Indicators for Measuring Eco-Innovation and Application in Brazil

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Abstract

Macroeconomic aggregates have undergone considerable evolution throughout the 20th century, due to the incorporation of new elements related to aspects such as income distribution and development quality. The Gini index that measures the income concentration of a particular group of the economic activity, and the HDI that evaluates the longevity, education and wealth generation of a nation, are examples of this evolution. We observed that in the first decade of the 21st century, modern society focused its attention more closely on another two aspects, the happiness of a nation that can be measured by the GDH index, and the degree of environmental sustainability of economic development. Countries such as the Netherlands, France, Canada, Denmark, and others, have been contemplating the development of ecological indicators of a specific and generic nature in order to measure the advances that surround the topic of sustainable development, both on a national and a corporate level. Innovation is the mainspring in the development of companies, and the innovation indicators were incorporated into international research (Oslo Manual) and in Brazil by the IBGE with the Technological Innovation Survey (PINTEC). The objective of this article is both to ascertain whether PINTEC incorporates the ecological indicators, and to provide subsidies for the discussion of the preparation of the Brazil Eco-Innovation Index. We conducted a review of the international literature explicitly stating the main eco-innovation indicators for a subsequent comparison with the work underway in Brazil. We aim to contribute by means of a debate to the preparation of a set of ecological indicators that need to be incorporated in research in Brazil.

Keywords: Eco-Innovation; Eco-Innovation Indicators; Technological Innovation Survey; Brazil Eco-Innovation Index.

Introduction

In the last century, the generation of wealth was by means of what was then known as the "brown economy" (United Nations Environment Programme, 2011), an economic system based on the pillars of production and demand (Chapple, 2008), strongly based on the belief in material (unlimited) progress and in the productive capacity of mankind. However, in the first decade of the new millennium the prevailing economic paradigm fostered not only the recurrence of economic crises (Chapple, 2008), but also the ecological crisis (Agostini, 1996). The ecological crisis demands a holistic view that considers the relationship between modern society and nature; it leads to a restructuring not only in the political and economic arena, but also in the institutional sphere on a global scale. A new economic paradigm called "green economy" (United Nations Environment Programme, 2011) is proposed in this context. The green economy can be defined as "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (United Nations Environment Programme, 2011, p. 16). The ecological scarcity is based on the perspective of the ecological dependence of society; it is created by complex and interdependent relations with the ecosystem, of which the limits of mankind are imposed by the laws of nature.

In general, the green economy aims at the efficient use of resources, environmental protection and poverty eradication, and is related to a broader definition of sustainable development. (United Nations Environment Programme, 2011). In this context, the public sector performs the role of promoting the transition between the paradigms by means of control policies in excessive environmental degradation, implementation of effective and adequate information programs, incentives, investments, infrastructure, and others (United Nations Environment Programme, 2011); one of the essential drivers for the transition process is the creation of eco-innovation indicators, which consist of the incorporation of environmental aspects in the innovations of processes, products, services, organizational structure and marketing (Kemp and Foxon, 2007; Kemp and Horbach, 2008; and Reid and Miedzinski, 2008).

In Brazil's case, there is a joint action between the Ministry of Science, Technology and Innovation (MCTI) and the National Council for Scientific and Technological Development (CNPq), which aim to promote research that facilitates the development both of technologies for the transition to the green economy and technologies for the prevention and mitigation of natural disasters, more specifically by means of project CNPq-MIT no. 29\2012 (National Council for Scientific and Technological Development, 2012). For this reason, it is vital to develop and\or have efficient mechanisms to measure eco-innovation, since this helps to identify its progress within the various dimensions of its scope of activity, and also to evaluate the countries and the dissociation of economic progress with environmental degradation (Arundel and Kemp, 2009).

Several authors indicate that the measurement process, more specifically in establishing appropriate indicators to evaluate eco-innovation, is undergoing a creation and structuring process (European Environment Agency, 2006; and Lázaro et. al., 2008). This is evident in the actual international literature on eco-innovation, in which there are authors who focus on eco-innovation indicators of a generic nature (Kemp and Horbach, 2008; Almeida, 2008; Oltra and Kemp and Vries, 2008; Huber, 2008; Kemp and Horbach, 2008; Kemp and Pearson, 2008; Reid and Miedzinski, 2008; Organization for Economic Cooperation and Development, 2009; and Arundel and Kemp, 2009), and eco-innovation indicators of a specific nature such as Material Input Per Service Unit (MIPS), Material Flow Analysis (MFA) and eco-efficiency (World Business Council for Sustainable Development, 2000; Verfaillie and Bidwell, 2000; Kemp and Foxon, 2007; Organization for Economic Cooperation and Development, 2008; Reid and Miedzinski, 2008; Lázaro et. al., 2008; and Rodrigues, 2009).

The studies made available by countries such as the Netherlands, France, Canada, Denmark, and others, have been contemplating the development of eco-innovation indicators in order to measure the advances that permeate the topic of sustainable development, both in the national sphere and in that of firms. However, in the specific case of Brazil, the development and the application of the ecological indicators is incipient. Thus, the underlying study is not intended to provide a complete overview, i.e., does not aim to explore all the ramifications available in the international literature on eco-innovation, but instead to promote debate on the topic of eco-innovation indicators in Brazil, and to stress the importance of their incorporation in the government evaluation systems in order to assess the capacity both of the country and of the organizations to fulfill the precepts of sustainable development.

The article presents four (4) sections in addition to this introduction. The second section involves the theoretical benchmark of eco-innovation, establishing the definition, taxonomies and eco-innovation indicators. The third section performs an analysis of the Technological Innovation Survey in Brazil (PINTEC) and a comparison with what is being developed internationally, aiming to furnish subsidies for the discussion concerning the preparation of a Brazil Eco-innovation Index. The fourth and last section sets out the final considerations of the study.

Definition of the Concept and Taxonomies of Eco-Innovation

Schumpeter (1936; 1985) defines innovation as a process that starts with invention, and materializes through the development of sequential activities able to transform a product and\or service that appeals to the consumer market. According to Schumpeter innovation is established by the: i) introduction of a new product and\or service, with which the consumer market is not familiar; ii) introduction of a new production method; iii) opening of a new market for the company; iv) new sources of supply of raw material; and v) a new structure in the industry. As a matter of fact, such characteristics are the driving force of the capitalist system (Schumpeter, 1985). However, with the ecological crisis (Agostini, 1996), innovation has been linked to environmental aspects (European Environment Agency, 2006); a new term was coined in the mid-1990s, eco-innovation (Kemp and Horbach, 2008), which is considered the sixth (6^{th}) wave of innovation based on the principles of sustainability (Lovins, 2008).

