to maintain. Technologies, knowledge and insights on impact, industries, people's preferences, and even of the impacts themselves change, e.g. if a type of disease becomes curable.

3.5. LCA in theory and practice

In a paper on "LCA in theory and practice", twenty-two university and industry experts on LCA state that most of the LCA work published is from academia and not from industry. They state that industry needs for them suitable LCA methods, and they conclude that "standardization of procedures is the key to ensure a common interpretation of results within the chain links" (Baitz et al., 2013). (Gmelin and Seuring, 2014, p.6) argue that practitioners can hardly manage differences and inconsistencies in data, and (Chkanikova and Kogg, 2015, p.2) argue that implementation of life cycle management is challenging due to difficulties in collecting and interpreting the required large amounts of data.

In this context, the authors of this paper doubt if current damage based LCA develops in a useful way for industry. Scientists, by the nature of their work, reveal ever more complexity of the real world by demonstrating how damage depends on spatial, temporal and inter-relational factors and by trying to broaden and deepen LCA tools, approaches and applications.

Although LCA tools are very effective in increasing the scientific knowledge on sustainability, it becomes increasingly difficult, if not impossible, for industry practitioners to understand the issues and data as provided in the databases, and for them to effectively assess the validity of the data for their particular cases.

We conclude that current LCA is a useful tool for comparative assessment of different products or processes at the development state of a product, for providing a total supply chain picture of environmental impacts, and for management decision-taking. But it is not suitable for sustainability measurement of specific products or for comprehensive measurements of the externalities resulting from products' life cycles.

For a more complete life cycle sustainability assessment (LCSA) and for promoting a balanced assessment of environmental (planet), social (people) and economic (profit) aspects, Klöpffer proposed to combine LCA with social LCA (SLCA) and Life cycle costing (LCC) (Klöpffer, 2008). UNEP called for further development in these directions (UNEP & SETAC, 2011).

LCSA includes social issues in the assessment and uses LCC for the costs aspect. However, SLCA is still in its infancy and, without a bottom-up system to transfer verifiable sustainability data through the supply chain, reliable data will always be very difficult, if not impossible, to obtain without control over the specific supply chain. LCC assesses the costs of a product from the perspective of the producer and user and was designed to include externalities that are anticipated to be internalized in the decision-relevant future (Hunkeler and Rebitzer, 2005, p.306), but it still has many of the limitations as LCA. E.g. LCC is damage-based with all its consequent uncertainty problems; also in LCC, usually alternatives are studied instead of specific products (Swarr et al., 2011, p.42); there is no standard on what to include or on how to value; costs are usually determined by rather subjective methods like "willingness to pay". See Horn for a more comprehensive summary of the difficulties with LCC (Horn, 2014).

This paper's authors have key questions about if there is a way to 'solve' these limitations of average data and damage based assessments. In our view it is crucial to move beyond the damage based perspective to the prevention-based perspective. In this sense a large step forward towards the objective measurement of product-related externalities is the EcoCost – Value rating method (Vogtländer and Bijma, 2000; Vogtländer et al., 2001). This LCA method uses the marginal preventative costs to reach a target as the sustainability measure. Expressing every sustainability issue as a monetary value, the method is suitable for comprehensive measurement and aggregation of very different issues. However, such a system has not been developed for social issues and continues to be a top-down type of LCA. But, embedded in a different context of data collection it can be useful and we use this method in the "Oiconomy project".

Many of the current LCA shortcomings for the measurement of specific products are related to the limited possibilities to transfer objective, reliable and up-to-date data through the often-complex supply chains of products. However, industry has demonstrated the ability to maintain a self-imposed and effective global system of standardization and verification. Trust in supply chain data is achieved by compliance with standards, verified by certification. The often hard to achieve own control over upstream supply chain actors is replaced by collective and standardized control. Certification on food safety is an example of how private standards can develop, in a few decades, into a system playing a fundamental role in global food safety (Henson, 2008; Hatanaka et al., 2008). (Chkanikova and Kogg, 2015, p.12) recommend industry to also consider certification for supply chain sustainability data collection.

One of the strengths of certification is the reversal of proof, to which organizations submit themselves. Without evidence of compliance, no certificate is issued and non-compliance may be assumed. The idea of the "Oiconomy project" is to utilize this type of system for the standardized and verifiable measurement and transparent transfer of preventative costs-based externalities through product supply chains, and thus we hope to make progress on LCA of specific products.

4. A new type of bottom-up LCA: the Oiconomy Project

The Oiconomy Project is comprised of four stages. The first stage, presented in this paper, is the development of a new type of bottom up, standardized and comprehensive LCA. In the second stage the necessary data will be collected and we will show how such a system could make it possible to effectively include social issues into LCA. The third stage will be the market testing of the system in different industry sectors, the development of necessary software and of a certification scheme, that is planned to be performed 2017. In the fourth stage, in a running system, the actors in a supply chain will measure, document and transfer the externalities related to a product, which will build up in the value chain, just like standard prices, until the end product, where the total hidden costs are exposed to the consumer. In principle the system makes it possible to also transfer more detailed information on the various issues, all expressed in preventative costs.

