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Measuring Sustainability:

A systems perspective on sustainability reporting

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Abstract

The paper is a critical revision of the sufficiency of sustainability reporting frameworks to represent *sustainability* performance. The paper sustains that while frameworks facilitate recording, classifying, and summarizing sustainability data (i.e. economic, social and environmental), they are insufficient to represent organizational sustainability performance. Using Systems Theory and systems proprieties the thesis illustrates how sustainability reporting frameworks fail to sufficiently represent sustainability performance as an organizational management tool.

El siguiente trabajo presenta una revisión crítica de la capacidad que tienen los marcos de reportes de sostenibilidad para representar el desempeño de las organizaciones. El trabajo sostiene que aun cuando los marcos existentes facilitan la recolección, clasificación y el compendio de información en sostenibilidad (i.e económica, social y medioambiental), el método resulta insuficiente para representar el desempeño en sostenibilidad de las organizaciones. Utilizando los postulados de la Teoría de Sistemas y en las propiedades sistémicas se ilustra cómo los marcos de reportes de sostenibilidad no logran representar el desempeño en sostenibilidad como herramienta organizacional.

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To SP and JO

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List of Acronyms

AD	Anno Domini
CO2	Carbon Dioxide
KWh	Kilowatt hour

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Purpose and Relevance

Sustainability reports are public reports by organizations which provide stakeholders with an overview of their sustainability performance on economic, environmental and social dimensions (World Business Council for Sustainable Development 2002:7).

As a primary source of non-financial organizational performance, sustainability reporting plays a vital role not only as an internal measurement instrument, but also as a guide for strategic decision making of companies; governmental agencies and Non Governmental Organizations; investors and other stakeholders; committed to "meeting the needs of the present without compromising the ability of future generations to meet their own needs"[1].

Sustainability reporting is increasingly being implemented internationally[2] by a diverse range of organizations[3]. The tool is recognized to serve a primary role in bringing about economic, environmental, and social improvements, as it provides a consistent platform of sustainability disclosure to enable effective stakeholder relations, investment decisions, and other market relations. (Global Reporting Initiative Guidelines p. 2).

As more governments and international institutions endorse and participate in the development of sustainability reporting guidelines, including the United Nations Global Compact, the Global Reporting Initiative and the International Organization for Standardization, its practice gains legitimacy as an organizational tool towards sustainable development.

Likewise, the increasing recognition of sustainability reporting as an instrument to measure non-financial performance and organizational dynamics supports the relevance of examining its capacity to sufficiently allow the measurement of sustainability management.

Previous studies have shown that current methods for measuring sustainability information in economic, social and environmental dimensions present limitations (Mayer 2008, O´Rourke D. 2004, Morse et al. 2005, Bell et al. 1999). These limitations frequently refer to issues of boundary setting (defining the entity); data selection (defining information) and standardization (defining data importance); and methodological appropriateness (defining process); resulting in an unclear picture of sustainable performance and complicating

[1] World Commission on Environment and Development. Our Common Future. Oxford: Oxford University Press, 1987, p.43.

[2] More than 80 % of the 250 biggest multinationals and more than 66 % of the biggest National companies include CSR reporting in their annual financial report following the GRI guidelines. http://www.kpmg.com/SiteCollectionDocuments/International-corporate-responsibility-survey-2008_v2.pdf

[3] See Global Compact Participant Research http://www.unglobalcompact.org/participants/search

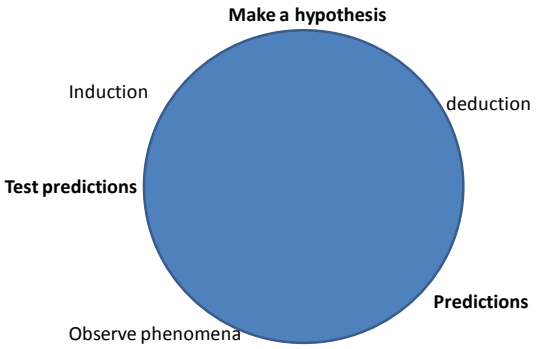
decision making based on sustainability information. Yet, little research has been done concerning limitations referring not to the accuracy of the information in terms of quantity, quality or adequacy of sustainability data, but to its actual sufficiency to represent sustainability performance.

Building on the postulates of Systems Theory to critically examine Sustainability Reporting (Blowfield et al. 2008:200) and on the examination of three sustainability reports, the following paper critically examines the sufficiency of frameworks to represent organizational sustainability performance. Findings support the hypothesis that while frameworks are sufficiently capable of representing change in specific indicators, they remain insufficient[4] to observe multidimensional or systemic performance (i.e. sustainability).

[4] *By insufficiency it is meant that the information in sustainability frameworks only allows the assessment of each indicator over time and not that of systems behaviour, and therefore the analytical approach of frameworks is insufficient to allow the assessment of sustainability.* The systemic requirement in terms of sufficiency is provided by the definition of sustainability as "*the level of human consumption and activity which can continue into the foreseeable future, so that the systems which provide goods and services to humans persist indefinitely"* (Mayer 2008:278)

Methodology

The method of the study is a combination of inductive (observe phenomena, draw a hypothesis consistent with the phenomena, examine predictions, draw a new hypothesis) Wudka (2006:1-7) and deductive (observe phenomena, make a hypothesis, test the hypothesis) methods. Both are used to examine the sufficiency of frameworks to represent systemic (economic, social and environmental) performance in sustainability reports.



The Global Reporting Initiative is used as template example of frameworks for sustainability. This framework provides guidelines for measuring economic, social and environmental information in organizations through 79 indicators grouped in 6 Protocols namely: Economic, Environment, Labour, Product Responsibility, Society and Human Rights.

In order to critically examine frameworks as a sufficient method to represent sustainability performance, as presented by Wudka (2006:1-7), in this paper:

1. An aspect of the universe is observed and a question is developed.

Around 150 sustainability reports[5] *of Asian companies*[6] *were assessed*. Assistance in the process of writing sustainability reports was given to companies and Global Reporting

[5] The reports were assessed utilizing two covering Economic (Business Behaviour and Corporate Governance), Social (Human Rights, Human Resources and Community involvement) and Environmental (Environment and Business Behaviour) aspects.

[6] An incomplete list of the companies evaluated includes: Qisda Corporation, Quanta Computer Inc., Realtek Semiconductor Corporation, Richtek Technology Corporation, Siliconware Precision Industries Company Limited, Simplo Technology Company Limited, Sino-American Silicon Products Inc., Synnex Technology International Corporation, Taiwan Semiconductor Manufacturing Company Limited, Transcend Information Inc-, Tripod Technology Corporation, Unimicron Technology Corporation, United Microelectronics Corporation, Vanguard International Semiconductor Corporation, Via Technologies Inc Winbond Electronics Corporation, Wintek Corporation, Wistron Corporation, Bajaj Auto Ltd., Zee Entertain, United Spirits, Cairn India, Hdfc Bank, Housing Development Fin., Indiabulls Real Estate, Infrastructure Develop, Kotak

Initiative trainings were developed for Malaysia, Korea, India and Indonesia. Additionally field experience was obtained through attendance of Corporate Social Responsibility conferences in Malaysia and Singapore; discussions with stakeholders of private, public and social sectors on development projects, supply chain management, responsible labour practices, etc. and discussions with colleagues, academics and practitioners of the field. Consultancy on sustainability reporting was provided to companies in Malaysia. Finally, three sustainability reports were used as instrumental case studies to support the critical examination of frameworks as a sufficient method to measure sustainability.

The question developed is:

To *what extent* is the information in sustainability frameworks sufficient in representing sustainability performance in organizations?

2. A hypothesis is built consistent to the phenomena observed and according to a problem observed.

Frameworks help to measure sustainability by recording, classifying and summarizing information in organizations. However, while the information of each indicator (e.g. turnover rate, energy consumption) allows measuring its individual performance overtime, systemically (i.e. economic, social and environmental) frameworks insufficiently allow the cohesive assessment of sustainability performance. In fewer words, while analytical performance can be evidenced in indicators, no systemic measurement can sufficiently be done with their information.

The hypothesis derived from these observations is:

H0: Frameworks are insufficient to represent and allow the assessment of *sustainability* performance *given their analytical nature to record, classify and summarize data.*

3. Data is examined and predictions tested

Adding to former research on the limits of frameworks and other methods to sufficiently measure sustainability, and the above mentioned exposure to the Global Reporting Initiative framework, three Asian sustainability reports are examined to evaluate the hypothesis. The examination draws on the information of six Global Reporting Initiative Indicators (2 economic EC1 and EC8 - 2 social SO1 and LA10 - and 2 environmental EN3 and EN16) over a three year period. These are further explained in section three.

Mahindra Bank, Reliance Capital, State Bank Of India, Glenmark Pharmaceutical, Abb Ltd., Aditya Birla Nuvo, Bharat Heavy Electrical, Gmr Infrastructure Limi.

The hypothesis is evaluated by examining if the analytical information in frameworks allows the assessment of systemic performance; that is, *if the changing trend in the two indicators from one dimension (e.g. turnover and impacts of income on communities) can be assessed systemically, or if the information is only able to show the development of each indicator individually.* Based on the examination, data is interpreted and conclusions are drawn.

The reports are chosen with no consideration of industry, size or nationality. The only parameters taken to select the sustainability reports are that they follow the Global Reporting Initiative framework and that they disclose the information of at least one of the indicators chosen from each dimension for a three year period

4. A new hypothesis is drawn from the conclusions

Frameworks collect sustainability information by grouping it first in indicators and later in economic, social and environmental dimensions. Each indicator obeys a particular unit of measurement allowing their assessment overtime. However, while analyzing information facilitates its compilation, organization and individual assessment, the analytical nature of frameworks to represent information is insufficient for the dimensional assessment of sustainability performance.

Based on the definition of sustainability provided by the World Commission on Environment and Development in 1987[7], and using Systems Theory and systems proprieties, the thesis illustrates that sustainability reporting frameworks fail to represent sustainability performance as an organizational management tool.

The Systems approach presented in part two of the thesis elucidates the system proprieties of all dimensions (i.e. growth, competition, progressive segregation & centralization, and finality) following system hierarchies. By doing so, it suggests a structure to overcome the insufficiency that existing frameworks have to represent sustainability performance.

The logico-theoretical groundings of the proposal are the backbone of the new approach.

New hypothesis (proposed but *not tested in the present thesis*) using a systems approach:

H1: Sustainability performance can be sufficiently assessed *by examining systems proprieties and hierarchies involved in sustainability, namely, economic, social and environmental (ecological).*

[7] "The level of human consumption and activity which can continue into the foreseeable future, so that the systems which provide goods and services to humans persist indefinitely"

Introduction

Sustainability reports are defined by the World Business Council for Sustainable Development[8] as public reports by organizations which provide stakeholders with a picture of the sustainability performance on economic, environmental and social dimensions[9].

They facilitate the compilation and assessment of economic, social and environmental information overtime. To operationalise the process of recording, classifying and summarizing data a number of frameworks and approaches have been developed over the past years for national, regional and organizational levels (Ness et al 2007). These include the Barometer of Sustainability, the Pressure State Response and the Global Reporting Initiative G3 (Organization of Economic Cooperation and Development 2002).

Sustainability frameworks present organizations with a consistent platform of sustainability information to facilitate the compilation and assessment of economic, social and environmental performance without indexing it, that is, without transforming it into a single unit of measurement and aggregating it (e.g. money or energy).

