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Measuring environmental performance in hospitals: A practical approach

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ABSTRACT

In hospitals, measuring environmental performance may lead to the reduction of environmental impact of their operations and improve the quality of processes and outcomes. Healthcare services employ a significant amount of hazardous and non-hazardous materials and produce polluting outputs. New frameworks are necessary to define relevant and meaningful indicators for monitoring and assessing environmental performance if healthcare systems and operations are to be improved. The literature review highlights concerns on the lack of strategic focus of performance indicators, relevance and robustness of metrics and difficulties for the deployment of measures within different hierarchical levels. Field studies conducted with 10 hospitals in the Southern region of Brazil underlined the scarcity of consistent frameworks applied in practice to measure, monitor, improve and report environmental performance. Considering this context, the study seeks to propose an alternative framework drawn from the review of literature, current legislation and feedback from field research. The proposed framework is operationalized through a 'process approach' and evaluated in terms of feasibility, usability and utility. Six case studies were conducted to test the applicability of the proposed approach. The framework was evaluated as 'Good' and 'Very Good'. Some of the advantages of the approach according to participants are: a) the framework and process make a significant contribution to practice, since they represent meaningful guidance for the formalization of strategies, goal setting and environmental assessment and monitoring; b) the approach is associated with a number of 'softer' outcomes related to the enhancement of communication and awareness of environmental issues, focus on environmental performance and continuous improvement initiatives; c) the framework facilitates the adjustment of hospitals to current legislation and quality requirements. Furthermore, the study contributes to a wider theoretical discussion on strategically focused public policy concerning the improvement of healthcare environmental performance. The framework and process also provide a systematic approach for hospitals performance monitoring and reporting.

1. Introduction

Hospitals in the US produce approximately 6700 tons of waste per day; healthcare waste is the fourth largest contributor of mercury to the environment. "Pollution prevention not only improves a facility's environmental performance, but can affect areas CEOs traditionally do care about" (Zimmer and McKinley, 2008). They spend substantial financial resources on waste disposal. This expenditure can range between 259 and 401 million dollars per year in US hospitals (Unger and Landis, 2016). According to Karlsson and Öhman (2005), one hospital in Sweden is capable of consuming 242,000 m^3 of water, 37 GWh of energy; it can produce 1330 tons of biodegradable waste, 127 tons of industrial waste, 123 tons of hazardous waste, 164 tons of paper waste and 14 tons of glass waste

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per year while caring for 150,000 patients. "The growth of environmental awareness and the development of stronger environmental regulations coupled with current needs to cut costs on public expenditure have brought the health sector's environmental issues to the fore". New regulations have forced hospitals to promote environmental performance through a more systematic manner. "Staff training and awareness underpin several of the short and medium/long term solutions suggested to reduce the waste at the source and recover value from that produced" (Tudor et al., 2005). Porter (2010) claims that enhanced performance depends on the existence of a common goal for different stakeholders. In healthcare, this goal relates to the definition of value represented by patients' health outcomes by currency unit invested. If this value is improved, patients, managers and suppliers can benefit from it while sustainability is attained.

Quality improvements lead to less waste of resources, improvements in patient satisfaction and medical care effectiveness (Maki et al., 2008). "[…] the measure should be capable of indicating whether the process has been delivered with sufficient effectiveness to make improved outcomes likely" (The Joint Commission, 2015). "Interest in linking indicators to goals and targets enables their use in tracking performance and helps link them to policy priorities" (Pintér et al., 2005). Although efforts related to improving environmental performance in healthcare have been put in place, outcomes have been unsatisfactory (Phillips et al., 2002; Lifvergren et al., 2008). Furthermore, whereas indicators related to the economic/financial dimension of the triple bottom line framework (Elkington, 1994) can be measured in dollars, finding a common unit of measurement related to the social and environmental dimensions presents a challenge (Slaper and Hall, 2011). According to Moldan et al. (2012), these indicators should be linked to reference values, targets and appropriate scaling.

In developing countries such as Brazil, healthcare operations face major challenges including high costs of healthcare services, limited productive resources and infrastructure, lack of public investments and strategically focused governmental policies. Hospitals are divided according to their organizational structure and relationship with the Unified Health System (SUS) established by the Brazilian Government. Three main groups can be found: (a) private entities for profit, (b) private not for profit entities (predominantly philanthropic associations) and (c) public hospitals (BRASIL, 2002). They are also divided by size: a) small (1–49 beds); b) medium (50–150 beds); c) large (151–500 beds); d) special or extra (more than 500 beds). 'Philanthropic' hospitals correspond to 2/3 (two-thirds) of the medical assistance (CMB, 2015). The Unified Health System (SUS) 'owns' 348,548 beds, which account for 68.72% of the total of hospital beds (CNES, 2014). McNatt et al. (2015) could not find any implemented and sustained national systems composed by comprehensive sets of indicators to monitor hospital performance in low-income countries. As per the authors, "the literature on the development and implementation of systems for monitoring hospital performance is largely dominated by case studies and reports from high-income countries with national health systems […]". Moreover, the loss of professionals in low and middle-income countries has represented a hurdle for healthcare systems (Willis-Shattuck et al., 2008). Improvements and new developments in conceptual, legal and methodological frameworks are necessary to incorporate sustainability thinking (Duić et al., 2015).