The desired future effect of the Oiconomy Project is that consumers and producers will gradually change to sustainable production and consumption. However, probably, as a fifth stage, a tax reform is necessary to convince the mainstream consumer to buy sustainable products. Other existing internalization systems, such as tradable emission rights, are hard to imagine for social issues. But even without tax reform "Oiconomy", a sustainable, full price economy, already exists as that part of the economy made by "Oiconomy consumers". This is a consumer who is seeking the lowest price for a product that causes zero damage on any environmental or social aspect in its complete product life cycle, who considers sustainability a required quality aspect of the product, and who, either under pressure of taxation or other internalization systems, or voluntarily, pays for the required preventative measures. The "Oiconomy producer" is a responsible organization willing to deliver Oiconomy consumer wants, and willing to submit itself to third party verification (see also Chouinard et al. (2011)).

4.1. The Eco Social Cost Unit as unit of product sustainability

Hidden costs can be measured as costs of damage, restoration, compensation or prevention. Comprehensive measurement of more than one type of impact requires a weighting step. Because weighting of damage, restoration or compensation is far more difficult and subjective than of preventative costs, the latter represents the most objective method. Industry thinks in terms of the costs that they need to spend for precautionary measures and therefore these preventative costs represent the magnitude of their industries' obligation to society.

The Oiconomy Standard (OS) (Croes, 2013) is a first model for the standardized measurement of all aspects of product unsustainability, expressed in a monetary unit, the Eco Social Cost Unit (ESCU), aiming to fill the need for standardization described in Section 3.4. The OS uses the principles of standard financial accounting for seeking to determine the hidden preventative costs of products at all links of the supply chain and for transferring these through the supply chain in a similar manner to standard costs. The ESCUs will be determined by the supply chain actors themselves according to a normalized, third-party-verified method. This way the OS aims to provide solutions to the shortcomings of damage based LCA (see Section 3.2). The certification system will enable bottom-up transfer of verified sustainability data through complex supply chains and therewith present a solution of the current top-down character of most current LCA's.

The OS considers all frequently described issues, mostly obtained from available international standards and guidelines. The ESCU is the sum of the preventative costs for all issues, described with the formula: $ESCU = \Sigma (Q_{Issue} \times P_{Issue})$. Q_{Issue} is the quantitative factor of an issue expressed in the relative unit and P_{Issue} is the price factor of one unit.

4.2. Determination of the quantitative factors

The OS provides a normalized measuring method for the magnitude (Q_{issue}) of unsustainability in all its issues, both environmental and social, and regulates these to be multiplied with the relevant price factors (P_{issue}).

The OS groups issues in categories, several with subcategories. The goals of its issue categorization are to systematically lead the practitioner through the various categories and to group issues on applicable measuring methods. Following the criteria of the OS, the practitioner obtains one comprehensive ESCU score that quantifies the total hidden preventative costs per functional unit of a product, and also provides a matrix of separate issue category scores. The OS categorizes environmental issues similarly to most current LCAs, although special attention is paid to categorize them by root issues. This can best be explained with an example. With the first generation of biodiesels, the issue of land use was underestimated, by mainly considering energy itself as the issue instead of a combination of a variety of root causes, which are included in the OS categories of pollution (GHG), resource depletion and land occupation. The same problem may cause incomplete sustainability assessment of organic food products. At present the OS is a first model, which may evolve in subsequent stages of the project and during later stakeholder consultation. Even its categorization may change, but that will not change the core philosophy of the system.

Considering social issues, new in LCA, the OS includes the commonly discussed categories related to of economic issues and labour conditions, but added issues that in industry are typically covered by governance programs (e.g. compliance programs on corruption and on quality) because verification on such issues becomes possible with the system of certification.

Currently the OS recognizes ten fundamental categories, comprising all types of regularly described environmental, social and economical issues: 1. Pollution; 2. Resources; 3. Land occupation; 4. Biodiversity and nature degradation; 5. Public health; 6. Waste and disposal; 7. Economic responsibility; 8. Labour conditions; 9. Corruption and violence; 10. Various social responsibilities (Croes, 2013).

4.3. Determination of the price factors

The OS requires the practitioner to allocate ESCUs based on a database with default price factors, unless she/he can demonstrate product-specific lower preventative costs. In sector 3.5 we addressed the problem that in current damage based LCA the common industry practitioner has not enough knowledge of the complex nature of the impact to be able to judge its applicability to his/her specific product, location and processes. In contrast, because calculating costs of measures and changes is the core activity of any business, in our proposed system, the industry practitioner will calculate and correct default values and contribute to the system. Directing industry focus to research into how to prevent damage and the related costs, is part of the goal of this project.