The non-reductionist measurement approach to sustainability allows for a more comprehensive sustainability picture. Also, by providing a multifaceted economic, social and environmental outline, frameworks provide a clearer picture of *"the level of human consumption and activity which can continue into the foreseeable future, so that the systems which provide goods and services to humans persist indefinitely"* (Mayer 2008:278, World Commission on Environment and Development 1987; US National Research Council 1999).

At the organizational level the use of these frameworks to report on sustainability is still largely discretionary. However, a growing number of companies[10] apply them to evaluate their internal sustainability performance.

Several reasons may account for this trend. Daub (2007:77) points out that "sustainability reporting can be considered a direct response to changes in society that have led to the increased monitoring and policing of companies by a critical public that is demanding more ethical behaviour". Additionally, sustainability frameworks assist organizations to identify

[8] Sustainability Development Reporting as Striking a Balance (2002)

[9] The GRI Guidelines (p. 3) define Sustainability Reporting as "the practice of measuring, disclosing, and being accountable to internal and external stakeholders for organizational performance towards the goal of sustainable development".

[10] According to the survey conducted in 2008 by Klynveld Peat Marwik Goerdeler 80% of the 250 largest companies in the world, representing a 30% increase since 2005, already report on sustainability.

and organize key economic, social and environmental indicators which assist in strategic decision making. They respond to the growing concern on the impact of human activity in the ecosystems that sustain it; and to the increasing expectations and demands of stakeholders (e.g. employees, non-governmental organizations, community leaders) hoping for "reliable and credible information from management … which truly represents the company's efforts and achievements" (Klynveld Peat Marwik Goerdeler report 2008:18).

Other reasons point to financial concerns. For example, Stilwell (2009:27) states that sustainability reporting "allows designing performance indicators to measure sustainability performance and ensure that any benefits and cost savings are being realized". Reports also assist in risk reduction efforts of organizations by assisting in the compliance with environmental regulations and provide investors with a more comprehensive image of the organizations performance in its long term vision of sustainability challenges through what has been called Social Responsible Investment.

Internally, organizations attain benefits beyond the financial realm in aspects such as reducing operating costs; improving stakeholder relations and enhancing its competitive position by strengthening its legitimacy (Daub 2007:77); motivating employees to take on responsibilities and develop skills as a means to career development; strengthening business ethics throughout the organization; and allowing innovative ideas to be raised by employees in areas such as supply chain or customer service, giving a more participative space to employees.

Whether economic, social or environmental; internal or external; financial or non financial; expectations are based on the assumption that the information gathered by sustainability reports represents the organization´s sustainability performance.

Taking the definition of sustainability provided by the World Commission on Environment and Development two premises can be defined to examine this assumption. Firstly, there are a number of systems which provide goods and services for humans to persist indefinitely. Second, the level of human consumption and activity which can continue into the foreseeable future is defined by all of these systems.

This is, since the continuation of human consumption and activity is defined by the systems that provide goods and services, it follows that the continuation of human consumption and activity *is defined by the continuation* of these systems.

What is most important regarding the topic of the paper on sustainability metrics is that from the conclusion it follows that assessing the systems which provide goods and services for humans to persist indefinitely *is* assessing sustainability.

In other words, the definition of sustainability as *"the level of human consumption and activity which can continue into the foreseeable future, so that the systems which provide goods and services to humans persist indefinitely"* (Mayer 2008:278, World Commission on Environment and Development 1987; US National Research Council 1999) not only describes the necessary and sufficient elements of a method that wishes to assess sustainability, it also sets the fundamental parameters to assess the sufficiency of frameworks to represent sustainability performance.

The Global Reporting Initiative is the most widely used organizational framework at the organizational level.

Table 1. Global Reporting Initiative Framework

Table 1
GRI framework for performance indicators

	Category	Aspect
Economic	Direct economic impacts	Customers Suppliers Employees Providers of capital Public sector
Environmental	Environmental	Materials Energy Water Biodiversity Emissions, effluents, and waste Suppliers Products and services Compliance Transport Overall
Social	Labour practices and decent work	Employment Labour/management relations Health and safety Training and education Diversity and opportunity
	Human rights	Strategy and management Non-discrimination Freedom of association and collective bargaining Child labour Forced and compulsory labour Disciplinary practices Security practices Indigenous rights
	Society	Community Bribery and corruption Political contributions Competition and pricing
	Product responsibility	Customer health and safety Products and services Advertising Respect for privacy

Source: GRI, 2002, p. 36.

Table 1 shows the categories and aspects in which the Global Reporting Initiative framework assists in the compilation and assessment of sustainability information. It is segmented in three dimensions (i.e. economic, social and environmental), six categories also called protocols (i.e. product responsibility, society, human rights, labour practices, environmental and economic impacts) and more than seventy indicators that cover a number of aspects of sustainability.

In the taxonomy of the Global Reporting Initiative the data of each indicator (e.g. revenue, energy consumption, CO2 emissions, and turnover rate of employees) reflects change overtime and facilitates the analytical assessment of internal performance[11].

By doing so, as Mayer (2008:279) explains, it is expected that policy makers "achieve and maintain sustainability, [through] timely information which demonstrates whether *a system is generally becoming more or less sustainable*, and specific information on which characteristics need the most improvement".

To examine whether the information in sustainability report´s frameworks is or not sufficient to represent the performance of the *"systems which provide goods and services to humans persist indefinitely"* (Mayer 2008:278) providing decision makers with information of the sustainability of the systems under assessment, it is necessary to understand what systems are and how they operate.

In sum, the assumption underlying the expectations of sustainability reporting, the definition of sustainability by the World Commission on Environment and Development and the foundations on which decision makers base their strategies all demand a systemic assessment of economic, social and environmental information.

In order to evaluate the sufficiency of frameworks to fulfill this requirement, the thesis has the following outline.

In section one sustainability reporting is defined and the methods and most commonly studied limits of sustainability measurements are presented.

Section two describes the systemic approach to observe sustainability performance. In this section the main concepts of Systems Theory and systems are presented including systems structure, proprieties, emergence, complexity and hierarchies. They are described as an introduction to Systems Theory and as the structure to examine the sufficiency of frameworks to represent sustainability performance and test the hypothesis. The former is possible given that "systems [science] has the potential to offer a transdisciplinary framework for a simultaneously critical and normative exploration of the relationships between and among human beings and their social, cultural, and natural environments" (Laszlo 1997: 6).

In the third section, three suitability reporting examples are examined based on the main concepts and structure of Systems Theory, and conclusions are drawn.

[11] To observe the full taxonomy please refer to http://www.globalreporting.org/ReportingFramework/ReportingFrameworkDownloads/ (last accessed December 30, 2010)

1. Sustainability reporting

If a man opposes evident truths, it is not easy to find arguments by which we shall make him change his opinion. But this does not arise either from the man's strength or the teacher's weakness; for when the man, though he has been confuted, is hardened like a stone, how shall we then be able to deal with him by argument? … His modesty is extirpated, and his sense of shame; and the rational faculty has not been cut off from him, but it is brutalized. Shall I name this strength of mind? Certainly not, unless we also name it such in catamites, through which they do and say in public, whatever comes into their head.

Epictetus, The Discourses

The project of sustainability is based in the indefinite maintenance of all systems necessary to provide the goods and services for humans to survive (World Commission on Environment and Development 1987; United States National Research Council 1999). Given the importance of sustainability as a conceptual construct in the last decades, it could be safe to say that all initiatives towards sustainability are considered valuable to humans. However to say that there is an agreement on the most suitable way to achieve its goals would be unsafe.

The United States National Research Council (1999) suggests the three systems to be sustained: community, life support systems and nature.

Operational methods to monitor, assess and report on these dimensions follow a wide variety of formats, scopes and methods. Examples of these include the Environmental Pressure Indicators developed by the Statistical Office of the European Communities; the fifty eight national indicators used by the United Nations Commission on Sustainable Development, the Gross Domestic Product and the Human Development Index; all of which record country based data. Regional methods include methods such as Material Flow Analysis, Substance Flow Analysis and Energy Analysis which collect data of regional systems based on physical, chemical and energy flows of non politically defined systems (Ness et al. 2007). Yet a third, more decentralized, group of sustainability monitoring systems centers in organizational performance.

Similar to the national and regional sustainability monitoring methods, organizational frameworks are multidimensional planning, monitoring, and assessment instruments for sustainable decision making.

Organizations started publishing reports on sustainability in the late 1980s (Wiedmann et al. 2009:362) and the practice gained momentum after the launch of the Sustainability

Accounting Guidelines in Johannesburg 2002. However, as of to-day sustainability reports do not embody a standard (unit) of account or a consistent technique of measurement (Robins 2006: 2-4) and are maintained as a discretionary practice in most countries.

Sustainability reports are defined by the World Business Council for Sustainable Development (2002:7) as public reports by organizations which provide stakeholders with a picture of the sustainability performance on economic, environmental and social dimensions over time.

They are developed to "provide decision makers with an evaluation of … integrated nature-society systems in short and long term perspectives, assisting them to determine which actions should or should not be taken in an attempt to make society sustainable" (Ness et al. 2007: 499).

Previous to the appearance of sustainability reports, organizations reported in a number of aspects which can be traced as influencing to-day´s non financial reports. These include Annual Reports that have traditionally included some topics found in sustainability frameworks such as ethical codes and governance issues. Environmental reports that encompass issues related to health and safety and basic environmental information usually disclosed by multinational companies. And Social reports, mainly published in Germanic countries, that have been the result of trade unions and federations inducing social demands in organizational activity (Daub 2007:76). All three of the reporting practices include topics currently observed in sustainability reports.

Aware of these traditions, authors such as Elkington (1998), Gray (1994, 2002) and Lamberton (2005) have influenced the development and theory of what sustainability reports are to-day.

Lamberton (2005: 13,14) describes the present sustainability frameworks as drawing from five general themes. These are (1) the definition of sustainability which includes its economic, social and environmental dimensions; (2) the use of indicators which facilitate measurement and assessment; (3) the multiple units of measurement which include qualitative and quantitative methods to describe organizational performance; (4) its interdisciplinary nature which demands the use of different scientific backgrounds including ecology, sociology and economy; and (5) the inheritance of traditional accounting principles and practices which are evident in the way organizations approach and implement it

Methods to measure sustainability

Sustainability frameworks are not the only method to measure sustainability. Ness et al (2007) present an overview of alternative methods to measure sustainability to that of frameworks. A brief description of three other categories includes indices, flow analysis and integral assessments.

- Indices

Indices are the result of aggregating the data provided by frameworks and presenting it in a singular unit of measurement. Examples of these include Gross Domestic Product and Net National Product which center in economic information. The monetary focus of these indices, it is argued, often misses critical sustainability factors such as social health and safety, energy consumption and greenhouse gas estimates.

Other indices depict a more comprehensive sustainable picture. Some examples include the Ecological Footprint in which the average consumption in food, transport, goods and services, and housing is estimated for a person on a yearly basis. The resulting evaluation is expressed nt in economic terms but in the per capita land area needed to maintain it[12].

Yet a third example in this category is the Human Development Index in which longevity, knowledge and living standards are used to assess development in a country (United Nations Development Programme 2004).

- Flow Analysis

An alternative way to measure sustainability is through the evaluation of products and services from cradle to grave. The measurement tools in this category focus in the analysis of the environmental impacts of products and services. (Ness et al. 2007:503).