Considering this context, the study proposes a framework to be used in practice by managers to measure environmental performance. The paper is divided in seven sections. The research design is discussed in Section 2. Section 3 summarizes the literature review, current legislation and feedback from field studies. Section 4 describes the proposed framework and process. Section 5 encompasses the refinement and testing phases. Section 6 contains a discussion on the results. Section 7 summarizes study conclusions.

2. Research design

The study included a comprehensive literature review on healthcare operations, performance measurement frameworks, measurement of environmental performance and Brazilian regulations related to the topic. The review included a bibliometric analysis of main authors, publications, research centers/universities and emerging themes from 1988 up until 2015, using citation analysis. Aiming to achieve further insight into the performance measurement practice, field studies were conducted in 10 hospitals in the Southern region of Brazil. All 10 hospitals are private, including small and medium-sized; seven units were philanthropic. Field studies include one or more visits to the facilities of an organization without involving a lengthier period for interaction (Gupta et al., 2006). The general manager of each hospital was interviewed. The interviewing guide contained the G3 Environmental Dimensions proposed by the Global Reporting Initiative (GRI, 2006). A theoretical framework was developed, using the literature review findings, current legislation and feedback from field studies. As the existence of a framework does not guarantee its application (Gouvêa da Costa et al., 2006), a three-stage process based on the Cambridge approach (Platts, 1993) was developed. The process approach defines vital operationalization elements. Different steps, tasks and those responsible for their completion are defined. The approach was deemed appropriate to test the framework applicability, since it is represented by elements with a practical focus. It creates a systematic process to address a process problem, the environmental performance measurement. Fig. 1 represents the research design.

Case research with action research are prescribed within the process approach. Case studies allow researchers to study a phenomenon as an integrated whole if provided with a systematic process for data gathering (Pope et al., 2000). Action research creates an iterative process of collaboration between the researcher (facilitator) and hospital staff beginning with the identification of

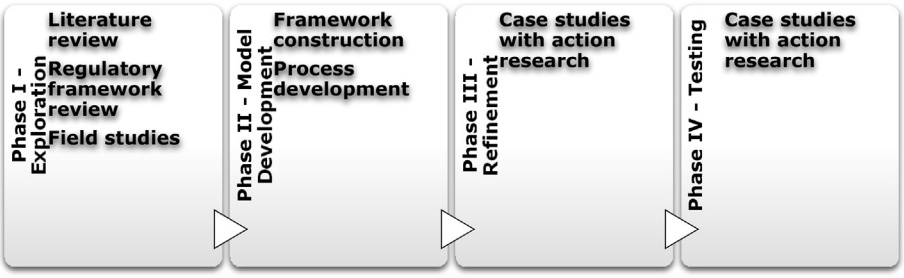

Fig. 1. The research design.

issues and leading to the development of new solutions (Bradley et al., 2009). The framework was applied in six hospitals. Three cases studies were included for refinement and three other hospitals represented testing cases. Multiple case studies permit cross-analysis of multiple contexts, using a replication logic (Yin, 2012). Emergent findings related to theory building can be clarified with varied sources of evidence through comparison (Eisenhardt and Graebner, 2007).

A facilitator (in this case, one of the researchers) conducts the process with a multidisciplinary group indicated by the project leader, who is designated by the hospital. The project leader is usually a senior member of staff. This figure is vital in the process. His role is to guarantee the presence of all participants, sufficient time and resources for the application. The approach provides a systematic process registered through worksheets (WS). In average, the application of the process took six workshops (WH) in seminar format, including the initial step of 'selling' it to the hospitals, the Point of Entry. Furthermore, it contains evaluation forms filled by participants, which analyze the model in terms of feasibility (can the process be followed?), usability (is the approach easily followed?) and utility (are the results useful for managers?) after each phase and after the end of the complete process.

3. Literature review

The literature review was summarized in three sections. Section 3.1 discusses the measurement process for healthcare operations. Section 3.2 contains the legal framework related to the environment and hospital operations in Brazil. Section 3.3 lists some of the performance measurement frameworks adopted in the country. Two main aspects were verified: frameworks currently adopted by hospitals and the impact of regulations on healthcare operations.

3.1. Performance measurement in healthcare

It is estimated that the NHS, British National Healthcare System, inpatient admissions produce 380 kg of CO_2 equivalents per patient, 80 kg of CO_2 equivalents per inpatient day, and 50 kg of CO_2 equivalents per outpatient appointments (Campion et al., 2015). Indicators such as Kilograms per solid waste by patient bed/day or Kilograms of solid waste per appointment, per day have been suggested. There is significant consensus in literature that a number of indicators are necessary to capture all relevant aspects of a particular system. A multiple stakeholder perspective has been indicated as one of the most important characteristics that contribute to the success of performance evaluation models, considering the complexity of healthcare operations (Tawfik-Shukor et al., 2007). Performance indicators should represent an integrated information network that is source for benchmarking and strategic planning. Performance indicators raise issue awareness and understanding; inform the decision-making; and measure the achievement of goals (Ventura et al., 2010). Specific indicators characteristics are required to evaluate performance efficiently: measurability, relevance, clarity, reliability, data accessibility, opportunity and long-term view (Feng and Joung, 2011). The existence of a framework dealing with measure deployment in the strategic, tactical and operational levels to include tangible, intangible, financial and non-financial aspects is also questioned by literature (Gunasekaran and Spalanzani, 2012).

