World Sustainability Series

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# Integrating Social Responsibility and Sustainable Development

## Addressing Challenges and Creating Opportunities

Springer

# World Sustainability Series

**Series Editor**

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Due to its scope and nature, sustainable development is a matter which is very interdisciplinary, and draws from knowledge and inputs from the social sciences and environmental sciences on the one hand, but also from physical sciences and arts on the other. As such, there is a perceived need to foster integrative approaches, whereby the combination of inputs from various fields may contribute to a better understanding of what sustainability is, and means to people. But despite the need for and the relevance of integrative approaches towards sustainable development, there is a paucity of literature which address matters related to sustainability in an integrated way.

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Editors

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# Preface

Sustainable development has become a matter of central concern to both public institutions and enterprises. Indeed, for many companies, a due emphasis to environmental issues is not only positive from the point of view of environmental gains, but also to the image of the business. Often, but not always, this is reflected in the preparation of formal strategies and programmes, which entail their institutional strategies and visions.

The wide area of social responsibility, often known as Corporate Social Responsibility (CSR), entails elements of social equality and environmental accountability, and eco-efficiency. Due to their complexity, the interrelations between social responsibility and sustainable development need to be better understood. There is also a real need to showcase successful examples of how public institutions and companies are handling their sustainability challenges.

It is against this background that this book has been produced. It is a truly interdisciplinary publication, useful to scholars, social movements, practitioners and members of governmental agencies and private companies, undertaking research and/or executing projects focusing on social responsibility and sustainability from across the world.

This book is structured around four parts:

Part One—Institutional Organisation, Structures, and Corporate Policies
Part Two—Approaches Towards Resource Efficiency (e.g. Energy, Water, Wastes, Materials)
Part Three—Community and Stakeholder Relations
Part Four—Information, Communication, Education and Training

We thank the authors and reviewers for their contribution. We hope that the contributions on this volume will provide a timely support towards the implementation of sustainability initiatives and will foster the global efforts towards promoting sustainable development practices across organisations.

Summer 2021 The Editors

# Contents

# Institutional Organisation, Structures, and Corporate Policies

# Appropriation of Disaster Risk Reduction in Brazil: Relations Between Civil Defense and Urban Planning as a Social Process Leading to Sustainability


**Katia Atsumi Nakayama and Marcio Siqueira Machado**

## 1 Introduction

The study of causes, impacts and consequences of natural disasters in Brazilian municipalities has become quite frequent (Ultramari 2013; Mendonça 2004; Deschamps 2008; Hummell 2009). Such discussions, are mainly focused on the research for strategies and transformative tools (Ultramari 2013). The existing literature on the institutional issues of resilience in developing countries is not completely established (Nakayama 2017). Variables like social responsibility, extreme poverty and informal settlements must be added to new studies. Specifically, in a country like Brazil where there is a transition process between a disconnected institutional approach and a more articulated one could be further detailed and new study cases produced. That would possibilitate comparisons and exchange of experiences between countries more frequently.

Despite the amount of these strategies, the peculiar Brazilian social context makes the implementation of risk policies a complex problem. In this context, it is possible to perceive that the appropriation and the identification of prevention strategies—mainly between Civil Defense and urban planning—bring to the discussions new challenges for urban management in municipalities.

The scenario of natural disasters in Brazil is the result not only of the event itself, but the consequence of social and environmental vulnerability. This exposes municipalities to a greater risk possibility (Veyret 2007; Deschamps 2008; Hummell 2009). As a result, in the case of adversities, vulnerable spaces become the arena of a

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set of crisis and reduction of the resilience capacity. They intensify impacts, creating a poverty and tragedy cycles.

About this situation, it is possible to understand that natural disasters management do not involve only the catastrophic consequences of the event, but also, the social and environmental aspects of cities and communities suffering these impacts. Considering these features, natural disasters management in the Brazil should include the spatial formation dynamics: as urban planning guidelines of land use and occupation.

In Brazil, the duty of prevention, mitigation, preparation, response and recuperation targeted to avoid disasters is legally recognized as the role of Regional Development Ministry, specifically, the Secretary of Civil Defense and Protection (Brasil 2012). Local Civil Defense Coordination has a main role in the risk and disaster management, which currently is mainly an urban question. At the same time, local urban planning departments are responsible for land use regulation. The integrated action of both can produce opportunities for better solutions to several urban issues.

The enhancement and development of the Civil Defense institutional framework in the country, in the last 10 years, produced positive transformations on their guidelines. Is it possible to observe that, despite the fact the Civil Defense has started as an institution characterized mainly by the assimilation of risk and emergency regulations, it can be also a body which could influence the urban management in the country.

Inside this context, this article discusses the urban management scenario in the Brazilian municipalities facing their adversities, its contexts and the concepts related to natural disasters. The research has the aim to understand and identify the appropriation processes of ideas of the Civil Defense guidelines by the local urban administrations—focusing on the urban planning issues, legislation and land use regulation. The analysis and research results are in the municipal scale. The case study is in the Curitiba Metropolitan Region (CMR), in 10 selected cities. The next parts of this work address the case study theoretical foundation.

## 2 National Protection and Civil Defense Policy Relevance to Urban Planning in Natural Disasters Prevention

The interactions and dynamics between the Protection and Civil Defense National Policies guidelines and the urban development policies are fundamental to the definition of new paradigms for natural disasters. The introduction of an enhanced concept of prevention in the NPCDP (National Protection and Civil Defense Policy) requires an articulated action from society, public administration and NGO's. The aim should be implement processes that change an historical pattern which mainly focused on post disaster actions. Law number 12.608/2012 (Brasil 2012) states:

> Article 3rd. The NPCDP is composed of prevention, mitigation, preparation, response and recovery actions connected to protection and civil defense: The NPCDP should be integrated to spatial planning policies, urban development, health, environment, climate change, water resources management, geology, infrastructure, education, science and technology and other

> specific policies, having in mind the implementation of sustainable development (translated by the authors).

In this context, urban planning is understood as a set of multidisciplinary actions aiming a goal, considering the amount of available resources and external factors as, for example: quality of involved stakeholders, definition of objectives and the context to achieve them (Duarte 2007). Besides this, Ultramari (2009 p. 178), defines the urban planning framework as: activities related to survey, several sectoral plans, regulation and control of land use and related activities as basic services (education, health care and security) and basic infrastructures (sanitation and sewage, street maintenance and transportation).

Thus, urban planning of cities is related to a plan with goals and expectations for a further moment. Public administration is responsible for this process, implementing and managing city plans actions (Ultramari 2009).

An example of urban planning and management is the municipal General Plan, a pillar of urban planning in Brazilian cities. According to Duarte (2007), the General Plan is one of the main tools proposed by the Statute of City (Law number 10.257/2010), due to the fact it gives an extensive responsibility to local scale actions.

It is highlighted that both the NPCDP and Statute of City are urban policies regulated by national scale laws, but focus on city responsibilities. Municipal administrations have the duty to implement these guidelines. The structure of Civil Defense in the country is driven by the Regional Development Ministry, by the Secretary of Protection and Civil Defense, followed by state and city level entities.

The application of urban policies in the spatial formation and city transformation are relevant to spatial processes. The appropriation of Civil Defense guidelines and regulations by the municipal administration are fundamental for the management of adversities related to natural disasters (Pinheiro 2011). As a result, together with the Municipal General Plan, the law number 12.608/2012 (that regulates NPCDP) can both contribute to improve urban development. This could happen not only considering regulation of spatial planning issues, but also the management of disaster risk prevention actions.

According to Rolnik (1997), urban regulation—or the set of urbanistic laws, decrees and norms—is a common action in space, which is capable of configuring and classifying the territory and also give a meaning to it. Urban regulation is also responsible to connect the population to their urban environment. Because space formation is related to legal instruments of planning, it is understood that the General Plans in cities, as land use, occupation legislation and Law no. 12.608/2012, are able to shape urban dynamics. Thus, in order to have a change in the disasters prevention in the country, it is necessary to apply guidelines created by the Civil Defense Coordinations and change the cultural resistance to transform the cumulative cycle of vulnerable urban spaces.

The modifications caused by Law no. 12.608/2012 were carried out by the City Statute (adding Articles 42-A[1] and 42-B) that regulate General Plans. The added

[1] Art. 42-A. In addition to the content provided by Art. 42, the General Plan of the Municipalities included in the national register of municipalities with areas susceptible to major impact landslides,

articles intended to oblige municipalities to control and monitor areas of risk or environmentally fragile, including guidelines for land use and occupation, housing, infrastructure and among others issues.

The data obtained through monitoring compose a database diagnostic that should direct specific policies for the characteristics of risk and impact in each municipality. This availability of data becomes relevant as it contributes to the formation of a reliable panorama of the disasters in the Brazilian municipalities. According to Feltrin et al. (2012, p. 10):

> From NPCDP, it is possible to prepare an urban planning based on research and studies about risk areas. With this planning it will be possible to reduce the risk of disasters, to provide relief and assistance to the affected populations and to recover the areas that are affected by disasters by assessing and identifying the threats and vulnerabilities of urban territory (translated by the authors).

Despite these good intentions, institutional relations are not always developed in an integrated and effective way in the Brazilian context. It is also essential that the processes of communication and application of standards and guidelines aim to jointly implement emergency, preventive, protective, preparedness and mitigation practices. Without the association between the departments responsible for urban planning in the municipality and Civil Defense activities, there is a barrier to the consolidation of the risk management structure in the country.

Thus, as Mendonça (2004, p. 148, translated by the authors) describes: success will not be achieved without the creation and application of an urban management with social participation, without strengthening the role of the public sector in conducting the process, and without true citizenship and democracy. Therefore, it is not only necessary to discuss the reasons that hinder the implementation of urban policies—not just related to the lack of economic resources—but also we should debate about the complexity of implementing these policies themselves, rooted in a sociocultural process of formation in the political structure in the country (Maricato 2000; Rolnik 1997).

If, on one hand, the implementation of effective urban policies seems far from the reality of the country, on the other, they may be an opportunity to build disaster management based on new concepts of prevention and protection. Thus, it is understood that, by creating urban space management mechanisms, the inclusion of NPCDP participation in the urban planning and formation of the municipality can influence the creation of joint solutions to complex problems of the municipality. Besides this, it can provide an overview of conflicts. As discussed in this section, the participation of urban planning has relevance in the consolidation of a disaster management policy.

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sudden floods or related geological or hydrological processes shall contain: I—land parceling, land use and occupation parameters, so as to promote diversity of uses and contribute to the generation of employment and income; II—mapping areas susceptible to the occurrence of high impact landslides, sudden floods or related geological or hydrological processes; III—planning of preventive actions and relocation of population from disaster risk areas IV—urban drainage measures necessary for the prevention and mitigation of disaster impacts (Brasil 2012, translated by the authors).

## 3 Appropriation of Regulations and Guidelines by Municipal Urban Administration

Law 12.608/2012 starts to introduce guidelines focused on urban management, proposing actions linking urban planning and risk management. The study of the connection between both stakeholders involved—municipal administration (urban planning departments) and Civil Defense municipal authorities—can enhance the recent concept of risk management prevention and preparation, taking into consideration the appropriation and experiences between entities that started to influence urban spatial dynamics.

The relations established among entities, mainly the ones related to regulations and guidelines, involve the concept of circulation of ideas, that means, they are related to the ability to appropriate new concepts by two administrative bodies: The Municipal Coordination of Civil Defense and Protection (MCDP) and the municipal departments responsible for urban planning decisions. About this process of circulation, Ultramari and Duarte (2012) discuss how unique ideas are able to be reproduced and connect to new contexts, suffering adaptations or transformations.

The ideas transference theme is quite new in the Brazilian academic research circles, however, this discussion is not a novelty for urban planning and public administration (Ultramari and Cantarim 2016). It is possible to notice the need for understanding how guidelines from specific contexts and from specific policy makers are transmitted and appropriated in different absorption rhythms, scales and temporalities (Haley and Upton 2010).

According to Ultramari and Cantarim (2016), ideas transference is a complex process in urban topics, which involves a set of stakeholders and also places. It is perceived that the processes of creation and communication of ideas are developed in a linear way but it is completely intangible and difficult to analyse. The scenario of its creation and the scenario of its application influence the way the idea moves; as a result, it should be observed carefully. Howlet and Morgan (2001) add that the circulation of ideas starts when practices and experiences are shared.

Furthermore, the appropriation of ideas can be the result of interactions between experts with a common interest. Haley and Upton (2010), describing experiences about the circulation of ideas in urban planning, discuss the possibilities (or the consequences) of the introduction of a specific idea in a new context. The authors point that the movement/interaction of ideas in urban planning is constant, despite the fact that adaptation and implementation processes are not always clear. The path of that idea can inspire the creation of new potentials. According to the authors:

> The challenge for critical planning action, committed to the moral attitudes […] is to work out how to create greater momentum for improving urban conditions throughout this complex interplay of exogenous and endogenous forces. Harnessing the potential of this interplay requires continual attention to the specific dynamics of structure influences, local agency, and culture and institutions. (Haley and Upton 2010, p. 32)

In the same way, ideas—or the way they circulate and the way the are implemented—can reduce or increase positive and negative points in the mechanism a

natural disaster is handled (Ultramari and Duarte 2009; Ultramari and Hayakawa 2015). This fact depends on the different levels of introduction, refusal or adaptation of such ideas. About this subject, Ultramari and Cantarim (2016) conclude that transference of ideas processes are related to the dissemination of knowledge and, therefore, related to learning possibilities.

In the present research context, it is highlighted that Civil Defense guidelines and regulations are examples of ideas in motion, that start to drive urban planning actions. Therefore, guidelines discussed in this paper are ideas transferred from one institution to another. Also, the ideias need to adapt to the urban planning field. The absorption process of these new principles influence directly the implemented actions. Thus, the relations among stakeholders are instruments to connect urban planning to the process of gaining resilience.

## 4 Methodology

This qualitative survey has the aim to verify the processes of appropriation and circulation of guidelines between two institutional stakeholders. Such study case understands, as a result, that for analysing these processes, surveys about stakeholders involved are necessary. This is produced by qualitative interviews. The study was performed during the year 2017. Structured questions[2] are selected with specific questions for each of the two set of stakeholders.