Eco-innovation is associated with a new product and\or process that creates value for the organization, but that, at the same time, presents a lesser environmental impact (James, 1997 apud Kemp and Foxon, 2007). To Reid and Miedzinski (2008), eco-innovation is defined as:

> Eco-Innovation means the creation of novel and competitively priced goods, processes, systems, services, and procedures that can satisfy human needs and bring quality of life to all people with a life-cycle-wide minimal use of natural resources (material including energy carriers, and surface area) per unit output, and a minimal release of toxic substances (Reid and Miedzinski, 2008, p. i).

In this case, eco-innovation is an innovation geared towards eco-efficient technologies; it provides direct and indirect benefits for the environment, aiming at the reduction of pollution, the development of environmentally friendly products and services, the efficient use of resources and others (Kemp and Foxon, 2007). In this context, eco-efficiency is defined by the World Business Council for Sustainable Development (2000) as being:

> "the delivery of competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing ecological impacts and resource intensity, through the life cycle, to a level at least in line with the earth's estimated carrier capacity" (World Business Council for Sustainable Development, 2000).

Just as in the literature on innovation, eco-innovation establishes taxonomies not only in order to classify it, but also to assist in the measurement process. Huber (2008) and Reid and Miedzinski (2008) point out five taxonomies of eco-innovation, which are: i) eco-innovation based on the life cycle perspective, which is grounded both in a new product and in significant improvements in any phase of the life cycle of the product. This taxonomy envisages a reduction, be it in the use the raw materials, or in the levels of waste produced in any phase of the life cycle of the product, i.e., from the production phase through to consumption; ii) product eco-innovation refers to the new and\or improvement of a respective product, in which the global impact on the environment is minimized; iii) process eco-innovation is based on the new and\or improvement of the productive system, aiming to fulfill some sustainable principles such as reduction in the consumption of water, energy, raw material, emission of gases and waste; iv) organizational eco-innovation that addresses the inclusion of specific environmental management tools; and v) marketing eco-innovation is based on the implementation of new methods in marketing, embodying significant changes in the product design, packaging, promotion of products, markets, and others.

Finally, eco-innovation can be classified according to its nature, as either sustainable and\or disruptive. In the sustainable approach eco-innovation is seen as a catalyst, serving as a means of support for the use of existing technologies, while disruptive eco-innovation is grounded in a new technology (Arundel and Kemp, 2009).

Eco-Innovation Indicators

The eco-innovation measurement process currently presents several not necessarily convergent ramifications. The economic theoretical benchmark that sustains the value creation concept is the first point of discord, due to the dichotomy between the neoclassical school, which assigns to utility a basic concept for the measurement of value creation and the Marxists whose theoretical benchmark is based on labor as an essential variable for value creation. Another material difficulty arises from the lack of consensus in establishing which are the relevant environmental indicators and the arduous task of establishing the relationship between innovation and environment-related aspects. For illustration purposes, not every cost cutting process is beneficial to the environment; we know that coal is used owing to its low cost. As process innovation is measured through cost reduction, not every process innovation is beneficial to the environment. Moreover, it is worth emphasizing the existing complexity, as a result of which the measurement process should consider all the phases of the productive chain, going from the extraction stage to production and consumption, and ending up with the disposal, since all the stages present a strong environmental impact (Kemp and Arundel, 1998). However, the development of eco-innovation indicators is undergoing a conformation process, according to the report from the European Environment Agency (European Environment Agency, 2006).

In general, traditional eco-innovation measurement processes are centered on estimating a value based on the investments made by companies, which aim to reduce the pollution originating from their productive processes. Kemp and Arundel (1998) and Lázaro et. al. (2008) believe that new indicators can be included, encompassing: staff training programs, design of products considered “green” and\or “ecological”, introduction of environmental learning techniques, creation of teams to deal with environmental problems or even environmental management and auditing systems.

Due to the complexity existing in the measurement process, the eco-innovation analysis can be divided into three levels, namely: i) micro that addresses products, processes, services and organizational structure; ii) meso that considers the industry, the supply chain, a region, systems of products and of services; and iii) macro that as the name suggests, takes into account economic aspects in the macroeconomic sphere (Reid and Miedzinski, 2008; and Kemp and Horbach, 2008). The underlying study will focus on the micro level eco-innovation indicators; thus, the micro level analysis considers the organizational performance on one hand, and the individual products and processes on the other, while organizational performance arises from the eco-innovations of products and of processes. (Reid and Miedzinski, 2008).

Reid and Miedzinski (2008) provide some indicators in order to evaluate efficiency in the use of resources, called Material Input per Service Unit (MIPS) (see equation 1). MIPS aims to measure the quantity of inputs used during the manufacture of a product and\or service; this indicator is of a holistic nature, as it starts with the extraction of the raw material, moves on to the total quantity of inputs consumed during the production process, and ends in the reuse, recycling and elimination processes. Hence productive efficiency is attainable through eco-innovation, in which the same quantity of resources may result in a larger quantity of products and of services offered.

$$\text{MIPS} = \frac{\text{Material Inputs}}{\text{Service Unit}} \qquad (1)$$

Source: Prepared by the authors from Reid and Miedzinski (2008, p.8)

However, one of the major challenges of eco-innovation consists of relating innovation to efficiency. According to Reid and Miedzinski (2008), eco-innovation targets the reduction of material flows. Thus technological and non-technological innovations must be linked to the elements of sustainable development. In this perspective, the Organization for Economic Cooperation and Development (2008) developed the Material Flow Analysis (MFA) indicator, which aims to measure the physical unit of the material flow. Table 1 below informs another six indicators formed from the MFA.

Table 1 – Material Flow Analysis Indicators

MFA Indicators	Description
Domestic Extraction Used – (DEU)	Measures the flow of materials extracted from the environment, which have physically entered the economic system via production and/or consumption.
Direct Material Input – (DMI)	Measures the input of materials for use in an economy. All the materials that have an economic value, and are used in the production and consumption activities.
Domestic Material Consumption – (DMC)	Measures the total quantity of materials used directly in an economy. The DMC may use generic measurements, such as consumption of energy, water and others.
Total Material Consumption – (TMC)	Measures the total quantity of materials used in domestic production and consumption. Includes the indirect flow of imports.
Physical Trade Balance –	Reflects the trade deficit and/or surplus. This is defined by the expression imports minus exports.

(PTB)	
Total Domestic Output – (TOD)	Refers to the environmental burden of the use of materials. And the quantity of materials that have left the environment, in response to economic activities.

Source: Reid and Miedzinski (2008, p. 11)

Eco-innovation is an innovation that leads to eco-efficient technologies. In this regard, ecologically-oriented projects assist in the conceptualization and measurement of innovation, referring to the changes in resource productivity and\or in the efficiency of the productive processes (Kemp and Foxon, 2007).