3.2. The Brazilian regulatory framework for hospitals and environment

Ten regulating documents deal with hospital waste control and disposal. The evaluation of organizations that provide healthcare services NA2 Rev. 01 of March 2006 is mandatory to acquire Hospital Accreditation with the National Organization for Accreditation (ONA, abbreviation in Brazilian Portuguese). The National Environment Council (CONAMA) and the National Health Surveillance Agency (ANVISA) have specific resolutions. ANVISA Resolution 63 defines good operating practices. CONAMA 358 addresses healthcare waste treatment and disposal and ANVISA Resolution 306 deals with waste management. The Brazilian Technical Standards Association (ABNT) has issued six standards on hospital waste. ABNT legislates on waste transport (NBR 14652); methods for the collection of perforating/cutting materials (NBR 13853); internal and external collection of waste under hygienic and safe conditions (NBR 12810); classification of materials and definition of terms (NBR 12808/NBR 12807); required procedures for intra-establishment management of healthcare services waste (NBR 12809).

In spite of existence of a legal framework, Da Silva et al. (2005) concluded from a study on 91 healthcare facilities in Brazil (two hospitals, 48 health centers and 22 clinical laboratories) that the practice, in most cases, do not comply with current legislation. Existing regulations are yet to produce better environmental performance. The scarcity of regulations that define the consumption of other resources such as water, electricity and fuel in Brazilian hospitals is also noteworthy. Recently, initiatives have tried to address the disposal of liquid waste by creating Eco-centers and Treatment Facilities for Effluents (Vieira et al., 2013). Concerns on measurement environmental performance are insufficient and limited due to a reduced number of issues (La Forgia and Couttolenc, 2008).

3.3. Environmental performance measurement frameworks applied in Brazil

Current legislation has prompted frameworks to measure healthcare environmental performance. That is the case with the Brazilian Manual of Hospital Accreditation (BRASIL, 2002). Nonetheless, it represents only an incipient guide. The existence of indicators is recommended without systematic guidance. General maintenance, waste and water potability are observed.

ISO 14001 lists principles that are periodically verified and evaluated for re-accreditation. Dimensions such as pollution of waters, lands and air are verified. Brazilian Hospital Albert Einstein (Hospital Israelita Albert Einstein – HIAE, in Brazilian Portuguese), the most modern private hospital in Latin America represents a certified organization. Its Environmental Management System has built commitment to environmental issues; a rational use of water, electricity and resources (SBIB, 2015).

The Syrian Lebanese Hospital (Hospital Sírio Libanes – HSL, in Brazilian Portuguese) is a hospitals philanthropic complex and one of the main medical centers in Latin America. HSL adopts a performance measurement framework based on quality programs and the 'Global Green and Healthy Hospitals Agenda'. Its programs have generated yearly savings of one million cubic meters of water and 679 tons of paper and recycling of 19 tons of glass, 23 tons of aluminum and 101 tons of plastic (HSL, 2015). Two primary objectives are envisaged: better utilization of input material (water, electricity, gas) and waste management/reuse of produced waste. Indicators focus on waste generation and inputs consumption.

The 'Global Green and Healthy Hospitals Agenda' used by HSL is also adopted in Brazil. The model was created by the coalition '*Salud Sin Daño*' (Health Care Without Harm), an international network of healthcare systems, hospitals, communities, unions and environmental organizations. The framework has 10 main objectives: leadership, chemicals, waste, energy, water, transportation, food, pharmaceuticals, buildings and purchasing (GGHHA, 2015). Although, the global agenda presents a comprehensive list of objectives, there is not guidance on how to develop specific indicators.

Recently, the Triple Bottom Line (TBL) framework has been deployed in Brazilian hospitals (Campos and Ramos, 2014). According to the researchers, the adoption of the framework has focused on the implementation of environmental initiatives to reduce energy and water consumption. Although, results were mostly positive, initially these initiatives required substantial investments. There was no involvement of teams or development of indicators. Brazilian hospitals have yet to approach systematically the environmental dimension. Concerns have focused on the financial sustainability of their operations, considering the philanthropic status of many of them (Froehlich and Bitencourt, 2015).

The GRI methodology is based on a voluntary initiative to standardize sustainability reports. Indicators related to the three dimensions of sustainability are suggested. HIAE has adopted the methodology. Regarding the environmental dimension, indicators are listed in terms of materials, energy, water, biodiversity, emissions, effluents and waste, products and services, compliance, transport, overall expenditure and investments in environmental initiatives, supplier environment assessment and environmental grievance mechanisms (GRI, 2014). The indicators suggested by GRI encompass essential aspects of environmental performance (Morhardt et al., 2002). GRI guidelines have been promoted by the United Nations Environment Programme (UNEP). It is regarded as the most prominent reporting guide by including a balanced approach of financial and social issues and environmental concerns.

4. The proposed framework and process

The proposed framework and process are presented in two sections. Section 4.1 describes the framework guidelines. Section 4.2 lists the proposed process phases and adopted strategies for field application.