The most recognized example of this group is Life Cycle Analysis. Life Cycle Analysis takes into account the whole existence of a product from the transformation of its raw materials all the way to its disposal, going through manufacture and distribution. Because of the manner it evaluates sustainability it is used more as an environmental measurement that can be used to minimize the impact of a product or service in nature (International Organization for Standardization 14040, Culaba et al. 1999).

Yet a second assessment tool under Flow Analysis is Life Cycle Costing which, as it name describes, examines the costs of a product through a breakdown of its stages. The way it

[12] A more comprehensive description of the tool can be found in http://www.footprintnetwork.org/en/index.php/GFN/

measures sustainability is by focusing in the values of the production, operation and disposal of a product or service (Taylor W. 1981).

Because Flow Analysis measurements center in a singular service or product, they may be argued to provide a less comprehensive picture of the integration of natural and social systems into their evaluations.

- Integrated Assessment

A final category of sustainability appraisal is the Integrated Assessment tools which are mainly used to support project specific decision making by providing *ex ante* scale assessments in the form of scenarios. Among them are the Conceptual Modeling and Systems Analysis, Multi-criteria Analysis, Risk Analysis and Uncertainty Analysis, Cost Benefit Analysis and Impact Assessment. (Ness et al. 2007:504).

Limits of sustainably measurements

As it was presented, a number of sustainability measurement methods have been developed each having its own strengths, weaknesses and specific uses. Some center in capturing a wide spectrum of economic, social and environmental variables, others focus in the evaluation of a product throughout its lifecycle, and others are better designed to present scenarios for project decision making.

Albeit the wide range of sustainability measurement tools available (frameworks, indices, flow analysis and integrate assessments), existing research presents particular and analogous limitations in their sufficiency to assess sustainability performance (Mayer 2008, O´Rourke D. 2004, Morse et al. 2005, Bell et al. 1999).

The limitations vary from issues of boundary setting (defining the entity); data selection (defining information) and standardization (defining data importance); to methodological appropriateness (defining process). The result of methodological shortcomings, whatever the case, is an unclear picture of sustainability performance and the consequent difficulties for decision making base in data results. These limitations, however, emphasize the relevance of examining the sufficiency of monitoring methods, as much as they represent an effort towards more accurate metrics in sustainability.

Mayer (2008:287) provides further insight into the common limitations that researchers and practitioners take into account when working with sustainability metrics:

- System boundaries

Political and legal fictions are rarely concurrent with natural systems when it comes to boundary setting. It is often the tendency to use non natural boundaries as measurement margins when deciding on the scope of sustainability data to be gathered. Although setting a fictional boundary facilitates the collection of data, measurements may result in misleading readings of sustainability which ignore natural flows of people, hydrologic resources and climate; all variables which surpass national or organizational boundaries.

In the specific case of sustainability reports, boundary limitations arise when decision-makers or analysts decide to set limits by including entities belonging to discontinuous spatial distributions. Examples of the former are often present in decisions over the inclusion of subsidiaries, joint ventures or suppliers all of which difficulty determining concrete system boundaries in organizational sustainability performance.

- Data inclusion

Data inclusion refers to the limitation that arises when choosing to include or exclude a variable and its effect in sustainability measurements overtime. Various reasons may account for this. For example, the weighting of data may be affected overtime if a sustainability indicator has been overseen or because has data become scarce or no longer available. The opposite may also happen with the later availability and inclusion of an indicator. This practice would make unsuitable assessing sustainability performance over time given the former data that did not contain the new available indicator.

On either case affecting data inclusiveness remains a limitation to sustainability measurements.

- Standardization and weighting methods

Often times a dimension of sustainability (e.g. environment) is given more weight in sustainability measurements by including more indicators than the others (e.g. social or economic dimensions). The higher the number of data in one dimension, the more dependent the estimates of sustainability performance become towards it.

In the case of indices this is specifically an issue. Indices standardize the units of measurement of indicators to aggregate data and reduce information variability. As a result indices assume an equal weight of indicators in their final value.

Both limitations, standardization and weighting methods, may be regarded as leading to uncertain results, given the particular variables and importance considerations by analyst when measuring performance in the economic, social and environmental systems.

- Aggregation methods

Complementary to standardization, aggregating sustainability data across systems assumes a possible additive relationship between the indicators they assess. This is a questionable assumption given particular economic, social and environmental variables and units of measurement of the economic, social and environmental dimensions.

Aggregating data assumes not only a similar weightage of data for each sustainability indicator or variable; it also assumes linear relations within and across systems which can be otherwise complex or non linear and therefore not respondent to compilation. This may lead to the over estimation of the value of the data by decision makers, and to bogus organizational strategies.

- Comparison

Finally, comparing performance results in sustainability across methods, and even within methods taking into account the previously mentioned limitations, results oftentimes in skewed representations of sustainability performance.

As it has been presented, there are at least four know methods to assess sustainability performance nationally, regionally and organizationally; they are (1) frameworks, (2) indices, (3) flow analysis and (4) integrated assessments. All methods face challenges when assessing sustainability data ranging from system boundaries, data inclusion, to standardization and aggregation of data which must be considered by analysts and decision makers when choosing methods and developing sustainability strategies.

These limitations affect the accuracy of the information on sustainability. However none of them assesses or questions the actual sufficiency of frameworks, indices, flow charts and/or integrated assessments to examine sustainability performance systemically.

Having presented a clear image of the expectations of sustainability reporting, its foundations, its most recognized methods of implementation and its limitations; it is possible to move to the next section of the paper.

The structure presented in section two is the base to examine the sufficiency of frameworks to assess sustainability performance systemically; that is of the economic, social and environmental systems sustainability is said to encompass. To do so section two presents the principles of Systems Theory and the proprieties of systems. This provides the logical construct to examine, in section three, the sufficiency of the Global Reporting Initiative framework as an organizational instrument of sustainability performance assessment.

2. General systems and systems

Every unit can be treated either as an unanalyzable whole endowed with constitutive properties which define it as a unity, or else as a complex system that is realized as a unit through its components and their mutual relations.

Humberto Maturana, Autopoiesis: The Organizations of Living Systems

In the introduction sustainability was defined as *"the level of human consumption and activity which can continue into the foreseeable future, so that the systems which provide goods and services to humans persist indefinitely"* (Mayer 2008:278).

It was also clarified how from this definition two premises follow:

1. There are a number of systems which provide goods and services for humans to persist indefinitely; and
2. The level of human consumption and activity which can continue into the foreseeable future is defined by all of these systems.

Leading to the conclusion that:

3. The continuation of human consumption and activity is defined by the continuation of these systems.

Based on the logical syllogism, a hypothesis was formed suggesting that the analytical approach to metrics of frameworks is insufficient to measure sustainability performance systemically. And, therefore, the economic, social and environmental indicators used in frameworks to compile data are insufficient to allow the examination of the systems they comprise.

In section one, on sustainability reporting, frameworks are defined and placed among alternative methods to measure sustainability including indices, flow charts and integrated assessments. Also, an overview was given of common limitations analysts and decision makers have to take into account when defining the entity, the information and variables relevance of the multidimensional metrics on sustainability.

Additionally, in section one it is clarified how frameworks analyze information in indicators facilitating data assessment and maintaining a non reductionist approach to sustainability measurement with a cost, as the hypothesis sustains, in the capacity of frameworks to assess the dimensions of sustainability.

Section two provides an overview of systems and Systems Theory. Understanding systems is expected to provide not only the means to test the hypothesis in section three but also a conceptual structure to value the implications in metrics of the definition of sustainability given by the World Commission on Environment and Development. For this reason system´s proprieties and hierarchies are presented as the basis by which non financial reports can be assessed in their capacity to measure sustainability, an insufficiency which is "essentially [a] problem of organization, orderliness and regulation, resulting from the interaction or an enormous number of highly complicated events" (von Bertalanffy 1950:140).

Systems theory

Systems theory is an interdisciplinary field of science that examines the commonly observed characteristics of complex systems in society, nature, science, and technology. It "attempts to better understand the behavior of complex systems that run through cycles of relatively long periods of equilibrium, order, and stability interspersed with relatively short periods of instability and chaos" after which new orders emerge (Rotmans et al. 2009:185). As it has been mentioned before, sustainability reporting is an organizational instrument that is intended to assess three of these systems, namely the economic, social and environmental systems[13].

Systems theory rests in the idea of assessing, valuing and examining complex phenomena which cannot otherwise be understood sufficiently with positivistic or relativistic approaches; phenomena that if analysed would be regarded as logically incoherent or mathematically chaotic. As such, Systems Theory contrasts with the understanding of reality as partial or statistically intelligible, and offers "the potential to provide a trans-disciplinary framework for a simultaneously critical and normative exploration of the relationships between and among human beings and their social, cultural, and natural environments" (Laszlo 1997:6).

Complexity is a key concept in Systems Theory. Through complexity it is possible to discern the *identity* of the system, that is, it is the *organized complexity* of a system that allows studying it as a system. In this sense, if a particular system, say an organization or a human body, were to be analyzed into its constituent parts, it would lose its identity, and it could not be studied as a system.

[13] In this regard a systems scientist, Robert Rosen (1985:16) commented in a meeting in the Center for the Study of Democratic Institutions that a systems examination of reality "provides … both the opportunity and the means to explore this virgin territory between biology and society".

In systems theory *complexity* is defined "in terms of the number of elements that it [a system] contains the nature and number of interrelations and the number of levels of embeddedness; when a high level of complexity exists in a system, it is considered a complex system" (Morales-Matamoros et al. 2010:70-71).

As the concept suggests, the complexity in physical, natural and/or social phenomena examined by system´s scientist is an *organized complexity*. It is precisely the complexity of that organization that calls for a non analytical approach to research, as even the most pristine understanding of the elements of a whole, or of individual linkages within the system, would say little about the joined interactions that maintain its organization.

A *system* is "a complex of interacting elements p1, p2… pn. Interaction means that the elements stand in a certain relation, R, so that the behaviour in R is different from the behaviour in another relation, R´. On the other hand if the behaviour in R and R´ is not different, there is no interaction, and the elements behave independently with respect to the relations R and R´ ". (von Bertalanffy 1950:143). Emergent scientific areas studying complex systems include cybernetics, ecology and international relations.

The fact that phenomena is organized in a series of complex relations and that systems are maintained is, singlehandedly, of special interest to systems theory. Energy, the currency of the universe and according to the second law of thermodynamics, tends to dissipate towards equilibrium (Green 1999:152) suggesting that the dynamic interactions between elements in complex systems would systematically consume the energy needed for its maintenance leading to its dissipation. However, systemic phenomena maintain complex interacting elements that evolve and increase their complexity, in a visually coherent organization in which the elements of a whole act as if "purposively maintained by an outside agency. Thus, there must be organizing forces or relations present that permit the conservation of its structure (and function). Internal relations in an entity not possessing such characteristics tend to degrade until a state of thermodynamic equilibrium is reached" (Lazslo 1997:8). Linked to this behaviour of systems, unintuitive from a purely physical perspective, are the later explained system proprieties.

A *complex system* can be defined as "a unity by the relations between its components which realize the system as a whole, and its proprieties as a unity are determined by the way this unity is defined, and not by the [computation of the] particular proprieties [or events] of each component. It is these relations which define a complex systems a unity and constitute its organization" (Varela et al. 1974:188).