Lázaro et. al. (2008) developed an indicator to measure eco-innovation. According to these authors, the indicator is composed both of innovation factors and of environmental factors. Equation 2 illustrates the two main factors considered in the eco-innovation equation, which are: i) the innovative effort parameter; and ii) the eco-efficient performance parameter. The two parameters are related to products, services and processes. According to these authors any innovation that can be classified as eco-efficient is an eco-innovation.

$$\text{Eco-innovation indicator} = \text{Innovation factor} * \text{Eco-efficiency factor} \tag{2}$$

Source: Lázaro et. al. (2008, p. 45)

For this reason, understanding eco-innovation and its true economic potential requires not only including the innovations related to processes, products, services, organizational structure and marketing, but also the agents involved and their respective impacts. In this context, the main indicators of the innovation factor illustrated in Equation 2 are grouped in four categories as informed in Table 2, and are: i) input indicators that cover a set of resources necessary for the development of the innovative activities; ii) output indicators that aim to control the activities related to the innovative results obtained; iii) indicator of the financial value that is based on the total sum of investments in technology venture capital, divided by the benefits arising from products, services and processes. iv) organizational innovation indicators that establish the alteration and creation of the structure, business practices, including innovation of processes, marketing and of the business model itself (Lázaro et. al., 2008).

Table 2 – Innovation factor indicators

Category	Indicators	Description
Input Indicators	Total RTD investments	Total percentage of innovation expenses: includes a range of innovation activities that encompass the internal and external environments. Spanning the acquisition and/or development of machinery and equipment, expenditures with licenses and patents, manufacturer's design, training and marketing innovation.
	Number of RTD projects executed	Refers to the number of RTD projects in processes, products and services executed over a period of time.
	Training expenses	Based on total expenses related to innovative processes, products and services.
	RTD staff	Based on the number of people who work at least 50% of the time on RTD projects.
Output Indicators	Intellectual Property	Number of patents granted. It is a means of measuring the intellectual property of innovation and of new ideas.
	New processes	Number of processes that are novel or improved.
	New products and services	Number of novel or substantially improved products and services.
	Sales resulting from innovation	Aims to obtain the percentage of sales reached after the innovation. A comparison is made between the pre- and post-innovation periods.
	Innovation expenses	$\textbf{\% of the business volume} = \dfrac{\textbf{Total Innovation Expenses}}{\textbf{Business Volume}}$ Innovation expenses include all the expenditures incurred in innovation activities.
Financial Value Indicators	Volume of investments in venture capital technology	$\textbf{VITVC} = \dfrac{\textbf{Total Sum of Investments in Venture Capital Technology}}{\textbf{Network of Benefits}}$

Organizational Innovation Indicators		Environmental certifications; Internal and external environmental audits; Formalized environmental policies; Environmental reports available to the public; Environmental programs for the employees.

Source: Prepared by the authors from Lázaro et. al. (2008, p. 46).

The eco-efficiency factor illustrated in Equation 2 presents variations over a particular period (Lázaro et. al., 2008). According to the World Business Council for Sustainable Development (2000), eco-efficiency can be measured from the product and\or service level. As seen in Equation 3, the value of the product and\or service refers to the value added; on the other hand, the environmental impact is hard to measure, based on the use of resources in the productive processes.

$$\text{Eco-efficiency} = \frac{\text{Value of the Product and Service}}{\text{Environmental impact}} \quad (3)$$

Source: World Business Council for Sustainable Development (2000)

Verfaillie and Bidwell (2000) provide the main indicators to measure the value of the product and\or service that embody: i) quantity of goods and services produced and\or supplied to the customers that refers to a physical measurement, i.e., the count of products and of services delivered to the end consumer, which can be measured by the mass and volume; and ii) net sales that are based on the sales recorded minus the discounts, returns and loans.

To Rodrigues (2009), the environmental impact (Equation 3) involves two analysis perspectives. The first perspective refers to the demand for consumer goods and its relationship with urban waste generation. The second perspective is based on the supply, i.e., considers all the technologies used, and the respective environmental impacts. According to Equation 4, the demand is influenced by the economically active population (EAP), by total employment (Ntotal) and by the real wage (wreal). The supply is composed of the firm's expectations in keeping with the demand. Accordingly, while the variables Ntotal and wreal increase as a result of economic upswings, the demand is also affected via consumption growth, with a resulting increase in the environmental impact; the opposite occurs during periods of economic recession. This equation evidences a trade-off between economic progress and the environment, in which eco-innovation is a means of resolving this dilemma (Rodrigues, 2009).

$$\text{Ienvironmentalt} = \frac{\text{wrealt}}{\text{taut}} * \frac{\text{Ntotal}}{\text{EAP}} \quad (4)$$

Source: Rodrigues (2009, p. 82)

Verfaillie and Bidwell (2000) present another perspective to evaluate the environmental impact providing the respective eco-innovation indicators: i) energy consumption: the total energy consumed that is equal to the energy purchased and\or obtained; ii) material consumption: meaning the sum of the weight of the materials purchased and\or obtained through other sources; iii) water consumption: meaning the sum of all the water purchased from a supplier; and iv) greenhouse gas emissions (GHG); considers the emissions of carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons and perfluorocarbons (HFCs and PFCs), and sulfur hexafluoride (SF6), originating from the production systems.

Furthermore, the four eco-innovation indicators can be measured by the respective equations (Equation 5 to 8) (Lázaro et. al., 2008).

$$\delta E = \frac{\left(\frac{E_0}{FU_0} - \frac{E_1}{FU_1}\right)}{\frac{E_0}{FU_0}} \tag{5}$$

Source: Lázaro et. al. (2008, p. 48)

$$\delta M = \frac{\left(\frac{M_0}{FU_0} - \frac{M_1}{FU_1}\right)}{\frac{M_0}{FU_0}} \tag{6}$$

Source: Lázaro et. al. (2008, p. 48)

$$\delta W = \frac{\left(\frac{W_0}{FU_0} - \frac{W_1}{FU_1}\right)}{\frac{W_0}{FU_0}} \tag{7}$$

Source: Lázaro et. al. (2008, p. 48)

$$\delta GHG = \frac{\left(\frac{GHG_0}{FU_0} - \frac{GHG_1}{FU_1}\right)}{\frac{GHG_0}{FU_0}} \tag{8}$$

Source: Lázaro et. al. (2008, p. 48)

All the eco-innovation indicators illustrated in Equation 5, 6, 7 and 8 conduct a comparative analysis between the period before and after (ex-ante and ex-post) the implementation of eco-innovation. In this manner, a result that is positive and\or higher than 0 represents the efficiency, and a result that is negative and/or equal to 0 indicates the inefficiency of the processes, products, services and organizational structure (Lázaro et. al., 2008). According to Lázaro et. al. (2008), productivity (Tau) is a variable that aims to balance the environmental impacts with economic progress, in which the measurement process is designed to identify the actual gain of organizational productivity in a given period resulting from the innovation (Equation 9).