The creation of questions follows an organized structured for the research variables and analysis categories. The set of questions—methodologically classified as focused, as it follows a predetermined organized script—was applied to two groups of technical staff: one in charge of civil defense (Municipal Coordination of Civil Defense and Protection—MCDP) and the other of local urban planning departments (Table 1 and Map 1).

It is important to point that all questions present a free possibility of answers, allowing the use of personal language and opinions. In a first moment, the idea was to conduct the interview personally, however due to schedule issues, in some cases a phone call was used. Among the 20 cities inside the Curitiba Metropolitan Region (CMR), the larger ones were selected, excluding Curitiba. This was done because due to its size, over a million inhabitants, and its importance, state capital, it could be harder to compare Curitiba to other cities. The medium size cities, not the smaller ones were selected because larger municipalities have a more complex set of relations and issues regarding policy making and civil defense issues. As a result, interviews were conducted in ten selected municipalities (Table 2).

The number of interviews can vary due to interviewees availability. Some interviews were added in the research process considering this. Interviews were saved by

[2]Partial database used in this article is also part of dissertation "Apropriação de Normas e Diretrizes da Defesa Civil pela Gestão Urbana: Municípios Selecionados da Região Metropolitana de Curitiba" (Nakayama 2017).

**Table 1** Questions done to MCDP and local urban planning departments

| Analysis categories | Selected topics |
|---|---|
| (1) Transformation in interinstitutional relations and between institutions and population in the last decade | 1. Was there any change in the interinstitutional relations between the Municipal Protection and Civil Defense Office and the City Administration in the last decade<br>2. In case of an affirmative answer: was there a special reason for this change? |
| | 3. Was there a change in the relations between the Municipal Protection and Civil Defense Office or the City Administration with the population?<br>4. In case of an affirmative answer: was there a special reason for this change? |
| (2) Transformation in urban space management | 5. The Municipal Protection and Civil Defense Office participate actively in decision making and proposals framing for urban space design and management?<br>6. Is there any change in the local land use regulation or business permits due to this?<br>7. Are there conflicts between civil defense guidelines or regulations and those adopted by city administration? |
| (3) Institutional Approach to informal settlements and risk areas | 8. In case of informal settlements, ilegal urbanization or occupation of proven dangerous sites, which eventually is known by the municipality: what is the civil defense offices/city administration opinion in this case? |

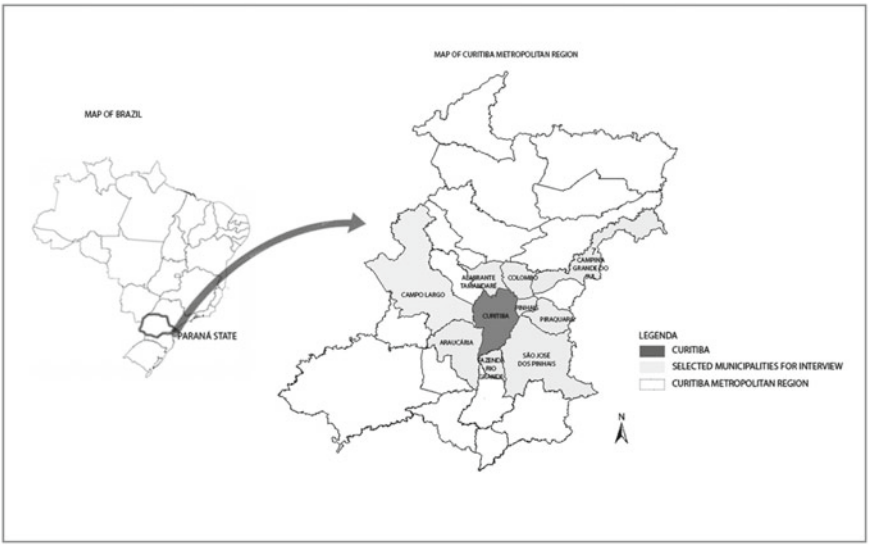
*Source* Produced by the authors based on Nakayama (2017)

tape recorded when authorized in order to not prevent interviewees to address sensitive topics. All names were preserved. Table 3 presents the quantities of interviews but not specific names. The methodology of data analysis and interview application are described in the next session. The average interview length was around 90 min.

## 5 Results and Analysis

The initially planned number of interviews was 20 (ten for city urban planning staff and ten for local civil defense authorities). Actually 14[3] were done: 6 interviews with city administration and 8 from civil defense authorities. Despite the fact the number of interviews were reduced, the majority of methodological goals were preserved.

[3]All the 20 municipals staff where invited to do the interview, but some selected interviewees did not accepted to do it.




**Map 1** Location of selected municipalities (darker on the map) in the Curitiba Metropolitan Region, Parana State, Brazil. *Source* Produced by the authors based on Nakayama (2017)

**Table 2** Ranking of selected municipalities by population size

| | Municipalities | City population |
|---|---|---|
| 1st | São José dos Pinhais | 264,210 |
| 2nd | Colombo | 229,872 |
| 3rd | Araucária | 131,356 |
| 4th | Pinhais | 125,808 |
| 5th | Campo Largo | 122,443 |
| 6th | Almirante Tamandaré | 111,586 |
| 7th | Piraquara | 102,798 |
| 8th | Fazenda Rio Grande | 90,648 |
| 9th | Lapa | 47,294 |
| 10th | Campina Grande do Sul | 41,447 |

*Source* The authors based on IBGE (2010)

Interviews were conducted in all selected municipalities inside the geographical framework.

**Table 3** Cities and related interviews

| Municipalities | Related interviews |
|---|---|
| Almirante Tamandaré | No interviews (*) |
| Araucária | Interview 03 and Interview 09 |
| Campina Grande do Sul | No interviews (*) |
| Campo Largo | Interview 05 and Interview 13 |
| Colombo | Interview 02 and Interview 11 |
| Fazenda Rio Grande | Interview 08 and Interview 14 |
| Lapa | Interview 07 and Interview 17 |
| Pinhais | Interview 04 |
| Piraquara | Interview 06 |
| São José dos Pinhais | Interview 01 and Interview 10 |

(*) did not accept to do the interview.
*Source* Produced by the authors based on Nakayama (2017)

## *5.1 About Transformations: In Relations and in Urban Space Management*

This category allows to analyse civil defense guidelines appropriation processes in the spatial planning organization and, consequently, it becomes the main turning point for the research. In order to better understand this question, municipalities were classified by typologies in which the consolidation level of the NPCDP was measured, that means enhancement in urban planning actions, land use regulations, and urban space organization (Table 4). In order to do so, three parameters were created for all interviews: typology of Municipal Coordination of Civil Defense and Protection (MCDP) action; civil defense infrastructure, and developed public policies typologies.

From the total of fourteen applied interviews, only two municipalities were considered high level of NPCDP consolidation. Five cities were classified as having a medium level of consolidation and two with low level (see Table 5). It should be pointed that classification and parameters were defined this way because all interviews had this answer; therefore, it was tried to standardize qualitatively information about each municipality for the analysis of different realities, however, variations may occur due to peculiarities and conflicts in the internal structure of local institutions.

Aboutchanges in urban space management from dialogues between urban planning departments and civil defense coordination, interviews demonstrate little interinstitutional improvement in the way spatial planning is regulated and implemented. Actually, the lack of integration between these two bodies of governmental organizations were legally prescribed by the NPCDP. It has been a natural barrier to the articulation of both entities.

In cases in which NPCDP are classified as low level of consolidation, MCDP only acts when there is an event, that means, the focus is on immediate actions

**Table 4** Classification parameter of different levels of NPCDP consolidation/integration

| Classification parameters | Features |
|---|---|
| Low level | Typology of MCDP action: MCDPs only act when there is some emergency<br>Focus on response and recuperation actions (immediate actions and post-disasters) |
| | Civil defense infrastructure: Little civil defense infrastructure, with no specific location for civil defense office, few equipments (cars, automobiles) and few staff personnel available |
| | Developed public policies typologies: disconnected, with no integration between MCDP and municipal urban planning authorities |
| Medium level | Typology of MCDP action: MCDPs participate in the mitigation and preparation process, but prevention measures are still limited (example: only helping in the identification of sensitive areas; participating in some commissions)<br>These are positive aspects but actually they do not have a role able to change spatial planning and risk management |
| | Civil defense infrastructure: they are well equipped but still lack staff personnel |
| | Developed public policies typologies: there is some integration between MCDP and municipal urban planning authorities but the role of each institution is still disconnected. There are few initiatives to articulate these institutions even if in only in operational issues |
| High level | Typology of MCDP action: MCDP's participate in the mitigation and preparation process, and prevention measures. Disasters risks are previewed in advance |
| | Civil defense infrastructure: larger availability of equipment and staff personnel |
| | Developed public policies typologies: Existence of some changes in the legal land use framework due to risk assessment. Integration between entities is identifiable |

*Source* Produced by the authors based on Nakayama (2017)

**Table 5** Number and classification of different levels of NPCDP consolidation/integrations

| Classification of municipalities | Quantity of municipalities inserted in each category |
|---|---|
| Low level | Total number of municipalities: 02 cities |
| Medium level | Total number of municipalities: 04 cities |
| High level | Total number of municipalities: 02 cities |
| Total | 08 cities[a] |

[a]Selected staff from city of Campina Grande do Sul and Almirante Tamandaré were not available to answer questions
*Source* Produced by the authors based on Nakayama (2017)

(response and recovery) and post-disaster initiatives. On this municipalities, the influence on land use regulation is not relevant. MCDP actions are limited to independent initiatives from local governments responsible for urban planning. Usually in such scenario, the concept of prevention in the MCDP is still restricted to warn the community. There is no integration with land use decisions. Civil defense actions are limited to emergencies.

In the intermediate level of consolidation, in which the majority of cities were classified, MCDP presented a better participation in the spatial planning management. MCDP was integrated into local urban planning decisions, especially helping to identify dangerous sites. Information is shared, thus local city urban planning authorities may use the data provided. Although there is still a better dependency relation between the institutions, persists a lack of collaboration from both sides and each sector is still individualized. This is confirmed by one of the interviews: the one responsible for actions related to land use is urban planning department, civil defense participates only in site interventions (Interview 10, 2017, translated by the authors).

These cases demonstrate municipalities that developed a faster way to manage adversities. Communication flows more freely and they show an openness for integration. Among the systems implemented, they presented an internal communication software between urban planning departments and civil defense, including phone numbers lists necessary for disaster management (usually departments composing a dedicated commission). Although, this does not guarantee the effectiveness of the actions needed. The time response and coordination of all stakeholders involved are sometimes still slow for the urgency of some disasters.

In the third case, high level of consolidation, it was possible to identify a more robust influence of MCDPs in spatial planning management. City administration presented a well structured organization (interinstitutional commissions and regular meetings) that integrates civil defense in the decision making process. This allows to manage city growth, propose solutions, monitor dangerous areas and identify new potentially risky sites. Especially concerning this research, it is possible to identify a clear set of proposed land use regulations influenced by civil defense issues. The social and environmental conflicts in the city are better managed when different entities work integrated.

On these cases, municipalities created spatial planning strategies to include the MCDP interpretation in the planning and growth of cities. In one of the cities, the issuance of building permits in more dangerous areas is confirmed only after an authorization report from civil defense authorities. In addition to that, it can be confirmed that MCDP is regularly invited to contribute in municipal urban planning departments meetings, creating integrated solutions to the complex problems of cities and minimizing possible conflicts.

## *5.2 Institutional Approach to Informal Settlements and Risk Areas*

About the institutional approach to informal settlements and as risky areas, it was found that the MCDPs act together with the population informing the competent urban planning department about the situation of the residents, mainly, when MCDPs verify that a certain region is vulnerable to natural disasters. In response to the informing warning, urban planning department publishes that the risk problem is much more complex: resources are scarce to solve one of the major problems of Curitiba Metropolitan Region (CMR).

The same context is not only verified in CMR, but also represents other Brazilian municipalities. It is evident that the consequences of an environmental disaster have a direct effect on the municipal budget. Emergency recovery costs are huge and are rarely foreseen in municipal development plans. All respondents, both from the municipal Civil Defense agencies and representatives of the local urban planning departments, report the difficulty of having a budget forecast for the theme and recognize the small amount of resources applied by the municipalities in this matter.

Despite the fact the conflict of irregular settlements and risky areas is a problem verified in all municipalities interviewed, it is noted that the structure to resolve it is still poorly solidified. Regarding the prevention duties of the MCDPs, it is verified that they inform the municipality about the risk, however they merely reproduce the alert report and expect the support or supervision from local authorities. As reported by the agents, the priority is on emergency action.

It was observed on this thematic that the same problems cited before are the causes of several barriers found in a continuous cycle of public administration, spatial formation and difficulties to overcome the socio environmental vulnerability and to consolidate a risk and natural disaster management policy in Brazil.

Interviews were conducted during the review process of some of the municipal General Plans. Some of the previous General Plans (2010) were still valid and it did not considered Law 12.608/2012. It is noticed that in cities where MCPD presents a larger influence in urban planning decisions, there is a more integrated approach in the commissions related to discuss the general plan reviews. In these cases, most of public administration decision makers seemed to look for improving the system. In cases where there was a medium and low level of NPCDP consolidation/integration there were mainly three scenarios: (1) some municipalities aiming to integrate more MCDPs into the urban planning process; (2) some MCDPs are participating in the review process of general plans, but not actively influencing decision about land use regulation considering risky areas; (3) in the worst cases, there is no formal participation of MCPDs and civil defense authorities participate only in general plan review public meetings if they are willing to do so.

## 6 Conclusions

Following the results, after the case study, it was verified that there is a strong relation and transmission of ideas or guidelines among analysed institutions. The comprehension of these links are fundamental to strategically address natural disasters for managers, technical staff, and city population. There are three main conclusions we draw from this study.