In theory if a complete supply chain consists of knowledgeable practitioners, the system could run without a database with default values, because every practitioner in the supply chain could determine the preventative costs based price factors her/himself. Because such verified (anonymized) new market-obtained data can be used for updating the database price factors, the system becomes self-learning, one of the features of the proposed Oiconomy system. This principle means that the price factors need to be based on market prices. The OS includes criteria controlling the quality of market-obtained new price factors. Initially however, default values for the price factors need to be predetermined for all issue categories.

For this determination a fundamental question is: to which level must unsustainability reduction be measured? Not all issues need to be reduced to the zero level because earth and mankind may have a certain resilience level on the relevant issue. An option is to set the standard to the best available practice. The disadvantages are that even the best practice may not be good enough, that the relevant practice is not sufficiently available to make a difference and that it may be unrealistically expensive. A more feasible option is the EcoCost/Value ratio method, which uses the marginal preventative costs to reach a target or standard as a measure (Vogtländer et al., 2000). The best way to explain the method is with an example. If the target on reduction of GHG emissions was an 80% reduction of global emissions, several major options of renewable energy generation, energy use efficiency improvements and life-style changes would be required because each of them alone will be insufficient to reach that target. Reasonably assuming that the cheapest technologies/changes will be used first, the marginal preventative measure is the most expensive (last deployed) major measure required to globally reach the target. ("major preventative measure" is defined as a measure that theoretically has the potential to globally make a difference).

Marginal preventative costs are determined for impact categories (similar to the midpoint categories in current LCA (Wolf et al., 2012, p.41)), characterized by a categorization factor (e.g. climate by the global warming potential). The different components (e.g. methane, CO_2) within the category are weighted by their characterization factor. Delft University of Technology (Delft University of Technology, (2012)) already maintains a database for most environmental issues. (This impact categorization is not the same as the one used in the OS for the determination, because of its totally different goals described in Section 4.2).

The concept of using marginal preventative costs was also proposed for the national accounting level by (Ekins and Simon, 2001), calling it "distance to sustainability". (De Bruyn et al., 2010) produced "shadow prices" for a large range of pollutants, based on both preventative costs and damage costs. So far the preventative costs-based method was used for environmental issues only. The Oiconomy project was designed to use the EcoCost/Value ratio system for the determination of the price factors, but to extend it for social issues, make it bottom-up, make the databases self—learning, and make it suitable for specific product assessment.

Considering the wanted self-learning character of the database with default price factors and to enable industry to the generate more specific price factors than existing default values, subcategories are not predefined. Industry may develop subcategories based on more specific impact definitions, product groups, industry sectors or processes. However, new subcategories may not be used for the purpose of hiding specific unfavourable situations in a larger category, which must be part of the verification process.

4.3.1. Procedure for the determination of price factors for ESCU's

In order to facilitate a uniform determination of the price factors, we suggest the following procedure:

1. Definition of the impact category or subcategory considered, together with the characterization factor, the indicator characterizing the relative weight within the category (e.g. the global warming potential for GHG emissions).
2. Determination of the specific standard or target to be achieved.
   a. Assessment of available effective international standards and conventions. (In some cases science has already demonstrated that existing international standards and conventions are not effective; in these cases a scientific no-effect level can be used)
   b. Without an effective international standard or no-effect level, set the target at 80% reduction of the issue (relative to 1998) or, if concrete measurement of that reduction level is not feasible, at the average level of the 20% best performers (e.g. countries).
   c. Where no such concrete target can be defined, determine the cost distance to perfect governance on the issue.
3. Listing of major available preventative measures.
4. Determination of the costs and net effects of available preventative measures and sorting the list by the costs per one unit of the characterization factor, with the lowest on top.
5. Assessment of which preventative measures are required to globally reach the target. The last and most expensive preventative measure to be employed shows the marginal preventative costs.

4.4. Advantages and disadvantages of comprehensiveness

Following the OS, a LCA will produce a comprehensive indicator for the preventative cost distance to a fully sustainable product, considering all frequently discussed environmental, economic and social issues. Comprehensive sustainability indicators have advantages and disadvantages. The disadvantages of comprehensiveness are the increasing complexity and labour intensity for the practitioner with every added issue, and that the sensitivity of the aggregated indicator tends to decrease with an increased number of issues, because where some indicators rise, others fall. This is a classic conflicting situation in multi-criteria decision theory (Munda, 2005, p.131). However, this situation is especially valid for relative measurement, where options are directly compared, and less relevant for product sustainability in the sense of its cost distance to a fully sustainable product. Another disadvantage is that the more issues that are included, the lower the chance of political or company agreement on full application. Complexity is the result of the aggregation of all relevant sustainability issues that exist in real practice. So the OS system was designed to reflect the complex reality and translate this into prevention costs per unit of product.