Taut = max (taut-1, taut-in) (9)

Source: Rodrigues (2009, p. 84)

Kemp and Horbach (2008), Arundel and Kemp (2009) and the Organization for Economic Cooperation and Development (2009) provide generic measures in order to measure eco-innovation at the micro level. Eco-innovation (Table 3) may be measured through input measures, intermediate output measures, direct output measures and indirect impact measures.

Table 3 – Modes of generic measurement for environmental innovation.

Modes of measurement	Data source
Input measures	R&D expenses and R&D personnel Expenditures with other innovations (for example, projects, software and selling).
Intermediate output measures	Quantity of patents and quantity of types of scientific publications.

Direct output measures	Quantity of innovations, description of individual innovations and sales of new products going from innovations.
Indirect impact measures	Change in the efficiency and in the productivity of resources.

Source: Prepared by the authors from Kemp and Horbach (2008), Arundel and Kemp (2009) and the Organization for Economic Cooperation and Development (2009).

The input measures are represented by investments in R&D in the environmental area, which provide direct and indirect results for the organization (Almeida, 2008). Generally speaking, R&D expenditures provide an indicator to measure innovative activities either at the organizational level or at the country level (Oltra and Kemp and Vries, 2008).

Arundel and Kemp (2009) point out that statistics in R&D are used extensively to evaluate innovation. However, it is a mechanism with limitations as it: i) considers only formal R&D laboratories, excluding small companies that conduct R&D informally; ii) does not consider non-technological innovations such as marketing, both organizational and institutional; and iii) does not cover the efforts made in the service sector. Therefore, the R&D analysis should consider investments geared towards environmental matters, spanning two perspectives, namely: i) environmentally motivated R&D; and ii) environmentally relevant R&D, in order to reduce the environmental burden that falls upon the company (Arundel and Kemp, 2009).

For intermediate output measures patents are useful to measure innovation. However, this indicator does not furnish the potential economic value. Moreover, the industry of services such as ecotourism hardly ever patents its innovations (Kemp and Horbach, 2008). However, the analysis of this indicator allows an evaluation of characteristics of innovative processes, and is made up of seven elements: i) level of innovative activity; ii) types of technological organizational innovations and competencies; iii) technological diffusion; iv) source of invention; v) degree of novelty; vi) technological strong points of nations; and vii) technological spillovers and the relation of knowledge (Kemp and Pearson, 2008).

Patents in the sphere of eco-innovation are called eco-patents. For a patent to be considered an eco-patent, it is necessary to have a description that informs the environmental gain arising from this invention (Arundel and Kemp, 2009). The eco-patent is an indicator that can be used to measure green inventions, in which the main motivation is the reduction of environmental impacts (Oltra and Kemp and Vries, 2008). Table 4 provides the main indicators in eco-patents, their definitions, and respective interpretations.

Table 4 – Eco-patent indicators.

Type of indicators	Definition	Interpretation
Eco-patent estimate	Accumulated number of eco-patents.	Evolution of eco-patients over time.
Eco-patent share	Share of eco-patent in total patents. National share of the eco-patent in the total number of patents in the same technological field.	Evolution of eco-patient over time, and across countries.
Technological specialization index	National share of the eco-patent in a particular area, divided by the overall share of the eco-patent in this area. Ditto for the companies.	The proportion of technological specialization is equal to 1.
Knowledge and value of the eco-patent	Citation rate of patents.	Knowledge flow as a proxy of patent value.
Diversification	E(X)=Σpi.ln PI Entropy. pi is the number of patents in a given technology.	Entropy of the distribution of patents among technologies as a proxy of the technological variety present in the distribution of patents among technologies in a particular industry.
Market	Rates of patents.	A proxy of the proximity of patents with commercial exploitation in the market.
Patent portfolios	Relative share of patents in various technological options, in relation to the total number of patents in the portfolio of companies.	Eco-patenting strategies of diversified companies.

Source: Oltra, Kemp and Vries (2008, p. 23)

The eco-patent is an indicator that can also measure the technological capacity of the firm and/or of a country in eco-technologies, by means of the equation illustrated in Equation 10.

$$RPA_{ij} = 100 * \tanh \ln[\frac{P_{ij} / \sum_{j} P_{ij}}{\sum_{i=1}^{n} P_{ij} / \sum_{ij} P_{ij}}] \quad (10)$$

Source: Kemp and Horbach (2008, p. 32)

Moreover, the intermediate output measures (see Table 5) referring to green products can be measured through the announcements made by the organizations, i.e., organizational announcements become an indicator to measure eco-innovation. Announcements need to emphasize environmentally material aspects of the product and/or service offered (Arundel and Kemp, 2009).

Finally, Lázaro et. al. (2008) provide an equation in order to assess the real impact of eco-innovation in the organizational sphere. Generally speaking, it aims to provide information relating to the eco-innovative effort of the firm, and that serves as a mechanism of support to this information (see Equation 11).

Eco-innovation indicator = Innovation factor * Eco-efficiency factor
= Result of the eco-innovation indicator * Number of units sold (11)

Source: Lázaro et. al. (2008, p. 51)

PINTEC

The Brazilian Institute of Geography and Statistics (IBGE) is responsible for conducting the Technological Innovation Survey (PINTEC). The purpose of PINTEC is the construction of sectorial and regional indicators related to the innovative activities of Brazilian companies, since the unit of analysis is the firm (Brazilian Institute of Geography and Statistics, 2012). The current PINTEC model involves technological innovations of products and of processes besides non-technological innovations referring to organizational aspects and marketing, according to the Technological Innovation Survey report of 2008, made available on the website of the Brazilian Institute of Geography and Statistics (Brazilian Institute of Geography and Statistics, 2012). It is also worth emphasizing that PINTEC is a transversal survey, in which the evaluation is carried out in specific periods of time, with three-year periodicity. PINTEC defines innovation as follows:

> “innovation refers to a new (or substantially improved) product and/or process for the company, which is not necessarily new to the market/sector of activity, and may have been developed by the actual company or by another company/institution” (Brazilian Institute of Geography and Statistics, 2012, p. 3).

This definition addresses the perspective of technological innovation that is established by processes and products. It also involves the nature of the innovation, which can be incremental and\or radical; and, finally, the internalization and\or externalization processes of innovative activities. From 2008, PINTEC began to measure non-technological innovations, concerning the organizational structure and marketing. The appreciation of non-technological innovations in the organizational structure is intended to identify both the development and the implementation of novelties. For non-technological innovations in marketing PINTEC investigates the organization’s capacity to respond to the consumer market.

PINTEC is built on three levels of measures, namely: i) input measures; ii) output measures; and iii) impacts arising from innovations; besides the non-technological innovations associated with the organizational structure and with marketing. The input measures that establish the Technological Innovation Survey are both activities related and unrelated to R&D, such as patent acquisition, software, contracting of technical services, equipment acquisition, and others. According to information published in the Technological Innovation Survey report of

2008, these indicators aim to measure the innovative efforts in products and processes undertaken by Brazilian companies.

