Managing sustainability with the support of business intelligence: Integrating socio-environmental indicators and organisational context

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ARTICLE INFO

ABSTRACT

In this paper we explore how management of sustainability in organisations can be supported by business intelligence (BI) systems. We suggest that BI has an important role to play in helping organisations implement and monitor sustainable practices. We pay particular attention to one phase of any BI project, the information planning phase, i.e., the systematic way of defining relevant information in order to integrate it in reporting activities. Using grounded theory, the main contribution of our study is to propose a conceptual model that seeks to support the process of integration of socio-environmental indicators into organizational strategy for sustainability.

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1. Introduction

The main purpose of this research is to explore how business intelligence (BI) models can support the management of sustainability business practices in contemporary firms. We advance the view that BI methods and tools have an important but as yet not well studied role to play in helping organisations implement and monitor sustainable and socially responsible business practices. The contribution of this paper is to shed light on *what role* and *how*.

After years of significant investment in putting in place a technological platform that supports business processes and strengthens the efficiency of operational structure, most organizations have reached a point where the use of tools to support the decision making process at the strategic level emerges as more important than ever. Herein lies the importance of the area known as business intelligence (BI), seen as a response to current needs in terms of access to relevant information through intensive use of information technology (IT) (Petrini and Pozzebon, 2008). BI systems have the potential to maximize the use of information by improving the company's capacity to structure a large volume of information and make it accessible, thereby creating competitive advantage, what Davenport calls "competing on analytics" (Davenport, 2005).

Moreover, the concepts of sustainability and corporate social responsibility (CSR) have been among the most important themes to emerge over the last decade at the global level. Although the concept of CSR historically precedes the emergence of the sustainability concept, the two are considered comparable concepts in this paper since both, nowadays, take into consideration environmental, social and economic dimensions. In addition, both refer to a long-term perspective based on requirements necessary to provide for the present without compromising the needs of future generations. Issues typically

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included in a sustainable and socially responsible agenda relate to business ethics, community investment, environmental protection, human rights and workplace conditions, among others. The increasing importance of sustainability and CSR should be assessed within the complex context of globalization, deregulation and privatization, where social, environmental and economic inequalities continue to increase (Raynard and Forstarter, 2002). In light of this contextual perspective, managers have to take into account not only increased sales and profits and/or decreased costs, but also sustainable development of the business itself and of the surrounding context. Therefore, a growing number of companies worldwide have engaged in serious efforts to integrate sustainability into their business practices (Jones, 2003).

Despite the explosion of interest in and concern with sustainable practices, their effective implementation faces serious obstacles. Up to now, most firms have kept the question of sustainability separated from considerations of business strategy and performance evaluation, areas that are often dominated by purely "economic" performance indicators. In addition to a definition of social and environmental indicators, the question of how they can be operated, visualized, and monitored is crucial in terms of value added to CSR management, once transparency and accessibility of corporate information (how it is generated and, once stored, how it is distributed and disclosed) become important issues (Clarkson, 1995).

Viewed separately, *sustainability/social responsibility* and *business intelligence* each represent relevant themes for investigation. Curiously, few studies have considered these two themes in conjunction. We argue that purposive use of BI tools and methods can improve the definition, gathering, analysis and dissemination of socio-eco-financial information among employees, clients, suppliers, partners and community. The term BI tools refers to technological applications and platforms (including software, hardware, data warehouse, network, etc.), while BI methods refer to methodologies concerned with different BI project phases. We pay particular attention to one phase of any BI project: the information planning phase, i.e., the systematic way of defining indicators, metrics and other relevant information in order to integrate them into monitoring and reporting activities.[1] The research question guiding this inquiry is: *How can the process of defining and monitoring socio-environmental indicators be integrated into the organizational strategy for sustainability?*

Our aim is to provide an original framework for theoretical advances in the field and actionable knowledge (Argyris, 2006) for supporting projects involving sustainability and CSR. By actionable knowledge we mean knowledge that enables organizational and societal members to make informed choices about important practical problems. The paper is structured as follows: Section 2 presents a review of literature around the two main themes: BI and sustainability/CSR; Section 3 presents the research method; Section 4 shows the results; Section 5 contains the discussion; and Section 6 presents the conclusion.

2. Literature review

2.1. Sustainability and corporate social responsibility

From a historical point of view, the seminal work of Bowen (1953) was one of the starting points of the field that has come to be known as corporate social responsibility (CSR). In our research, we define CSR as a comprehensive set of policies, practices and programs that are integrated into business operations, supply chains, and decision-making processes throughout a company, with the aim of inculcating responsibility for current and past actions as well as future impacts (BSR, 2008). Likewise, although issues around sustainability have a long history, the predominant interpretation of sustainable development was introduced by the Brundtland Commission's report in 1987: meeting the needs of the present without compromising the ability of future generations to meet their own needs. From a corporate point of view, a strategy for corporate sustainability must meet the needs of the firm's stakeholders without compromising its ability to meet the needs of future stakeholders as well (Hockerts, 2001). Elkington (1998) defines a sustainable enterprise as a company that contributes to sustainable development by delivering economic, social and environmental benefits simultaneously – the so-called *triple bottom line.*

The two terms, sustainability and CSR, have progressively converged and today they encompass similar dimensions and are often applied as synonymous or equivalent terms (Emerson, 2003; Mazon, 2004). First, both concepts involve multiple levels of analysis – individual, groups, firms, communities, etc. – and multiple stakeholders – employees, shareholders, clients, suppliers, partners, community members, etc. Second, CSR and sustainability deal with issues related to three distinct spheres that sometimes overlap: social, environmental and economic. It is important to note that the economic sphere is not limited to short-term performance indicators like return on investment (ROI), but also refers to elements that contribute to long-term financial success, like company reputation and company relationships. Consequently, managing sustainability and CSR implies seeking a balance between short- and long-term considerations, and among the interests of a larger group of stakeholders than those addressed by "traditional" management (Raynard and Forstarter, 2002).

To present a comprehensive review of CSR and sustainability literature is, today, a colossal task that would require an entire paper just for that purpose. For reasons of length, we summarize here three selected groups of work that characterize, from our perspective, important moments in the conceptual evolution of CSR and sustainability concepts from a management point of view (Table 1).