The advantages of comprehensiveness are that complexity for the consumer is reduced, a total view is obtained, and industry is not pushed from one issue to the other. Comprehensiveness is in our view the best choice for product sustainability measurement, providing complete information. However, because the OS determines the comprehensive ESCU score by aggregation of category scores, the possibility remains for the presentation of a matrix of category scores and any choice of aggregations of category scores.

5. System boundaries for the Oiconomy system

One of the major shortcomings of LCA, if used for specific products and the transfer of coherent data through the supply chain is the lack of standardization in the choice of system boundaries.

Although the Oiconomy system is envisioned to become as objective as possible, some choices will have to be made and system boundaries will have to be set, if only by making definitions and by the choice of categorization of considered issues and system boundaries. First we need to realize that taking preventative costs as a measure is a choice that gives implicit damage preference to all issue categories, with the probable consequence, that industry will improve first on the issues with the best balance of preventative costs and benefits. However, in our opinion this is much more objective than damage-based systems basing themselves on panel opinions or DALYs, because even the largest possible polls, those of national elections, demonstrate large and rapid changes in people's opinions. Preventative costs also change, but because costs are the core of normal business, can be maintained much easier.

5.1. The included sustainability issues

Sustainability is a multi-issue concept. Though typically applied to environmental issues, current LCA also distinguishes environmental and social issues (ISO, 2006b). Economic issues can be categorized either separately or under social issues. There is no agreement on what must be considered a sustainability issue. In the Brundtland Report sustainability is defined as: "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (United Nations World Commission on Environment and Development, 1987, p.15), which is a very generic definition.

In developing the OS as a comprehensive model standard addressing both environmental and social (including economical) issues, existing standards and guidelines were investigated for their suitability to be used as a standard for product sustainability and to learn what issues need to be considered. We conclude that at present no comprehensive standard for product sustainability, universally applicable to all types of products, is available.

However, well recognized standards are available on quality, environment, health and safety governance, and on product safety and many other issues, (e.g. ISO, 2004; OSHAS, 2007).

A wide range of issue labels is available, setting criteria for one or a limited number of issues, and another range of industry sector labels or product labels. Well recognized examples are the labels of Fair Trade (Fairtrade International, 2011), MSC (Marine Stewardship Council, 2010) and FSC (Forest Stewardship Council A.C, 1996). Cradle to Cradle (McDonough Braungart Design Chemistry, 2010) includes both environmental and social criteria and the EU Ecolabel system (Der Blaue Engel, 2013; SMK & SV&A 2006).

A wide range of conventions, treaties and legislations is available, providing standards and principles on both environmental and social issues. Some examples are the Universal Declaration on Human Rights (UN General Assembly, 1948), the ILO Declaration on the Fundamental Principles and Rights at Work (ILO, 1998), the Codex Alimentarius (WHO & FAO, 2013), the Brundtland Report (United Nations World Commission on Environment and Development, 1987) and the 2001 Stockholm Convention on Persistent Organic Pollutants (The Secretariat of the Stockholm Convention, 2009).

A very comprehensive and also well recognized guideline on sustainability is ISO 26000 (ISO, 2004), addressing a wide range of environmental and social issues, although it was not written as a standard but as a business guideline on a wide range of environmental and social issues. However, In ISO 26000, financial responsibility is underrepresented, although corruption is considered.

Also well recognized is the Global Reporting Initiative (GRI). The GRI offers a choice between a core option of aspects to be reported on by companies, and a comprehensive option, including a very complete set of environmental, social and economical aspects (GRI, 2013). However the GRI purely focuses on transparent reporting, without any assessment on the accomplished level of sustainability.

All current standards and labels assess compliance or noncompliance. They cannot be used for the measurement of the distance to product sustainability. An exception may be the rating labels, measuring product performance, but always on a very limited number of issues, such as the European energy labels (The European Parliament & The Council of the European Union, 2012).

Guidelines and conventions are often described in vague and generic wordings and do not always explain the basis upon which the selections of input data were made.

The Oiconomy standard (OS) will consider all sustainability issues described in ISO 26000 and the GRI and those summarized by the IISD review on sustainability initiatives (Potts et al., 2014), extended with some new criteria, especially on the recently discussed financial/economic responsibility. To facilitate future stakeholder assessment, in a special section the authors of the current version of the OS described their position on the more controversial issues of genetic modification and other new technologies, nuclear energy, animal welfare, policy time scope, conflict and corruption, land use, poverty and inequality.

5.2. To what detail needs to be measured?

Product life cycles may comprise many components and services, many of which are irrelevant and complicate the system. Details need to be truncated. The Oiconomy Standard (OS) sets its truncation level at 80% as a preliminary, which is also the minimum stated for LCA by the JRC (JRC, 2010), which means that we propose that initially the 20% most minor details need not to be included in the calculations. Because there are financially and physically minor activities that still may have a major sustainability impact (e.g. emission of highly toxic chemicals), the OS excludes a series of high impact items and activities from this detail truncation. In a running system it will always be possible to slowly raise the percentage, e.g. to 95%, which is a more usual truncation level in LCA and advised by the JRC. A preliminarily low detail truncation level was chosen because the OS considers far more issues than current LCA, which may become too demanding for the practitioner.