The output measures addressed by PINTEC cover the intellectual property of new and/or substantially improved products and processes. The objective of intellectual property, as underlined in the triennial report of 2008, is to investigate the main methods of appropriation of the innovations, whether formal through patents, trademark, registration of design and copyright, or of a strategic nature covering trade secrets, design complexity, advantages of time over competitors, and others. Finally, PINTEC evaluates the impacts arising from innovations pertaining to products, markets, processes and aspects related to the environment. These measures aim to identify the direct and indirect effects on the company's competitiveness through innovative activities. The main impacts of innovation are associated with relative aspects, namely: i) market: maintenance and expansion of market share; ii) product: improvement in the quality of goods and services; iii) process: increase in the productive capacity; and iv) environmental impact: reduction in the consumption of water, energy and raw material. On the other hand, the less important impacts are related to performance in the environmental sphere, according to the triennial report of 2008 (Brazilian Institute of Geography and Statistics, 2012).

On the other hand, several studies have been conducted in Brazil in order not only to evaluate, but also to suggest new indicators for the Technological Innovation Survey (Furtado and Quadros, 2006; and Santos and Basso and Kimura, 2012). The Department of Scientific and Technological Policy of the Geosciences Institute of Universidade Estadual de Campinas created the Brazil Innovation Index (IBI).

The creation of the IBI stems from the assumption that the innovation process is complex and involves several dimensions, with special emphasis on two, namely: i) the innovative effort undertaken by companies; and ii) the impact of innovation on technological and economic perspectives. Thus, two aggregate indicators are proposed in order to evaluate the innovation process at the firm level: the Aggregate Indicator of Effort (AIE) and the Aggregate Indicator of Result (AIR).

Both the AIE and the AIR are split into two indicators each: i) AIE is composed of the Index of Innovative Activities (IIA) and Index of Human Resources (IHR); and ii) AIR is formed by the Patent Index (PI) and by the Economic Impact Index (EII). IBI is calculated using the respective formula illustrated below in Equation 12.

$$\begin{aligned} &IBI = (AI \cdot P_1 + IRH \cdot P_2)Q_1 + (PT \cdot P_3 + IRV \cdot P_4)Q_2 \\ &Onde, \\ &P_1 + P_2 = 1 \qquad P_3 + P_4 = 1 \qquad Q_1 + Q_2 = 1 \end{aligned} \tag{12}$$

Source: Santos, Basso and Kimura (p. 108, 2006)

The main intervening variables that compose the aggregate indicators of the IBI model present a conceptual structure based on the Oslo Manual. It considers both the human resource activities and innovative activities. Human resource activities are associated with the quantity of employees dedicated to R&D and stratified according to academic background; innovative activities are related to internal and external R&D efforts through acquisitions of machinery and software, training expenditure, launches of industrial projects and new products. And, finally, AIR that measures the performance based on indices related to the share of new and/or substantially improved products in the organizational revenue (Furtado and Quadros, 2006).

Santos, Basso and Kimura (2012) expanded the definition of performance suggesting that AIR (indices that measure the share of a new and\or substantially improved product in the organizational revenue) can incorporate the use of metrics traditionally used in corporate finance, replacing the revenue growth indicator with the performance variables ROA, ROE, ROS and Profit Margin. In addition, going from the theoretical benchmark of the Resource-Based View, these authors suggested that the indicator 'innovative capacity of firms' is related to three constructs: human capital, structural capital and relational capital; there is a considerable difference of opinion regarding how to define and measure these constructs.

According to these authors, the construct is composed of four aggregate indicators: i) internal capital indicator: considers expenses originating from training, internal R&D activities, machinery acquisitions and introduction of innovation; it aims to verify the internalization of activities related and unrelated in R&D; ii) relational capital indicator that is measured by means of the externalization of activities related and unrelated in R&D; iii) human capital indicator (IRH of the IBI model) evaluates the level of qualification of the staff allocated to the R&D area; it is measured based on the number of doctors, masters, specialists and graduates; and iv) AIR that considers financial metrics such as ROA, ROS and Profit Margin; ROE was excluded as it does not satisfactorily explain the business performance (Santos and Basso and Kimura, 2012).

As our goal is to furnish subsidies for the incorporation of eco-innovation indicators in PINTEC, we will be making a comparison between the indicators proposed by this survey and the indicators addressed in the international literature. Table 5 presents a summary of the comparison between the indicators considered by PINTEC and the ecological indicators considered in the international literature.

Table 5 - Comparison between the PINTEC indicators and the ecological indicators of the theoretical review.

Technological Innovation Measures – Micro Level	**Indicators covered by PINTEC**	**Ecological indicators covered in the theoretical review**
Input Measures	Internal R&D activities **(Likert four-point scale\Value of expenditures)**	Environment-oriented R&D **(Value of expenditures)**
	External acquisition of R&D **(Likert four-point scale\Value of expenditures)**	N\D
	Acquisition of other external knowledge, exclusive software **(Likert four-point scale\Value of expenditures)**	N\D
	Acquisition of software **(Likert four-point scale\Value of expenditures)**	Acquisition of software of environmental management systems and design of products considered “green” and\or “ecological”
	Acquisition of machinery and equipment **(Likert four-point scale\Value of expenditures)**	N\D
	Training **(Likert four-point scale\Value of expenditures)**	Training programs with ecological considerations
	Introduction of technological innovations in the market **(Likert four-point scale\Value of expenditures)**	N\D
Output Measures	Intellectual property **(Number of patents, copyright, and others)**	Eco-patent, main indicators: Estimate of the eco-patent **(Accumulated number of eco-patents)** Share of eco-patent **(Share of the eco-patent in the total number of patents)** Technological specialization index **(National share of the eco-patent in a particular area, divided by the global share of the eco-patent in this area)** Knowledge and value of the eco-patent **(Patent citations index)** And others
	New and/or substantially improved products	New and/or substantially improved products **so that the environmental impact is minimized**