We outline the work of Elkington (1998), who proposed the triple bottom-line concept, allowing organizations to interpret sustainability through the integration of the three primary dimensions noted above: economic, environmental and

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[1] Taydi (2006) carried out a comprehensive review of BI project phases and proposed six typical phases: preliminary study, conception, development, implementation, testing and training. The information planning phase is the most important step of the first phase, the preliminary study.

Table 1
Three groups of studies on CSR and sustainability concepts.

Period	Conceptual advances	Main authors
1960s and 1970s	Integrate "motivators" and extend the scope of "beneficiaries" of socially responsible initiatives to include external stakeholders	Eells (1960), Blau and Scott (1962), Emery and Trist (1965), Walton (1967) and Zenisek (1979)
1970s and 1980s	Define and categorize indicators for the support and assessment of corporate sustainable practices	Abbot and Monsen (1979) and Clarkson (1985)
1980s and 1990s	Consolidate the integration of three dimensions: social, economic and environmental	Carrol (1979), Wartick and Cochran (1985), Wood (1991) and Elkington (1998)

social. To better manage the complexity of articulating these dimensions, three types of linkages can be derived. The first point that can be made relates to the way in which environmental and social sustainability can contribute to economic sustainability itself. This situation is usually considered a "business case" for sustainability, since it allows companies to follow stakeholder strategies towards environmental or social sustainability goals. Secondly, one can examine how economic and social sustainability contributes to environmental quality – which is considered a "green case." And finally, the "social case" examines how economic and environmental sustainability can contribute to increasing social justice and equity (Dyllick and Hockerts, 2002).

Consequences of the evolution of CSR and sustainability models include the emergence of principles, norms and certifications aimed at guiding corporate actions and strategies at a global level. *Millennium Development Goals* and *Agenda 21*, for example, are global pacts that lay down basic values to direct socially responsible and sustainable business actions. Norms and certifications that focus on processes, like *ISO 14001 and SA 8000*,[2] were created to provide monitoring tools for use in the practice of CSR and sustainability. Reports such as the *Global Report Initiative (GRI)* originated as templates for assembling information about projects, benefits and social actions so as to bring transparency to CSR and sustainability actions. Finally, indexes like the *Dow Jones Sustainability Indexes* attest to worldwide valorization of firms that explicitly seek a balance between financial performance and business practices concerned with social and environmental impact. *Dow Jones Sustainability Indexes* are the first global indexes tracking the financial performance of the leading sustainability-driven companies worldwide, providing asset managers with reliable and objective benchmarks to manage sustainability portfolios.

CSR and sustainability are becoming an important dimension of corporate strategy and an increasing number of firms are trying to determine and monitor the social and environmental impacts of their operations (Neto and Froes, 2001; Zadek, 2005). Despite such flourishing interest, the effective incorporation of sustainability into business strategy and management faces serious obstacles. A key element seems to be definition and monitoring of indicators that take into account the three dimensions – social, economic and environmental – and the various stakeholders – employees, clients, suppliers, shareholders and community members. But how can this be effectively integrated into managing the firm?

2.2. Business intelligence methods and tools

From a historical standpoint, what we call business intelligence (BI) has been evolving over the last 35 years. In the 1970s, initial versions of analytical software packages appeared on the market. The 1980s saw the release of spreadsheet software, e.g., Excel, which is still widely used today. By the mid-1980s and early 1990s, so-called executive information systems (EIS) were introduced and quickly grew in popularity by promising to provide top management with easy access to internal and external information relevant to decision-making needs, placing "key information on the desktops of executives" (Rasmussen et al., 2002, p. 99). The "easy access" was due to user-friendly interfaces and powerful analytical functionalities. Similar factors accounted for the popularity of decision support systems (DSS), i.e., software developed to support exception reporting, stop-light reporting, standard repository, data analysis and rule-based analysis. Although both EIS (Volonino et al., 1995; Turban and Walls, 1995) and DSS (Carlsson and Turban, 2002) systems captured the attention of numerous researchers, therefore consolidating flourishing research areas for almost two decades, their popularity continually decreased in practice. Reasons for this decline included the fact that EIS required a lot of manual work to convert and load data from data sources, and the view that DSS's scope was somehow narrow.

In the 1990s, three technological improvements brought about a revolution in analytical applications scenarios, accounting for the emergence of business intelligence (BI) systems: data warehouse technologies (Inmon, 1996; Kimball, 2000), ETL tools (extraction, transformation and loading) and powerful end-user analytical software with OLAP capabilities (online analytical processing) (Body et al., 2002). Furthermore, the impact of the internet is far from negligible: current versions of analytical products are web-based and, through Internet or intranet connections, users can investigate and analyze data from home, while traveling or from any other location (Carlsson and Turban, 2002). Today, terms like DSS and EIS have virtually disappeared, and BI is the accepted term for analytical and strategic information systems, including an array of

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[2] ISO means International Standards for Organizations. The ISO 14000 family addresses various aspects of environmental management. ISO 14001, in particular, provides the requirements for establishing an EMS, i.e., an environmental management systems (http://www.iso.org). SA8000 is part of the Social Accountability International (SAI), whose mission is to promote human rights for workers around the world. SA8000 represents a comprehensive and flexible system for managing ethical workplace conditions throughout global supply chains (http://www.sa-intl.org).

applications classified under three broad headings: analysis (data mining and OLAP), monitoring (dashboards, scorecards and alert systems) and reporting. A literature review around the theme *business intelligence* (BI) shows "separation" between technical and managerial approaches, tracing two broad patterns (Table 2).

The managerial approach sees BI as a *process* in which data gathered from inside and outside the company are integrated in order to generate information relevant to the decision-making process. The role of BI here is to create an informational environment in which operational data gathered from transactional systems and external sources can be analyzed, in order to reveal "strategic" business dimensions.

The technical approach presents BI as a *set of tools* that support the process described above. The focus is not on the process itself, but on the technologies that allow the recording, recovery, manipulation and analysis of information. For example, Hackathorn (1999) sees convergence of the technologies of data warehousing, data mining and web mining as a challenge: to create a single architecture, a single corporate BI platform, for all these technologies.

Despite the differences between technical and managerial approaches to BI, they share two basic ideas: (a) the core of BI is the gathering, analysis and distribution of information, and (b) the goal is to support the strategic decision-making process. By strategic decisions we mean decisions related to implementation and evaluation of organizational vision, mission, goals and objectives, which are supposed to have medium- to long-term impacts on the organization, as opposed to operational decisions, which are day-to-day in nature and more related to execution (Petrini and Pozzebon, 2008).