4.1. The developed framework

Indicators should be action-oriented and developed using a bottom-up approach based on the knowledge from specific contexts (Girard et al., 2015). Scientific soundness and applicability should be achieved. Three aspects are known to address scientific soundness: reliability, validity and adjustability. It involves parsimony and comprehensiveness (Carlucci, 2010). Pintér et al. (2012) argue that organizations with superior environmental performance are forthcoming in disclosing their environmental status; they look into the future through indicators that reveal risks of non-sustainability. Although a number of models and indicators to measure environmental performance have been proposed in literature, initiatives related to the environmental dimension tend to lack strategic focus. The main purpose behind these initiatives has been connected with regulations, accreditation requirements and elements pertaining to quality programs. The deployment of measures in different hierarchical levels has become troublesome due to lack of strategic focus (Robèrt et al., 2002). Field studies conducted in Brazilian hospitals emphasized the scarcity of consistent frameworks to measure environmental performance. Literature review findings, current legislation and feedback from field studies were used to develop the framework. These inputs became eight 'content guidelines' for the framework and process. Table 1 lists these guidelines, implications and supporting references.

G1 constitutes the foundation for the framework by including three main phases of the performance measurement process: conception, implementation and analysis. Addressing G2, G3 and G4, the indicators should be developed/selected using criteria such as measurability, validity and controllability. The selected indicators were drawn from the GRI dimensions, legal aspects (RDC ANVISA 63, RDC ANVISA 306, CONAMA 358) and 'best practices' related to the 'ISO 14001', 'Balanced Scorecard', 'Hospital Accreditation Manual' and 'Green Hospitals Agenda'. All selected indicators correspond to environmental issues. Identified indicators are related to the definition of goals. These goals are deployed within hierarchical levels: strategic, tactic and operational. This represents Phase I – Conception. G5 indicates that the implementation of measures is related to the communication of defined indicators, since the completion of tasks shows the efficiency and effectiveness of actions. This represents Phase II – Implementation. G6 and G7 suggest that the monitoring of goals is vital for the performance measurement. G8 refers to the way environmental performance is reported to stakeholders. This represents Phase III – Analysis. The framework is operationalized through a three-phase process: (1) Conception; (2) Implementation and (3) Analysis. Fig. 2 represents the proposed framework.

The 'process approach' is defined by 5Ps (Platts et al., 1998): Purpose, Procedure, Project management, Participation and Point of entry. A multidisciplinary group performs activities prescribed in

Table 1
Framework content guidelines.

	Content guidelines	Implications	Supporting references
G1	Performance measurement systems should be developed, implemented and evaluated.	The framework should be developed considering three phases: conception, implementation and analysis.	Bititci et al. (1997); Bourne et al. (2000); Neely (2005).
G2	Performance measurement should be connected with organizational goals.	The environmental performance measurement system should be linked to the strategic focus of the organization.	Bititci et al. (1997); Fiksel et al. (1999); Bourne et al. (2000); Kaplan and Norton (2001); GRI (2014).
G3	The performance measures should be deployed in three organizational levels: strategic, tactical and operational.	The environmental performance measurement system should encompass different organizational levels.	Platts (1993); Gunasekaran and Spalanzani (2012); Weir et al. (2009); Feedback from field studies.
G4	Legal requirements	The field research and literature review indicate the need to fulfil environmental regulations.	McGlynn (1997); Kleindorfer et al. (2005); Townend and Cheeseman (2005); Veleva et al. (2003); Feedback from field studies.
G5	Performance indicators should be developed based on criteria such as measurability, validity and controllability.	Measures should be reliable in order to characterize the environmental performance of hospitals.	Neely et al. (2002); Tawfik-Shukor et al. (2007); Van der Geer et al. (2009); Feng and Joung (2011).
G6	Evaluation of indicators	Performance indicators should be evaluated in terms of the purpose for their conception.	Becker (1997); Bossel (1999); Bourne et al. (2000); Neely (2005); Clarkson et al. (2008).
G7	Monitoring of strategic goals	Collected data should be analyzed to evaluate the achievement of strategic goals.	Bititci et al. (1997); Bourne et al. (2000); Neely (2005); Scerri (2010).
G8	Environmental reporting	Through performance evaluation reports, it is possible to characterize the environmental performance of hospitals.	Bourne et al. (2000); Neely (2005); Montabon et al. (2007).