The first conclusion, analysing the interviews, it is possible to conclude that from 2012 (Creation of Law 12.608/2012) there was an improvement in actions dealing with disasters. As demonstrated by the interviews in the category 1, topics 1 and 2 questions. It is highlighted that, until this moment, despite the fact that national policies are better defined, organized and consolidated regarding civil defense competencies, there is still a passive approach that focuses on helping instead of actively preventing. This is reinforced in a scenario where policies, organizations and public administration sectors are extremely disconnected. Usually the actual solutions are based in short-term visions with no full understanding of the several areas involved in a problem. That is even more serious when complicated issues, like environmental questions, are managed.

This process shows the difficulties to implement an efficient transformation in the risk prevention policies. Simultaneously, it is observed that in the municipalities in which there is a more robust integration between civil defense and the MCDP spatial planning regulation, a more efficient approach to adversities were perceived. This fact may be understood as a positive externality.

In the Second conclusion it is observed that the appropriation of civil defense regulations and guidelines by city administration still lacks a more developed structure. Thus, the paradox is confirmed. At the same time, it is demonstrated that: in one hand the structuration of a civil defense and protection system and its integration with city administration is incompleted and limited by several constraints; in the other hand there is a huge potential to include these transformations.

It is also important to remember that the Law 12.608/2012 is promulgated only two years after the beginning of the process of general plan revisions. Considering this opportunity, it observed that a lot of concepts and specific tools to improve prevention, protection, and risk could have been added in the spatial planning policies.

The third conclusion shows from the interviews in the selected metropolitan region that municipalities still confirm the presence of a vulnerable social and environmental situation. The same scenario is observed in other Brazilian cities (Ultramari 2009; Deschamps 2008; Hummel 2009). It is possible to verify that the structuration of a civil defense prevention and protection system in the spatial urban management started only some years ago and it is still not complete. Most of cities are working on this process. As a result, it is possible to point that the conclusions made here can change as the majority of general plans will have to be revised and effectively start to integrate disaster reduction politics in their municipal planning content. The different stakeholders involved can influence the final policy output. The existence of information, the creation of a legal framework or even the introduction of new

technologies, like GIS based disaster risk mapping, may be less efficient if there is no integration between different institutions.

The main constraints for this paper was the resistance from most of the municipal staff and civil defense staff to answer the questionnaires. This is understandable as the sensitive aspects of the information deals with hierarchy, institutional relations, and politics.

There are opportunities to further research in the same issue. More interviews can be conducted in the future. Other geographical locations could be selected to compare results. Curitiba and its metropolitan region is well known in Brazil for a high level of governance and efficiency. This may not be the case in other states or regions. Other interviews could be also conducted in the same cities after the approval of the General Plan review to create a panorama of this issue in Brazilian cities. The positive externalities found could be better comprehended and used for improving the civil defense system in a new perspective. The resilience and, consequently, in sustainability in cities depend on this institutional articulation.

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# Social Advancement as a Critical Success Factor in a Model of Translation and Control of Strategy in Agro-Industrial Cooperatives


**Reginaldo Ferreira Barreiros, Roberto Max Protil, Vilmar Rodrigues Moreira, and Luiz Carlos Duclós**

## 1 Introduction

Since the successful case of the Rochdale Cooperative in the nineteenth century, the modern cooperative movement has spread around the world, based on solid values and principles. Since then, it has offered economic agents an alternative for the development of economic systems, which prioritize the production factor of labor over capital, in the search for a fairer distribution of financial surpluses in economic business and the consequent desired long-term social advancement.

Several branches of cooperatives have developed since then, such as consumer cooperatives, agricultural cooperatives, financial cooperatives, labor cooperatives, housing cooperatives, infrastructure cooperatives, and others. In this paper, we analyze agricultural cooperatives. These cooperatives usually arise in contexts of market imperfection, to increase farmers' bargaining power in oligopolies and oligopsonies.

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In this way, cooperative societies have their appearance, usually associated with a response to some market failure (Fulton 1999). Thus, agricultural cooperatives emerge and enable themselves as an advantageous alternative in providing services to members, compared to investor-owned firms (IOFs). So, the virtue of agricultural cooperatives, in their initial stage, is present in the possibility of offering services such as technical assistance; sale of inputs; reception, storage, and marketing of products, with economic advantages for farmers, the cooperative's members.

However, while the growth of agricultural cooperatives, arises another opportunity, not present at the time of their creation: the possibility of making use of the production capacity of raw materials by the members and invest themselves in agro-industries. Doing so, the members envision another complementary objective that relies on the possibility of increasing control over the downstream stage of the supply chain of agricultural products and consequently reducing the risk of hold-up problems (Hendrikse and Veerman 2001a, b). By investing in agro-industry, the primary agricultural cooperative becomes another category, identified in the literature as marketing cooperative, but which in this paper is named as agro-industrial cooperative.

This evolution in the field of agricultural cooperatives is in line with the phenomenon that has been occurring in the agribusiness sector concerning increased complexity resulting from disruptive innovations, globalization, brand development, and the need for increased competitiveness. Understanding these more complex cooperatives justifies research that enables the design of appropriate management models that take into account the duality of these organizations (Hanel 1994).

In this context, the social advancement arises as an essential conditioner factor for the sustainable development of the communities, in line with the doctrine and principles of the cooperative movement, and that should be considered in a model of translation and control of strategy in this kind of organization.

Agro-industrial cooperatives are of great economic and social importance in the State of Paraná—Brazil and compete with other large, professionally structured agribusiness companies. For the proper strategic positioning in highly competitive markets, whose product prices often derive from agricultural commodities, cooperatives feel a strong need for professionalization in their management.

Having peculiar characteristics regarding their corporate governance, which significantly differentiate them from IOFs, there is a lack of more specific studies, in particular about models of strategic control, regarding the development of management methods adapted to the peculiar characteristics of agro-industrial cooperatives.

In light of the theoretical foundation about translation and control of strategy and about cooperatives and their relations with the sustainable development, arises the problem of this research: How to insert the social advancement and its effects on sustainable development, in the process of translation and control of strategy in Brazilian agro-industrial cooperatives?

## 2 Translation and Control of Strategy

By studying the performance evaluation and control systems for the implementation of business strategies, Simons (2000) developed a model of strategic control levers, involving four dimensions related to the Ps of strategy (Mintzberg et al. 2000): strategy as perspective; strategy as position; strategy as plan and strategy as pattern.

Strategy as perspective involves the consideration of values, beliefs, and ideals as master guides of the organization. It depends on the belief systems designed to communicate, give support and establish commitment among the individuals who make up the organization in order to develop a culture that reproduces the values declared in the company's mission.

The strategy as position considers the limits that should govern the company's behavior and management decisions according to the risks that should be avoided. It also considers the limits derived from the intended strategic positioning of the organization in the market regarding the pressures and competitiveness of the industrial sector (Porter 1998).

After the definition of the mission and the strategic positioning of the company through the analysis of the competitive dynamics of the market and the resources, skills, and internal capacities, there is the dimension of the strategy as plan. In this phase, the objectives and goals are set, communicated, and distributed formally throughout the organization, as well as the necessary resources are planned and coordinated so that the objectives can be achieved. In this phase are also defined performance measures and actions needed to achieve the goals.

Finally, the dimension of the strategy as pattern considers that from the actions of the people who constitute the basis of the company, ideas also emerge that can become suitable strategies for the organization. These are called emergent strategies, leading to the organizational learning process (Mintzberg and Quinn 2001).

The control levers associated with performance measurement techniques, such as the Balanced Scorecard—BSC (Kaplan and Norton 1997)—which fall within the Simons model (Simons 2000) as diagnostic control systems on the Plan lever, and interactive control systems in the Pattern lever—enable effective coordination and management of the business by the managers, or provide conditions for proper strategic management of the company.

Ward and Peppard (2002) suggest the combination of BSC with the critical success factors (CSF) to provide a holistic approach to the requirements for the development of Information Systems. Critical success factors are the key points that define the success or failure of an objective set by the planning of a particular organization. Rockart (1979) defines the CSF as a limited number of areas and their results, which, if satisfactory, promote the success of the competitive performance of the organization.

## 3 The Cooperative Movement

The attitude of cooperation has accompanied humanity since its inception. Bialoskorski Neto (2012) mentions cooperative actions since the beginning of civilization, from ancient civilizations, such as the Babylonians, as well as the middle and modern ages, reaching the contemporary age. For Engelhardt (1994), since human civilization began to be established, first business units based on associations of people under the aegis of communities have developed in various parts of the world.

Ostrom (2009) states that the theory of collective action is relevant to the study of cooperation in various contexts. The cooperation (or lack of this) in collective action situations is a very common variable in the work of the social sciences. One cannot study life within a social group without examining how individual actors deal with problems related to collective objectives.

Bialoskorski Neto (2012) reports that the cooperative movement, as currently disseminated, originated from ideas of the associationist utopian socialist economic school, in reaction to the proletarianization provoked by the Industrial Revolution in the late eighteenth and early nineteenth centuries, when it began to take place the economic rise of a small part of the population—the businessmen—while the workers lived in poverty. This economic school, whose principal representatives were Robert Owen, Charles Fourier, Louis Blanc, and William King, argued that a co-ownership of the production factors could replace the market. In this sense, the Utopian socialist school differed from the socialist scientific school, which advocated the simple suppression of private property, with the compulsory participation of individuals in a new community system, with the centralization of planning by the state.

Among the economists of the associationist utopian socialist school, it was Robert Owen's ideas that underpinned the genesis of the cooperative doctrine, which inspired the emergence in 1844 of The Rochdale Society of Equitable Pioneers, a consumer cooperative, considered the first cooperative of the modern cooperative movement. The principles adopted by the Rochdale pioneers were as follows: (Engelhardt 1994).

(a) democratic principles and procedures;
(b) open membership;
(c) limited interest rates on share capital;
(d) refunds according to the value of individual purchases;
(e) accumulation of a reserve fund;
(f) payment in cash upon receipt of goods;
(g) further education for members;
(h) religious and political neutrality.

The success of the Rochdale cooperative inspired the spread of its model throughout Europe, kicking off the modern cooperative movement. According to Engelhardt (1994), in 1849, the first cooperative of artisans arose in Germany, based on the Schulze-Delitzsch model. In 1885, the movement based on this model, whose principles are listed below, consisted of 922 loan associations with 466,575 members:

(a) self-help as an absolute necessity;
(b) self-responsibility;
(c) equal rights for each individual in the cooperative group;
(d) solidarity in the assumption of liability by the group;
(e) democratic self-government;
(f) strict refuse to accept outside help from the state.

According to Engelhardt (1994), also in Germany, from 1863, the small farmers' cooperatives based on the Raiffeisen model emerged, which summed 423 cooperatives in 1888 with 24,466 members. The principles of the Raiffeisen model cooperatives were as follows:

(a) religious and moral as well as material advancement of the members;
(b) limitation of the membership groups to small village-size districts;
(c) restrictions on share capital and dividends;
(d) unlimited mutual liability of the members;
(e) voluntary administration of the cooperatives, without payment;
(f) accumulation of an indivisible foundation fund.

Many of the doctrinal principles that guided the formation of the Rochdale Society of Equitable Pioneers, considered to be the beginning of the modern world cooperative movement, continued to be propagated by the International Cooperative Alliance (ICA) for the formation and development of cooperatives. These principles were also influenced by contemporary thinking about liberty, equality, fraternity, and solidarity, from which emerged the following concepts spread and practiced by cooperatives for a long time (Lambert 1975):

(a) democratic management;
(b) open membership;
(c) limited interest rate on capital;
(d) distribution of pro-rata surpluses;
(e) political and religious neutrality;
(f) cooperation between cooperatives;
(g) cooperative education.

Nowadays, the International Cooperative Alliance defines that the "Cooperatives are based on the values of self-help, self-responsibility, democracy, equality, equity, and solidarity. In the tradition of their founders, cooperative members believe in the ethical values of honesty, openness, social responsibility and caring for others" (ICA 2015), and the cooperative principles—the guidelines by which cooperatives put their values into practice, are as following: (ICA 2015).

1. Voluntary and open membership

   "Cooperatives are voluntary organizations, open to all persons able to use their services and willing to accept the responsibilities of membership, without gender, social, racial, political, or religious discrimination."

2. Democratic member control

   "Cooperatives are democratic organizations controlled by their members, who actively participate in setting their policies and making decisions. Men and women serving as elected representatives are accountable to the membership. In primary cooperatives, members have equal voting rights (one member, one vote), and cooperatives at other levels are also organized in a democratic manner."

3. Member economic participation

   "Members contribute equitably to, and democratically control, the capital of their cooperative. At least part of that capital is usually the common property of the cooperative. Members usually receive limited compensation, if any, on capital subscribed as a condition of membership. Members allocate surpluses for any or all of the following purposes: developing their cooperative, possibly by setting up reserves, part of which at least would be indivisible; benefiting members in proportion to their transactions with the cooperative; and supporting other activities approved by the membership."

4. Autonomy and independence

   "Cooperatives are autonomous, self-help organizations controlled by their members. If they enter into agreements with other organizations, including governments, or raise capital from external sources, they do so on terms that ensure democratic control by their members and maintain their cooperative autonomy."

5. Education, training, and information

   "Cooperatives provide education and training for their members, elected representatives, managers, and employees so they can contribute effectively to the development of their cooperatives. They inform the general public—particularly young people and opinion leaders—about the nature and benefits of cooperation."

6. Cooperation among cooperatives

   "Cooperatives serve their members most effectively and strengthen the cooperative movement by working together through local, national, regional, and international structures."

7. Concern for community

   "Cooperatives work for the sustainable development of their communities through policies approved by their members."

This 7th principle was first stated as a separate and distinct cooperative principle in the reformulation of the cooperative principles agreed by the members of the Alliance at its General Assembly in Manchester in 1995 (ICA 2015). Since then, the concern for sustainable development is explicitly declared as integrating the principles of the cooperative movement.

In July 2019, a General Assembly of United Nations published a report reviewing the role of cooperatives in achieving the Sustainable Development Goals, analyzing emerging issues and strategies for strengthening cooperatives in the light of the critical challenges that they face in their pursuit of sustainable development for all and concluding with policy recommendations for the further advancement of cooperatives. The General Assembly also declared that: (United Nations 2019).