	(Yes or no)	
	New and/or substantially improved processes **(Yes or no)**	New and/or substantially improved processes **with environmental considerations**
Impacts	Product **(Likert four-point scale\ Percentage of net sales and in exports)**	N\D
	Market **(Likert four-point scale)**	N\D
	Processes **(Likert four-point scale)**	Efficiency in the productive system through the eco-innovation indicator: Eco-efficiency $\textbf{Eco-efficiency} = \frac{\textbf{value of product and service}}{\textbf{Environmental impact}}$ Productivity of resources, through the eco-innovation indicator: MIPS $\textbf{MIPS} = \frac{\textbf{material inputs}}{\textbf{service unit}}$
	Environmental impact **(Likert four-point scale)**	Eco-efficiency $\textbf{Eco-efficiency} = \frac{\textbf{value of product and service}}{\textbf{Environmental impact}}$
Non-Technological Innovation Measures		
Organizational	Novelty of the organizational structure	Environmental certifications Internal and external environmental audits Formalized environmental policies Environmental reports available to the public Environmental programs for the employees
Marketing	Changes in the marketing channels	**Introduction of environmental aspects in the promotion of products**
Technological Innovation Measures – Meso Level	**Indicators covered by PINTEC**	**Ecological Indicators covered in the theoretical review**
a) Eco-innovation activities of companies from various industries **b) Eco-efficiency at the meso level**	N\D	Micro-aggregate indicators + Data on commerce Data on flows of materials associated with the industry or other area of activity Systemic dynamic modeling of the impacts of the eco-innovations Analysis of patents Thematic analyses or case study on eco-innovative products or type of eco-innovation using the systemic approach (value chain, product systems)
Technological Innovation Measures –Macro Level	**Indicators covered by PINTEC**	**Ecological Indicators covered in the theoretical review**
a) National innovation and eco-innovation system **b) Eco-innovation activity and economy, consumer behavior and natural environment**	N\D	Micro-aggregate indicators on the eco-innovative activities of companies + data on commerce Analysis of patents Publications Contribution of eco-innovation activities in particular (vales added) to the productivity of resources (DMC\GDP and EMC\GDP)

Source: Prepared by the authors from Kemp and Arundel (1998), Kemp and Horbach (2008), Oltra, Kemp and Vries (2008), Lázaro et. al. (2008), Reid and Miedzinsk (2008), Arundel and Kemp (2009), Organization for Economic Cooperation and Development (2009), Brazilian Institute of Geography and Statistics (2012)

According to Table 5 the measurement process encompassed by PINTEC is focused on the firm's innovative capacity (micro level) addressing technological (processes and products) and non-technological (organizational structure and marketing) innovations. On the other hand, the international literature on eco-innovation indicators addresses another two levels in order to evaluate the industries and the country in eco-innovation. These levels are: i) meso level; and ii) macro level.

At the micro level, more specifically in the input measures, PINTEC analyzes the degree of importance of innovative activities using a scale of four points referring to the activities related and unrelated to R&D, as well as the expenditures incurred in these activities. On the other hand, the eco-innovation indicators contemplated by international literature consider in the measurement process the expenses incurred in the eco-innovative activities, more specifically in the expenditures with R&D involving environmental concerns. The output measures of PINTEC involve the number of property right registrations, and whether the company has introduced a new and\or substantially improved product and process or not. The eco-innovation indicators that concern the output measures, in turn, highlight the eco-patents, which can be measured by: i) eco-patent estimate: aims to evaluate the evolution of the eco-patent over time; ii) eco-patent share: analyzes the evolution of the echo-patent over time between countries; iii) technological specialization index: aims to identify the proportion of technological specialization; and iv) knowledge and value of the eco-patent: investigates the flow of knowledge as a proxy of the value of patents. Finally, the impact measures gauge the real impacts of innovations on the company's competitiveness, while PINTEC evaluates the degree of importance by means of a four-point scale in products, processes, markets and environmental impacts. Furthermore, PINTEC analyzes the percentage of net sales arising from product innovations. According to the international literature on eco-innovation indicators, impact measures can be gauged through two expressions, namely: i) eco-efficiency: measured by the value of the product and\or service that encompasses the quantity of goods and services produced or supplied to the customers, being divided by the environmental impact that involves two analysis perspectives. The first perspective refers to the demand for consumer goods and its relationship with urban waste generation. The second perspective is based on the supply, i.e., considers the technologies used and the respective environmental impacts; and ii) MIPS that aims to measure the quantity of inputs used during the manufacture of a product and\or service; this indicator is of a very far-reaching nature (holistic), as it starts with the extraction of the raw material, moves on to the total quantity of inputs consumed during the production process, and ends in the reuse, recycling and elimination processes.

The meso level covered by the international literature on eco-innovation indicators evaluates the global system of a product and\or service, technological regimes, industrial sectors, infrastructure and regions. We highlight five branches in Table 5: i) micro-aggregate indicators + data on commerce; ii) data on the flow of materials associated with the industry or other area of activity; iii) systemic dynamic modeling of the impacts of the eco-innovations; iv) analysis of patents; and v) thematic analyses and\or case study on eco-innovative products or type of eco-innovation using a systemic approach (value chain, product systems).

The macro level considered in the literature on eco-innovation indicators, seeks to evaluate the impacts of eco-innovation on macroeconomic aggregates such as the GDP, consumer behavior and even the impact on the natural environment (consumption of material and energy, waste production, quality of the soil air and water). In Table 5 we highlight 5 branches of research that merit the attention of researchers: i) micro-aggregate indicators on the eco-innovative activities of companies + data on commerce; ii) analysis of patents; iii) publications; and iv) contribution of eco-innovation activities in particular (values added) to the productivity of resources (DMC\GDP and EMC\GDP). It is worth emphasizing that we did not evaluate all the eco-innovation indicators that cover the meso level and the macro level in this review of literature, yet they should all be studied in order to identify the most important in the Brazilian context.

As can be seen in Table 5, we adopted a prudential posture. The impacts (results) of a new and\or substantially improved product that incorporates environmental concerns were considered unavailable. This is because we believe that in order to assume a scientific position, the results must be confirmed by scientific research and not just represent an ideological or doctrinaire position. We acknowledge that we did not conduct a literature sweep to confirm the impacts.

The first index marked in the IBI model is internal capital; it considers the innovative activities undertaken by Brazilian companies, in which the measurement process is by means of investments made in activities related and unrelated in R&D. Accordingly, the measurement process is strongly based on the resources allocated in these activities. The IBI model considers the expenses arising from internal activities in R&D, training and acquisitions of machinery (Santos and Basso and Kimura, 2012). In order to evaluate the firm's capacity to eco-innovate, the internal capital index must consider the eco-innovation indicators concerning R&D investments geared towards the development of products and processes with environmental considerations, expenses incurred with training based on environmental technique learning systems, and others (Kemp and Arundel, 2008; Lázaro et. al., 2008; Almeida, 2008; and Oltra and Kemp and Vries, 2008). Based on the form of the Technological Innovation Survey of 2011, more specifically on the measures that concern innovative activities, it is suggested that the respective eco-innovation indicators be added according to Table 6 below. We emphasize that the table aims to furnish subsidies for the debate about the incorporation (or not) of eco-innovation indicators in research conducted in Brazil.

Table 6 – Measures of innovative activities – eco-innovation indicators.