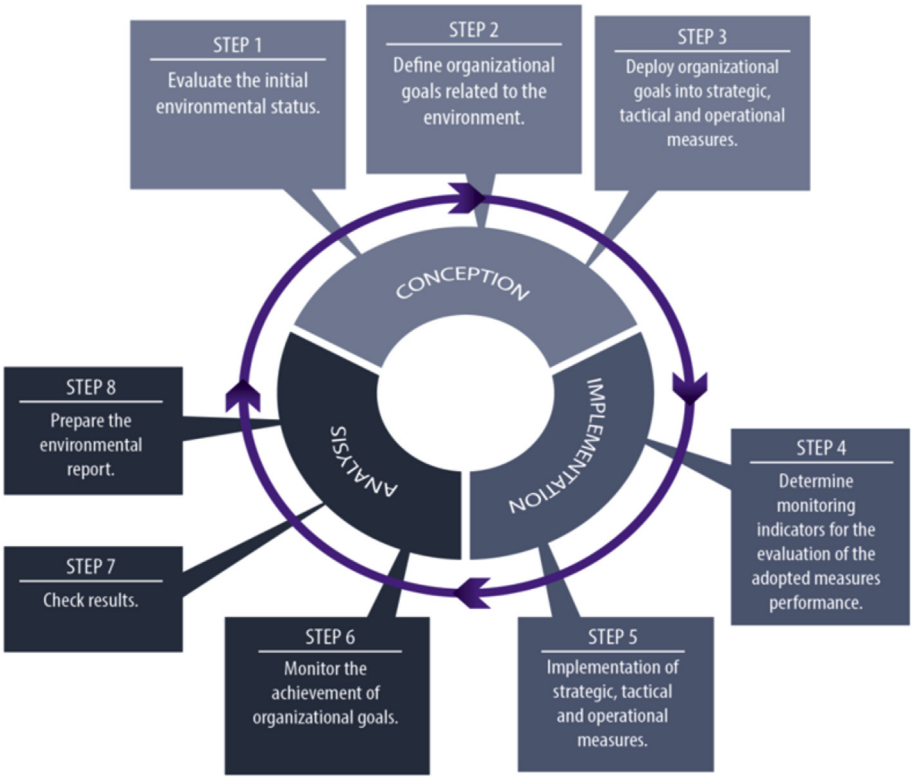

Fig. 2. The proposed framework.

the process during workshops (WH) in seminar format and worksheets (WS) record the collected information. Interviews with key actors are also employed. The facilitator is available in case any assistance is required. Participants evaluate the process after each stage in terms of feasibility, usability and utility.

4.2. The process

The process comprises three phases, eight steps and fourteen worksheets. Every step is related to a purpose and represents input for the next. A facilitator is available to coordinate activities.

Step 1: Evaluate the initial environmental status.

In order to elaborate organizational goals, an initial evaluation of the hospital environmental current status is necessary. The environmental dimensions indicated by the G4 GRI Guidelines (GRI, 2014) are used to address significant aspects of environmental performance: (1) Materials; (2) Energy; (3) Water; (4) Biodiversity; (5) Emissions, Effluents and Waste; (6) Products and Services; (7) Compliance; (8) Transport; (9) Overall; (10) Supplier Environmental Assessment; and (11) Environmental Grievance Mechanisms. The fulfilment of Brazilian legal requirements is also verified. Successful experiences reported in literature are used to evaluate the initial status of the hospital operations as 'best practices' also impact on performance and tend to guide learning and corrective feedback (Rosen et al., 2008). The existence of a formalized hospital environmental strategy is examined.

Step 2: Define organizational goals related to the environment.

To establish a consistent strategic focus, the hospital environment strategy (when existent and formalized) is used to define organizational goals. In the absence of such strategy, organizational goals are determined from the list of crucial aspects to be observed.

Step 3: Deploy organizational goals into strategic, tactical and operational measures.

These measures are related to tasks that should be performed in order to achieve organizational goals. Actions are deployed into the strategic (high administration), tactical (managerial) and operational (staff in general) levels to attain goals.

Step 4: Determine monitoring indicators for the evaluation of the adopted measures performance.

Monitoring indicators to evaluate the achievement of goals are proposed for each measure/task. The definition of indicators is based on the following principles: measurability, validity and controllability.

Step 5: Implement strategic, tactical and operational measures.

After determining monitoring indicators and existing information sources for the performance measurement, measures are communicated to the responsible areas so that necessary action is taken.

Step 6: Monitor the achievement of organizational goals.

The measurement includes timely performance evaluations. Monitoring actions allow the reflection on the development of organizational goals and successful implementation of strategies.

Step 7: Check results.

The analysis of organizational performance is performed within this step. It is possible to consider reviewing organizational goals and/or identify the reasons why goals were not achieved.

Step 8: Prepare the environmental report.

Data is compiled and presented to the high administration; the report is then communicated to remaining stakeholders.

Refinement and testing are necessary to further develop any suggested methodologies (Veleva and Ellenbecker, 2001). Six of the 10 hospitals previously assessed as field studies were approached for the framework application. Three case studies were included for refinement and other three for testing. Table 2 comprises different phases, worksheets and objectives of the proposed process.

The following section is organized in three main items. Section 5.1 describes the rationale behind the selection of case studies. Section 5.2 and Section 5.3 discuss the refinement and testing phases.

Table 3
Characterization of the studied hospitals.

Hospital ID	Source of capital	Number of beds	Size
H1	Philanthropic Association	100	Medium
H2	Philanthropic Association	100	Medium
H3	Philanthropic Association	20	Small
H4	Philanthropic Association	51	Medium
H5	Philanthropic Association	68	Medium
H6	Philanthropic Association	17	Small

5. Application of the process

5.1. Selection of case studies

Considering the importance of not for profit hospitals, all six case studies were represented by these hospitals. According to Portela et al. (2004), 75.3% of hospitals have less than 100 beds (small and medium) and are located predominantly in the countryside (population: 30,000 or less). In average, 65 beds per hospital are available in Brazil. Currently, private hospitals represent 70% of the total existing in the country (CNES, 2014). The case studies were selected considering the similarity between the characterization of hospitals in the South of Brazil and the rest of country. Two small-sized and four medium-sized private hospitals were included in the study and identified as H1, H2, etc. for confidentiality reasons. Table 3 contains the characterization of the studied hospitals.

5.2. Refinement phase

None of the hospitals presented a formalized environmental strategy. To evaluate the initial environmental status and identify organizational goals, H1 and H2 listed the following dimensions of GRI: (1) Materials; (2) Energy; (3) Water; (5) Emissions, Effluents and Waste; and (11) Environmental Grievance Mechanisms. H3 listed the same aspects but excluded (3) Water. Table 4 summarizes the dimensions/aspects identified during Phase I.