From a technical point of view, the stage is set for rapid growth in adoption of BI applications in the coming decades. Nowadays, BI technologies integrate a large set of diversified resources (packages, tools and platforms), and various products are being released aimed at fulfilling different needs related to the search for and use of information, ranging from report extractors (used on a more detailed informational level) to dashboards applications (used to consolidate within a single control panel the information linked to performance factors in a largely summarized level) and sophisticated mining applications (used to build predictive business models). The large variety of tools helps explain why an extensive range of apparently dissimilar applications is commonly labelled "business intelligence". The literature review also shows that advances in knowledge in one stream of BI, the technical, have been greater than on the managerial side. Although the volume of information available in data warehouses is increasing and the functionalities of analytical tools are becoming increasingly sophisticated, this does not automatically mean that firms and individuals are able to derive value from them (Burn and Loch, 2001).

2.3. Looking for BI and information planning methods that integrate sustainability

While the increase in general knowledge of the technological features and functionalities of BI tools continues unabated, the same is not true of knowledge of BI *methods* that guide the conception and operation of these tools. One example of BI methods involves those methodologies focusing on identification of strategic information which needs to be integrated into data warehouses and BI applications (Miranda, 2004). The BI literature displays a lack of clear frameworks that could serve as guides to such an important phase: the definition of user requirements and information needs. The literature on BI is short on methodological approaches to information planning. Research by Taydi (2006) showed that most methodologies applied in BI projects are proposed by vendors and consulting firms, and that those methodologies are not examined, validated or tested by BI academic research. Faced with this absence of conceptual frameworks in BI literature, we reviewed literature on three related areas: data warehousing, IT strategic planning and managerial accounting.

In the data warehousing literature, one finds a huge number of studies based on two authors, Inmon (1996) and Kimball (2000), who are directly concerned with defining the structure and content of a data warehouse. However, both Inmon and Kimball provide few guidelines regarding definition of corporate performance indicators, which is the heart of a BI system from a corporate level perspective.

The IT strategic planning literature identifies alignment of organizational strategy and IT strategy as a key factor in the success or failure of any IT project, BI included. This means that the chances of success in implementing any IT are directly related to the way in which the implementation is articulated in terms of organisational strategy and of the characteristics of each industry (Reich and Benbasat, 2000). The information definition phase should be linked to corporate strategic planning since BI systems are supposed to link operational and strategic dimensions of an organisation through the flow of information (Eisenhardt and Sull, 2001).

Finally, managerial accounting literature contributed significantly to our debate through the wide range of studies based on the balanced scorecard (BSC) approach. The core of BSC is translating the corporate strategic view into a set of measurable

Table 2
Two business intelligence approaches.

	Main focus	References
Managerial approach	Focus on the process of gathering data from internal and external sources and of analyzing them in order to generate relevant information	Liautaud (2000), Luckevich et al. (2002), Schonberg et al. (2000), and Kalakota and Robinson (2001)
Technical approach	Focus on the technological tools that support the process described above	Kudyba and Hoptroff (2001), Watson et al. (2002), Scoggins (1999), Hackathorn (1999), Dhar and Stein (1996) and Giovinazzo (2002)

results that provide executives with a quick and understandable view of the business (Kaplan and Norton, 1996). Its development was motivated by dissatisfaction with traditional performance measurements which were concerned only with financial metrics, and which focused on the past rather than the future. As a result, BSC associates indicators and measures with monitoring of the company's strategic objectives through the use of four different perspectives: financial, clients, internal processes and organisational learning and innovation (Kaplan and Norton, 2001).

In addition to integrating multiple perspectives, BSC includes other mechanisms that appear important to our inquiry, particularly the linkage between operational and strategic levels (Chenhall, 2005). In its original formulation, BSC did not take a sustainability dimension into account and, thus, did not address the issue of how to transform sustainability into a constituent part of the corporate strategy. Nonetheless, its core feature – multidimensionality – opened up space for a number of efforts towards transforming a BSC so as to integrate sustainability.

2.4. Linking BI and sustainability through the concept of sustainable scorecard (SBSC)

There have been a number of attempts at integrating a social and environmental dimension within a BSC model. We recognize four main strategies that gradually transform a BSC into a "sustainable" BSC or SBSC (Table 3).

The simplest strategy is integration of one or two socio-environmental indicators into the BSC perspective that is more vulnerable in terms of sustainability issues. This amounts to a first step in strategic management of sustainability, but is still considered a "partial SBSC" (Bieker et al., 2001). Kaplan and Norton's (2001) recent writings, for example, can be included within this partial approach as they propose integration of environmental considerations into the internal processes perspective.

A second approach proposes integration of socio-environmental indicators into all four perspectives, not just one (Brown, 1996). This approach is known as "transversal SBSC," in which environmental and social indicators span all four BSC fundamental dimensions. Such an approach significantly increases integration of sustainable management compared to the "partial SBSC" (Figge et al., 2002).

A third approach represents a further step in terms of integration. This approach proposes inclusion of a distinct fifth dimension specifically embracing social and environmental sustainability. Such a solution, which is called an "additive SBSC" (Figge et al., 2002), would elevate sustainability's status in the company and would probably be found in companies with a high degree of exposure to sustainability issues.

Finally, we can note a more comprehensive approach called "total SBSC" which is considered a combination of the "transversal" and "additive" approaches previously described. The fifth dimension, sustainability, would be related to trend indicators for all four dimensions and would be part of the cause–effect relationship among them. Johnson (1998) also proposes relating environmental indicators to organizational strategies through a cause–effect relationship.

Although integration of sustainability into management models is present in managerial accounting literature as reflected in different models of SBSC, these models are not yet integrated into BI literature, particularly as regards BI methods related to the information planning phase. Indeed, it was the absence of the sustainability theme in BI literature which led us to embark on a grounded approach, which means trying to learn from experiences of enterprises that excel in sustainability practices what role ICT – BI systems in particular – are playing or could play.

3. Research methods

The methodological approach guiding our empirical work is an adapted version of grounded theory that begins with a genuinely inductive approach, i.e., one that starts from scratch without any theoretical model guiding data collection and analysis, but which integrates existing theoretical models in the last phase of data analysis (Pandit, 1996). We benefit from intensive empirical work with firms in the forefront of sustainability as well as from the literature review, particularly that concerning SBSC, in the final phase of theory building.