Measures of Innovative Activities	Description	Scale
Internal R&D	Comprehends the creative work, undertaken systematically, with the objective of increasing the **collection of knowledge related to environmental aspects** and the use of this knowledge to develop new applications, such as **new and/or substantially improved product in which the global impact on the environment is minimized**, and **new and/or substantially improved processes of the productive system aiming to fulfill some sustainable principles such as reduction in the consumption of water, energy, raw material, emission of gases and waste**. The design, construction and testing of prototypes and of pilot installations often constitute the most important phase of the **environment-oriented R&D activities**. Also includes the development of software, providing this involves a technological or scientific advance **associated with environmental matters.**	What is the importance of the **environment-oriented R&D activity,** carried out in the research execution period? **(We initially thought of a Likert four-point scale)**
Acquisition of machinery and equipment	Acquisition of machinery, equipment and hardware, specifically purchased for the implementation of **new and/or substantially improved products and processes that aim to decrease the global environmental impact.** However, if the acquisition of this machinery and equipment were preponderantly for the performance of R&D activities, both their importance and their expenditure should be considered in R&D.	What is the importance of the acquisition of **environment-oriented** machinery and equipment, made in the respective period? **(Likert four-point scale)**
Training	Training geared towards the development of **new and/or significantly improved products and processes that aim to decrease the global environmental impact**, and related to the innovative activities of the company, which may include acquisition of external specialized technical services. However, if this training has been preponderantly for the performance of the R&D activities, both its importance, and it expenditure, should be considered in R&D.	What is the importance of training in environmental technique learning systems, held between the respective period? **(Likert four-point scale**)

Source: Prepared by the authors from the Brazilian Institute of Geography and Statistics (2012), Santos, Basso and Kimura (2012), Kemp and Arundel (1998), Lázaro et. al. (2008), Almeida (2008) and Oltra, Kemp and Vries (2008).

In Table 6 the input measures aim to evaluate the eco-innovative activities of the firm, represent the company's efforts with the purpose of improving its collection of technologies with environmental considerations, and consequently, for the development and implementation of new and/or significantly improved products, services and processes. For this purpose the eco-innovative activities will be measured with a basis on three eco-innovation indicators, namely: i) environment-oriented internal R&D; ii) acquisitions of machinery and equipment; and iii) training. It is also worth emphasizing that each eco-innovation indicator uses a four-point scale (Linkert). The eco-innovation indicator environment-oriented internal R&D evaluates the effort of eco-innovative activities of the firm aimed at the development of knowledge related to environmental matters; the indicator measures its degree of importance through the respective scales: high, medium, low and did not develop. The eco-innovation indicator acquisition of machinery and equipment has the purpose of evaluating their level of importance to the development of new and\or substantially improved products and processes that aim at lesser environmental impacts, using the four-point Linkert scale (high, medium, low and did not develop). Finally, the eco-innovation indicator training that seeks to verify whether training programs aim at innovation with environmental considerations, covering both the productive process (by means of cleaner productions and reductions in the use of raw materials) and the manufacture of products (reducing environmental impacts during their use); the training indicator is evaluated by means of a four-point scale (Linkert). It is worth emphasizing that, besides assessing the importance of these eco-innovative activities, it is also necessary to include the amount of expenditures allocated to each activity.

Santos, Basso and Kimura (2012) used the relational capital index (which to avoid further discussions can be built from a resource, as declared by the Resource Based View, which identifies the company's ability to relate externally) in their study. According to these authors, the index aims to analyze the externalization of activities related and unrelated in R&D. Actually, this index outlines the behavior of Brazilian companies; according to the results of the study, Brazilian companies tend to subcontract activities related to the R&D area. The relational capital index can be measured via eco-innovation indicators, which address both the acquisition of environmental management systems software and design of products considered "green" and\or "ecological", and the acquisition of knowledge involving ecology-oriented products and processes (Kemp and Arundel, 1998; and Lázaro et. al., 2008). Based on the form of the Technological Innovation Survey of 2011, more specifically on the measures that concern innovative activities, we submitted the incorporation of eco-innovation indicators for discussion in order to evaluate the relational capacity, according to Table 7.

Table 7 – Relational capital measures – eco-innovation indicators.

Relational Capital Measures	Description	Scale
External acquisition of Research and Development	The **environment-oriented** R&D activities carried out by another organization (technological companies or institutions), and acquired by the company.	What is the importance of the external acquisition of **environment-oriented** R&D made in the respective period? (***Likert* four-point scale)**
Acquisition of software	Acquisition of (design, engineering, processing and transmission of data, voice, graphs, videos, for automation of processes, etc.), specifically purchased for the implementation of new and/or substantially improved products or processes **that aim to decrease the global environmental impact.** Not include those recorded in R&D. However, if the acquisition has been preponderantly for the performance of **environment-oriented** R&D activities, both their importance, and their expenditure should be considered in R&D.	What is the importance of the acquisition of **environment-oriented** software, made in the respective period? (***Likert* four-point scale)**

Source: Prepared by the authors from the Brazilian Institute of Geography and Statistics (2012), Santos, Basso and Kimura (2012), Kemp and Arundel (1998) and Lázaro et. al. (2008).

The relational capital measures informed in Table 7 encompass two eco-innovation indicators: i) external acquisition of R&D; and ii) acquisition of software; they aim to measure both the firm's capacity in transactional activities, more specifically in the acquisition of external environment-oriented R&D and of software, and their importance to the development of new and\or substantially improved products and processes aimed at the reduction of the global environmental impact. The eco-innovation indicator environment-oriented external R&D evaluates the degree of importance of the acquisition of this knowledge to the development and the implementation of new and/or substantially improved production systems and products that attend to environmental matters, and is measured by means of a four-point scale (Linkert).

The human capital index that estimates the level of qualification of the staff allocated to the R&D area is measured based on the number of doctors, masters, specialist and graduates (Santos and Basso and Kimura, 2012). In the specific case of eco-innovation, the human capital index will not only measure the degree of qualification of the staff allocated to the R&D area, but will also evaluate the number of staff allocated to the specific development of processes and products with environmental considerations. Considering the form of the Technological Innovation Survey of 2011, more specifically in the measures that concern internal activities (R&D), it is suggested that eco-innovation indicators be added to evaluate human capital, according to Table 8 below.

Table 8 – Human capital measures – eco-innovation indicators.

Human Capital Measures	Description	Scale
Location	Indicates the location of the company's **R&D department with exclusively environmental concerns** or, if there is no formal unit or more than one, where the **R&D activities with an exclusively environmental concern** are predominantly concentrated.	Percentage of activities with environmental concerns, carried out in the respective period **(Likert four-point scale)**
Degree of qualification	Aims to identify the staff allocated to the **environment-oriented R&D (meaning: environmental concerns)** in a stratified manner, according to academic background.	Company staffing structure, normally occupied in the **environment-oriented** R&D activities, and according to the level of qualification. (Mapping: doctors, masters, specialists and graduates). Inform the number of **environment-oriented** projects **(Classify the number of environment-oriented projects in relation to the total number of projects)** The time dedicated to **environment-oriented** activities.