> Cooperatives contribute to all aspects of inclusive social development and to the realization of the 2030 Agenda for Sustainable Development. In recent years, the cooperative movement has grown, in particular, as a result of the impetus provided by the International Year of Cooperatives in 2012. The cooperative model exists in almost every field of human activity, especially in agriculture and food industries, insurance, health care, wholesale and retail

> trade, and new areas or sectors, such as the platform economy and environmental protection. Given their people-centered business models, cooperatives are owned and operated by their members and are strongly committed to the development of their local communities.

The Brazilian Cooperative Organization—OCB statement about the cooperative movement in Brazil is described below: (OCB 2019).

> The cooperative movement is "a business model based on entrepreneurship and democratic participation. Unite people and share results. This is the proposal of the cooperative movement. What is sought is joint prosperity, meeting the needs of the group, not individualism. In particular, cooperative practice promotes, simultaneously, economic growth and social inclusion. It is a constant search for sustainable development - which for the cooperative movement is a priority as part of its principles and is present in its products and services. This socially responsible and sustainable movement mobilizes tens of millions of Brazilians of all ages, genders, races, and creeds, and has a significant place in the country's economy. Their actions are also grounded in ethical values of honesty, transparency, democracy, and social responsibility. More than 6,500 Brazilian cooperatives operate in 13 business segments, leading approximately 360,000 direct jobs. They are societies of persons constituted to serve their members, representing them in operations, strengthening their bargaining power and market space. In a cooperative, the distribution of results is linked to the operations performed and not to the participation by the capital. In it, everyone has the right to vote, and decisions are made democratically, based on values of mutual aid, responsibility, equality, equity, and solidarity.

## 4 Agro-Industrial Cooperatives

According to ICA (2015), a cooperative is defined as follows: "A cooperative is an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise."

This definition is in line with Georg Drahein's (apud Hanel 1994) concept of the dual or double nature of the cooperative organization. On the one hand, the cooperative is mainly an association, or a group from the sociological aspect, whose members are the owners and individual supporters of the organization. On the other hand, the cooperative is also a joint company of the economic undertakings (the farms) of the members. The owners of the cooperative company are the individual members of the cooperative group. In this sense, the cooperative is seen as an organization that should be directed towards achieving the goals of its members as users, i.e., the role of the cooperative is mainly the economic and social promotion of its members (Grosskopf 2009).

According to Staatz (1989), until the 1960s, the debate about cooperative organizations was focused on the discussion if cooperatives represented a form of vertical organization of farmers, becoming just as an extension of the individual undertakings of the members; or if cooperatives could legitimately be considered as organizations with own scope and independent decision-making process, regardless of the interests of farmers in their farms. In this sense, the debate focused on the discussion if the cooperative's management was implementing the wishes of the members, guided by

their interests, or sought the achievement of the cooperative objectives, as an organization acting independently of its members, having the vision of collective interests, not always convergent with all individual interests.

Staatz (1989) states that Stephen Enke started a different discussion, but perfectly adherent to real conditions, when he said that on the day-to-day of a cooperative, its administration is faced with situations in which decisions must be made, based on choices often antagonistic with each other, of what should be maximized between the interests of the members and the own cooperative's needs. From this discussion arose studies based on the approach of cooperatives as independent organizations with their own goals and as variants of IOFs.

Enke's model emphasized that the cooperative's management would have to balance the benefits received from two different sources to maximize the result of the members. Initially, the benefits received by members, derived from its operations with the cooperative, as it can provide lower prices for purchased inputs and higher prices for products sold by members. In addition to these primary benefits that are pursued initially by the members, another type of interest should be considered, derived from the adding value process provided by the cooperative for products delivered by the members. That is, benefiting the products delivered and operating in market conditions, the cooperative would offer financial returns derived from a lucrative business in different markets (Staatz 1989).

Prioritizing benefits focusing on just one of these financial sources of return would tend to reduce the overall returns for the members. That is, focusing only on the returns derived from the operations of the members with the cooperative, could limit the cooperative's capitalization in the long term, with effects on competitiveness and future returns for its members. On the other hand, focusing only on the strengthening of the cooperative at the expense of short-term economic advantages for the members could significantly compromise the return of individual members' farms. Enke, therefore, emphasized a crucial specific implication of cooperative organizations: the need to balance the benefits of members as users and as owners of the cooperative (Staatz 1989).

Another important concept related to cooperatives is their ability to regulate prices in imperfect markets. This concept in literature is defined as the competitive yardstick, which benefits the whole market, both cooperative and non-cooperative members. Hoffman and Royer (1997) state that:

> Farmer cooperatives have benefited from favorable public policies because they generally are perceived as procompetitive forces that improve the performance of imperfect markets and increase general economic welfare (Sexton and Iskow). Central to this notion is the "competitive yardstick" concept, which maintains that the existence of a cooperative in a market will force profit-maximizing firms to behave more competitively. The logic behind the yardstick is that the cooperative will offer farmers more favorable prices because of its practice of providing members service at cost price. Competing firms must match the cooperative's performance to avoid losing patrons to it. Consequently, the market will move toward competitive equilibrium.

## 5 Methodology

The research was conducted having systems thinking (Senge 2000) as the epistemological approach. According to Morgan and Smircich (1980), the epistemological approach on systems considers reality as a process of change and highlights the importance of the monitoring process and how a phenomenon changes over time concerning its context. In this case, the most appropriate research methods are those that capture the processes of change through historical analysis.

According to Dülfer (1994), the General Systems Theory is suitable for the study of cooperative societies, since it allows the independent analysis of objects that constitute sub-systems and the subsequent integration of these sub-systems in a supra-system.

The research was conducted, seeking the development of a model that could identify the factors involved in the process of translation and control of strategy, as well as their interrelations in system dynamics qualitative language. Social advancement, as discussed in this paper, was one of the processes analyzed, Other analyzed processes to design the model were the technological advancement and economic performance of the members; the commitment between members and cooperative; the capitalization of cooperative; the cooperative education and the cooperative's organizational culture; the professionalization and cooperative's efficiency; and the balance between cooperative and members. The whole model was designed by Barreiros (2012) as recommended by system dynamics qualitative language, through closed reinforcing or balancing loops, integrating the variables with their causal relations, feedbacks, and delays.

It was used the qualitative research strategy, collecting data through interviews and document checking. The research was conducted in two stages. Initially, interviews were conducted with five experts in cooperatives of the Paraná Cooperatives Organization—Ocepar.

From the results of interviews with experts, an instrumental case study was conducted in Agro-industrial Agraria Cooperative—Agraria. According to Stake (2005), the instrumental case study is recommended when studying a particular case, to understand the phenomenon in question.

Data collection for the case study in Agraria was made by document analysis and interviews with a purposive sample of twelve managers of the cooperative. The choice of respondents was based on intentional theoretical criteria, searching for people who could adequately express the meanings associated with the research problem, as recommended by Warren (2002).

Data were analyzed using thematic content analysis, co-occurrences analysis of registration units in different context units, and structural analysis, in order to enable better understanding of the links among analytical categories and their view as a system composed by interdependent parts that indicate that the change in a category can influence the whole set (Bardin 2010).

The taxonomic structure of analytical categories, based on the theoretical background of translation and control of strategy and on agro-industrial cooperatives, was made according to the criteria described below.

The first criterion relates to the strategic control levers, according to Simons (2000). According to the control lever, the analytical categories received the first classification, as follows: **PE**—for **Perspective**; **PO**—for **Positioning**; **PL**—for **Plan** and **PA**—for **Pattern**.

In the case of Plan lever and according to the perspective of the BSC, the categories received the second classification, as follows: **Learn**—for growth and learning perspective; **IP**—for the Internal Processes perspective; **Cust**—for Customer perspective; **Fin**—for Financial perspective. In addition to these four original perspectives of BSC, two more were explored in the analysis, related to the specific features of cooperative organizations: the **Social** perspective, that is a clear objective of cooperative movement; and the **Relationship with Members** perspective, which arises from the specificity of management of cooperative organizations, that depends on balance between cooperative and members in several mutual relations, not always with convergent interests. The analytical categories of Social perspective were represented by the word **Social** and the ones of Relationship with Members perspective by the acronym **Rel.M**.

The third criterion for the classification of analytical categories lays in the fact that they refer to the **cooperative** sub-system, represented by the letter **C** or to the **membership** sub-system, represented by the letter **M**. For the fourth criterion, the analytical categories were classified according to their nature. For the fifth criterion, some categories were further classified by types, according to their degree of diversification.

Example of an analytical category:

- **PL_Social-Social Benefits-Externalities:** lever: Plan; perspective: Social; nature: Social benefits; type: Externalities.

## 6 Results and Discussion

This section identifies the Agro-industrial Agraria Cooperative and presents the results of the content analysis of two hermeneutic units: interviews with experts of Ocepar and interviews with Agraria's managers. It is still displayed a network of relationships among analytical categories as a result of structural analysis from the two hermeneutic units.

## *6.1 The Agro-Industrial Agraria Cooperative*

The proper choice of the cooperative was of fundamental importance given the need for access to information and internal processes. The choice fell on the Agro-industrial Agraria Cooperative, which will be henceforth referred to in this paper as Agraria, located in the district of Entre Rios, municipality of Guarapuava, State of Parana, southern Brazil.

Agraria was created in 1951 by immigrants of Germanic origin, known as Danube Swabians. These people inhabited the south-eastern region of Europe (ex-Yugoslavia, Romania, and Hungary) since the eighteenth century. After World War II, an immigration project of 500 families was conceived to set up an agricultural cooperative in Brazil, supported by the humanitarian institution Aid Switzerland for Europe. At the time, the Brazilian Government was interested in developing wheat farming in the country, which was incipient. The arrival of these settlers would be a way to promote wheat cultivation in Brazil (Agrária 2019a).

The early years were not easy for these settlers. There were many difficulties in cultural adaptation and adaptation to the soil and climate conditions of the Entre Rios region. Infrastructure conditions were deficient, with the need to build houses, schools, churches. There were problems with crop frustration due to weather and soil acidity, especially in wheat crops.

According to Gärtner and Pires (2011), the problems faced by the pioneers during the first years of colonization led, in the sixties decade, to the evasion of 50% of the families, who eventually returned to Europe or looked for other opportunities in Brazilian cities, in the process of industrialization and absorption of labor.

Agraria went through several phases, with importance for almost thirty years of management of Mr. Mathias Leh, who stood out as a leader and had the vision to promote the capitalization of the Cooperative, to carry out the agricultural expansion project of the members and the investments in agro-industries by the cooperative. There were several forms of capitalization used by the cooperative throughout its existence, and the predominant currently is the appropriation of financial surpluses internally generated by the own businesses operated by Agraria.

One way or another, the capitalization has always been made possible by some individual economic sacrifice of the members, seeking some future collective economic benefit. An emblematic example was the capitalization carried out under Mr. Mathias Leh's management, provided by the payment of a specified amount for each ton of fertilizer supplied to the members, which allowed Agraria financial capacity to acquire new areas of land and carry out land reform in the colonies. The member who acquired 100 hectares had to resell the smaller area to the neighbor. Everyone earned and grew because this land reform enabled the emergence of a substantial class of medium farmers that has sustained the cooperative until today (Teixeira 2010).

Agraria's membership is made up of 650 members, of which 461 are active (Agrária 2019b). Inactive members are, for the most part, older farmers, already retired, but still associated with the cooperative. It is a cooperative with a relatively

small number of members, but the average size of the farms of these members is larger compared with other cooperatives in Parana. The degree of homogeneity of the membership is also high compared to other cooperatives in Parana. Agraria's members focus their activities on grain production, especially soybean and corn, as summer crops and wheat and barley as winter crops. It is in winter crops that Agraria and its members stand out compared to the rest of the state of Parana.

Agraria concentrates its agribusiness in the following areas:

(a) malting of barley for malt production;
(b) milling wheat for the production of wheat flour and wheat bran;
(c) soybean crushing for soybean oil and soybean meal production;
(d) industrialization of corn for the manufacture of feed and corn grits and flakes.

One feature that has highlighted Agraria nationally is the quality control of its processes. Agraria has already received an award in the Sustainable Development category, in the Cooperative Contest of the Year, promoted by the Brazilian Cooperative Organization—OCB. Additionally, participating in contests promoted by Brazilian press agencies, Agraria has already received similar awards in other categories, as Social Responsibility and Professional Management; the best agribusiness company in the grain category; and the best agribusiness company in the grain sector.

Since 2007, Agraria's gross sales have exceeded one billion reais. In 2018 it was three billion, five hundred and twenty-four thousand Reais, which amounted to approximately one billion dollars. Agraria's economic size makes it one of the most relevant agribusiness companies in Brazil. Agraria was ranked 274th among the 1000 largest companies in Brazil, according to Valor 1000 magazine, and 74th among the 400 largest companies in Brazilian agribusiness, according to Exame magazine.

Agraria's strategic formulation process begins with defining the cooperative's mission and future vision. Agraria's mission is: "To develop, produce and sell agro-industrial products and services, adding value with appropriate technology and superior quality, seeking client satisfaction, and respecting the individual, the principles of the cooperative movement, and the environment" (Agrária 2019b). Agraria's vision for the future is: "To be a national benchmark in agro-industrial production technology and cooperative management" (Agrária 2019b). Both Agraria's mission and future vision have their contents strongly linked to agro-industrialization, technology, quality, market orientation, and cooperative management. The declared values of Agraria are ethical attitude, quality, cooperation, tradition, and ownership sense.

The history of the organization of settlers from Europe, provided by Agraria, has gone beyond the economic issue, also involving the social dimension, as the Cooperative promoted actions for the construction of houses and churches, the construction and maintenance of schools and hospitals, and encouraged the preservation of Swabian culture and traditions.