In terms of complying with current legislation, all three cases showed similar concerns related to water quality and the internal environmental where services are provided. Nonetheless, H3, a small-sized hospital, did not emphasize the need for a waste management plan. Based on identified aspects, organizational goals were defined and deployed into actions within hierarchical levels: strategic, tactical and operational. The number of goals varied across cases. For instance, in H1, the participants identified

Table 2
The developed process.

Phase	Steps	WS	Objectives
Conception	1	1	Determine the current adopted environmental strategy and practices
	2	2	Define the list of aspects for measuring and goal setting
		3	Define organizational goals
	3	4	Deploy organizational goals into strategic, tactical and operational actions
		5	Prioritize actions to be performed
Implementation	4	6	Characterize performance indicators according to minimum criteria
		7	Define responsibilities and schedule for each strategic action
		8	Define responsibilities and schedule for each tactical action
		9	Define responsibilities and schedule for each operational action
	5	10	Implement strategic, tactical and operations actions
Analysis	6	11	Monitor goal achievement
	7	12	Check obtained results through the evaluation of monitoring data
		13	Check the effectiveness of corrective actions
	8	14	Develop environmental report

Table 4
Dimensions/aspects identified in the evaluation of the current status (H1–H3).

Identification	H1	H2	H3
Formalized environmental strategy	No formalized strategy	No formalized strategy	No formalized strategy
Listed GRI dimensions	Materials; Energy; Water; Emissions, Effluents and Waste; Environmental Grievance Mechanisms.	Materials; Energy; Water; Emissions, Effluents and Waste; Environmental Grievance Mechanisms.	Materials; Energy; Emissions, Effluents and Waste; Environmental Grievance Mechanisms.
Aspects related to RDC 63 ANVISA	Solid waste plan; Guide to handle and transport contaminated healthcare products.	Solid waste plan; Water quality control; Guide to handle and transport contaminated healthcare products; Clean healthcare services environment; Quality of equipment and materials for disinfection and sterilization processes.	Water quality control; Clean healthcare services environment.
Aspects related to RDC ANVISA 306 and CONAMA 358	Healthcare services waste management plan.	Healthcare services waste management plan.	None listed.
Aspects related to literature 'best practices'	Environmental training plan (ISO 14001); Internal communication system (ISO 14001); Hospital Sanitization Procedure (Hospital Accreditation).	Environmental training plan (ISO 14001); Internal communication system (ISO 14001); Stakeholders perspective (BSC); Hospital Sanitization Procedure (Hospital Accreditation); Purchase and provide healthy and sustainably grown food (Green Hospitals Agenda).	Environmental training plan (ISO 14001); Purchase and provide healthy and sustainably grown food (Green Hospitals Agenda).

Table 5
Deployment of goals into hierarchical levels (H1–H3).

Hospital ID	Number of goals	Strategic Actions	Tactical Actions	Operational Actions
H1	11	12	13	9
H2	16	14	15	12
H3	8	8	7	6
Total	**35**	**34**	**35**	**27**

'materials' as an important dimension and a reduction of 5% in consumption as a related goal. As strategic actions, creating a procedure-training program and a continuous education program were established. As tactical actions, 'Nurses' will create a standard procedure and 'Sanitization' will review the SOP – Standard Operating Procedure Manual. As operational action, 'General' will remove materials after the empty packaging is delivered (pens, adhesive plasters, micropore™). As indicators, some can be cited: number of plastic cups used every month; number of units of office supplies used every month; existence of a revised SOP Manual; and number of training sessions planned/executed in the procedure-training program. Table 5 shows the number of goals and actions established across cases.

In the refinement phase, it was possible to identify improvement opportunities for the developed process. Regarding Worksheet 1 (WS1), many of the indicators suggested by GRI were not applicable to the case studies (small and medium hospitals). It was suggested that they should be excluded. Indicators such as 'habitats protected or restored' and 'NO_x, SO_x, and other significant air emissions' were deleted.

In addition, participants and facilitator felt that some of the information contained in WS5, WS7, WS8, WS9 and WS11 could be added to other worksheets. The score related to the prioritization of actions ('0' – low priority; '1' – medium priority; '2' – high priority) initially present in WS4 was incorporated into WS5. WS6 corresponding to the "characterization of performance indicators according to minimum criteria for monitoring" (before refinement) was renumbered as WS5. Moreover, the evaluation of the status of actions (WS11 before refinement) was incorporated into WS5 (after the refinement). Before the refinement, WS7, WS8 and WS9 separated the implementation of actions at the strategic, tactical and operational levels by including department, person/persons responsible for a specific action and lead time for completion. This information was added to WS5 and the three worksheets were suppressed. Thus, the process and worksheets were modified for the testing phase. The process included the same phases and steps and nine worksheets (instead of 14). Table 6 shows the process after the refinement.

5.3. Testing phase

None of the hospitals presented a formalized environmental

Table 6
The developed process (after the refinement).

Steps	WS	Objectives
1	1	Determine the current environmental status
2	2	Define the list of aspects for measuring and goal setting
	3	Define organizational goals
3	4	Deploy organizational goals into strategic, tactical and operational actions
4	5	Characterize performance indicators according to minimum criteria for monitoring
5	6	Implement strategic, tactical and operations actions
6	5	Monitor goal achievement
7	7	Check obtained results through the evaluation of monitoring data
	8	Check the effectiveness of corrective actions
8	9	Develop environmental report

Table 7
Dimensions/aspects identified in the evaluation of the current status (H4–H6).