Based on the former, Systems Theory is an approach to examine organized wholes, or complex systems, as wholes or systems and not only as the sum of their parts. In the case of international relations this would mean examining international politics not as an arena

of anarchic states pursuing their own security interests but as a wider network of interacting actors which are not sufficiently defined by their sovereignty. The interaction between Nations, nongovernmental organizations, multinationals and even people must therefore be taken into account[14]. The fact that the international system is complex and hierarchically organized provides therefore a sufficient scenario for it to be studied by Systems Theory[15].

A systemic understanding of phenomena attained relevance in the XX century following the work of scientists such as Ludwig von Bertalanffy, Robert Rosen, Humberto Maturana, Ervin Laszlo, Viktor Schauberger and Niklas Luhmann. Methodologically, as Lazlo (1997) and Rosen (1985) point out, Systems Theory eloquently presents the existence of theoretical and empirical systemic realities and the limitations of classical ways of the former to represent the later.

In principle Systems Theory "is a logico-mathematical field, the subject matter of which is the formulation and deduction of those [systems] principles which are valid for systems in general" (von Bertalanffy 1950:139). As such, System Theory is not limited to its theoretical explanatory capacity but "used broadly, similar to our speaking of the theory of evolution which comprises about everything between fossil digging, anatomy and the mathematical theory of selection; or behaviour theory extending from bird watching to sophisticated neurophysiological theories" (von Bertalanffy 1968:xix).

Examining phenomena through a system´s lens is synonym to observing reality as highly complex network of interactions in which, nonetheless, recurrent patterns exists in both problems and behaviour. Biologist Ludwig Von Bertalanffy (1950:139), one of its major figures, phrased it by saying that "there are principles which apply to systems in general whatever the nature of their component elements or the relations or forces between them". His view is summarized in three premises:

1. "The number of simple differential equations which are available and which will be preferably applied to describe natural phenomena is limited … [or in social sciences] *the number of intellectual schemes available is rather restricted and they will be applied in quite different realms".*

[14] Terrorism, as a non state threat to security, is a topic that could be better examined systemically in International Relation Studies.

[15] "A system contains two or more integrated elements where (1) an element has an effect in the functioning of the whole, (2) each element is affected by at least one other element in the system and (3) all subgroups of elements also follow the same two characteristics (Laszlo 1997:7)

2. The world in which we live, "i.e. the totality of observable events", although complex, is sufficiently harmonious to "allow the application of the relatively simple schemes [derived] from our intellectual constructions".

3. "Laws of the kind considered are characterized by the fact that they hold generally for certain classes of complexes or systems, irrespective of the special kind of entities involved[16]" (von Bertalanffy 1950:137-138)

In sum, in a systems examination of phenomena it is not sufficient to analyze and study the function of the elements of an organization. Additionally to the proprieties of the elements that identify it, the relations between systems components must be taken into account. "Accordingly, the same organization may be realized in different systems (isomorphically) with different kind of components as long as these components have the proprieties which realize the required relations" (Varela et al. 1974:188).

Studies based in systems research, whether mathematical or logical, are synthetic rather than analytical. As such systems scientists study phenomena not by reducing it to its components but by reducing it to its dynamics (Laszlo 1997:9). Methodologically a systems examination of phenomena rather than pursuing the explanation of a function, of a task, of an element, pursues the elucidation of one or more *emergent proprieties*; proprieties that could otherwise not be studied by analyzing the function of the composing elements of the whole.

Another key concept in Systems Theory is *emergence*. It denotes "that the global properties defining higher order systems, structures or "wholes" can in general not be reduced to the properties of the lower order subsystems or "parts" (Heylighen 2010:1). In this sense, a higher level of organization allows the *emergence* of new proprieties not portrayed by the constituent parts of a system[17]; proprieties that would disappear if the given system, say a body or an organization, is analyzed.

Emergence is defined by Goldstein (1999:49) as "the arising of novel and coherent structures, patterns, and properties during the process of self-organization in complex

[16]He writes "For instance, the exponential law states that given a complex of a number of entities, a constant percentage of these elements decay or multiply per unit time. Therefore this law will apply to the pounds in a banking account, as well as radium atoms, molecules [or] bacteria" (von Bertalanffy 1950:138). The example does not state the fact that *the same* complex or structure exists in different areas of phenomena. This would contradict the systems idea of hierarchies and emergent qualities.

[17] In this regard, *autopoiesis* is the emergent propriety of the cell, as presented by Varela, Maturana and Uribe (1974) that differentiates biological from purely physical systems. No physical body regenerates itself. In the same token, it may be that *choice* is a propriety that differentiates a social system from a purely biological one.

systems". Swarm behaviour in schools of fish, flocks of birds or football fans are simple examples of emergent proprieties deductible only in elements when taking part of an organized system.

Propriety emergence, complex organization and hierarchies are, as presented above, all intertwined concepts in systems theory. Each is necessary to understand the other in a sort of tautological feedback, and all are necessary to facilitate the examination of topics under systems research.

As it will be shown below all systems share a number of proprieties despite their hierarchical level. It is the emergence of particular proprieties that allows systems/complexes to define their *identity* and elucidates their organization/structure and purpose.

General proprieties of systems

Despite the particular proprieties that each complex, or system, may portray, Von Bertalanffy suggested a number of common laws or proprieties shared by all systems (1950:138). Four proprieties are presented that allow the examination of phenomena systemically. These are:

1. Growth

The growth of a system is directly proportional to the number of elements present, whether it increases or decreases, finding a limiting value as it reaches saturation[18].

2. Competition

The competition between developing systems, system elements and their parts under growth stand in constant proportion throughout their life[19].

[18] The sigmoid function is the mathematic representation of systemic growth "In chemistry, this is the curve of an autocatalytical reaction, i.e. a reaction in which the reaction product obtained accelerates its own production. In sociology, it is the law of Verhulst describing the growth of human populations with limited resources" (von Bertalanffy 1968:62)

[19] The allometric equation in biology, "which applies to a wide range of morphological, biochemical, physiological and phylogenetic data", and relates the size of an organism to the size of any of its parts is an example of competition. Pareto´s (80-20) law in sociology can serve the purpose of explaining competition by, for example, showing the distribution of income among a group of individuals. (von Bertalanffy 1968: 65).

3. Progressive segregation & centralization

The increasing complexity of a system implies the gradual segregation of its conforming parts into individualized wholes[20] (new systems). As elements become increasingly independent, regulation of the system as a whole decreases while each part becomes more specialized.

The centralization that accompanies progressive segregation refers to a particular element, or trigger, around which the new segregated system develops[21].

4. Finality (teleology)

Systems developing to attain a stationary (homeostatic[22]) state, in a cyclical or segregative manner, do so not only in terms of the actual conditions but also in terms of the stage, *telos*, to be attained. This state is also called an attractor which in complex systems does not only refer to homeostatic states but also to limit cycle, fixed point and the so called strange attractor (Goldstein 1999:56)

From defining 4 proprieties present in all systems, it does not follow that in a system all variables and characteristics are defined *ex ante*, but that as a system, an organization obeys

[20] It is identified when "a system [gradually] passes from a state of wholeness to a state of independence of the elements" Progressive segregation, homologically found in physiological and sociological organizations, implies a regressive capacity of the system as a whole to regulate its segregating parts, which, in compensation, become increasingly selfregulated: systems in themselves. Given the fact that completely isolated systems are a rarity, the specialization of the parts that become progressively self regulated, specialized, increasingly makes them irreplaceable for the system as a whole, suggesting that the loss of a part would most likely lead to the breakdown of the whole system. "Segregation into subordinate partial systems implies an increase of complexity in the system. Such transition towards higher order presupposes a supply of energy, and energy is delivered continuously into the system only if the later is an open system, taking energy from its environment" (von Bertalanffy 1950: 149)

[21] Because of the necessary existence of a leading part, a small change in such element, e, derives in a considerable change in the system. "From the energetic viewpoint, in this case, we do not find <conservation causality>, where the principle *causa aequat effectum* holds, but <instigation causality> an energetically insignificant change in e causing a considerable change in the total system" (von Bertalanffy 1950:150).

[22] Considere the basis of organic regulations, homeostasis (i.e. the dynamic process of balance maintenance in organisms where actions are regulated through a feedback loop in which a receptor captures stimulus and a control apparatus examines the data triggering an effector response), while in most physical, inert or closed, systems the final state of a specific process (e.g. movement, growth) is directly affected by the initial state of its components (e.g. planetary system), in organic (open) systems "the final state may be reached from different initial conditions and in different ways" as a result of the interaction (i.e. energy, material exchange) between levels of system strata and their surrounding environments as long as there is a clear teleology (e.g. body/organ/cell; environment/ organizations/ people) (von Bertalanffy 1950).

certain proprieties that can be examined and that the system always portrays a particular *telos*.

Finality can also be described as the process in which a system (or organization) developmentally achieves a conscious structure (builds up into a given whole) based on the dynamic interaction of its parts.

Concerning social systems, this is a development from the classical mechanistic view of the physical systems studied by Newton, by adding to its aimless laws, the idea of purpose, observed in their [social systems] *organization*, and present in more complex systems such as the biological or social.

Deterministic explanations (e.g. rational choice) demanding direct causal chains often fall short of explaining sociological phenomena and social change, but are chosen to facilitate their "scientific" analysis as it would be done with physical or biological experiments. Alternative explanations (e.g. the social organizations of A. Toynbee, the invisible hand of A. Smith, Markov Processes) provide instead a systemic understanding of social change (sometimes called complex causality[23]) as organized bodies with particular proprieties and therefore demand different methods to quantitative or idiographic analysis.

The former are the proprieties that can be deduced as being part of physical, biological and social systems. As it has been presented the emergence of new proprieties is not to be considered an anomaly or a proof against these system proprieties. Rather, it is to be expected as it exemplifies the evolutive characteristic (increasing complexity) and the hierarchical structure of phenomena.

Having gone through the fundamental concepts of complexity, systems and emergence, and through the recount of system proprieties, the skeleton from which to examine the sufficiency of frameworks to assess sustainability is complete.

The assessment of the hypothesis is based first in the definition of sustainability provided by the World Commission on Environment and Development and in the fundamentals of Systems Theory. The examination of the sufficiency of frameworks to assess the economic,

[23] About complex causality in ecology Luhmann comments: "En los contextos ecológicos nos encontramos hoy con una complejidad que se sustrae a la atribución a decisiones. Sabemos, o podemos al menos suponer, que importantes condiciones ecológicas de la vida son modificadas por decisiones sobre el empleo de la técnica y sus productos, pues pueden producir daños gravosos para aquélla. Pero apenas podemos atribuir este problema a decisiones individuales, ya que las extremadamente complejas cadenas causales de numerosos factores y el largo plazo de las tendencias no permiten una atribución semejante." *Complejidad y modernidad: de la unidad a la diferencia*, p. 165.

social and environmental systems as Goldstein comments (1999:57) is sustained given that "the configuration of the components of a complex system offers more explanatory insight into the dynamics of the system than do explanations based on the parts alone".

3. **Systemic examination of sustainability frameworks**

Boltzmann already understood that probability and irreversibility had to be closely related. Only when a system behaves in a sufficient random way may the difference between past and future, and therefore irreversibility, enter into its description. Our analysis confirms this point of view. Indeed, what is the meaning of the arrow of time in a deterministic description of nature? If the future is already in some way contained in the present, which also contains the past, what is the meaning of the arrow of time? The arrow of time is a manifestation of the fact that the future is not given, that, as the French poet Paul Valery emphasized, "time is construction".