Therefore, besides acting in the economic area, Agraria invests in social and cultural activities in the Entre Rios Colony. The following entities receive support from Agraria:

(a) Entre Rios Agricultural Education Association, founded in 1968, which gave rise to the Imperatriz School, which offers comprehensive training for students,

including German language instruction. In 2018, the College received subsidies from Agraria of R $4.21 million, (Agrária 2019b);
(b) Semmelweis Hospital, which received subsidies from Agraria in 2018 in the amount of 1.73 million Reais, which is equivalent to more than 50% of hospital costs (Agrária 2019b);
(c) Swabian-Brazilian Cultural Foundation, created in 2001, to preserve the culture of the Danube Swabians. In 2018, the Foundation received subsidies from Agraria in the amount of 3.63 million Reais (Agrária 2019b);
(d) Mathias Leh Cultural Center, founded in 1992, with an auditorium for 650 people, music classrooms and exhibition space;
(e) Entre Rios Historical Museum, existing since 1971, which preserves the memory of the colonization of Entre Rios by the Danube Swabians;
(f) Entre Rios Ladies Association;
(g) Social Projection Project;
(h) Entre Rios Fire Department;
(i) University Radio Entre Rios FM;
(j) Churches.

## *6.2 Social Advancement*

It is discussed below, aspects related to the social benefits that are generated by the cooperative, as a consequence of the economic evolution of the members, as well as by other sources, such as the generation of jobs, income and payment of taxes by the cooperative. The positive effects of social advancement on the cooperative's organizational culture are also discussed.

### 6.2.1 Experts Interview Results

In the opinion of the experts, social advancement is an essential objective of cooperatives. The cooperatives are not created with the objective of financial return of the capital of their owners, but with the objective of economic organization of the productive system of their members, aiming to increase the members' income in their enterprises and, in the long run, balanced social progress, as a consequence of the economic progress of the members.

In addition to the social benefits generated to their members, cooperatives, as organizations that arise in their regions, develop lasting economic relationships with other economic agents in the community, which leads job creation, relationships with suppliers and increased income with trade activities benefits, that is, other economic agents also benefit indirectly from the growth of cooperatives. The following categories of analysis represented these factors:

- **PL_Fin-M-Economic Performance**
- **PL_Fin-C-Economic Performance**

- **PL_Social-Social Benefits**
- **PL_Social-Social Benefits-Members Perception**
- **PL_Social-Social Benefits-Externalities.**

The categories identified above, in addition to significant co-occurrences among themselves, also occur frequently associated with analytical categories related to cooperative doctrine, mission, balance, economic promotion of members, organizational culture, commitment between cooperative and members, fidelity, production delivered, cooperative financial surpluses and distribution of financial surpluses. There are several excerpts that associate social advancement with the economic evolution of members; as well as the effect of the perception of social benefits by the members on the strengthening of the cooperative's organizational culture, and consequently on the commitment between cooperative and members, fidelity, production delivered and increase of the cooperative's financial surpluses. Thus, this part of the analysis considers the relationships between the categories already identified and more the following ones:

- **PE_Cooperative Doctrine**
- **PE_Mission-Sustainability**
- **PE_Mission-Balance**
- **PE_Mission-Social Advancement**
- **PO_Economic Promotion Members**
- **PO_Balance Cooperative/Members**
- **PO_Agro-industrialization**
- **PO_Market-Price Regulators**
- **PO_Commitment Cooperative/Members**
- **PL_Learn-C-Culture**
- **PL_Learn-C-Culture-New Generations**
- **PL_Rel.M-Fidelity**
- **PL_Rel.M-Delivered Production**
- **PL_Rel.M-Incentives for Cooperation**
- **PL_Fin-C-Financial Surpluses**
- **PL_Rel.M-Financial Surpluses Distribution.**

The co-occurrences among the considered categories were well distributed in different contexts, in particular, those relating to different experts when discussing the theme of social advancement. The distribution of co-occurrences in different contexts indicates the emergence of particular patterns between the views of respondents, which reinforces the existence of relationships among the considered analytical categories.

In the opinion of experts, social benefits, in the context of Parana State, lie at the heart of cooperative societies, which have as one of their principles the sustainable development of their communities. The social benefits begin with the economic advancement of the members themselves, with increased income and living levels of the members and their families. Other indirect benefits are associated with the growth of cooperatives, such as job creation; the strengthening of regional economies, due

to the economic progress of cooperatives; the payment of taxes, which should result in better services for the general population; and also the role of cooperatives as price regulators, which benefits not only members but also other non-cooperative producers. These factors can be seen in the consolidated memos below, which are extracted from the data and summarize the experts' opinions:

(a) Cooperatives are organizations that arise in different regions, and which essentially bring the economic vocation of these regions. They organize the production chain and provide business development and viability, which express the capabilities of local economic agents. They do not depend on companies coming from other regions to invest in the locality. This feature gives the cooperative a strong commitment to the community. Unlike other companies that seek business opportunities, regardless of location, cooperatives look for opportunities that reinforce the economic advantages of the community itself. The focus of the cooperatives is to enable business and add value to members in their locations. Several examples show that the development of certain regions in Parana occurred directly due to cooperative activities, as the case of Cafelândia region, for example, whose development depended heavily on the activities of Copacol Cooperative, which adopted a strategy of adding value to the production of small producers, especially via integrated poultry systems. Currently, the influence of Copacol's activities on Cafelândia's economic and social conditions is very strong. In addition to the economic and social advancement of members, jobs are generated, trade and other services depend on the income generated by the economic agents orbiting around Copacol. Without the cooperative, the reality would be different, with much less expression of the local economic vocations;
(b) The social concern is at the heart of the cooperative societies. Cooperatives are founded to economically organize the activities of their members to improve their income equitably. It is not the purpose of the cooperative to accumulate profits for a few owners, but to increase the members' income, either by the benefits of increasing the bargaining power of the cooperative in negotiations with the market; either by the distribution of financial surpluses accumulated by the cooperative, in proportion to the operations of each member with the cooperative. It is possible to notice that in Parana, in localities where there are well-structured cooperatives, the tendency is for the Human Development Index to increase. In the Lar cooperative, for example, it is possible to compare the economic situation of members in the eighties and the current situation. Significant progress has been made due to the cooperative's strategy of adding value via agro-industries and diversifying activities, with the transfer of economic advantages to members. With an increase in income, members can rise socially, to improve their educational level, and to improve their prospects of standard living for the new generations. It is possible to observe a reduction between differences in living standards and access to resources and services between urban and rural areas. Cooperatives have a great responsibility in this process because their mission is linked to the development of their region;

(c) The first concern of cooperatives must be with the economic evolution of their members. Social advancement depends on this economic advancement of members. Besides, there are indirect effects on the community, such as job creation, increased income for the general community, and tax collection, which should result in better community services. Another significant indirect effect is the cooperative's role as a price regulator. Cooperatives do not regulate prices only for their members. Non-associated producers also benefit indirectly as other primary purchasers are pressured to raise their prices where there is a strong cooperative with sufficient bargaining power to avoid price degradation for farmers. In this respect, the cooperative movement stands as a counterpoint to the concentrating tendency of capitalism. The cooperative organization, as an alternative management model, is more focused on fairness in the distribution of benefits generated by value addition, with better income distribution. By this reasoning, the influence of the members' economic advancement on the social benefits generated by the cooperative is strong;
(d) Members realize the economic and social benefits generated by cooperatives. Members are proud to participate as partners in an organization that has made it possible to aggregate the value of primary production, the transformation of grain into animal protein, for example, especially because this advancement provides prospects for members and their families. This perception contributes positively to the consolidation of appropriate organizational culture in the cooperative. However, there is a risk of diminishing this perception by the new generations, who did not experience the reality before the emergence of the cooperative and did not experience the initial difficulties of the cooperative. Cooperative education has the responsibility to make new generations aware of this issue;
(e) The main community of the cooperative is its membership. Therefore, its priority objective must be related to the sustainable development of the member. The cooperative may worry about social responsibility outside the cooperative if it can afford it, but first, it has to do internal development work. Therefore, there is a strong influence of the members'profits on the social benefits generated by the cooperative.

### 6.2.2 Results of the Agraria Cooperative Study Case

From interviews with managers, it was possible to identify three main sources of social benefits generated by the cooperative. Firstly, a clear and direct source, consisting of the grants that the cooperative makes to the Imperatriz School, the Semmelweis Hospital, the Swabian-Brazilian Cultural Foundation, among other institutions. In this case, the cooperative deliberately assumes expenses, supported by the decision of the cooperative members, who contribute with a discount of 0.5% on the value of their products sold in the cooperative, to form the Health and Social Support Fund—FASS. Other indirect sources of social benefits generation are the taxes collected by the cooperative, which are passed on to the public authorities,

which are responsible for providing the return on social benefits and infrastructure. Agraria paid in 2018 the amount of R $405.32 million in taxes. Finally, the other source of social benefits derives from the cooperative and member's economic evolution, through job creation, income increase and distribution, and improved educational levels of community members. These factors can be seen in the consolidated memos below, which are extracted from the data and summarize the managers' opinions:

(a) Agraria's tradition in the social issue is different compared to other cooperatives. Since its foundation, given the deficiencies of the Government in the areas of infrastructure and social services, the cooperative has also assumed the role of community organizing agent. Therefore, the cooperative itself traditionally assumes some investments in the social segment, with the consent of the members. That is, the members already authorize Agraria to make some investments and subsidies in the social segment, reducing the cooperative's financial surpluses. The cooperative subsidizes services such as schools, hospitals, cultural activities, fire brigades, street and square maintenance, churches, and senior support programs. These grants are accounted for as cooperative costs. Some cooperatives do, and others do not do this direct social assistance. In the case of Agraria this social assistance is significant;
(b) The cooperative subsidizes Semmelweis Hospital, which is in deficit. Without this hospital, residents of Entre Rios would have to travel to other cities, as Guarapuava or Pinhão, in need of hospital services. The hospital does not only attend members, employees, and their families, but the entire community, through the Unified Health Service—SUS, or through various health agreements. The cooperative subsidizes the Imperatriz School, which is in deficit. Scholarships are granted to children of members and also to children of employees. The cooperative subsidizes the Swabian-Brazilian Cultural Foundation, which promotes cultural activities related to music, theatre, dance groups, and painting;
(c) Investments in the social segment are possible as long as there are good financial results in the cooperative business. The economy precedes social. As the cooperative is viable, it becomes possible to maintain these social investments. The economic outcome, if well-intended and distributed, can be directed to community development;
(d) The very economic development of Agraria's members represents social advancement in the community. When comparing the economic situation of the pioneer settlers with the current situation of the members, it is noted that the evolution of the farms infrastructure was substantial, consolidating modern and profitable agricultural farms, with increase in income generation; improvement in educational level—most of the sons of the members have a university degree, many of them are trained in the agricultural area, many are Agronomists—in living conditions; in consumption levels; and in job creation;

(e) Job creation and tax payments by the cooperative can be considered as sources of social benefits. Given that the economic activity of the cooperative generates approximately 1200 direct jobs, this means making income possible for hundreds of families. As the cooperative, in its economic activity, pays municipal, state, and federal taxes, it is feeding the government systems, which are responsible for returning the taxes generated through social benefits and infrastructure. In the generation of taxes comes the question of agro-industries. Some taxes that Agraria collects are calculated based on revenues, currently exceeding three billion reais. Other taxes like Income tax and social contributions are calculated on net financial surpluses of operations derived from non-cooperative acts. This flow shows that as revenues and financial surpluses increase, more taxes are collected;

(f) The economic strength of Entre Rios—the largest district in Brazil—is due to Agraria's economic activities. Twelve thousand people live in the district, most of them with some direct or indirect connection with Agraria or its members. Agraria is responsible for much of the taxes collected by companies in Guarapuava. Without the taxes collected by Agraria, Guarapuava would have a significant loss in the Municipal Participation Fund. On the other hand, Entre Rios misses the application of municipal resources in the maintenance of basic social services and investments in infrastructure very much;

(g) As Agraria assumes and maintains a series of investments in the social segment, this reinforces the ties that its members have with the cooperative. The relations of the members with the cooperative begin to transcend a purely economic issue since the children of the members are educated in a school maintained by the cooperative; medical emergencies that occur with community members are resolved at the hospital maintained by Agraria; and cultural activities that bring people closer to the community are promoted by the Foundation maintained by the cooperative. Agraria subsidizes all this, but with resources that come from the members themselves, who feel responsible for these benefits. This process reinforces the identity of individuals with the collective and feeds back the culture of the organization and the community itself, which has its essential value in cooperation. The preservation of this value is fundamental in the succession of generations;

(h) The objective assessment of the social benefits generated by the cooperative is difficult to do. Controlling the investments made is easy, but the benefits generated are diffuse and distributed over time. A possible indirect form of evaluation would be through member satisfaction surveys, which are conducted every two years at the cooperative, or by monitoring the degree of direct or indirect participation of members in the administration, maintenance and activities of organizations maintained by the cooperative. Despite this difficulty of objective evaluation, there is a conviction that members realize the social benefits generated by the cooperative, by the very continuity of investments, which they formally approve, at the ordinary annual meetings. There is usually no question of such subsidies, and on the contrary, some members even think that, as

Agraria generates sufficient financial surplus, more resources should be invested in social benefits.

### 6.2.3 Structural Analysis Results

Based on data from thematic content and co-occurrence analysis, structural analysis was carried out. Figure 1 shows the social advancement network of relationships among the analytical categories identified from the interviews with the experts of Ocepar and with the managers of Agraria. This network was developed according to the co-occurrence of the analytical categories in different contexts and the respective interpretations of the interviewees' opinions.

The structural analysis performed, illustrated in Fig. 1, allows the identification of the following relationships among the analytical categories:

(a) the cooperative doctrine concerning the control lever of perspective is the basis for the conception of the cooperative's mission;
(b) the cooperative's mission, also concerning the control lever of perspective, is broken down into categories related to sustainability, social advancement and balance;
(c) from the mission of the cooperative, emerge the categories concerning the control lever of positioning, classified as commitment between cooperative and members; economic promotion of members; agro-industrialization; price regulator; and balance between cooperative and members;
(d) the positioning of the cooperative regarding the balance between cooperative and members is associated with the economic performance of both;
(e) the two positionings of the cooperative regarding (a) the commitment between cooperative and members and (b) the economic promotion of members, allow the establishment of incentives for cooperation, which in turn influences the fidelity of the members;
(f) the economic performance of members provides long-term social benefits;
(g) the economic performance of cooperatives provides social benefits such as job creation and those derived from the tax payments. In the case of Agraria, the cooperative's performance also provides direct social investments in community services such as education, health, culture, and others.
(h) the social benefits generated by the cooperatives are perceived by the members, with positive effects on the organizational culture of the cooperatives;
(i) adequate cooperative organizational culture positively influences the commitment between cooperative and members, the fidelity of members and, consequently, the production delivered to the cooperative;
(j) production delivered to the cooperative positively influences the generation of financial surpluses by the cooperative;
(k) the generation of financial surpluses by the cooperative positively influences the distribution of surpluses to the members, closing the cycle by increasing the financial result of the members, and, in the long run, leading to social benefits.