Identification	H4	H5	H6
Formalized environmental strategy	No formalized strategy	No formalized strategy	No formalized strategy
Listed GRI dimensions	Materials; Energy; Emissions, Effluents and Waste.	Materials; Emissions, Effluents and Waste; Environmental Grievance Mechanisms.	Materials; Energy; Water; Emissions, Effluents and Waste.
Aspects related to RDC 63 ANVISA	Solid waste plan; Guide to handle and transport contaminated healthcare products; Clean healthcare services environment.	Solid waste plan; Guide to handle and transport contaminated healthcare products; Clean healthcare services environment.	Document and register of urban vectors and pests; cleaning water tanks every six months; Guide to handle and transport contaminated healthcare products; Clean healthcare services environment.
Aspects related to literature 'best practices'	Stakeholders perspective (BSC); Hospital Sanitization Procedure (Hospital Accreditation); Purchase and provide healthy and sustainably grown food (Green Hospitals Agenda); Environmental training plan (ISO 14001).	Environmental training plan (ISO 14001); Stakeholders perspective (BSC); Hospital Sanitization Procedure (Hospital Accreditation).	Environmental training plan (ISO 14001); Internal communication system (ISO 14001); Hospital Sanitization Procedure (Hospital Accreditation).

Table 8
Deployment of goals into hierarchical levels (H4–H6).

Hospital ID	Number of goals	Strategic Actions	Tactical Actions	Operational Actions
H4	10	9	9	9
H5	10	10	12	9
H6	12	12	15	11
Total	**32**	**31**	**36**	**29**

strategy. All three hospitals listed 'materials' and 'emissions, effluents and waste' as crucial GRI dimensions. Aspects related to RDC ANVISA 306 (waste management) and CONAMA 358 (healthcare waste treatment/disposal) were not cited by participants, indicating noncompliance with current legislation. The units focused on aspects related to 'best practices'. Table 7 presents aspects identified in the studies. Table 8 shows actions deployment.

In Hospital 6, 12 goals were established, including: an energy reduction of 10%, a materials reduction of 20% and application of a pest control procedure (30 days for training). Six of the goals were achieved during the process and the remaining six were ongoing. The report reflected the progress of initiatives.

6. Discussion on the results and lessons learnt

The hospitals included in the study did not present a formalized environmental strategy. Kaplan and Norton (2004) pointed out the need for a correlation between strategy and performance measurement. By translating strategy into action, it is possible to obtain superior performance. Considering the absence of a formalized environmental strategy, managers of the studied hospitals felt the need to develop a plan focusing on cost reduction and standardization of provided services. This 'plan' was generated through the framework application: identified aspects and established goals. The majority of actions planned by the hospitals involved cost-related issues and procedure development.

Regarding GRI dimensions, energy and water represented the most cited. Goals related to water and energy were established in five of the six case studies. One of the specific challenges related to healthcare operations is inadequate infrastructure in terms of electricity and sources of clean water (Brandeau et al., 2004). Policies for the use of energy and water are vital for the achievement of environmental sustainability (Townend and Cheeseman, 2005). The Syrian Lebanese Hospital (HSL) demonstrates the importance of these measures. The objectives behind their environmental management plan address (1) a better utilization of water, energy and gas and (2) waste management.

Other highlighted aspects encompass effluents and waste, and mechanisms of grievances and complaints related to environmental aspects. RDC ANVISA 63, RDC ANVISA 306 and CONAMA 358 establish criteria for a plan for a healthcare waste management. The plan includes handling, sorting, identification, internal transport, temporary inventory, treatment, external inventory, collection, external transport and final disposal. In all six cases, there was a waste management plan. Developing standardized operational procedures following quality principles was a recurrent goal in the cases. Applying Operations Management and Quality principles and techniques has generated advances in the improvement of healthcare services (Bradley et al., 2005).

In two of the hospitals, the perspective of stakeholders was considered. Rodrigue et al. (2013) exploited the influence of stakeholders in the selection of environmental performance indicators (EPI). Aspects such as training and communication were also listed across cases. This finding is consistent with Tudor (2007). The authors concluded that a more effective participation in recycling and waste management initiatives can be achieved through incorporating sustainability to organizational policies; enhanced communication; creating training and development programs; and publicizing the benefits from sustainable practices. Manga et al. (2011) emphasized the challenges in countries such as Brazil: inefficient separation of waste, lack of training for employees, inadequate waste collection, fragile legislation, inadequate handling of infectious waste and joint disposal of residential and healthcare waste. This context indicates the need for strategic focus through the generation of goals and initiatives to be communicated. The commitment of stakeholders is vital for the achievement of successful outcomes.