Ilya Prigogine and Isabelle Stengers, Order out of Chaos

The paper started with a presentation of the methods to measure sustainability and their limitations focusing in sustainability frameworks such as the Global Reporting Initiative for organizations. It also presented the connecting thread of the thesis, namely, the examination of the actual sufficiency of frameworks to assess sustainability performance.

In section two the paper presented Systems Theory which showed the most important concepts and proprieties of systems and set the structure to test the hypothesis and assess frameworks in their capacity to measure sustainability. The assessment is possible given the syllogism derived from the definition of sustainability given by the World Commission of Environment and Development.

The third and final section of the paper consists in the examination of three specific cases in which organizations have used the Global Reporting Initiative framework to assess their sustainability. The organizations chosen belong to three different industries, propriety development, telecommunications and transportation, there are Malaysian Resources Corporation Berhad, Telecom Malaysia Berhad and Korean Air.

From each company two indicators from the economic, social and environmental systems are examined over a period of three years. The three systems examined are:

- Economic system[24]

[24] In relation to the economic system George Soros comments "Economics, which became the most influential of the social sciences, sought to remove this handicap [The uncertainty created by actors with choice] by taking an axiomatic approach similar to Euclid's geometry. But Euclid's axioms closely resembled reality while the theory of rational expectations and the efficient market hypothesis became far removed from it. Up to a point the axiomatic approach worked. For instance, the theory of perfect competition postulated perfect knowledge. But the postulate worked only as long as it was applied to the exchange of physical goods.

The first of the three systems examined by sustainability frameworks is the economic system Economic information in sustainability frameworks is encoded qualitatively and quantitatively. The purpose of encoding economic system information as a system in sustainability reporting is sustained by a positive correlation between Corporate Social Responsibility and business performance (Carroll 1999, Gray 1994, Elkington 1998, Hart 1996). The reason for encoding economic information is to facilitate management decision making for better business decisions.

- Social System[25]

The second system examined by sustainability frameworks is the social system. Social information in sustainability frameworks is encoded both qualitatively and quantitatively. The Social system is more *complex* that the Economic (which can be considered a subsystem).

The inclusion of the social system in sustainability frameworks is sustained by the positive relation between stakeholder participation and social welfare in which a wider participation of internal and external organizational actors better legitimizes economic decisions (Freeman 1984, Mitchel et al. 1997). Therefore the reason to include social information in sustainability reports is to facilitate inclusive decision making for social welfare.

- Environmental system

The last of the three systems included by sustainability frameworks is the environmental system. Environmental information in sustainability frameworks is encoded both qualitatively and quantitatively using different units of measurement.

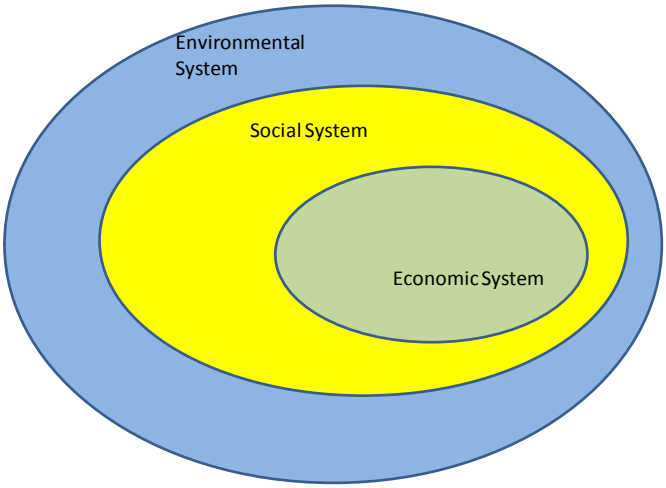
When it came to production, as distinct from exchange, or to the use of money and credit, the postulate became untenable because the participants' decisions involved the future and the future cannot be known until it has actually occurred." http://www.businessinsider.com/full-text-of-george-soros-speech-2012-6#ixzz1xbph4ui3

[25] Referring to the relation between the Social and Environmental systems and the rules that guide them from systems perspectives George Soros comments "Social events, by contrast, have thinking participants who have a will of their own. They are not detached observers but engaged decision makers whose decisions greatly influence the course of events. Therefore the events do not constitute an independent criterion by which participants can decide whether their views are valid. In the absence of an independent criterion people have to base their decisions not on knowledge but on an inherently biased and to greater or lesser extent distorted interpretation of reality. Their lack of perfect knowledge or fallibility introduces an element of indeterminacy into the course of events that is absent when the events relate to the behaviour of inanimate objects. The resulting uncertainty hinders the social sciences in producing laws similar to Newton's physics." http://www.businessinsider.com/full-text-of-george-soros-speech-2012-6#ixzz1xbph4ui3

The assessment of the environmental system in sustainability frameworks is sustained by the relation between the better use of the natural resources and social welfare. The reason for assessing environmental information in sustainability frameworks is to facilitate management decision making for better environmental practices.

While all systems provide goods and services for humans to persist indefinitely, the hierarchical order of the economic, social and environmental systems is given by the need to maintain a higher level system for the lower one to survive (See graph).

Graph 1. Hierarchy in Sustainability Systems



For the Global Reporting Initiative framework information about the three systems is considered relevant for sustainability. The indicators demonstrate the topics considered more relevant aspects to be assessed economically, socially and environmentally.

As previously described, frameworks assist in sustainability measurements by analyzing sustainability data in indicators each portraying a particular unit of measurement. The use of indicators provides a multifaceted image of sustainability making it possible to assess change in the specific aspect of sustainability and avoiding aggregative reductionism of information. This process is expected to facilitate the evaluation of data and performance in the economic, social and environmental systems in organizations by assessing *"the level of human consumption and activity which can continue into the foreseeable future, so that the systems which provide goods and services to humans persist indefinitely"* (Mayer 2008:278, World Commission on Environment and Development 1987; US National Research Council 1999).

The Global Reporting Initiative portrays +-30 environmental indicators per organizations according to industry including: main materials used by weight or volume, energy consumption, CO2 emissions, water usage and total weight of waste, among others. The

Economic dimension includes nine indicators which cover issues such as turnover rate, financial assistance from the government, risk assessment on activities and opportunities due to climate change, etc. Finally, the Social dimension (as shown in graph in the introduction) includes four protocols: Labour, Human Rights, Product Responsibility and Society. Its indicators include information on Life Cycle Analysis, customer satisfaction data, employees covered by collective bargaining agreements and the impacts of its operations on society, among others.

Using the Global Reporting Initiative framework to examine the hypothesis, three reports of Asian companies are assessed in six different multidimensional indicators. Two economic (EC1: Economic value generated; EC8: Investments and services for public benefit); two social (SO1: Impacts of operations on communities; LA10: average hours of training per year per employee); and two environmental (EN3: direct energy consumption; EN16: direct greenhouse gas emissions).

The indicators are chosen at random from each of the three dimensions, four are quantitative (EC1, LA10, EN3 and EN16) and two are qualitative (EC8 and SO1). They represent some of the different units of measurement portrayed by the Global Reporting Initiative. Each of the indicators, within its specific dimension, is qualitatively examined in its capacity to allow assessing sustainability performance systemically.

In order to carry out the examination, first, the development trend of each indicator is described. By this it is meant that the development of the quantitative and qualitative measurements of each indicator over the three years is summarized and the trend of the information described.

Following the description of the information in the indicators (two per dimension) the presence of shared developmental patterns over the three years is observed. In other words, the qualitative summary is studied in the sufficiency of the information of the economic, social and environmental indicators to represent the emergence of system proprieties (growth, segregation and centralization, competition or finality) over the three year period. This is done by observing if the description of the behaviour of the indicator is only sufficient to allow the assessment of its individual performance over time, or if the description of the indicators of the same dimension is sufficient to represent the activity in *"the number of systems [economic, social and environmental] which provide goods and services for humans to persist indefinitely"* (World Commission on Environment and Development 1987).

A shared developmental trend among indicators of the same dimension is interpreted as a sign of emergence and is used to assess if the information in the indicators is or not sufficient to allow any sustainability performance assessment.

The presence of emergence, more than explaining the behaviour of the indicators or predicting an specific type of relation between them is "descriptive of the [systemic] patterns, structures or proprieties that are exhibit in the macro level" (Goldstein 1999:59). Observing emergence in sustainability metrics as pattern behaviour within complex and dynamic systems has an operational use. It is a way of detecting, yet not measuring, the non linear relations between the elements in the system. It is also a way of observing hierarchical systems behaviour since propriety emerge encompasses the very idea of non reductionism to a single system to which all phenomena can be analysed[26] as it happens when information is indexed. In a few words, observing propriety emergence is observing systemic behaviour.

For example, for the environmental dimension, the energy consumption of organization A, is examined in its sufficiency to represent systemic behaviour of energy consumption together with the CO2 emissions during the same period of time, based in the development trend of both indicator over the three years examined.

If no pattern is suggested, frameworks are regarded as insufficient to allow any sustainability performance assessment given their insufficiency to assess systems´ behaviour. If a shared pattern is observed in the description of the two indicators of a given dimension then systemic behaviour is perceived by the indicators of the framework in a non aggregative manner. If this occurs further information is examined that describes such systemic behaviour and allows for sustainability assessments. *If no further information is provided then frameworks are regarded as insufficient to allow any sustainability performance assessment given their insufficiency to assess systems behaviour*

Table 2. Organizations Assessed

Company	**Sector**	**Years assessed**	**Indicators**
Malaysian Resources Corporation Berhad	Real Estate Developer	2009,2008,2007	EC1, EC8,S01,LA10,EN3,EN16

[26] Contrastingly, Crutchfield (1994:2) explains "indeed, the detected patterns are often assumed implicitly by analysts via the statistics they select to confirm the patterns ´existence in experimental data. The obvious consequence is that <structure> goes unseen due to an observer´s choices … it is rarely, if ever, the case that the appropriate notion of pattern is extracted from phenomena itself using [appropriate] discovery procedures. Briefly stated, in the realm of pattern formation <patterns> are guessed and then verified … At some basic level, though, pattern formation must play a role".

Telecom Malaysia	Telecommunications	2008,2007,2006	EC1, EC8,S01,LA10,EN3,EN16
Korean Air	Transportation	2008,2007,2006	EC1, EC8,S01,LA10,EN3,EN16

Selection of Organizations

The selection was done from companies that disclosed information about at least one of the two Global Reporting Initiative indicators chosen from each system for the last three years. Among the three companies two are Malaysian: Malaysian Resources Corporation Berhad which is a real estate developer and Telecom Malaysia which is a telecommunications company. The third and last company is a Korean airline, Korean Air. The information is public and can be downloaded from the companies´ website.

As mentioned above, the evaluation is done qualitatively and systematically. First the economic, then the social and later the environmental development data are examined for emergent systemic pattern behaviour. Second, the information presented by the indicators overtime is examined in its sufficiency to allow the assessment of sustainability performance. *If the information only allows the assessment of each indicator over time and not that of systems behaviour, then the analytical approach of frameworks is insufficient to allow the assessment of sustainability*. If the information depicts emergent systemic pattern behaviour of systemic propriety (growth, segregation and centralization, competition and finality) then a further examination is done for sufficiency of information for systemic assessment. *If no further data is disclosed then although patterns of systemic behavior were observed, no performance assessment can be done of the economic, social and/or environmental systems.*

In other words, using the premises derived by the definition of sustainability by the World Commission on Environment and Development (1987):

- There are a number of systems which provide goods and services for humans to persist indefinitely, and
- The level of human consumption and activity which can continue into the foreseeable future is defined by these systems.