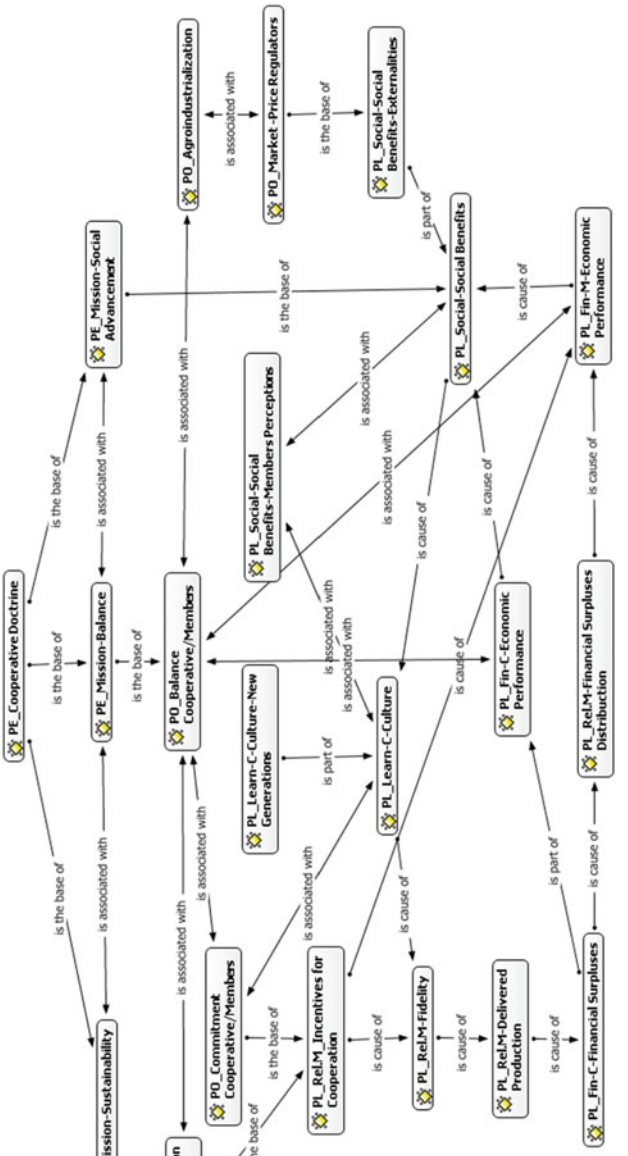


**Fig. 1** Network of social advancement. *Source* The authors

(l) Indirect economic and social benefits are also derived from cooperatives acting as price regulators in their localities, benefiting all farmers, regardless of whether they are or not associated with the cooperative.

## 7 Conclusion

This paper discusses the insertion and influences of social advancement in the process of translation and control of strategy regarding the context of Brazilian agro-industrial cooperatives. It is concluded that a model of such a process should consider social advancement as a critical success factor, related to the control levers of Perspective, Positioning, and Planning (Simons 2000).

The research results led to the conclusion that a model of translation and control of strategy in agro-industrial cooperatives should consider the peculiarities of this type of organization, especially concerning the social objective that cooperative societies have sought since their foundation, incorporating in the adaptation of the BSC, the **Social** perspective and the **Relationship with Members** perspective, beyond the traditional perspectives of Growth and Learning, Internal Processes, Customer and Financial.

The epistemological approach of systems thinking, adopted in the research, led to the identification and establishment of relationships among the main analytical categories in the study. Thus, starting from the context of the origin of the cooperative analyzed in the case study, and seeking to know the changing process captured by historical research, meaningful relationships arose regarding cooperative doctrine, cooperative mission, agro-industrialization strategic positioning, promotion of members, balance between the cooperative and the membership, commitment, incentives for cooperation, fidelity, economic performance of the cooperative, economic performance of the members, social benefits, cooperative organizational culture, and sustainable development in the cooperative community.

The critical success factor of social advancement, discussed in this article, is part and is linked to a broader and complex model of translation and control of strategy in Brazilian agro-industrial cooperatives (Barreiros 2012), which also considers other critical success factors such as the technological advancement and economic performance of members; the commitment between cooperative and its members; the capitalization of the cooperative; the cooperative education and organizational culture of the cooperative; the professionalization and efficiency of the cooperative; and the balance between cooperative and members.

This work contributes to increasing the level of theoretical knowledge about the insertion of social advancement in models of translation and control of strategy in agro-industrial cooperatives, a theme that is still little explored in the Brazilian literature, despite the great economic and social importance of agro-industrial cooperatives in Brazil, mainly in Parana State, where large Brazilian cooperatives are concentrated.

From the results found, a series of new researches can be carried out. Initially, complementary research could be carried out, aiming to extend the spectrum of the data to other realities, as a way to test the external validity of the results of this research, confirming or refuting them. Another way of complementing this research is to continue the search for the objective of the project to which it is inserted, that is to develop a Decision Support System, through a quantitative model, which allows the realization of virtual experiments, through simulation.

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# Architecture-Oriented Agile Approach for Sustainability Reporting


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## 1 Introduction

Due to the dynamics of the current organizational market, it is crucial for organizations to report in a transparent manner their projects, indicators, and practices related to sustainability. Nowadays, such disclosures are complex to accomplish as it may involve some adequacy projects, it requires simultaneous delivery of value across different areas, as such sustainability practices cover the entire organization, and in order to have a complete report, there is a need to gather a wealth of information as well as analyze it in a short time and by a reduced staff.

Another point to consider is that the reporting team is not active in all areas that provide the indicators that make up the report. Thus, it is a process that demands a

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high commitment from those involved, stipulates a high number of requirements that must be presented, and demands validation of much information about the indicators. For these reasons, it is a thread with a high risk of failure, since the information must be clear and coherent because this report is the key to understand the attitude of organizations towards the identification, analysis, care, and solution of potentials and reals impacts caused by the business.

Therefore, the sustainability report is the practice of measuring and disseminating through a report the social, economic, and environmental impacts caused by the daily activities of an organization—a company, a nonprofit organization or a government institution (Global Reporting Initiative 2019a; Calabrese et al. 2016). Since it is a tool that allows organizations to explain how they manage the economy, the environmental and social impacts related to their business (Global Reporting Initiative 2019a). That is, it discloses how the actual and potential impacts caused by the organization's activities are identified, analyzed, and resolved (Global Reporting Initiative 2018).

Also, the report can be seen as a way of explaining actions and other pertinent information to organizations' stakeholders. Thus, maintaining a dialogue with shareholders and other stakeholders (Romero et al. 2019). Since it is relevant and a requirement of the GRI G4 Guidelines—and after GRI Standard—there is integration, relation, strategies and communication with stakeholders (Global Reporting Initiative 2011, 2019a).

For this reason, the procedure designed to assist in the implementation of organizational adequacies projects, called "architecture-oriented agile approach," will be used to guide an automobile company, named Company Y, located in the metropolitan region of Curitiba, in the state of Paraná, Brazil, to disclose its sustainability-related projects, indicators, and practices through the Global Reporting Initiative (GRI) report model, for being internationally recognized. The largest companies in the world are using "some kind of guidance or framework to guide their sustainability reporting. The GRI framework is most commonly used, with 63% of N100 reports and 75% of G250 reports" (KPMG 2017).

This procedure was selected because it is capable of dealing with all the aspects which dynamically contemplate the reporting and it is an approach that covers all the steps that are essential to do in order to have the success of the adequacy project. Remembering that organizational change can be defined, according to Levovnik and Gerbec (2018), as "any change of position or responsibility within an organization or any change in a political organization or procedure that affects the safety of the process."

## 2 Research Design

This procedure is covered by steps from 0 to 5. The zero phase establishes the team responsible for the coordination of the project, which should be composed of: the interlocutor (animator) who will be responsible for the progress of the project, according to the procedure systematic; the project owner, who will be responsible for

managing the entire backlog and sprint cycles; scrum master, who will be responsible to managing the throughout the project, as well as stakeholder expectations, requirements compliance and potential risks and; the people involved in the execution, who are responsible for the operationalization of all the actions.

After Phase 1 is planning the transformation project, defining the requirements that need to be met, understanding their impact on the organizational system, prioritize these requirements (e.g., using the MoSCoW tool), in order to classify them into groups of importance for the project. After this, how the company will meet the relevant project requirements is defined through the modeling of the aspects. These aspects are correlated with the requirements in order to identify relationships with each other. Since a requirement can be met for more than one aspect or one aspect can fulfill more than one requirement. Besides, an analysis of risks can be performed but should be aligned with the strategies defined in Phase 0. The second Phase is diagnosing the organizational system to be transformed, assessing how well the company already meets the defined requirements of the transformation project (e.g., creating the "AS IS" model). The third Phase is creating the "TO BE" model that meets the defined requirements and provides a transition view on how the current model can evolve and reach the project purpose. The fourth phase is driving change based on the SCRUM method, in which an architecture requirements backlog is kept, and gradual changes are realized according to it, helping involved people organize how change is conducted. In this phase, the current model is updated according to the incremental changes that are implemented, until the current model reaches or is close enough to the future model. In the fifth and final phase, the results of the application of the whole procedure are evaluated—whether the current model reached the future model, whether the project purpose was accomplished, and how the current model may be further developed. Figure 1 presented the procedure.

The procedure is based on the SCRUM method because it is one of the most used approaches to agile methodology. This framework focuses on what has already been developed to obtain sequential increments, generating precuts and services from the items of higher priority to the ones with minor priority. It requires constant communication between participants (Paschek et al. 2016).

SCRUM's main idea is to make systems flexible enough to adapt to changes in requirements, resources and technologies to achieve value-added results. In this way, it allows the development of several processes and techniques, consisting of the stages of planning of the iterative cycles (SPRINTs), execution of these cycles, daily meetings for follow-up, meetings for SPRINTs review and retrospective meetings. Therefore, SPRINTs represent the set of activities that are executed sequentially in each iteration (Raj et al. 2015).

Also, in each phase, there is a set of worksheets that are used to operationalize the procedure; however, for each project, different worksheets will need it. Therefore, first, it is of paramount importance to define each of them. Table 1 presents a list of worksheets that could be used in each of the phases of the procedure.

Nevertheless, it is not an obligation using them once this definition must be made by the project team, as the worksheets must fit the project purpose and be aligned with the intent of each phase of the procedure.

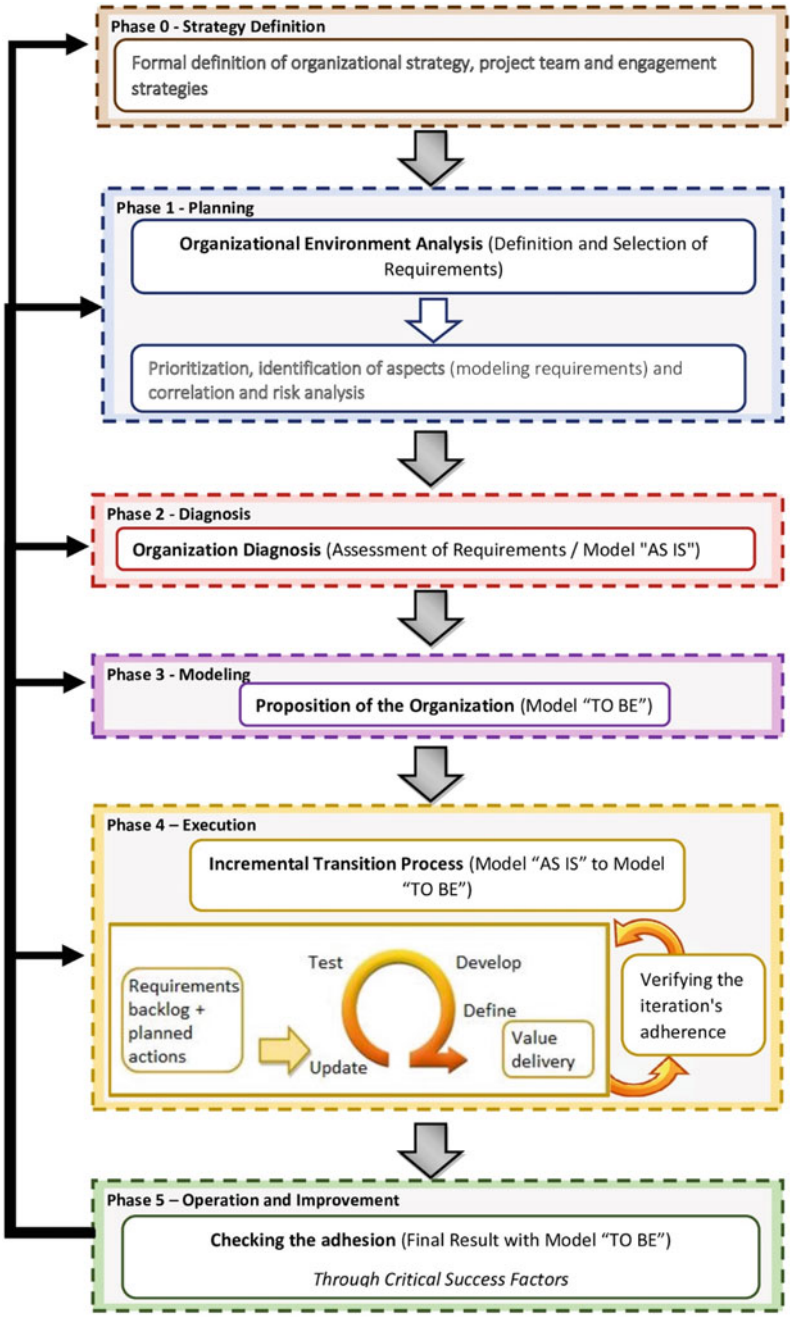


**Fig. 1** Architecture-oriented agile approach for driving organizational adequacy

**Table 1** List of worksheets for each procedure phase

| Phases | Worksheets |
|---|---|
| Phase 0—Strategy definition | Forms, risk management plan, executive summary, project chapter, and others |
| Phase 1—Planning | Workshop, frames, matrices, forms, MoSCoW tool, VUCA Framework, 5W2H tool, risk analysis spreadsheets, risk management plan, and others |
| Phase 2—Diagnosis | Checklist, process Modeling, Architecture models, questionnaire and others |
| Phase 3—Modeling | Plan of action, process modeling, architecture models, checklist and others |
| Phase 4—Execution | Forms, checklist, and others |
| Phase 5—Operation and improvement | Checklist, forms, reports, process modeling, architecture models, questionnaire and others |

## 3 GRI Standard

The GRI Standard was prepared by the Global Reporting Initiative (GRI). This is a world-renowned nonprofit organization that helps companies, government, and other institutions understand and communicate the impact of their business on critical sustainability issues. This is done through guidelines and norms drawn up since 1997, that guide the preparation of a report, which is composed of actions and indicators related to the social, economic and environmental aspects of the organizational business (Global Reporting Initiative 2018).