5.3. Definition of origin and end of the supply chain

Unlimited upstream investigating supply chains never end, and may even lead to endless circles (e.g. iron ore mined with steel machines). The same may apply downstream, because materials may be recycled forever. Therefore both the beginning and end of the life cycle need to be defined. “Origin” may be defined as the location of extraction, being a mine, land (agriculture or nature) or sea. But this definition is insufficient where many resources are purchased for the process of extraction. For example, for dairy products, the animals may be fed with either farm-grown grass, or with externally sourced feedstuffs. In the grass case, the farm is the logical origin, but not in the external feed case.

For trade and tariff considerations, so called “Rules of Origin” (RoO) are used. There are no GATT agreements on RoO, but four criteria are commonly used (Krishna, 2005):

1. Requirements in terms of addition of content, which may be value or physical.
2. Requirements in terms of change in tariff heading in a classification system.
3. Requirements in terms of processes.
4. The requirement of the last “substantial transformation”.

These RoO are primarily used for economic reasons and intended for countries rather than for industry. For the purpose of this project, the definition “substantial transformation” is too vague; requirements in terms of processes would require a huge database for all the different cases, and the system of changes in a classification system has little relation to our purposes. However, the first option can be applied at company level and in any situation and seems the best criterion of truncation for the Oiconomy project. Applying our proposal of detail truncation at 80%, these projects' rules of origin then lead to the following proposal: “*The life cycle shall be investigated upstream to the stage of extraction (mining, agriculture, fishing and sea exploration) and even further back until that stage at which both physical weight- and value addition to the product are over 80%*”.

Also the concept of “grave” needs to be defined. Ideally recycling leaves no waste at all. But in practice at least two issues need to be considered:

1. Recycling may cause downgrading, limiting future use, recycling or future value. Therefore the OS requires calculation of a downgrading factor, depending on the value loss of the material.
2. Recycling processes may cause substantial damage themselves, which effect is covered by the OS because recycling processes are explicitly addressed.

5.4. The setting of the temporal boundaries

Current LCA is subject to temporal problems, the four most important of which are:

1. Targets and costs depending on the temporal scope (e.g. considering depletion issues). In literature only one of such temporal choices could be found where the IPCC has set a (not very hard) scope of 100 years (United Nations Framework Convention on Climate Change, 1998; United Nations, 1998) for the global warming potential of the various greenhouse gases (GHG's). In this project, where temporal truncation is required, we use this 100-year scope.
2. Present issues with future impact (e.g. cancer and climate change) present a serious problem in current damage-based LCA. Preventative costs-based systems do not experience this problem.
3. Damage occurring by the later use of the product (e.g. fuel for a car). In most cases the OS allocates future energy ESCUs to the energy source and ESCU's for preventative utensil adaptations to the utensil. The aspect is further discussed in section 5.10 on double counting. For any ESCU allocation for future impact, the OS truncates at a maximum of 100 years' use of a product.
4. Damage depending on future disposal technology (for long life products). Preventative costs-based methods overcome the problem by using costs of current prevention.

5.5. Addressing both costs and benefits of preventative measures?

As numerous pollution prevention practices have shown (Gallup and Marcotte, 2004; Cagno et al., 2005), prevention usually not only brings costs, but also benefits. For example, good quality governance saves on failure costs, good health and safety governance saves on lost hours, good sustainability and responsibility may prevent future restoration costs and claims and improve the image of the company, and good waste and recycle management prevents disposal costs and saves on purchasing new raw materials. In these arguments we see both prevention and a damage orientation. Various systems of eco-efficiency measurement (Schmidheiny and Zorraquin, 1998) and environmental management accounting (e.g. Jasch, 2006) have been developed to assess and base decisions on a balance of costs and benefits. External benefits, at least partly being the prevented damage, as discussed above, are often uncertain, changing, subjective and very complicated. Therefore they are not suitable for inclusion in the standard calculation and default values of ESCUs.

There are many examples where even the internal balance of costs and benefits is positive, especially if savings can be made on reducing waste and procurement (e.g. US Environmental Protection Agency, 2014; Jasch, 2003). In such cases, including benefits in the ESCU's would make them negative. Obviously these situations currently do not hurt or inspire the involved companies enough to make a change. Because internal benefits are often very case specific, they cannot be included in the default ESCU values. However in decision making industry will surely consider these. Therefore in the current version of the OS we propose a system in which the internal benefits may only be included if their sound calculations and taken change decisions at the highest corporate level can be demonstrated.