Grounded theory is a well-known research approach in social science and related fields that was originally developed by Glaser and Strauss (1967). The authors propose inductive discovery of theories from systematic analysis of empirical data. In part, this inductive perspective grew out of the authors' disappointment with the predominant hypothesis-based and deductive practices in social science. Since their seminal work, *The Discovery of Grounded Theory*, other books and articles have further developed and debated this method (Glaser, 1994, 1998; Glaser and Holton, 2004; Strauss and Corbin, 1990, 1994, 1997).

Table 3
SBSC (sustainable balanced scorecards) approaches.

Type of approach	Main features
Partial SBSC	Integrates one or two socio-environmental indicators into a single perspective
Transversal SBSC	Integrates one or more socio-environmental indicators into all four perspectives
Additive SBSC	Integrates one or more socio-environmental indicators into a fifth perspective
Total SBSC	Both transversal and additive

Important characteristics of grounded theory, as originally proposed by Glaser and Strauss are: (1) construction of theory, and not just codification and analysis of data, is a critical aspect; (2) as a general rule, the researcher should not define a conceptual framework before beginning the research, so as to allow concepts to emerge without being influenced by pre-defined "biased" concepts; and (3) analysis and conceptualization are arrived at primarily through data collection and constant comparative referencing of each piece of data with extant theoretical constructs and concepts. In sum, it seeks to enhance an existing category and/or to form a new one, and/or to establish new points of relationship among categories.

Moreover, grounded theory can be considered a qualitative research method that seeks to generate new theories through basic elements: concepts, categories and properties. Instead of learning from an existing theoretical view (deductive approach), it emphasizes learning from the data (interactive and inductive approach). In addition, what primarily distinguishes grounded theory from other qualitative methods is its specific focus on theoretical development through continuous interdependence between data collection and analysis (Strauss and Corbin, 1997). Grounded theory entails a method that seeks, without forsaking flexibility or rigor, to provide a clear methodological structure for systematic collection and analysis of data, something frequently absent from other qualitative approaches (Calloway and Knaap, 2005). A summary of the steps guiding our empirical research is presented in Table 4. The main particularity of this adapted version, as proposed by Pandit (1996), is the inclusion of step 9.

We considered this adapted version of grounded theory appropriate to our investigation because of its emphasis on the learning process as growing out of the data, rather than out of existing theoretical models (therefore, not found in the review of literature). Recalling our research question (step 1), it asks: *How can the process of defining and monitoring socio-environmental indicators be integrated into the organizational strategy for sustainability?*

The field work was carried out in the state of Sao Paulo, a region of Brazil which features an effervescent business movement towards sustainability. A large number of firms publish social and environmental reports, namely the *iBase Social Balance* and the *Ethos Social Balance*, and take part in the *Bovespa Sustainable Business Index* (equivalent to *Dow Jones Index of Sustainability*).

We decided to avoid following a pre-conceived model and, instead, let the empirical work help us in drawing up a new model. However, we did not ignore what we found in the literature review. On the contrary, models found in the literature, particularly the four SSBC models, were integrated into the final segment of the literature comparison phase (step 9), as suggested by Pandit (1996), allowing us to enrich our conceptual model without eliminating the fecundity stemming from inductive work.

3.1. Case selection

Grounded theory points out the importance of non-random theoretical sample selection (Pandit, 1996). The selection process should ensure that issues considered important for the research question are truly being addressed (step 2). With this goal in mind, we established the following three criteria for selecting Brazilian firms located in Sao Paulo (selected companies meeting at least two of them): (1) the company should be an advocate or signatory of at least one of the various principles, norms, certifications or reports related to sustainability (GRI, ISO14001, SA 8000, etc.); (2) the company should be indexed by the *Dow Jones Sustainability Index* and/or the *Bovespa Sustainable Business Index* (Brazilian index); (3) the company should have received awards or public recognition for actions related to sustainability. Based on those criteria, five large companies recognized as leaders in sustainability practices were selected, denominated as FIN1, FIN2, FIN3, IND1 and COS1. Two of them (FIN1 and IND1) met two of the above criteria, and the others (FIN2, FIN3, and COS1) met three of

Table 4
An adapted version of grounded theory in 9 steps.

Phase		Main activities
Research design phase		
Step 1	Review of technical literature	Defining the research question
Step 2	Selecting cases	Theoretical (not random) sampling
Step 3	Develop rigorous data collection protocol	Defining themes that delineate the boundaries of the research question, and building an initial guide for interviews.
Step 4	Entering the field	Overlapping data collection and analysis Using flexible and opportunistic data collection methods
Data collection phase		
Step 5	Data ordering	Sequencing events chronologically
Data analysis phase		
Step 6	Analyzing data	Using coding and memo
Step 7	Theoretical sampling	Looking for theoretical replication across cases Returning to step 4 (until theoretical saturation)
Step 8	Reaching closure	Looking for theoretical saturation when possible
Literature comparison phase		
Step 9	Compare emergent theory with extant literature	Making comparisons with conflicting frameworks Making comparisons with similar frameworks

the designated criteria. FIN1, FIN2 and FIN3 are banks, IND1 and COS1 are manufacturers of plastic pipes and cosmetics, respectively (a detailed description of the companies is available upon request).

3.2. Data collection

In all cases selected, data were collected from semi-structured interviews and supporting documentation (i.e., annual reports, social balances and websites). A research protocol was developed to guide the entire data collection process (step 3). The data collection was structured around three broad themes: (1) organizational structure, strategic planning; (2) sustainability and CSR vision, and definition of indicators; and (3) BI project maturity. It is important to clarify that these three themes do not correspond to a theoretical framework (grounded theory approach precluding such a framework), but were defined in order to help delimit the study focus, to set boundaries for the research question and to guide the field work of the researcher.

Following grounded theory guidelines, data should be collected and simultaneously analyzed. The questions included in the interview protocol (also available upon request) ranged from broad to specific, and they changed as concepts, categories and relationships emerged from the data collected and analyzed. Concepts changed from simpler to more elaborate and refined. Also, because of the overlap existing between data collection and analysis, as the study evolved, we had to make a more purposive selection of new respondents. For example, due to new concepts (the seed of a theoretical model) that emerged from the collection/analysis process, we have identified categories that should be further developed. Consequently, we were forced to select new respondents (saturation had not been attained at that point) or ask for a second round of interviews with respondents already interviewed (step 4).