Based on the GRI, it can be considered that "GRI Standards are the first global standards for sustainability reporting. They have a modular and interrelated structure and represent global best practices for reporting a range of economic, environmental, and social impacts" (Global Reporting Initiative 2018). In addition to having a new modular structure, the GRI Standard version when compared to the old G4 version has the following changes: revised format with more explicit requirements; content clarifications; greater flexibility and transparency in how to use the Standards; Restructuring/relocating selected content; (to reduce duplication and improve the logical flow) and Overall editing—clarity (Global Reporting Initiative 2019b).

The sustainability report is prepared based on the material topics of the organization. These, in turn, are the areas portrayed in this type of report: environmental, economic, and social. Thus, the GRI Standard is subdivided into two groups. The first of these is made up of reports composed of universal standards, i.e., the norms for the preparation of the report, while the second group refers to reports that present the patterns of specific topics (environmental, economic, social). Table 2 demonstrates this division of the GRI standard.

Importantly, the standard has two forms of report development, and it is up to the organization to choose the type of report that will be prepared. The core model is

**Table 2** GRI standard division

| Notebooks | Function | Notebook type |
|---|---|---|
| GRI 101—Foundation | The starting point for using the GRI Standards | Universal standard |
| GRI 102—General disclosures | To report contextual information about an organization | Universal standard |
| GRI 103—Management approach | To report the management approach for each material topic | Universal standard |
| GRI 200—Economic | Guide to reporting economic aspects | Topic specific standards |
| GRI 300—Environmental | Guide to reporting environmental aspects | Topic specific standards |
| GRI 400—Social | Guide to reporting social aspects | Topic specific standards |

centered, targeted at the enterprise core, and the comprehensive one that needs to contain more detail about related indicators.

In the standard, this differentiation is made through frames. Since the indicators required by the GRI are arranged through a framework called "reporting requirements," which make up the requirements to be described in the report, of the essential type. Moreover, below this table are the additional requirements, called "report recommendations." These, however, the organization is only required to comply with if it opts for the comprehensive type report (and be a material topic).

However, if the organization that chooses to produce the report in the essential model and identifies additional information (recommendations, guidelines, complementary actions, practices, and others) regarding the theme and/or indicator required by the GRI Standards, which is not required by this type of report; they can be added without interfering with this structure as they would be framed as a complement to the report. Emphasizing that this addition can be made exclusively on a material topic or a set of them (materiality).

However, in the comprehensive model, the organization does not have this flexibility, as it is required to present all other requirements and related indicators arranged as complementary in all specific topics that it must report according to their materiality. Remember that the type of report chosen must be arranged in the presentation of the report. Both publishing options (core or comprehensive) allow the creation of new indicators if it is a material topic, and it is not fully covered by GRI.

Moreover, for the company in question, this reporting process is voluntary, since in Brazil, according to Law No. 13303, of June 30, 2016, not all business sectors are required to report their sustainability practices (Presidência da República 2016). Moreover, when it comes to companies located outside Brazil, they need to comply with other sets of rules and laws that determine this obligation. However, organizations can design their sustainability report template or opt for one already known and used. There are several models available, but nowadays, the GRI model has an excellent credibility in the international scenario (KPMG 2017).

## 4 The Application Case

Frequently, when the organization chooses to produce the sustainability report according to GRI Standards, it always addresses all specific topics, i.e., economic (200), environmental (300), and social (400) perspectives. However, for the purpose of explaining the use of the procedure in this case, part of the social booklet was selected, since the result of the other notebooks and indicators would be performed in the same way. Thus, it was considered that applying the procedure on a portion of the indicators, i.e., a cut-out of the reports would be enough to demonstrate its applicability. Since all reports follow the same structure logic. So, Fig. 2 presents the clipping used in the procedure test. So, this strategy and type of application can be considered as phase 0.

However, the other impacts (material topics) were listed in the prioritization stage, i.e., the first stage of phase 1 of the procedure, as you can see from Table 3, addressing the 15 material topics that should make up the sustainability report.

**Fig. 2** GRI clipping used


**Table 3** Prioritization

| Value for business | Requirements (people, society, customers, and business) = IMPACTS |
|---|---|
| | Complex (addresses different subjects) |
| Must | Local communities, diversity and equal opportunity, employee health and work environment, business ethics and compliance, Socioenvironmental impacts of the supply chain |
| Should | Industrial park safety (fire prevention, explosion, and pollution), human rights, sustainable cities and urban mobility, stakeholder dialogue (cross-cutting), research and innovation |
| Would | Water management, energy management, emissions management (product and manufacturing), waste management and circular economy, profit and economic viability |

However, as the focus was given to the social record, topics about this aspect were considered extremely relevant to the project. Furthermore, consequently, those of the other notebooks (environmental and economic) were in the category of "not going to have for now." Hence, no topic was classified in the category "could."

Remembering that, for this purpose, only aspects related to the group classified as MUST were made, according to the prioritization through the MoSCoW tool, which defined in four different groups; must, should, could and would (not going to have for now).

Moreover, all were considered, according to the VUCA classification, as complex, because each topic covers different forms (various ways of being met) and indicators. For this reason, the other categories of VUCA classification do not appear in Table 3, which are volatiles (change rapidly), uncertain (there is doubt about its impact), and ambiguous (lack of clarity) material topics.

Then, after the prioritization is completed, it is necessary to model which aspects will be performed by the organization in order to meet the guidelines indicated by the GRI Standard. In this case, modeled aspects will be the indicators, which will be demonstrated in the report in order to describe how the company acts towards each of the selected material topics, which are presented in Table 4.

Because the clipping was made before the social booklet (GRI 400), the indicators, 203-1 and 203-2, modeled on the local community development topic will be disregarded in the next stages of the example, since they interact with economic booklet (GRI 200). However, it should be noted that, in a complete case, this relationship will appear in the correlation matrix and, consequently, considered for project development. Then, the correlation was expounded, which resulted in a $5 \times 11$ matrix, due to the 5 requirements and 11 indicators, which is presented in Table 5.

Considering this, it is clear that indicator 413-1 has an indirect relationship with the material topic of "diversity and equal opportunities"; 405-1 and 405-2 relate to the topic of "employee health and work environment" and; There are also links between the indicators of the topics of "business ethics and compliance" and "social and environmental impacts of the supply chain". That is, the quadrants of the matrix that present the letter "v" characterize the relationship between the indicator and the topic. In contrast, those that are composed of the letter "n," indicate the non-existence of such behavior.

Having completed the planning stage, the second phase of the procedure begins, the diagnostic phase. That is the stage in which the team responsible for preparing the report began searching for all current information about the selected indicators. This survey was conducted through interviews, formal or informal, depending on the type of information collected, and the employee interviewed; through internal environmental management software and work tools, like Microsoft Excel and Microsoft Word.

For these interviews, the tool, called payrolls, was used as a basis. This is a document composed of a set of questions to be answered by the company's employees consulted for the preparation of the report, due to the actions within the organization. This is because they relate to the development of the report through its attributions within the organization. Thus, the set of questions asked for context purposes are

**Table 4** Organizational structuring framework

| Requirements | What? | How? | Where? | Who? | When? | Why? | Aspects lo model |
|---|---|---|---|---|---|---|---|
| Themes (impacts) | What should be tracked and managed? | How should work and processes be performed (eg. management approach) | What are the space changes (eg. location)? | What are the stakeholders and their responsibilities? | What are the weather changes?(eg. measurement time, review time] | What are the motivations that drove decision making (intentions and values)? | What are the indicators (qualitative or quantitative)? |
| Local Communities | Verify the social impacts of community activity and product use | Borda Viva Association (financial support, training, management) Polo social Unilehu. Mapa social (pontos de emergentes para ação) | Neighborhood in which the company is located, as well as Curitiba and metropolitan region And regarding the product, it's all over Brazil | The Company Institute (through another CNPJ) is responsible for internal social responsibility actions | Monthly and daily support | Company worldwide guideline through its global social responsibility strategy—MOBILIZE and to drive the development of its surroundings | 203-1 (relationship with economic) 203-2 (relationship with economic) 413-1 |
| Diversity and Equal Opportunity | Promotion—Gender Equity Programs/PNE/ Internal Diversity Control | Selective process, internal promotion actions | Internal | Internal/government | | Strategic, representative view of gender equity | 405-2 405-1 |

(continued)

**Table 4** (continued)

| Requirements | What? | How? | Where? | Who? | When? | Why? | Aspects lo model |
|---|---|---|---|---|---|---|---|
| Employee Health and Work Environment | Ensure safety, quality of work environment Contraction rate, education and training, worker engagement | Incentives. Projects like the health club (benefits for employees who take care of their health in a preventive way) Strong labor relationship with unions Manufacturing school for employee performance improvement | Internal | Internal, syndicate | | Promote employee w elf are | 404-1<br>401-1<br>401-2<br>401-1<br>401-2<br>401-3 |
| Business Ethics and Compliance | Verify chain sustainability practices (ensure sustainable supply chain practices) | DUE DILIGENCE Internal System | Interna—compliance sector External—report channel | Suppliers, external company, internal personnel | | Perform supply chain control | 414-1<br>414-2 |
| Socioenvironmental impacts of the supply chain | | | | | | | |

**Table 5** Correlation matrix

| Generic requirements (material topics—impacts) | Modeled requirements | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 413-1 | 405-2 | 405-1 | 404-1 | 401-1 | 401-2 | 402-1 | 403-2 | 404-3 | 414-1 | 414-2 |
| Local communities | *V* | N | n | N | n | n | n | n | n | n | n |
| Diversity and equal opportunity | *V* | *V* | *v* | N | n | n | n | n | n | n | n |
| Employee health and work environment | N | *V* | *v* | *V* | *v* | *v* | *v* | *v* | *v* | n | n |
| Business ethics and compliance | N | N | n | N | n | n | n | n | n | *v* | *v* |
| Socioenvironmental impacts of the supply chain | N | N | n | N | n | n | n | n | n | *v* | *v* |

**Table 6** Collection interview question set

| Questions |
|---|
| 1. Has your sector (and/or activity) won any awards or recognition in 2018? |
| 2. What are company x products here in Brazil? |
| 3. Show Market share and total product sales in 2018 |
| 4. Are there any changes to the text in the sequence? Is it necessary to enter other information? |
| 5. Were there changes in 2018 regarding size and structure? Ex: new factory, office |
| 6. What were the significant events of the year? |
| 7. Are there any changes to the text of 2017, see below, regarding the communication? |
| 8. What are the main letters, initiatives, and standards that the company adheres to? |
| 9. In addition to the information requested, is there any other relevant data from your industry/activity that you want to report as an indicator or highlight? |

presented in Table 6. Since for reasons of confidentiality, the specification was not exposed.

Besides, through these interviews, it is possible to validate if there is a need to create indicators that meet the requirements laid down by the GRI Standard. Also, it is used for this collection: the indicator form, which is used to obtain the information that characterizes each indicator. This includes guidelines on how the indicators are defined, reasons why they suffered changes, and/or deviations of results, among other data.

In order to define the structure of the report, the prognostic step was made, as described in the procedure. In which it was chosen that the type of report to be submitted to interested parties would be the core one. This is the most succinct form, considering that even so, the set of information to be transcribed in the report is complex, given a large number of details that must be presented about each of the indicators.

Moreover, if the need to create any indicator were identified, its definition would be performed in this third phase of the procedure, that is, the modeling.

In this way, the report execution process was started using the SCRUM method. Given this, each SPRINT cycle refers to one stage of report creation. Recalling that the actions previously performed are not included in the execution of SCRUM, since they precede this phase and provide all the necessary foundation for its development. For this reason, if at the end of each iteration, the result obtained is not as expected, the interaction is repeated until the appropriate objective is reached. This is why a specific assessment is made at the end of each SPRINT cycle.

Such evaluations are performed in different ways according to the purpose of each of the interactions. For example, in the analysis of the information collected about the indicators, compliance validation is made of what was raised. For the writing of the report, its writing is evaluated, seeking to review possible grammatical errors and texts inconsistent with the reality of the company and information from the indicators.

Importantly, Table 7 is not representing all returns executed during the preparation of this report. However, it represents the chronology of the actions, and in the case of cycle reapplication, was performed before starting the next interaction with another objective.