Source: Prepared by the authors from the Brazilian Institute of Geography and Statistics (2012) and Santos, Basso and Kimura (2012).

The objective of human capital (Table 8) is to assess how deeply the organization is engaged in environment-oriented projects by means of two eco-innovation indicators: i) location; and ii) degree of qualification. The eco-innovation indicator location measures the degree of importance of activities geared towards environmental matters at the company, which can be measured using the four-point scale (Linkert) (high, medium, low and not relevant). The eco-innovation indicator qualification is measured through three aspects. The first maps out the degree of qualification of the people involved in research and development of products and of new and\or substantially improved processes with environmental considerations. The second is a relationship of the number of environment-oriented projects in relation to the total number of projects developed by the company, aiming to identify the company's engagement with environmental matters. The third and last aims to identify the degree of importance of dedication of human capital to environment-oriented activities (by means of the time dedicated to these, using a four-point Linkert scale).

Finally, the AIR measures the performance arising from innovations, and is composed of the Patent Index (PI) and the Economic Impact Index (EII) (Furtado and Quadros, 2006; and Santos and Basso and Kimura, 2012). The patent index aims to identify the different methods that Brazilian companies adopt in order to protect and prolong the benefits of their innovations, using both legal protection and strategic methods; in order to be able to incorporate eco-innovation indicators we suggest the eco-patent index. An eco-patent consists of the detailed description of an innovation and its relationship with environmental gains (Oltra and Kemp and Vries, 2008; Kemp and Pearson, 2008; and Arundel and Kemp, 2009). According to Oltra, Kemp and Vries (2008), eco-patents can be measured through the respective ecological indicators, which are: i) estimate of eco-patents; ii) share of eco-patents; iii) technological specialization index; iv) knowledge and value of the eco-patent; v) diversification; vi) market; vii) patent portfolios; the economic index impact will be based on financial metrics such as the ROE, ROS and Profit Margin, aiming to appraise the organizational performance in the presence of eco-innovations.

Figure 11 provides a summary of the main indices and their respective eco-innovation indicators (suggestion for discussion). The conceptualization of each index (construct) was suggested in the previous sessions.

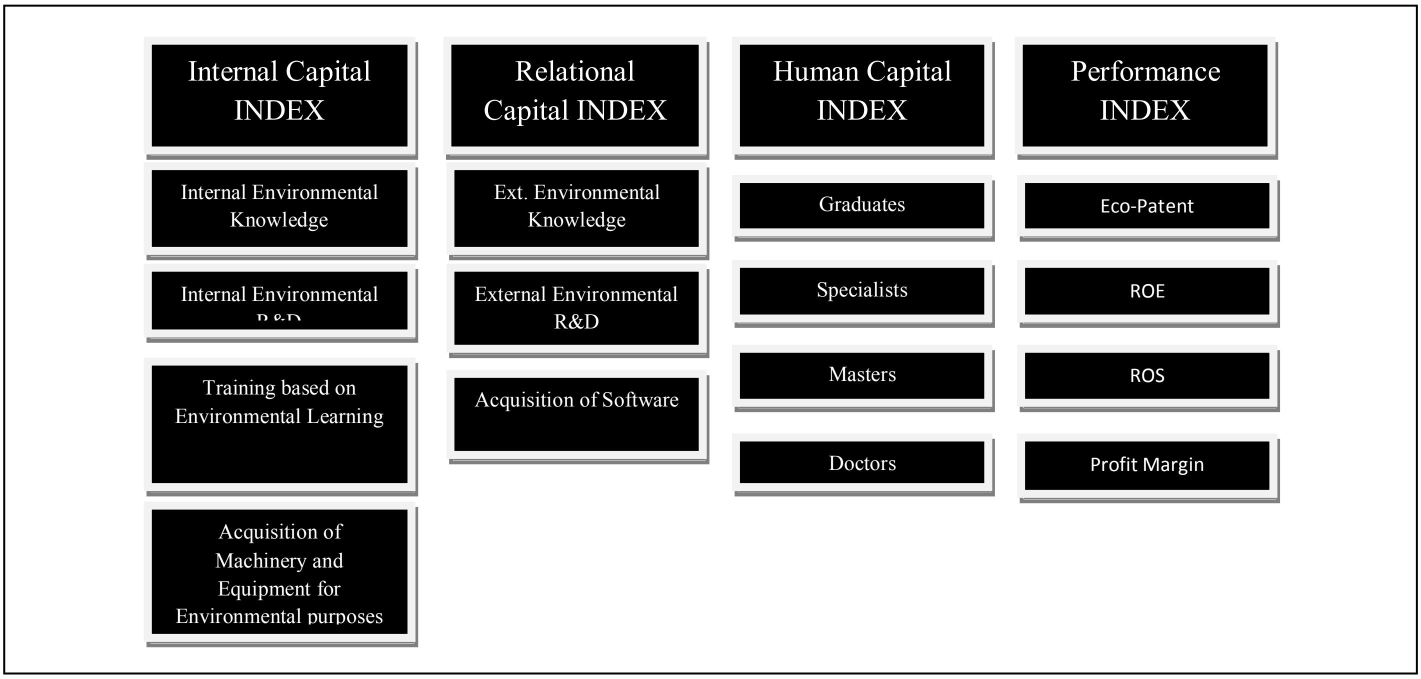

Figure 1 – The eco-innovation indicators considered in the Eco-Innovation models.
Source: Prepared by the authors from Kemp and Arundel (1998), Lázaro et. al. (2008), Almeida (2008), Oltra, Kemp and Vries (2008), Brazilian Institute of Geography and Statistics (2012) and Santos, Basso and Kimura (2012).

Final Considerations

The proposal of this study was firstly to perform a review of the international literature on ecological aggregates, also called eco-innovation indicators.

The Technological Innovation Survey was examined presenting the three main firm-level analysis measures: input measures, output measures and impact measures. We made a comparison between what is being done in Brazil and abroad in relation to eco-innovation indicators.

We presented the Brazil Innovation Index (IBI) and a suggestion aiming to incorporate eco-innovation indicators in the Technological Innovation Survey so as to enable us to assess the firm's capacity to eco-innovate.

If on the one hand we can highlight the effort made by the Brazilian federal government to promote research that facilitates both the development of innovations within the scope of the firm and the development of technologies that allow the transition to the green economy, and on the other hand we highlight the concern of Brazilian researchers with incorporating eco-innovation indicators in research performed in Brazil, there is still a long way to go. The objective of this article was to furnish subsidies for the discussion of the relevance of the inclusion of eco-innovation indicators in research carried out in Brazil.

We believe that there is a pressing need for extensive debate about eco-innovation indicators, both conceptually and quantitatively (measurement process), for indicators (constructs) to be incorporated into the

Technological Innovation Survey, and for the Brazil Innovation Index to have a session dedicated to eco-innovation.

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