In sum, in the first round of interviews we conducted 16 interviews and in the second round, five interviews, totalling 21 interviews (Table 5). All interviews were conducted between March and September 2006. The interviewees were basically selected for their deep knowledge of the firms' sustainability processes and practices, including all phases: planning, operationalizing and evaluation. Interviews were recorded (audio) by one of the authors, except for the IND1 company, where interviews were conducted by a third researcher, part of our research team, who used a very similar research protocol and provided access to interview transcriptions. The IND1 case proved to be very important during data analysis, given that this organization is substantially advanced in terms of integrated sustainability, including a "total SBSC" and a well structured BI platform.

3.3. Data analysis

Our next step was to prepare a detailed description of each company, based on interviews and supporting documentation (step 5). After that, several techniques suggested by grounded theory were employed (steps 6 and 7). First, using an open coding technique, we identified concepts, possible categories and related properties from the collected data, i.e., categories were drawn from the data itself. Identified concepts were organized into categories, from which properties or sub-categories were also identified, establishing relationships between them (axial coding). Selection of category names reflects the use of

Table 5
Summary of data collection through interviews.

Firm	Total	First round		Second-round	
		Function of respondents	Duration[b] (h)	Function of respondents	Duration[b] (h)
FIN1	Four respondents Five interviews	(a) Business manager 1[a] (b) Executive planning manager 1 (c) Senior planning analyst	1.30	(a) Business manager 1[a] (b) Business manager 5	1
FIN2	Four respondents Five interviews	(a) Sustainability Senior analyst[a] (b) Sustainability Executive manager (c) Business manager 2 (d) Business manager 3	2	(a) Sustainability senior analyst[a]	1.30
FIN3	Three respondents Three interviews	(a) Sustainability coordinator 1 (b) Business manager 4 (c) Support area manager	1.30	–	–
COS1	Three respondents Three interviews	(a) Sustainability coordinator 2	4.30	(a) Executive planning manager 2 (b) Systems analyst 3	1.30
IND1	Five respondents Five interviews	(a) Quality control and environment director (b) Social communication director (c) IT manager (d) Systems analyst 1 (e) Systems analyst 2	2	–	–

[a] Two interviews with the same respondent.
[b] Average duration of each interview.

terms applied by the respondents themselves – so-called indigenous terms – and the use of terms brought by the researcher as a way to make sense of the data – so-called sensitizing terms.

At this point, the first theoretical propositions could be developed and the drafting of memos (research insights) began. This process was applied in each selected case (FIN1, FIN2, etc.) and the results systematically compared across cases. Once all cases were analyzed, data was reassessed and re-coded, using the scheme of categories and properties identified, according to the constant comparison method.

In each iteration, we tried to scrutinize the internal consistency of the structure of categories and properties being conceived. The emergence of new concepts that did not fit into the existing set of categories and properties forced us to question the emergent model and follow up with additional interviews. These new interviews (with new respondents or second-round interviewees) allowed further development and understanding of the categories, properties and their relationships. In short, the study went back and forth through data collection many times. The interaction between data and concepts ended when reassessments generated no new categories, sub-categories, or questioning of existing ones – in other words, when the theoretical saturation point was reached (step 8). Lastly, we compared the model grounded from the analysis to conceptual models previously reviewed in the literature, particularly the four SBSC models (step 9). The intention was to promote a final refinement of certain categories and properties. This dynamic allows for a balance between learning from empirical data and from existing theories without diminishing the value of an inductive approach.

4. Research results from a grounded theory approach

Fig. 1 illustrates the main contribution of this study, a BI conceptual model that seeks to support the processes of definition and monitoring of socio-environmental indicators and their integration into the firm's business strategy and practices. Accomplishing grounding through systematic execution of the nine steps of the adapted grounded approach, this model is original and helps with integration of sustainability and social responsibility practices into corporate management systems using the support of BI tools and methods.

Like any typical conceptual model, it is built of categories and properties, or relationships between categories. The model encompasses two complementary building blocks: *Organisational Context* and *Indicators in Perspective*. The first component identifies a group of organizational categories, facilitating incorporation of sustainability into business strategy and management. The second component identifies a structure that integrates socio-environmental indicators with financial indicators, and categorizes them in a way that provides a multidimensional perspective on organisational performance.

The *Organisational Context* encompasses three views: corporate vision, organisational structure and organizational mechanisms. It confers huge importance on top management's commitment to the principles of sustainability as the starting point for the process of integrating sustainability into business strategy and practices. The motivators of top management's commitment might be of an external and/or internal nature: compliance with legal requirements and regulations; pressure from stakeholders and local community; pressure from employees; a quest for enhanced corporate image, etc. Whatever the motivation, top management's commitment is seen as a driver for building leadership and for changing the organisational structure in a way that allows effective incorporation of sustainability, particularly through creation of a governance structure and of a formal sustainability area with responsibility for promoting sustainability in all other areas.

Corporate vision and organisational structure are the drivers for a set of organisational mechanisms that will legitimate and consolidate the integration of sustainability: implementation of an educational program to promote sustainability internally and externally; implementation of clear mechanisms for communication and monitoring; and implementation of a system of recognition and valorization of sustainable practices and initiatives. Although these three mechanisms jointly form
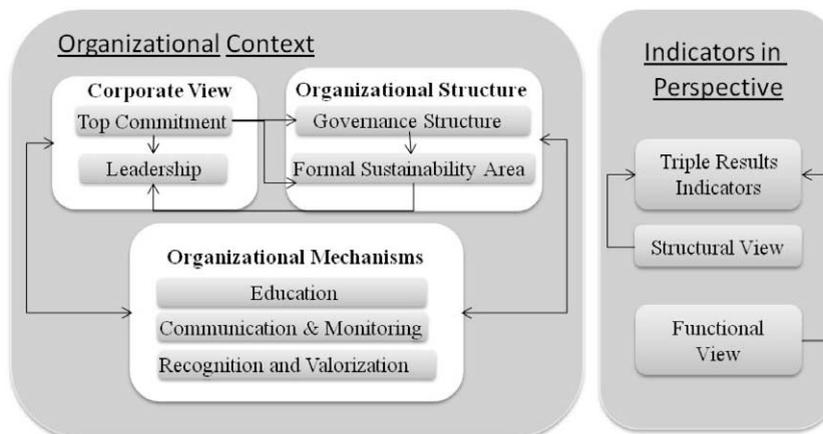