Then, the sufficiency of frameworks to represent sustainability performance is based on the examination of their capacity to allow the assessment of systemic behaviour.

Data examination

Two indicators were chosen from the economic, social and environmental dimensions taking the Global Reporting Initiative framework. The chosen indicators are EC1, EC8, SO1, LA10, EN3 and EN16. Three sustainability reports from companies are chosen with the only parameter of having the information of at least one of the two indicators from each dimension.

The information portrayed by the reports are an example of what can be expected from any sustainability report chosen at random in any country and belonging to any type of industry following the Global Reporting Initiative framework.

The unit of measurement of economic indicator EC1 for all companies is Ringgit Malaysia. If a company reports using a different currency the information is converted to Ringgit Malaysia using an internet currency converter. The indicator describes the total turnover of the company during each year during a period of three years.

Indicator EC8 is mainly qualitative referring to the investment and services for public benefit of the company. This indicator can respond to different possible units of measurement to assess public benefit performance according to industry and chosen implementation programme.

Indicator SO1 describes the direct or indirect impacts of the company´s operations. Just as EC8 this indicator responds to different possible units of measurement according to the implementing program of an organization.

The unit of measurement for indicator LA10 is time. It describes the average hours of training per year per employee.

Indicator EN3 shows the direct energy consumption of the company. This measurement usually includes electricity, oil and alternative energy sources (e.g. eolic, photocells). The unit of measurement of this indicator is KWh. Because of the size and number of operations of an organization, it is usually an approximation.

Indicator EN16 describes the direct green house gas emissions of each organization. The unit of measurement of this indicator is metric tons. For similar reasons to those presented for EN3 these measurements are also an approximation.

Table 3. Data Malaysian Resources Corporation Berhad

Inicator/ Year	2009	2008	2007
ECONOMIC			
EC1	921616000 RM	788552000 RM	903702000 RM
EC8	PINTAR programme donations of RM 220000. Benefits to 1534 primary level pupils. 600 sets of school supplies donated.	As part of PINTAR, MRCB sponsored a 2 day Primary School Achievement Test 8SPSR) for all six schools, aimed at preparing the PINTAR students for the real exainations in september 2008. This programme was conducted by the Berita Harian Education Unit for 552 Primary students and convered four subjects: Mathematics, Science, English and Bahasa Malaysia.	Based on the 2007 UPSR results, both schools – SK Dato Kramat and SK Kampong Jawa - have improved significantly by 20.63% and 4.8% respectively. The numbers of students achieving all 5As increased from nine for SK Dato Kramat in 2006 to 18 in 2007 after undergoing one year of the PINTAR programme, while at SK Kampong Jawa, the number of straight-A students increased from none in 2006 to two in 2007. The number of students obtaining more than 3As at SK Dato Kramat increased from 33 in 2006 to 35 in 2007 despite a drop in student population sitting for the UPSR from 94 in 2006 to 87 in 2007. On the whole, the number of students achieving As in key subjects – English, Mathematics and Science, increased significantly from 59 to 89 students in 2007.
SOCIAL			
SO1	In 2007 MRCG launched an online community portal dedicated to the Brickfields community which aims to provide a forum for communication and networking between the residents.	As the majority of our operations take place in urban areas, we recognise that our activities and operations have asignificant impact on the communities located in these areas. Our flagship operation is the Kuala Lumpur Sentral development (KL Sentral) which incorporates the largest transit hub in Malaysia. Due to its proximity to the historical area of Brickfields, we recognize the Brickfields community as being a significant local stakeholder in our operations.	Living in the age of information technology, we are naturally aware of the many benefits that new technology can bring to the business community. Under our Information Communication Technology (ICT) CSR programme, we created two ICT centres in 2006, namely the KL Sentral Multimedia Super Corridor (MSC) Cybercentre Showcase and Incubation Centre. Through these centres, we aim to promote the development of new ICT based companies and to provide support facilities for the development of a creative community within Kuala Lumpur Sentral development. The development of the Incubation Centre is to nurture and develop potential new companies in the field of ICT. Our incubation programme initiated in February 2007 saw the involvement of 10 companies
LA10	7.27 hours	9.17 hours	9.32 hours
ENVIRONMENTAL			
EN3	16918279 kWh	15142019 kWh	15556794 kWh
EN16	9423 CO2 Metric Tones	8434 CO2 Metric Tones	8665 CO2 Metric Tones

Qualitative summary

Economic

EC1 shows a decline in profits during the year 2007 and 2008 from 903,702,000 to 788,552,000 Ringgit Malaysia and an increase of the net sales of the company by 2009 up to 921,616,000 Ringgit Malaysia.

EC8 focuses in describing the development of the "Promoting Intelligence, Nurturing Talent and Advocating Responsibility" program. The indicator shows no consistency in the

aspect being measured. While in 2007 the indicator refers to academic improvements, in 2009 the performance shifts to number of students covered by the program. In 2008 the indicator focuses in a particular examination for primary students mentoring with 552 primary pupils that received additional classes for a state examination.

As a result, the "transformation programme with the core component aimed at Motivation and Teambuilding programmes; Educational Support and Skills Building; Capacity and Capability Building; and reducing vulnerabilities by addressing social issues in schools"[27], developed by Malaysian Resources Corporation Berhad and described in EC8 cannot be compared to itself or to the trend of EC1 and the economic performance of the company. No examination is possible to elucidate if economic downturn of the company in 2008 had any effects in the school adoption program and no systemic patterns are evident.

Social

Indicator SO1 describes the impacts of the operations of the company in its surrounding communities and recognizes a specific community area, Brickfields, as receiving a significant impact from the company´s operations.

SO1 lacks any particular or consistent aspect of measurement referring to the company´s social impact in Brickfields over time. The description that is done over the impacts of the operations of Malaysian Resources Corporation Berhad, shifts from the Information Communication Technology programme in 2007, to an online community portal in 2009.

LA10 describes the average number of hours per year per employee. Indicator LA10 shows a decreasing performance in average of training hours per employee per year, from 9.32 in 2007 to 7.27 in 2009 going through 9.17 in 2008.

Because the lack of consistency of indicator SO1 no trend or pattern can be traced between the two social indicators and no systemic assessment can be done.

Environment

Energy consumption and Greenhouse gas emissions indicators, EN3 and EN16, show similar patterns of decreasing consumption and emissions from 2007 to 2008 (from 15,556,794 KWh to 15,142,019 KWh; and from 8,665 to 8,434 metric tons) and increasing consumption an emissions from 2008 to 2009 (from 15,142,019 KWh to 16,918,279 KWh; and from 8,434 to 9,423 metric tons) which shows the emergence of a growth pattern.

However, no further information is provided by the analysis in terms of systemic performance remaining an analytical disclosure of two environmental areas of

[27] http://www.mrcb.com.my/main/newsletter/vol_7_no_1.pdf last viewed December 4, 2010.

sustainability. Because of this, although a similar pattern is observed in the indicators pertaining to the environmental system no further systemic assessment can be done of it using the information found in the indicators.

Observations for Malaysian Resources Corporation Berhad

No systemic relations in the form of patterns are found are found for Malaysian Resources Corporation Berhad on either the economic or the social systems. In the environmental system although the emergence of patterns in *growth* are evident between energy consumption and Greenhouse gas emissions between 2007 and 2009, no assessment of systemic performance can be sufficiently carried given the analytical format in which information is maintained.

Table 4. Data Telecom Malaysia Berhad

Inicator/ Year	2009	2008	2007
ECONOMIC			
EC1	874900000 RM	8608000000 RM	8296000000 RM
EC8	Telecom Smart School was formed in 1999 to spearhead the National Smart School Pilot Project. In doing this it was helped to transform the Malaysian Education System into a highly advanced technologially based process. This will encourage technology to be used as an enabler in the academic environment.	Being responsible towards the Environment means safeguarding the natural resurces that we have today for future generations. TM continuously strives tolessen its environmental footprint by taking practive steps to minimise damages to the environment. Begining with practicacl day-to-day activities, TM encourages a corporate culture that fosters environmental values.	Improving procurement practices TM handbook on Procurement Ethics guides the company´s dealings with employees, customers, business partners, competitors and other parties.
SOCIAL			
SO1	TM is commited to maximising the value of telecommunication networks and services by ensuring access for everyone. Through our communications services we aim to close the gap that exists in the community in areas such as language, culture, income, disabilities, illiteracy and age	In 2007 an Environmental Awareness Campaign was launched, focusing on the importance of protecting forests, planting trees, reducing pollion and protecting the quality of drinking water	In Education, TM´s objective is to assist the nation in the development of human capital and capacity building. And thereby meet its socio-economic development goals. Towards this end, TM has contributed and continues to contribute through the provisin of scholarships from its foundation, Yayasan Telekom Malaysia (YTM) through its own training and staff development programmes and also through the establishment of the Multimedia University
LA10	58 hours	no info	no info
ENVIRONMENTAL			
EN3	13156362 kWh	11693567 kWh	9919790 kWh
EN16	23619618000 CO2 Metric Tones	20993462000 CO2 Metric Tones	17809000000 CO2 Metric Tones

Economic

Indicator EC1 shows the economic performance of Telecom Malaysia as having a steady increasing performance between the years of 2007, 2008 and 2009 with 829,600,000 Ringgit Malaysia 860,800,000 Ringgit Malaysia and 874,900,000 Ringgit Malaysia respectively.

Indicator EC8, investment and services for public benefit, focuses not only in different issues in each of the three years (2007 in education, 2008 in an environmental awareness campaign, and 2009 in efforts to maximize telecommunication networks) but also discloses no parameter of measurement for the performance of the disclosures. As a result no trend can be observed in relation to the economic system.

Social

The information disclosed by Telecom Malaysia regarding the impacts of its operations on communities, SO1, portrays no parameter of measurement and also shifts from education efforts in 2007, to environmental awareness in 2008, to telecommunication networks in 2009.

LA10 has no sufficient information to make any claims of patterns between the two indicators in the social system.

Environment

Similar to what was seen in EN3 and EN16 for Malaysian Resources Corporation Berhad, both environmental indicators follow a similar behavioral pattern during 2007, 2008 and 2009 the approximate value of energy consumption for Telecom Malaysia for these years as seen in the table was 9,919,790 KWh, 11,693,560 KWh and 13,156,362 KWh respectively. The values for CO2 emissions in the three years were 17,809,000,000; 20,993,462,000 and 23,619,618,000 metric tons.

A similar increasing pattern in dimension performance between the two environmental indicators is regarded as emergent systemic behaviour over the three year period. However, the analytical manner in which the information is presented by the framework renders insufficient evidence of the sustainability performance of Telecom Malaysia as no further examination of the data is done and no further conclusions can be assessed.

Observations for Telecom Malaysia

No systemic relations in the form of patterns are found are found for Telecom Malaysia on either the economic or the social dimensions. In the environmental dimension, as it happened with Malaysian Resources Corporation Berhad, even though patterns in systemic behaviour are evident in *growth* between energy consumption and Greenhouse gas emissions between 2007 and 2009, no systemic assessment of sustainability performance can be sufficiently carried given the analytical format in which frameworks maintain information.