In total, 67 goals, 192 actions and 81 indicators were listed in the cases. Usually, performance indicators are classified according to the hierarchical where their management occurs (Gunasekaran et al., 2001). They were categorized as strategic, tactical and operational. Indicators should be adjusted and/or developed to represent benchmarking and meaningful guidance for strategy planning. The feedback from case studies participants emphasized the importance of the deployment of measures proposed by the framework. According to managers, this definition motivates

personnel to perform tasks. Moreover, indicators should present certain characteristics (Feng and Joung, 2011). Mannion and Davies (2002) recognize the existence of report cards (especially in the US), but the robustness of indicators still represents a pitfall in terms of meaning, validity and risk evaluation of indicators. In addition, the involvement of stakeholders and an in-depth understanding of the needs of final users is required to forge a partnership for superior performance. Characteristics such as measurability, relevance, clarity, reliability, data accessibility, opportunity and long term view were observed in the characterization of indicators in the case studies. Measures related to cost reduction for water and energy were proposed in all cases. Several other measures related to the standardization of procedures were also listed. The indicators allowed the monitoring of goal achievement. The proportion of achieved goals was 59,70% and those ongoing (35,82%). All goals were achieved in the process. Three goals could not be verified (4,48%); in two cases, long term goals were planned (two years) and, in one case, a goal was aborted. Table 9 lists the status of goal achievement.

Overall, the feedback related to the framework's applicability was positive. In the refinement phase, the model was considered 'Good' and 'Very Good' in terms of feasibility, usability and utility (Scale: 1 – 'Very Little'; 2 – 'Little'; 3 – 'Average'; 4 – 'Good'; 5 – 'Very Good'). In the refinement phase, the results obtained were: feasibility – 'Good' (6%), 'Very Good' (94%); usability – 'Good' (11%), 'Very Good' (89%); utility – 'Good' (16%), 'Very Good' (84%). Participants felt it contributed to highlight the strategic importance of environmental strategies and performance measurement. Nonetheless, it was suggested by participants that the process could be applied using a software tool. This would optimize the time and maintain prompt records for future reference. In addition, the model could underpin decision-making, according to managers. In the testing phase, the framework was regarded as 'Good' and 'Very Good'. The results were: feasibility ('Good' – 40%/'Very Good' – 60%); usability ('Good' – 23%/'Very Good' – 77%); utility ('Good' – 35%/'Very Good' – 65%).

The framework is associated with four main contributions. Firstly, it proposes a model where the measurement of environmental performance is vital for the achievement of organizational goals in healthcare operations; the hospitals reflect on established goals, monitor progress and report their performance to stakeholders. This contribution addresses a recognized weakness of current performance indicators, that is, the lack of strategic focus. Moreover, addressing the environmental dimension is incorporated into the measurement process. Secondly, it is associated with a systematic process, combining theory and practice; feasibility, usability and utility are achieved by the model. This relates to the practice in hospitals. According to managers, the indicators developed in the process are characterized and linked to actions to be executed and monitored. The actions planned in the framework become meaningful guidance for managers and professionals toward superior environmental performance and continuous improvement strategies. Third, the framework facilitates the adjustment of hospitals to current legislation and quality requirements by official entities and users. This relates to the improvement of processes, evaluation of operational efficiency, improvement of environmental indicators and reduction of waste. Participants perceived the framework to be associated with several benefits for their units and departments. It is important to emphasize that the strategic focus brought by the framework also generated enhanced team commitment and motivation for goal achievement. Hospital managers highlighted the enhancement of communication. The proposed model was regarded as efficient in translating environmental issues into actions for each hierarchical level (strategic, tactical and operational) based on specific contexts. Finally, the proposed framework and process allowed a more in-depth understanding of a particular context, its idiosyncrasies, challenges and opportunities for improvement related to measuring environmental performance in hospitals.

Table 9
Status of goal achievement (H1–H6).

Goal achievement	H1	H2	H3	H4	H5	H6	Total
Achieved	5	6	8	8	7	6	40
Not achieved	0	0	0	0	0	0	0
Ongoing	5	9	0	2	2	6	24
Unable to verify	1	1	0	0	1	0	3
Total	11	16	8	10	10	12	67

7. Conclusions

Concerns on the lack of strategic focus of performance indicators, relevance and robustness of metrics and difficulties for the deployment of measures within different hierarchical levels are emphasized by literature and practice. In light of the importance of performance measurement for the healthcare sector, especially in hospitals, robust frameworks are required. Measures raising awareness and continuous improvement in organizational processes are necessary. The study represents a starting point in proposing a meaningful framework to measure environmental performance in hospitals within the Brazilian setting that can influence public policies. Some of the advantages of the approach according to participants are: a) framework/process make a significant contribution to practice, since they represent meaningful guidance for the formalization of strategies, goal setting and environmental assessment and monitoring; b) 'softer' outcomes related to better communication and awareness of environmental concerns, focus on improving environmental performance were also identified by participants; c) the framework facilitates the adjustment of hospitals to current legislation and quality requirements by official entities and users. The framework was regarded as 'Good' and 'Very Good' in terms of feasibility, usability and utility. Nonetheless, the present study is also associated with some limitations. The proposed model was applied in small and medium hospitals (refinement and testing phases). Investigating the influence of size in the rationale of healthcare operations and environmental performance should be considered. Additionally, the selected hospitals belong to one of the five regions of Brazil. Given the continental dimensions of the country, the applicability of the framework should be tested in large and special hospitals with formalized environmental strategies. Furthermore, the study contributes to a wider theoretical discussion on strategically focused public policy concerning the improvement of healthcare environmental performance. Because of the usefulness of the framework, managers felt a software tool could facilitate the adoption of the model for the evaluation of environmental performance and reporting to stakeholders. Further research will include the development of a software tool for the process application as suggested by participants.

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