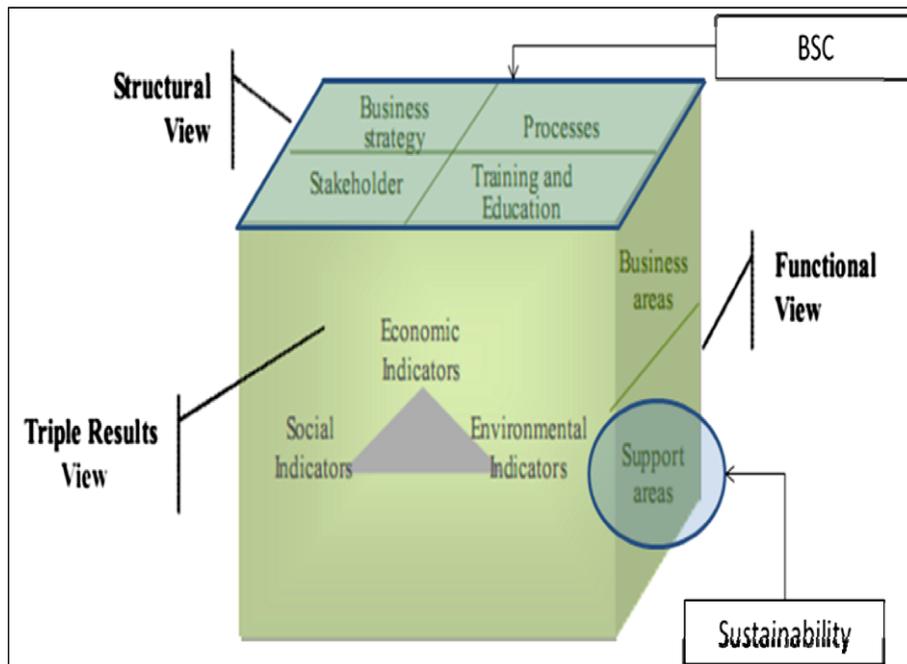**Fig. 1.** A BI conceptual model that integrates sustainability.

Fig. 2. Details of the perspective "Indicators in perspective".

the basis for integrating sustainability, one is directly related to BI projects: communication and monitoring. To be able to communicate and to monitor sustainable practices and advances in those practices, there needs to be put in place a set of sustainability-related indicators which (Fig. 2), in turn, cannot be effectively implemented without support of a BI platform.

The identification of the *Organisational Context* categories and their interdependence represents an important part of our model, offering a frame within which a BI project can be developed. For reasons of length, the current paper cannot further explore the full richness underlying the *Organisational Context* categories.[3] We concentrate the next sections on the second component, *Indicators in Perspective*. While *Organisational Context* offers foundations for effective integration of sustainability into business strategy and organisational practices, the second part of the model, *Indicators in Perspective*, complements such integration with an effective management tool, allowing systematized monitoring and analysis of economic, social and environmental indicators. *Indicators in Perspective* supports primarily the first phase of a BI project: the definition of information needs. It also constitutes a guide for data storage (factual tables and dimensions of a data warehouse and data marts) and for data analysis that will occur once the BI system starts to be used.

Indicators in Perspective rests on a multidimensional structure which seeks to allocate economic, social and environmental indicators at the same level of importance (Fig. 2). Three views of *Indicators in Perspective* emerged from our data analysis: Triple Results, Structural and Functional. The first view, *Triple Results*, corresponds to the well-known concept of "triple bottom-line", and its purpose is to guarantee equal weight to economic, social and environmental indicators.

The second view is called *Structural View*, is represented by four macro-level dimensions used to assess business performance: business strategy, stakeholders, processes, and training and education. Although these four dimensions have emerged inductively from systematic data collection/analysis as prescribed by the grounded theory approach, they are comparable to the four dimensions set out in the BSC: finance, customers, process and learning and growing. We discuss the reasons for and implications of this parallel in the next section.

The *business strategy* dimension offers a view of indicators as a function of strategic objectives and themes defined by the organisation. For example, the organisation might define a strategic theme or objective as "reduction of environmental impacts", which would involve factors such as water consumption, garbage disposal and carbon dioxide emission.

> *"This year we have 17 indicators considered more strategic, more relevant, and are linked to strategic objectives by the executive board and different departments [...] when each department defines its strategic map, an indicator can be in more than one field and the [coordinators] know that any department can have a socio-environmental objective as part of their strategic map"* (Sustainability coordinator, COS1).

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[3] For more information about organisational context categories, see Bansal (2003), Sharma and Henriques (2005), Stone (2006) and Tregidga and Milne (2006).

The *stakeholder* dimension represents a view which is a function of the main affected groups, not limited to investors and shareholders. For example, local community can be part of the stakeholders, incorporating indicators related to educational action for the community and members of volunteer staff.

"*The view of the stakeholders is very important for us. We have meetings to discuss objectives and themes related to socio-environmental impacts. For example, last year we invited the call-center supplier and transportation companies to discuss indicators of quality of life of their staff, like how much of their employees' quality of life is compromised just by working for COS1. This information can be an indicator for us*" (Sustainability coordinator, COS1).

The *process* dimension illustrates performance indicators as a function of those internal processes considered strategically critical and generates economic, social, and environmental assessments for stakeholders. For example, the internal process labelled "improvement of factories operations" might be considered an important objective, leading to definition of total quantities of residues and recycling rates as indicators.

"*One of our strategic objectives is to reduce the emission of greenhouse gases and for this I do need to see how it can be done internally. Today, I know that we don't have environmental problems within the production line; we have standards above those legally required. However, this is still a relevant problem because we have a huge impact from the logistic processes, like product transportation.*" *(Sustainability coordinator, COS1).*

Finally, the *training and education* dimension represents analysis of indicators in light of initiatives identified to promote human capital and long-term growth and innovation. For this dimension, the main source is people-related information, like number of scholarships, enrolment rates in internal educational programs, and number of union participants.