Table 5. Data Korean Air

Inicator/ Year	2008	2007	2006
ECONOMIC			
EC1	27729896 RM	23827720 RM	21934380 RM
EC8	Korea Air introduced eco-friendly next-generation aircraft from 2009 to 2015. Starting with the three B777-300ERs in 2009, a total of 48 next-generation aircraft including the B777-300ER, A380 and B787 will join our fleet by 2015, completing our competitive edge as a high-end global carrier.	Participation in the construction of the environmetally friendly research and development and expo center in the International Building District of Sogodo New City in partnership with inha University of Icheon. This center is built to promote the succesful development of the Icheon Free Economic Zone.	Points to Sustnaibility report 2006 (showing 2005 data)
SOCIAL			
SO1	Transporting Relief Materials to Earthquake-hit Sichuan Province Korean Air dispatched a special cargo plane to deliver 2,000 blankets and 3,000 boxes of bottled water as well as medical staff from Inha University to aid refugees in Sichuan Province, China, which was devastated by a very large earthquake. Since 1998, Korean Air has offered support and transported relief goods to regions devastated by disasters such as a flood in China's Hubei Province, an explosion in Yongcheon, North Korea, an earthquake in Nigata, Japan and a tsunami in Southeast Asia. In the future, Korean Air will continue its commitment to borderless sharing by extending a helping hand whenever and wherever its support is needed.	Under the goal of realizing lifelong edcation, labor-management harmony and the development of exelent human resources, Korean Air established and funded Korea´s first corporate educational facility, Jeongseok College, and provided students scholarships. As of 2007, Jeongseok College has produced a total of 2, 896 graduates.	Jeongseok University To promote lifelong learning, cooperative labor-management relations, and talented workforce management, Korean Air established Jeongseok University (former Hanjin Industrial University) within the company in 1988, the first in the Korean corporate world. In 2007, under its financial support for school operation and tuitions, 2,896 graduates from the university have gone on to become employees of Korean Air. In line with a growing demand for higher education, the university is working hard to provide quality education by, for example, adding an industrial engineering bachelor curriculum and providing a total of three bachelor programs.
LA10	118.40 hours	90.97 hours	84 hours
ENVIRONMENTAL			
EN3	132178143 kWh	132191153 kWh	123036180 kWh
EN16	12168942 CO2 Metric Tones	12509192 CO2 Metric Tones	11594435 CO2 Metric Tones

Economic

Indicator EC1 over the three year period depicts a steady increase in net profits for Korean Air starting with 21,934,380 Ringgit Malaysia in 2006, going up to 23,827,720 Ringgit Malaysia in 2007, and finishing with 27,729,896 Ringgit Malaysia in 2008.

EC8 has no information for 2006 and in the years 2007 and 2008 presents no consistent performance parameters for assessment. The information in the indicator describes research investments for public benefit in 2007 and the introduction of 48 eco friendly aircrafts in 2008. Therefore no sustainability performance in the economic system is evident.

Social

For 2006 Korean Air SO1 indicator describes the Jeongseok University set up by the company in 1988. While this project may be considered to have relative high impact of the company´s operations in communities, the information in 2007 adds no real value to the

performance indicator of 2,896 students graduated. Information for 2008 describes a different operational impact with in kind provisions for relief in the Earthquake-that hit Sichuan Province.

LA10 describes a constant increase from 2006 to 2008 from 84 to 90.97 to 118.40 average hours of training per employee per year. However it is not possible to make any statements on sustainability performance between the two indicators.

Environment

The direct energy consumption of Korean Air, EN3, increases from 123,036,180 KWh to 132,191,153 KWh between 2006 and 2007. Between 2007 and 2008 the energy consumption has a slight decline to 132,178,143 KWh.

Similarly, the direct Greenhouse gas emissions, EN16, increased from 11,594,435 metric tons in 2006 to 12,509,192 metric tons in 2007 and then decreased 12,168,942 describing a similar patter to the trend followed by the information in energy consumption. Just as it happened in the two previous companies, Korean Air environmental system indicators show signs of emergent system pattern behaviour. However, no further examination of the data can be done.

Observations for Korean Air

Similar to the former two examples, no systemic relations can be established for Korean Air. In the environmental dimension where emergent patterns in behaviour of both energy consumption and Greenhouse gas emissions between 2006 and 2008 are evident in *growth*, no assessment of sustainability performance can be sufficiently carried given the analytical format in which frameworks maintain information.

The relational pattern, as in the previous cases, although sufficient to assess the behaviour of each indicator over time, is insufficient to allow the assessment of systemic performance.

Data Findings

From the research done in sustainability metrics and the assessment of the three companies above some conclusions can be drawn concerning the sufficiency of frameworks to allow the assessment of sustainability performance.

Frameworks do not aggregate sustainability data allowing for a non-reductionist assessment of the sustainability performance and, according to the definition of sustainability of the World Commission on Environment and Development, allowing each particular system (i.e. economic, social and environmental) to maintain its identity.

Additionally, because of its analytical approach to sustainability and the different units of measurement portrayed by the different indicators frameworks such as the Global Reporting Initiative also avoid problems of skewed weighting of data, that is, the number of indicators (amount of data) of one system does not take prevalence over the others on sustainability assessments.

Nevertheless, the Global Reporting Initiative framework shows limitations in the compilation of data regarding issues of boundary setting and data inclusion.

The limit of boundary setting in the Global Reporting Initiative framework is evident in the approximations done in environmental indicators (EN3 and EN16), and in the different (or nonexistent) aspects measured in indicators EC8 and SO1. Both characteristics mentioned above and present in Malaysian Resources Corporation Berhad, Telecom Malaysia Berhad and Korean Air.

Boundary setting is a principle for framework based measurements, just as it is in any other of the presented methods for sustainability assessment. In the case of frameworks, boundary setting is often regarded as deriving in sustainability performance insufficiencies on data collection given the non natural boundaries of legal fictions (whether countries or companies) over which measurements are made. By selecting a non natural boundary it is argued that measurements omit sustainability information of certain flows of people or natural resources beyond the scope of the assessed area. In organizational reports this refers to the variable inclusion of suppliers, subcontractors, joint ventures and/or subsidiaries in organizational sustainability reports.

In the cases where similar patterns of quantifiable information can be seen, these patterns, although described in different units of measurement, suggest systemic *growth*. No sign of segregation and centralization, competition or finality is possible to examine with the Global Reporting Initiative indicators. It is therefore important to remark that different units of measurement do not necessarily impede the examination of systemic performance.

This was the case is Malaysian Resources Corporation Berhad, Telecom Malaysia and Korean Air in the indicators EN3 and EN16 for the environmental system. In all three cases examined there was evidence of *growth*, and therefore of systemic behaviour. Nonetheless, the analytical framework in which information is maintained renders insufficient to sustain further systemic examination.

Conclusions

The evidence of the presence of systemic proprieties in the case studies of Malaysian Resources Corporation Berhad, Telecom Malaysia and Korean Air is deductible from the examination of emergent patterns in *growth* observed in the information of the two indicators examined in the environmental system in all three companies.

In all cases, although the information in the two indicators of the environmental system depicts emergent systemic pattern behaviour, no further examination of the data is done and therefore no systemic performance assessment can follow.

The insufficiency of the Global Reporting Initiative framework to assess sustainability, however, cannot be said to rest in the limitations of data inclusion, system boundaries or standardization since even portraying those limitations, the Global Reporting Initiative framework is capable of revealing the emergent *growth* propriety of systems.

In other words, seen from a systems perspective, even in a scenario with data limitations, portrayed by indicators EN3 and EN16 in the three companies and evident in the approximations of the energy and Greenhouse Gas Emissions measurements, there is still sufficient information to observe system behaviour and make systemic propriety statements, namely, *growth.* Similarly, the insufficiency of frameworks to assess sustainability performance cannot be attributed to the different units of measurements used to assess the indicators on each system, as there is still sufficient information to observe system behavior and make systemic propriety statements, namely, *growth*.

The claim of the hypothesis in which frameworks are insufficient to assess sustainability performance is sustained, not in the uncertainty brought by limitations of data inclusion, system boundaries or standardization, or in the particular units of measurements in frameworks, but in the fact that information remains analyzed without any further synthesis or systemic examination.

In the words of von Bertalanffy (1968:37), the insufficiency of non financial reporting to represent sustainability data is based in measuring "phenomena not resolvable into local events, [of] dynamic interactions manifested in the difference of behaviour of parts when isolated or in higher configurations; [of] systems of various orders not understandable [only] by the investigation of their respective parts in isolation".

For frameworks the limitations of sustainability measurements seem an insurmountable challenge mainly because tools based in analytical data gathering seem to oversee the systemic nature of sustainability or, as Mayer describes it (2008:278), the ever changing economic, social and environmental scenarios and nonlinear feedbacks.

In this way, if

- There are a number of systems which provide goods and services for humans to persist indefinitely, and
- The level of human consumption and activity which can continue into the foreseeable future is defined by these systems.

Then, the insufficiency of frameworks to represent sustainability performance is based on the insufficiency of frameworks to assess the systems which provide goods and services.

Within Sustainability reporting frameworks information remains as indicators within specific dimensions set. This misses a further step of synthesis of data in which systems are observed and sustainability according to the concept of the World Commission on Environment and Development can be assessed.

Systems Theory and system proprieties may provide a structure to facilitate the process of assessing the systems that provide goods and services for humans to survive indefinitely.

Bibliography

Articles

Archel P; Fernandez M and Larrinaga C. (2008), *The Organizational and Operational Boundaries of Triple Bottom Line Reporting: A Survey*, Environmental Management, Vol. 41, p.106–117

Beattie V. and Davie E. (2006), *Accounting Business and Financial History*, Accounting, Business & Financial History, Vol. 16:1, p. 1–25.

Boulding K. (1956), *General Systems Theory: The skeleton of science*, Management Science, Vol. 2:3, p. 197-209.

Burchell J. and Cook J. (2006), *Confronting the "corporate citizen" Shaping the discourse of corporate social responsibility*, International Journal of Sociology and Social Policy, Vol. 26:3/4, p. 121-137

Carroll, Archie B (1999), *Corporate Social Responsibility*, Business & Society, Vol. 38:3, p. 268-296.

Crowe M. (1999), *Pierre Duhem, the History and Philosophy of Physics, and the Teaching of Physics*, Physics in Perspective, Vol1:1, p. 54-65.

Crutchfield J. (1994), *Is Anything Ever New: Considering Emergence, in Integrative Themes*, G. Cowan, D. Pines, and D. Melzner, editors, Santa Fe Institute Studies in the Sciences of Complexity XIX, Addison-Wesley, Reading, MA. http://reference.kfupm.edu.sa/content/i/s/is_anything_ever_new__considering_emerge_94972.pdf

Culaba, A., Purvis, M (1999), *Methodology for the life cycle and sustainability analysis of manufacturing processes*, Vol. 7:6, p. 435-445

d´Arcy A. (2001), *Accounting classification and the international harmonisation debate: an empirical investigation*, Accounting, Organizations and Society, Vol. 26:4-5, p. 327-349.

Daub, C.H. (2007), *Assessing the quality of sustainability reporting: an alternative methodological approach*, Journal of Cleaner Production, Vol. 15:1, p. 75-85.

Dietz S, Neumayer E (2007), *Weak and strong sustainability in the SEEA: concepts and measurement*, Ecological Economy, Vol: 61, p. 617–26.