In addition, in order to properly value voluntary positive contributions to society and the environment, the OS includes a separate section on positive contributions, allocating negative (or bonus) ESCUs. In order to avoid double counting, bonus ESCUs may also be allocated for environmental taxes already paid. Like preventative costs, which are actual and do not represent the magnitude of the damage, bonus ESCUs are equal to the actual money spent on positive contributions and not to the expected external benefits.

5.6. The setting of targets for sustainability aspects

As discussed above, for the determination of the price factors and marginal costs, targets/standards are required. For many issues targets are available (e.g. for most hazardous chemicals a certain concentration; for child labour and corruption, zero). If no suitable target is available, or for example, if for political reasons available targets are insufficient to be really effective, the following procedure is proposed for the determination of targets and marginal costs:

1. If available, on environmental issues the no-effect level is taken as the target. Without a no-effect level, 80% global reduction of the 1990 (year of the Kyoto protocol) impact is taken as the target. However if all potential practices together are insufficient to reach the target, the most expensive major preventative practice will be taken as the standard.
2. On social issues, where possible, the same procedure is to be followed, or else, the average performance in a benchmark of the 20% best performers on preventing the issue is to be taken as a target. For various social issues for which this procedure will be used as the target-setting method (e.g. for the setting of a fair wage), countries will be the performing units. For this purpose, by an assessment of available indicators in country performance, (Croes and Vermeulen, 2015) proposed a benchmark group of countries, based on the Sustainable Society Index (Van de Kerk and Manuel, 2012). Where no target making methods are available these may be derived from democratically grown practices in this benchmark group.
3. If no concrete target can be determined, the OS takes a perfect governance system as the target, using the principles of well developed risk-based certification standards on issues like quality, labour conditions and health and safety. The costs of such a system, including all its consequences, show our marginal preventative costs.

5.7. Default price factors based on net effect

The preventative costs of a measure must be based on the net effect. For example, in the assessment of solar panels intended to reduce GHG emissions, all emissions during the lifecycle of the panels must be considered. Even best practices rarely have zero issues. Sustainability is a multi-issue concept. Ideally, assessing a best practice on a specific issue, both the impact reduction of the relevant issue and the impact on other sustainability issues are considered.

Initially however, it would be far too complex to take all the other involved issues into account at the initial determining of default values of the marginal preventative costs/price factors. However in a running system, following the principles of the OS, self-learning and specifically designed for comprehensive assessment, all the other aspects will gradually be included and preventative costs corrected. A preventative measure against child labour is to employ a fairly paid adult enabling her/him to provide proper education to his children; a windmill as a measure against climate change, may be have been produced based on polluting mining.

5.8. Price level choice considering spatial price differences

Product supply chains may be extremely complex and involve many countries. Price levels show great spatial variation. Which price level of preventative measures should be chosen as a measure for the price factors?

In the opinion of the leader's of the Oiconomy project's long-term goals, ESCUs should be at the lowest level that makes mainstream consumers and industry change to more sustainable production and consumption. The consumer's location determines the price level of ESCUs required to result in a mainstream change. Most global consumption is still in high income countries, and price levels in emerging markets tend to develop towards high price levels (Hofrichter, 2012; Halpern and Wyplosz, 2001). Price levels in low income countries are often so much lower that even doubling or tripling of, for instance, land prices would not lead to major consumption changes in high income countries. This would favour the option of using developed countries' prices.

However there are more arguments in favour of freely using market prices, e.g.: many goods are only produced in low income countries which in their development depend on their low labour costs and the Oiconomy project is not intended to be used for protectionist purposes; for the self learning aspect of the system the price factors need to be based on market prices (see Section 4.3); the price factors are based on the costs of preventative measures with the potential of globally making a difference (see Section 4.3), which limits short term and local price variations; every product has its price in the current economy and a hidden price, outside the current economy. Hidden costs depend on, and should vary according to, actual costs. Weighing these arguments, we consider the actual market cost the only logical choice. But doing so, it is important to use our proposed method comprehensively indeed, including the social issue of fair wages, because without comprising that issue the system would not lead to proper development of low income countries.

5.9. The effect of spatial and temporal impact differences

(Potting and Hauschild, 2006) point out that the level of impact may be location-dependent. E.g. water is not scarce everywhere and halve times, eutrofication, photochemical ozone formation and ecosystem resilience depend on temperatures. The impact may also be time-dependent. E.g. a disease may become curable and new recycling technologies may develop. In damage-based measuring systems spatial and temporal differentiation would be required, but not in preventative cost-based systems, unless at a specific location an impact is totally absent. The OS includes a general criterion permitting the applicant to demonstrate such location-specific exemption.

5.10. The issue of double counting

If a product has an impact in different categories, prevented by one single measure (e.g. oil depletion and GHG emission, both prevented by using renewable energy) ESCUs will be allocated in different categories, causing double counting. As much as possible the OS avoids double counting by means of its categorization. In addition the OS includes a criterion allowing avoidance of double counting if that can be demonstrated by the practitioner.