"*The improvement of quality of the relationship with the internal constituency implies the development of the staff and the provision of education related to sustainability [...] awareness, so they can make use of [sustainability] as a value for the company and then develop a series of indicators that minimize human failure and can identify and make a diagnosis of what can be improved, and about what people need to be educated to validate our claim as a sustainable company.*" *(Sustainability senior analyst, FIN2).*

The data analysis allowed us to further detail the four macro-level dimensions of the structural view. As shown in the two first columns of Table 6, for each dimension of the structural view we identified main components. For instance, the business strategy dimension can be subdivided into two components – corporate and business units; the stakeholders dimension can be subdivided into several components – clients, suppliers, shareholders, etc. This level of detail is not obligatory but optional; it depends on the degree of granularity desired by a given firm in the analysis of its performance.

Finally, the third view, the *Functional View*, offers an analysis closely related to business operations and concrete business practices by function or area. The goal is to evaluate a company's performance based on indicators that measure actions developed in each of the company's areas or departments following strategic guidelines. The functional view reflects the different departments of the company which can be related to business and/or to support areas. We denominate as *business areas* those directly related to the final activity of the organization. In the case of an industrial organization, those are areas in which primary activities are directly related to the manufacturing and distribution of the final product like retailing, post-retail processes, production and distribution. In the case of a banking firm, it would involve, among others, the production department (insurance, credit cards, assets, etc.) or the sales department. The *support areas* are those which make the

Table 6
Details of structural and functional views.

Structural view		Functional view	
Dimensions	Components	Areas	Sub-areas
Bussiness strategy	Corporate Subsidiary or business unit	Business (primary activities)	Product Sales
Stakeholders	Owners, shareholders and investors Internal and external collaborators Clients Suppliers Environment Society and local community Government and regulatory authorities	 Support (supporting activities)	Post-sales Production Distribution research and development Product Procurement Audits
Processes	Planning Product or services development Finance Human resources Operation		Risk management Information technology Financial Human resources Sustainability
Training and education	Infrastructure Technology people Best practices		

primary activities possible, such as information and technology, finance and human resources departments. The third and fourth columns of Table 6 show a detailed description of these functional views. In this table we can identify an area, termed sustainability which, due to its importance, is discussed in the next sub-section.

Thus, the proposed model seeks to fill gaps identified in the literature related to systematization of CSR indicators while integrating them within a concrete management model. The model attributes equal importance to economic, social and environmental indicators. The basic goal of the *Indicators in Perspective* model is to make possible visualization and analysis of an indicator under the umbrella of different dimensions related to it.

For example, a strategic business objective might be defined as "to reduce fixed assets" at the corporate level. According to the *Triple Results view,* environmental and economic indicators (one or more) should be defined and associated with this objective (in this particular case, we do not have social indicators associated with this specific objective). Given that fixed assets might affect atmospheric pollution as well as costs, three indicators might be initially defined: (I1) rate of fixed assets reduction; (I2) rate of pollution impact; and (I3) rate of fixed assets costs. Regarding the BI multidimensional model (see again Fig. 2), these three indicators might be analyzed, in addition to the *Triple Results view*, in terms of the other two views. According to the *Structural view*, I1, I2 and I3 would be associated with the *Operation* of the *Processes* dimension. According to the *Functional view*, I1, I2 and I3 would be associated with the *Production sub-area* of the *Business area* and/or to a support area – in this case, the *Sustainability sub-area* (if a formal sustainability sub-area was constituted). In short, analysis of indicators can be accomplished in a context of fertile multidimensionality, allowing decision makers to gather rich understanding of their sustainability practices across several business dimensions.

4.1. The role of BI in supporting sustainability

As described in the case selection, the five firms included in our investigation are recognized as leaders in sustainability. Yet despite their leadership status, in only one organization could we identify a mature BI platform fully integrated with the corporate management system (i.e., IND1). The other four firms succeed in performing well in terms of sustainability practices, but have neither a methodology nor an automated process for systematization of indicators. The causes of such a situation were identified as involving the fact that processes of collecting, consolidating, analyzing and distributing such indicators are carried out manually or are partially automated, and/or are carried out without guiding underlying assumptions. This absence of mature BI systems allowed us, initially, to question the role and importance of BI systems in supporting sustainability. However, as the empirical work evolved, we could perceive that even though the four firms have taken seriously managerial integration of sustainability practices, the lack of more sophisticated informational support is recognized as a significant weakness and an obstacle to be overcome in the near future.

> "We face several problems today because we do not have an integrated system. Because the indicators are elaborated in silo, in different areas by different people that are not working together, some months ago an indicator X was reported with different values in two different public reports." (Sustainability coordinator, FIN3).

The lack of support to information management decreases the reliability of the information collected – socio-environmental indicators – and also impedes their integration with other indicators required for effective decision making. In addition, factors deeply affecting management of the business and implementation of new strategies include time spent on gathering and validating the required indicators, lack of real-time and updated information at given moments, lack of understanding of indicators' meaning due to the absence of clear conceptualization (e.g., what is the definition of the indicator and what is its purpose?) and the lack of transparency.

> "Although we try to centralize here [sustainability area] all the information, several times we have trouble in gathering the numbers of areas like 'product'. For them, this is an additional task. In addition, we have the job of explaining again and again what the indicator means (...)"
> (Sustainability senior analyst, FIN2).

BI systems are seen by these firms as an important alternative, a technological platform that will offer an open and permanent channel of communication and information diffusion for supporting sustainability practices.

5. Discussion

Using a grounded approach, the major contribution of this paper is to propose a BI conceptual model that helps to support the process of defining and monitoring socio-environmental indicators that, combined with financial indicators, are integrated into the firm's business strategy and practices. One of the strengths of the conceptual model is the synergy of two building blocks: *Organisational Context* and *Indicators in Perspective*. While *Organisational Context* defines categories that, once articulated in a consistent way, help promote the integration of sustainability into business strategy and management, *Indicators in Perspective* identifies a structure that brings socio-environmental indicators and traditional financial indicators closer together and categorizes them in a way that provides a multidimensional perspective on organisational performance. Proposing this model, we provide contributions to research and practice by filling a number of gaps revealed by literature reviews on both themes: sustainability and BI projects.