DiMaggio P.J; Powell, W.W. (1983), *The Iron Cage revisited: Institutional isomorphism and collective rationality in organizational fields*, American Sociological Review, Vol. 48:2, p. 147-161

Ehrenfeld J (2004), *Can industrial ecology be the "Science of Sustainability"?,* Journal of Industrial Ecology, Vol: 8:1 p. 1-4

Goldstein J (1999), *Emergence as a Construct: History and Issues,* Emergence, Vol. 1:1 p. 49-73

Gray R (1994), *Corporate reporting for sustainable development: Accounting for sustainability in 2000 AD,* Environmental values, p. 17-45.

Gray R and Milne M, (2002), *Sustainability reporting: Who's kidding whom?,* Chartered Accountants Journal of New Zealand, Vol. 81:6, p. 66–70.

Harris J. (2000), *Basic principles on sustainable development*, Global Development and Environment Institute, Working Paper 00-04, Tufts University[28]

Heylighen F. (2010), *Self-organization, Emergence and the Architecture of Complexity*, Transdisciplinary Research Group, Free University of Brussels, Pleinlaan 2, B-1050 Brussels, Belgium.

Hubbard G. (2009), *Measuring organizational performance: beyond the triple bottom line*, Business Strategy and the Environment, Vol. 18:3, p. 177-191.

Lamberton G. (2005), *Sustainability Accounting: a brief history and conceptual framework*, Accounting Forum, Vol 29, p. 7-26

Laszlo Ervin (1997), *The Contribution of the Systems Sciences to the Humanities*, Systems Research and Behavioral Science, Vol. 14:1, p. 5-19

Mattessich R. (1994), *Accounting as a cultural force: past, present, future*, The European Accounting Review, Vol 3:2, 354-374.

Varela F; Maturana, H. and Uribe R. (1974), *Autopoiesis: The organization of living systems, its characterization and a model*, titulo original "*De máquinas a seres vivos*" BioSystems, Vol. 5:4, p. 187-196

Mayer A (2008), *Strengths and weaknesses of common sustainability indices for multidimensional systems,* Environment International Vol: 34, p. 277–291

[28] http://ase.tufts.edu/gdae/publications/Working_Papers/Sustainable%20Development.PDF (Last accessed April 16, 2010)

McKendrick N. (1970), *Josiah Wedgwood and Cost Accounting in the Industrial Revolution*, Economic History Review, Vol. 23:1, p. 45-67.

Mickulecky, D. (2007), *Causality and Complexity: The myth of objectivity in science*, Chemistry & Biodiversity, Vol. 4:10, p. 2480-2491.

Miller P. and Napier C. (1993), *Genealogies of Calculation*, Accounting Organizations and Society, Vol. 18, No. 7/8, p.631-647.

Mitchell, R. K., Agle, B. R., & Wood, D. J. (1997). *Toward a theory of stakeholder identification and salience. Defining the principle of who and what really counts*. Academy of Management Review, Vol 22:4, p.853- 866.

Mitchell M; Curtis A; Davidson P. (2008), *Evaluating the process of triple bottom line reporting: Increasing the potential for change*, Local Environment, Vol.13:2, p. 67-81

Morales-Matamoros O; Tejeida-Padilla R; Badillo-Pina I, *Fractal behaviour of complex systems*, Systems Research and Behavioral Science, Vol. 27:1, p. 71-86.

Morhardt JE, Baird S, Freeman K (2002), *Scoring corporate environmental and sustainability reports using GRI 2000, ISO 14031 and other criteria*, Corporate Social Responsibility and Environment Management, Vol. 9, p. 215-233.

Morse, S.; Fraser, E (2005), *Making 'dirty' nations look clean? The nation state and the problem of selecting and weighting indices as tools for measuring progress towards sustainability*, Geoforum, Vol. 36:5, p. 625-640

Ness, B; Urbel-Piirsalu, E; Anderberg, S; Olsson, L. (2007), *Categorizing tools for sustainability assessment*, Ecological Economics, Vol. 60:3, p. 498-508.

Nurnberger, A; Seising, R; Wenzel, C. (2009), *On the fuzzy interrelationships of data, information, knowledge and wisdom*, NAFIPS 2009 - 2009 Annual Meeting of the North American Fuzzy Information Processing Society, p. 1-6

Olalla-Tárraga M. (2006), *A conceptual framework to assess sustainability in urban ecological systems*, International Journal of Sustainable Development & World Ecology, Vol: 13:1, p.1–16.

Owen A (2002), *Getting started on sustainability reporting*, Environmental Quality Management, vol. 11:3, p. 3-12.

Palenberg M; Reinicke W and Witte J.M. (2006), *Trends in non-financial reporting, Paper prepared for the United Nations Environment Programme, Division of Technology,*

Industry and Economics (DTIE). http://www.gppi.net/fileadmin/gppi/nonfinancialreporting01.pdf

Pattee H. (2007), *Laws, Constraints, and the Modeling Relation: History and Interpretations*, Chemistry & Biodiversity, Vol. 4:10, p. 2272-2295.

Pawlowski C.W; Fath B.D; Mayer A.L; Cabezas, H. (2005), *Towards a sustainability index using information theory*, Energy, Vol. 30:8, p. 1221-1231.

Pezzoli K (1997), *Sustainable development: a transdisciplinary overview of the literature*, Journal of Environmental Planning and Management, Vol: 40, p.549–574

Reich R, (1998), *The new meaning of corporate social responsibility*, California Management Review, Vol. 40:2, p. 8–17.

Robins F (2006), *The Challenge of TBL: A Responsibility to Whom?*, Business & Society Review, Vol. 111:1, p. 1-15

Rotmans J; Loorbach D. (2009), *Complexity and Transition Management*, Journal of Industrial Ecology, Vol: 13: 2, p. 184-196

Schmandt-Besserat D. (1979), *An Archaic Recording System in the Uruk-Jemdet Nasr Period*, American Journal of Archaeology, Vol. 83:1, p. 19-48

Stilwell Graham (2009), *Sustainability Reporting*, Financial Management, p: 27-29

Taylor, W (1981), *The Use of Life Cycle Costing in Acquiring Physical Assets*, Vol. 14:6, p. 32-44.

Von Bertalanffy L.(1950), *An Outline of General System Theory*, British Journal for the Philosophy of Science Year, Vol. 1: 2, p. 134-165.

Von Bertalanffy L. (1972), *The history and status of General Systems Theory*, The Academy of Management Journal, Vol. 15: 4, p. 407-426.

Yamey B.S. (1949), *Scientific Bookkeeping and the Rise of Capitalism*, Economic History Vol. 1: 2-3, p. 99-113

Varela F; Maturana, H. and Uribe R. (1974), *Autopoiesis: The organization of living systems, its characterization and a model*, titulo original "*De máquinas a seres vivos*" BioSystems, Vol. 5:4, p. 187-196.

Von Bertalanffy L. (1950), *An Outline of General System Theory*, The British Journal for the Philosophy of Science, Vol. 1, No. 2 (Aug., 1950), pp. 134- 165

Zhang, Yan; Yang, Zhifeng; Li, Wei (2006), *Analyses of urban ecosystem based on information entropy*, Ecological Modelling, Vol. 197:1-2, p. 1-13

Reports

Ecological footprint standards 2009, http://www.footprintstandards.org/

Global Reporting Initiative National Annexes

Global Reporting Initiative Sector Supplements

Global Reporting Initiative Sustainability Reporting Guidelines

Klynveld Peat Marwik Goerdeler (2002), *International study of corporate sustainability reporting 2002*, Amsterdam: Graduate Business School.

Klynveld Peat Marwik Goerdeler (2008), International *Survey of Corporate Responsibility reporting*, http://www.kpmg.com/SiteCollectionDocuments/International-corporate-responsibility-survey-2008_v2.pdf

O´Rourke D (2004*), Opportunities and obstacles for corporate social responsibility reporting in developing countries*, University of California, Berkeley, for the World Bank and the International Finance Corporation.

United States National Research Council (1999), *Our common journey: a transition towards sustainability*, Washington D.C., National Academy Press.

United Nations Development Programme 2004, *Human Development Report: Cultural Liberty in Today´s Diverse World*, United Nations Development Programme, New York.

World Commission on Environment and Development (1987), *Our common future*, Oxford, UK, Oxford University Press.

World Business Council for Sustainable Development (2002), *Sustainable development reporting: striking the balance*, WBCSD: Geneva, Switzerland.

Word Business Council for Sustainable Development (2002), *Sustainable development reporting: striking the balance*, Geneva, Switzerland.

World Commission on Environment and Development (1987), *Our Common Future*, Oxford: Oxford University Press.

Websites

International Accounting Standards (IAS) http://www.iasplus.com/index.htm

International Federation of Accountants http://www.ifac.org/IAASB/Pronouncements.php#Standards.

Carbon Disclosure Project https://www.cdproject.net/en-US/WhatWeDo/Pages/overview.aspx

Global Reporting Initiative http://www.globalreporting.org/Home

Non-equilibrium Social Sciences http://www.nessnet.eu/2012/06/12/george-soros-recently-spoke-at-trento-italy-economics-conference/ & http://www.businessinsider.com/full-text-of-george-soros-speech-2012-6#ixzz1xbph4ui3

Books

Bell S. and Morse S. (1999) *Sustainability Indicators: Measuring the Immeasurable*, Earthscan, London.

Blowfield M. and Murray A. (2008), *Corporate Responsibility: A critical introduction*, Oxford University Press, New York.

Elkington J. (1998). *Cannibals with forks: the triple bottom line of 21st century business*. Gabriola Island, BC:New Society.

Freeman R. (1984), *Strategic Management: a Stakeholder Approach*, Pitman, Boston MA.

Green B. (1999), *The Elegant Universe,* WW Norton and Company Inc., New York.

Hart S. (1996), *Beyond Greening: Strategies for a Sustainable World*, Harvard Business Review

Hawkins D. (2006), *CSR: Balancing tomorrow´s sustainability and today´s profitability*, London, Palgrave Macmillan.

Henriques A. (2001), *Sustainability: a manager´s guide*, London, British Standards Institution.

Henriques A and Richadson J (2004), *Triple Bottom Line: Does it all add up*, Earthscan Publications

Leipziger D. (2003), *The Corporate Social Responsibility Code Book*, Greenleaf, Sheffield.

Luhmann N. (1995), *Social Systems*, Stanford University Press, Stanford, California.

Luhmann N. (1998), Complejidad y Modernidad: de la unidad a la diferencia, Trotta, Madrid.

March J. G. and Simon, H. A. (1959), *Organizations*, New York Wiley.

Prescott-Allen R (2001), *The wellbeing of nations: a country-by-country index of quality of life and the environment*, Washington DC, Island Press, 2001.

Prigogine I. & Stengers I. (1984), *Order Out of Chaos: Man's new dialogue with nature*, New Science Library, Shambhala/Boulder & London.

Rosen R. (1985), *Theoretical Biology and Complexity: three essays on the natural philosophy of complex systems,* Academic Press, Halifax, Nova Scotia.

Schröeder M (2005), *Is there a difference? The performance chcaracteristics of SRI Equity Indexes,* Working paper, Mannheim:Center for European Economic Research

Steger U. (2004), *The business of sustainability: building industry cases for corporate sustainability,* Basingstroke, Palgrave Macmillan.

Von Bertalanffy L (1968), *General System Theory: Foundations, developments, applications*, George Braziller, New york

Wudka Jose (2006), *Space-time, Relativity, and Cosmology*, Cambridge University Press, Cambridge.