Another type of double counting may occur where utensils and consumption items are causally related, e.g. a car needing fuel. The car is the direct cause of GHG emissions, because the purchase of the car predetermines an average impact during its lifetime of use of the fuel. If the Oiconomy system were to be used only for sustainability measurement of a product, ESCUs will be allocated to both car and fuel for driving the car, without double counting being an issue. If however in a future stage, ESCU's are used for real internalization of currently externalized costs, the consumer will be provided with ESCUs both for the car and for the fuel. In this case we have a case of double counting and ESCU allocations must be corrected, e.g. by reducing the ESCU allocations to the car with the average ESCUs internalized in the energy sources.

6. Next steps: research challenges and limitations

After having described the principles, rules and the proposed system boundaries of the proposed Oiconomy system as a product specific, comprehensive and bottom-up type of LCA, we now discuss the next steps of the project, some research challenges and the limitations of the system that we did not discuss before.

6.1. Filling the database with the default price factors

In the second stage of the project the necessary default price factors will be collected and we will show how the system allows for inclusion of social issues into LCA. A model of the database, preliminarily called “Oiconomy Foundation (O.F.) Database” is presented at http://oiconomy.geo.uu.nl. Because the Oiconomy system follows the ideas of the EcoCost/Value ratio system, price factors for most environmental issues are available and maintained by the (Delft University of Technology, (2012)). The authors of this paper have already submitted papers on the price factors of the social issues of a fair income and fair inequality, using the principles presented in this paper. With the price factor of fair wages, also the factor for child labour will be determined because a fair wage for an adult also provides the preventative costs for child labour. With these social aspects added to EcoCosts, the system is ready for a market test. Default price factors on other social issues may be gradually added later, hopefully with the help of the scientific community and industry itself.

The third stage of the project will be the market testing of the system in different industry sectors and their upstream supply chains and the development of necessary software and of a certification scheme, which is planned to be done in 2017. In the fourth stage the running system will expose the currently externalized costs of a large range of products, purely as sustainability information of the true price for the sustainable alternative of the product and without consumers actually paying these costs.

6.2. Certification/verification systems

The Oiconomy standard was envisioned to use the global system of certification and accreditation for the verification of compliance with the standard in the supply chain, but the total system and issues to be verified are much larger than usual and therefore, undoubtedly more expensive than most current certification schemes.

However, for most organizations only a limited number of issues apply. The research challenge is to develop a risk-based certification system, where auditing character, criteria, frequency and time depends on the risks, e.g. defined by risk matrices or hotspot databases, relating issues to countries and industry sectors, performance and certification history of organizations, transparency, e.g. in GRI reporting, other certifications, history of audits, and the involved countries and their corruption levels.

6.3. Use of ESCU's for internalization of externalities

The primary goal of the Oiconomy system is to provide a comprehensive sustainability measure of specific products, equal to the product life cycles' embedded externalities. We have used the measure of the preventative costs based externalities because they may represent consumers' and industries' collective hidden responsibility to nature and the weak. Although already practised and proven effective, the internalization of externalities by means of a tax reform is still in its infancy and limited to energy use and carbon emissions. Taxation systems affect many more aspects of communities than only sustainability and are the responsibility of politicians. Until now the absence of a system for the measurement of product related externalities may have contributed to the lack of internalization, which limitation we hope to eliminate with this project.

6.4. Objectivity of the system

The proposed Oiconomy system is not completely without value choices. The chosen preventative costs as quantitative measure in itself is a choice that makes an issue independent of the perceived magnitude of damage. However it is designed on some generic, one-time chosen, system choices, all described in this paper, limiting individual choices of researchers and practitioners to a minimum and thereby, potentially providing a more objective comprehensive product sustainability measurement system than what is possible with the current LCA tools. Also with other system choices, the methodology remains the same.

6.5. Measuring issues without concrete targets

On some issues no generic concrete targets or preventative measures are available, e.g. on the issues of quality and occupational health and safety. Control on such issues is commonly achieved by third party-verified risk-based management systems, like the OSHAS health and safety standard (OSHAS, 2007). A simple criteria weighting is commonly applied by distinguishing key criteria and other criteria. However, these standards only measure compliance or non-compliance, where we want to measure the cost distance to a very high level of performance. One idea to accomplish this is to score companies on the different governance criteria and study the relation between the measured level of governance and the cost distance to full compliance to the governance criteria. This idea presents three research challenges.

The first is to, based on the opinion of certification and industry experts, develop a rating system measuring the quality of governance. The second challenge is to determine, in different industry branches, the costs difference between perfect and poor performance on the relevant issues. The third challenge is to determine the cost-distance to such perfection at different levels of governance as determined by scoring the compliance to governance criteria.

As argued in Section 4.3 the system could in principle run without default values, relying on industries' own, but verifiable, calculations of the preventative costs on an issue. If above method proves not feasible, a standard, such as the OS, will have to require such calculations for the issues without concrete default values.