First, one of the interesting capabilities of this model is fostering awareness that the implementation of a BI project aimed at supporting management of sustainability cannot be conceived of merely as a technological project, independent of important organisational initiatives. To work well, a BI project, particularly in the phase involving definition of relevant information needs, must take place in close relationship with other organisational categories, such as top-level commitment and leadership, governance structure and organisational mechanisms like recognition and valorization. This is in line with Eisenhardt and Sull (2001), who proposed linking the information definition phase with corporate strategic planning since BI systems are supposed to link operational and strategic dimensions of an organisation. A number of BI projects fail because they are taken as merely "technical" projects. Likewise, the BI literature has perpetuated the separation between managerial (focus on process) and technical (focus on tools) approaches, showing inequalities in their respective evolutions.

Our results help shed light on what role BI projects can play when the goal is to help integrate sustainability – essentially a role of support through BI methods and tools – and how BI projects become instrumentally important but context-dependent. Our results show that BI systems are seen by firms as a technological platform that offers an open and permanent channel of information monitoring and sharing for supporting sustainability practices. However, the development of a BI platform should be framed within a conceptual model that guides the definition and integration of socio-environmental indicators without neglecting the importance of the organisational context.

Secondly, the absence of the sustainability theme within BI literature impelled us to embark on a grounded approach. From the experience of enterprises that excel in sustainability practices, we tried to learn what role BI projects are playing or could play. Choosing an adapted grounded theory approach for our conceptual model can be considered original as it was built from iterative data gathering and analysis using firms that excel in terms of sustainability practices, but does not neglect existing theoretical models. Step 9 of the adapted version of grounded theory suggests a literature comparison phase, where conflicting or similar frameworks are systematically compared with the emergent conceptual model. In our case, we compared our conceptual model with existing SBSC models, yielding insightful conclusions. For instance, the *Indicators in Perspective* element rests on a multidimensional structure which seeks to attribute equal importance to economic, social and environmental indicators. This alignment accords with the literature review, which suggests the importance of multiple views and the central position being occupied by the triple-bottom-line concept.

In addition, comparison of the four dimensions of the *structural view* with the four axes of the BSC was quite interesting. The four dimensions of our conceptual model – business strategy, stakeholders, processes, and training and education – emerged inductively from systematic data collection/analysis, as prescribed by grounded theory approach. Surprisingly, these four dimensions are quite similar to the four axes of BSC – finance, customers, process, and learning and growing. After careful analysis, we considered our four dimensions more appropriate in a sustainability context than the SBSC, which integrates sustainability issues into existing axes or into an additional axis. By replacing "finance" with "business strategy", our model enlarges the scope of the firm's strategic goals, which can easily encompass sustainability goals. Also by replacing "customers" with "stakeholders", we take into consideration the various social actors intrinsically involved with sustainability matters: employees, suppliers, shareholders and community members in addition to customers. In short, step 9 helped us recognize that although the similarities between our model and the well-known BSC model reinforces the validity of our conceptual work, our model is richer in terms of the purpose for which it was conceived: to purposively integrate sustainability into a firm's strategy.

A third important result of our research is the inclusion of *sustainability* as a particular sub-area of the support area (functional view). This inclusion brings sustainability actions and activities closer to the operational side of the business with the goal, in fact, of supporting business operations. Making sustainability a support activity does not decrease its strategic role within the organisation. For instance, human resources is a support area that has a strategic role in many organizations. As proposed by the *Organisational Context* building block, adapting organisational structure to include a formal sustainability area in its governance structure is an important step in the process of integrating sustainability into organisational strategy and practices.

A fourth element to be discussed concerns literature on BI. Despite undeniable technological advances in BI implementation, it is clear that the major difficulties are not technical but methodological and conceptual in nature. The major barriers involve how to conceive and implement BI systems which effectively support strategic purposes and are integrated into corporate management systems. Some authors see the emergence of the concept of corporate performance management (CPM), and its use by a number of BI researchers, as a symptom of increasing concern with the strategic dimension of BI management models, i.e., the focus on identification of strategic information from the very beginning of the development of BI "solutions" for decision making processes (Miranda, 2004). However, CPM has evolved in conceptual but not in practical terms. In the course of everyday operation, companies claiming to have adopted CPM are still deeply focused on incorporating the budgeting process into existing software without taking into consideration relevant issues like CSR and sustainability. Our model contributes to the integration of defining and monitoring of eco-socio-financial indicators into the organisational context, showing that implementation of a BI system requires a conceptual model guiding its development that take both technical and managerial dimensions into account.

6. Conclusion

This study seeks to advance our knowledge of how BI projects can support the integration of sustainability into business strategy and management, particularly regarding the initial phase of BI projects where performance indicators are defined

based on the firm's strategic goals. Social responsibility and sustainability are becoming part of an organisation's vision, mission and goals. However, most of the time, they are not integrated into operative business management models, remaining detached in practice from corporate strategy and appearing more as particular actions and activities related to social projects in the community, philanthropic initiatives or regular changes in business process. The main motivation for our study grew out of our years of work in the BI area, and we see BI as a set of methods and tools, based on intensive use of IT, that has a large potential, still unexplored, for supporting sustainability practices and management. We have attempted to develop a model that integrates social, environmental, and economic questions while according the same degree of importance to each. The *Indicators in Perspective* model attempts to categorize social, environmental and economic indicators in a way that allows evaluation and analysis of business strategy and management within a single frame of reference. The multidimensional structure developed for integrating economic, social and environmental indicators is part of the facilitation process supporting a firm's attempt to become truly sustainable. Moreover, this structure is of fundamental importance as the purposive choice and periodic (preferably real-time) monitoring of indicators are essential to maintaining a company's reputation for sustainability.

Using an adapted version of grounded theory, the main contribution of our study is to propose a conceptual model that seeks to support the process of definition and monitoring of socio-environmental indicators and its relationship with management and business strategy. Although the model was grounded from Brazilian cases, we believe that it shows a certain degree of transferability to firms located in other countries, particularly if differing socio-economic norms are taken into account. A BI system has evident importance as a communication and information diffusion channel, preferably one that is open, trustworthy, transparent and permanent. In supporting the monitoring and evaluation of business results while maintaining information integrity, BI systems strengthen interaction between groups with a view towards established objectives, and serve as a tool for collaborators to learn, discover and exchange information regarding social and environmental actions taken within the organisation and by other organisations. This feedback process is an essential feeding source, which reinforces organisational behaviour aimed at socially responsible performance. Future research might build on the results proposed here by refining and extending the conceptual model, by reflecting about the transferability of the proposed model to different contexts, and by applying it in concrete situations (using action-research, for instance).

Acknowledgments

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