6.6. Feasibility of certification and the implementation plan

Although certification has been proven to be effective on several issues, such as on food safety, we also know that some major problems exist. An audit is not a complete verification of a company's operations, but a sample. Although a certification scheme usually consists of a series of audits, investigating all criteria, the quality of audits heavily depends on the size of the sample and available auditing time. Because auditing time is expensive, pressure on auditing time and therefore on auditing quality is inevitable. Although the great majority of certifications are quite effective, industrial incidents or even deceptions make certification unpopular with the public. Our proposed certification scheme, including all environmental and social aspects, would be expensive indeed. Therefore a challenge is to reduce audit times e.g. by collective schemes for small companies and a risk based certification scheme, in which frequency and investigated criteria for instance depend on hotspot databases, industry sector, location, other certificates and other risk indicators.

In this paper we argued that the Oiconomy system makes LCA far less complex for the practitioner, which is undoubtedly true in a successfully running system, because in fully certified supply chains all ESCU's can simply be obtained from certified direct suppliers. However, as explained above, it will probably need some force to convince mainstream suppliers to submit to the system and get certified. Possible initiators applying such force are for instance large retailers and other influential companies or governmental institutions, which have been such initiators before (Konefal et al., 2005; Havinga, 2006). If such actors adopt the proposed system and challenge their upstream partners in the supply chain by requiring their certification, that will help to make the process become activated. Some force and advice may also be applied by NGO's, certification bodies and consultants guiding the system.

7. Discussion and conclusions

To date no method exists for the comprehensive measurement of product sustainability, including both environmental and social issues. Our literature review showed that current LCA, if used for this purpose, has serious shortcomings. The most important shortcomings are: the lack of a measuring standard, the lack of considering social issues, the top-down approach, the weighting of different issues, the very laborious procedures of addressing specific supply chains, its limitation to environmental aspects, the very complex nature of impact based data, and difficult data maintenance.

Internalization of currently externalized costs is a frequently mentioned solution in a free market economy for correcting sustainability issues. The product embedded externalities, representing their cost distance to sustainability, may be a measure for product sustainability.

Prices of end products have been established by gradual transfer of prices in the supply chain; various certification systems demonstrate industries' ability to verify supply chain data, and the EcoCost/Value rating system (Vogtländer et al., 2000) demonstrates how preventative costs-based weighting allows for comparison and aggregation of different issues.

We therefore, propose a system for the measurement of product sustainability by copying the normal mechanism for transfer of prices through the supply chain for the currently hidden, preventative costs-based “Eco Social Cost Units” (ESCUs). The ESCU is the sum of the preventative costs for all issues, described with the formula: $ESCU = \Sigma(Q_{Issue} \times P_{Issue})$. Q_{Issue} is the quantitative factor of an issue expressed in the relative unit and P_{Issue} is the price factor of one unit.

By the introduction of the Oiconomy standard as a first model standard for the measurement and transfer through the supply chain of preventative cost-based externalities, controlled by certification, most shortcomings of current LCA can be solved. The standard systematically leads the practitioner through all issue categories and the involved production process stages, determining the quantitative factor and a database provides default values of the price factors.

The measuring standard may be useful to help to overcome differences between definitions of the functional unit, scope and measuring methods, thus making results comparable and allowing for aggregation of different issues. Certification may make it possible to reliably transfer sustainability data through the supply chain, to verify supply chain-specific issues, and to help create a self-learning database, which may be more accurate and easier to maintain than current LCA databases. Many social issues become verifiable and measureable.

Where impact assessment is extremely complex and mostly out of industry comprehension, costs are their core business, enabling them to correct default price factors. Preventative costs are not subject to the inherent uncertainty and temporal problems of damage based assessment. Although using preventative costs is a choice, for seeking to consider all issues to be equally important, they do not depend on subjective weighting systems like “willingness to pay”.

Standardized system boundaries are an absolute requirement for uniform measurement of product sustainability. The authors of this paper present their vision of the system boundaries of the system and the processes for the determination of the price factors.

Price factors for most environmental issues are available as EcoCosts from the Delft University. Most challenging for the determination of price factors of social issues is to set the necessary targets. The authors present a method for setting reasonably objective targets based on the practices of the 20% top performers (e.g. countries), and already submitted a papers on targets for a fair wage and on inequality.

Major challenges for the system will be the determination of the default prices for governance-measured issues such as quality, occupational health, and to overcome the costs of the required verification/certification scheme. For governance measured issues we envision a system of scoring a company on common governance standard criteria and relate this score to cost differences between high and poor governance companies. However, although more demanding for industry, the system is designed to work without these default values, and of course its ultimate goals is to lead industry to calculating preventative measures themselves and thereafter also executing them.

To accomplish reasonable certification costs we envision a risk based certification scheme, limiting the issues to be verified, auditing need and frequency based on hotspot databases, industry sector, location, other certificates and other risk indicators.

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