**Table 7** SCRUM method for sustainability reporting

| # | Iteration (PVM) | Involved | Deadline | Objective | # of previous iteration | Feedback—SPRINT cycle evaluation |
|---|---|---|---|---|---|---|
| 1 | Iteration 1 | Drafting team | 20 days | Collect indicator data (MUST) | - | Data collected—MUST |
| 2 | Iteration 2 | Drafting team | 10 days | Analysis of the collected data (MUST) | 1 | Analysis validation—MUST |
| 3 | Iteration 3 | Drafting team | 20 days | Collect indicator data (SHOULD) | 2 | Data collected—SHOULD |
| 4 | Iteration 4 | Drafting team | 10 days | Analysis of the collected data (SHOULD) | 3 | Analysis Validation—SHOULD |
| 5 | Iteration 5 | Drafting team | 40 days | Report elaboration | 4 | Written report |
| 6 | Iteration 6 | Project team | 15 days | Report writing validation | 5 | Validated writing |
| 7 | Iteration 7 | Project team | 10 days | Budget assurance test by outside company | 6 | Budget test |
| 8 | Iteration 8 | Project team | 10 days | Approval of Final Review | 7 | Approved report |
| 9 | Iteration 9 | Senior management team | 8 days | Approval of the report | 8 | Approved report |
| 10 | Iteration 10 | Project team | 2 days | Perform Assurance Test | 9 | Not approved due to high costs involved |
| 11 | Iteration 11 | Contracted external company | 30 days | Diagramming | 10 | Diagramming completed |
| 12 | Iteration 12 | Project team | 15 days | Diagramming approval | 11 | Approved Diagramming |
| 13 | Iteration 13 | Project team | 5 days | Publication | 12 | Report Posted |

The number of reviews and re-execution are according to the need found by the organization, by evaluating the result of each interaction, comparing with the previously proposed objective. Generally, 1 review is made per area, at the stage of collecting and analyzing indicator information and 12 reviews at the writing and final validation stages.

Subsequently, the report was continued; thus, for its preparation, covering all material topics, including those that were not part of this first test, totaled 12 SPRINT content review. This was a record as 26 revisions were required last year.

Finally, in this case of application, the operationalization and improvement stage proposed by the procedure is characterized by the validation stage through an external company. This organization would test the information contained in the report. Due to the fact that, in this case, this process was not performed because of the high costs arising from this hiring, the final validation step did not occur. This is, the company chose not to perform owing to the high costs involved, and then, this step of the procedure was not performed.

## 5 Discussion

There are several benefits to using an agile approach—SCRUM Method—for sustainability reporting, specifically the GRI Standard (covered in this paper). The main gains are linked to the way architecture-orientation enables the improvement of problem-solving processes at different stages. For example, GRI Standard provides requirements, guidance, suggestions, and obligations, but does not provide detailed modus operandi for report execution. Using the SCRUM Method made it possible to describe the steps, the execution mode, and the person responsible for the task, thus, besides gaining control of the processes, it is possible to improve them in each sprint cycle. Main direct and indirect gains observed in project implementation:

- Decrease in the number of revisions at all stages;
- Less time for the elaboration of the whole report and consequently publication;
- Increased report quality due to process control.
- Processes improvement;
- Improved engagement and communication between project actors;
- Internalization of knowledge and mode of operation (i.e., learning);
- Decreased cost of the report as the agile methodology favors the use of fewer people in a shorter timeframe.

Furthermore, the use of worksheets allowed a better organization of the whole process of elaboration of the sustainability report. For example, the MoSCoW tool prioritizes requirements according to their influence on the success of the adequacy project. The “must” must be completed to succeed; the “Should” are those that conduct critical but less urgent activities; “Could” are those that can be removed due to resource constraints and; “There won’t be for now” are the ones that would be nice to have, but they can be done later (Oliveira 2014). And, the organizational structuring

framework identifies all relevant indicators needed through materiality, that is, aligns the demands of the GRI Standard with the reality of the company and stakeholders. But here there is a dichotomy. Stakeholders—more specifically investors— want reports to provide relevant indicators while providing reliable information (strict audit processes) and facilitating comparability between companies (benchmarking) (Bernow et al. 2019). There is still ambiguous, incomplete information and continence of indicators (Boiral and Henri 2017). However, as each company has its particularities presented in the materiality process, it is impossible to replicate an indicator structure for different companies. As the context is different, that is, the indicators should also be. Balancing this investor demand requires a kind of "balance scale", standardizing material topics to industry, business size, or other forms of business profile grouping. In a study, Ali et al. (2017) show that different business characteristics influence the publication of sustainability reports. In this way, it is possible to automate material topics according to certain particularities.

In this context, all phases of the procedure were performed in sync and in a complementary manner, due to the fact that the report was made in an incremental manner. Moreover, each phase provided the necessary support for the next phase to occur, and then, the procedure can be considered a guide for the implementation of this type of adequacy project. This shows that the process of reporting is increasingly integrated and holistic, linking sustainability dimensions with the stakeholders, functional areas and thereby enhancing the organization's contributions to a more sustainable society (Lozano and Huisingh 2011). With the increasingly synchronized, organized and holistic sustainability report the document emphasizes the quality principle and completeness. In a paper Odriozola and Baraibar-Diez (2017), the quality presented in the sustainability reports favors the organization to have a good brand reputation. In other words, sustainability reports are directly and indirectly associated with the market perception of the company.

Sustainability practices in an organization are achieved through corporate governance (Hussain et al. 2018). The use of agile approaches favors the detailing and consecutive improvement of processes (such as the steps for preparing the sustainability report). Thus, agile mechanisms, such as SCRUM, can facilitate faster and more efficient adoption of new practices compared to traditional design methods. In addition, the implementation of sustainability committees and external advisors, as well as promoting transparency, help to increase the quality of the report (Fuente et al. 2017), and agile methodologies can help to structure such management actions.

## 6 Conclusion

The procedure used was able to guide and assist in the preparation of the sustainability report, according to the parameters laid down by the GRI Standard. Since it directed what would be the necessary steps to report the sustainability projects and practices. Thus, through this application, it was possible to test the ability of the procedure to

assist in the implementation of this type of organizational adequacies projects, which is very positive.

Since the report was elaborated in a shorter time and it is possible to affirm that if use this approach to develop the sustainability reports, probably, the final result will be more realist and coherent with the organization's actions. That is, the sustainability report will be more assertive and will include a broader range of information, requiring fewer resources, whereas it occurs adaptively and gradually, according to the characteristics and needs of companies.

So, the company's sustainability report was a faster elaboration than in the other years, since a minor revision was needed and contemplated all the relevant information, as it covered all material topics provided by the GRI Standard, not limited to those illustrated in this paper. Thus, this paper contributes to the evolution of the subject, showing that it is possible to use agile approaches as background for the elaboration of sustainability reports based on the GRI Standard. This made it possible to streamline report publication time, control processes, and improve review steps, re-execution of information and validations (which is a big problem for companies that publish their sustainable performance). Also, as a specific contribution to the application company (Company Y), there was a strategic alignment of the way of conducting its projects since the organization adopts SCRUM to elaborate actions involving the business transformation.

Nevertheless, the result obtained through the application of the procedure may have a potential influence from the person responsible for the development since it was the interlocutor of the use in this report elaboration project. Moreover, there was a temporal limitation to cover all the notebooks of the GRI Standard, which implied the use of the selected clipping.

Also, it is important to make more practical applications of this procedure that address other organizational aspects and continue the application, using the other GRI notebooks. Also, it is relevant to consult some experts on the topics covered in the development of the procedure to further analyze its potential use. Thus, it will be possible refine it and constantly improve it. So, that is always up to date with organizational demands.

For future work, it is recommended to note the gains from using agile methodologies in long-term sustainability reporting. Also, the application of agile approaches to other sustainability projects is suggested. That is, to use for the elaboration of the sustainability report (application of this article) and, also, in the projects that involve corporate sustainability that after execution will compose the indicators of the next sustainability reports. It is still recommended for future studies the elaboration of automation mechanisms of spreadsheets and processes, that is, possible use of software to further optimize, streamline and connect the steps.

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# Sustainable Procurement Process: A Case Study at a Public Higher Education Institution in Brazil


**Juliany Helen das Graças Pinto and Marcell Mariano Corrêa Maceno**

## 1 Introduction

Concerns about environmental issues have increased in companies as a result of mismanagement between economics and environmental impact of these organizations (Maceno et al. 2018).

Concerns about environmental issues have increased in companies as a result of mismanagement between economics and environmental impact of these organizations (Maceno et al. 2018).

In the eighteenth century, with the industrial revolution, the production model had several changes in the production-customer-economy relationship (Jesus and Chrispino 2015; Curi 2012). These changes include the adoption of a circular flow system, where the products and services generated by companies are consumed by people in order to obtain revenue (Coelho et al. 2013). During the twentieth century, an industrial boom provided economic growth never experienced before and was supported by important people of that period, such as Henry Ford, Frederick Taylor, Max Weber, among others (Curi 2012). Consequently, people consumed more as a result of increased purchasing power. However, the excessive consumption of products led to an excessive consumption of natural resources (Maceno et al. 2018; Maceno and Pawlowsky 2014; Leonard 2010) In other words, the impact on nature has been intensified as a result of increased production.

The pressure on the environment enhanced, because the circular flow economic model was reductionist, which means that the economy was an isolated and ideal system (Coelho et al. 2013). However, any system needs material and energy that,

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according to the Law of Mass Conservation and the Laws of Thermodynamics, is not able to achieve total efficiency (100%), without any loss or surplus (Maceno and Pawlowsky 2014; Fresner 1998).

Thus, until the middle of the twentieth century, the degradation of the environment with the extraction of resources and the dumping of waste was not noticeable (Coelho et al. 2013). However, the environmental accidents from the 40 s to the 60 s, and the pressure from scientists and non-governmental organizations to the situation of the environment gave rise to the movement for the conservation and maintenance of nature. Hence, it is possible to affirm that the initial milestone for making the environmental issue prominent on the Planet came with the Conference of United Nations for Environment and Development, in Stockholm in 1972 (Curi 2012).

Next, a gradual change in market logic began. Thus, only growing economically was no longer viable, since it was recognized as a need to balance the economy, the environment and society. This idea became tangible, through the concept of sustainable development and the triple bottom line created by Elkington (1994).

In this context, the concept of Sustainable Development emerged, having as its proposal contemplating economic growth, social issues, and environmental protection. In other words, it is a way to guarantee a less predatory future for the next generations without compromising the inexorable course of capitalism (WCED 1987).

This idea would only be possible through the joint action of the Government, the private sector, and the third sector (Matias-Pereira 2010). The public sector serves as a reference to other sectors, being able to use its influence to intervene in the political-economic scope to guarantee the regular functioning of activities.

In Brazil, 21.5% of the national Gross Domestic Product (GDP) (ICLEI 2015) was destined only to the Union's purchases in 2012. This represented approximately 500 billion dollars. This amount must be managed properly, since Brazilian society is stratified at disproportionate levels. Therefore, the concern with the optimization of financial resources is significantly relevant, since it is an ethical and social responsibility. Thus, it is necessary the commitment of the public sector to adopt sustainable criteria (Biderman et al. 2008).

Also, in 2012, approximately 37% of the amount designated to the Ministry of Education's budget (R$74 billion) was allocated to purchases from its related universities. This means that the model adopted by these Public Higher Education Institutions has "a fundamental role in the social and professional formation of individuals, influencing aspects related to culture, ethics and citizenship" (Hegenberg 2013, p. 19).

Thus, Sustainable Public Procurement would be a solution for integrating environmental and social conditions into public procurement processes, as it allows the purchase of a product with better benefits for the consumer and the ecosystem. This fact has been confirmed in Europe, where purchasing power is equivalent to 15% of the European Union GDP, of which 75% are consumables (Biderman et al. 2008).

In other words, sustainable public procurement provides benefits for public administrations, whether in the short or long term, such as national development, improvement of environmental performance, financial benefits, development of new markets for sustainable products and services, and incentive to local and regional markets,

also stimulating the acquisition of sustainable products. It is also perceived the efficient use of public resources, improving the working conditions of employees since companies generally comply with labor laws and do not use child labor (UNEP 2012).

Several countries have adopted sustainable bidding standards, such as United Kingdom, Canada, United States, Netherlands, Norway, South Africa, Japan, Sweden, Austria, South Korea, and Switzerland. In Brazil, efforts have been made to adopt criteria through Law No. 11079/2004 (general rules on public–private procurement) (Brasil 2004), Law No. 8666/1993 (bidding and contracts of the public administration) (Brasil 1993), Decree No. 5540 (regulates the auction in electronic form for contracting goods and services) (Brasil 2005), Normative Instruction No. 01/2010 (establishes the criteria of environmental sustainability in the acquisition of goods, contracting of services or buildings in the Federal Public) (Brasil 2010), Decree No. 7746/2012 (establishes criteria and practices for promoting sustainable national development in Federal Public Administration contracts) (Brasil 2012), among others.

However, there is not a precise list of specific criteria in Public Higher Federal Education Institutions (Brazil) that could assist in the procurement process (Hegenberg 2013), such as in other countries. For example, in Hamburg (Germany), it could be quoted simple measures that environmental authorities developed, such as they:

> exchanged every two old light bulbs for a more energy-efficient light bulb in 300 public buildings. They consequently reduced annual electricity consumption by about 4.5 million kWh (equivalent to approximately 2700 t of $CO_2$ emissions, taking into account fossil fuel consumption in that country for electricity generation). Considering the price of 0.5 per kWh, the saving obtained was of 225,000 on the Hamburg energy bill" (Biderman et al. 2008, p. 43).

In order to optimize sustainable procurement processes, the International Organization for Standardization (ISO) has developed the standard ISO 20400 (ISO 2015). It has several criteria that can be adopted in the implementation of this type of procedure in public and private institutions (ISO 2015). It is noteworthy that this regulation does not replace the legislations determined by the public sector, but it includes criteria that can help the implementation of sustainability.

In this context, this article aimed to propose a sustainable procurement process based on ISO 20400 (2015) in a Public Higher Education Institution (PHEI) from Brazil.

## 2 Methodology

This research was developed by five steps, as it is shown in Fig. 1. The figure was organized following the steps defined by Gil (2008) for a case study:


**Fig. 1** Steps of the method used in this research

*S1—Step 1: Study Problem*

In the first step, the research problem was defined after a meeting with PHEI Budget Sector managers. The brainstorming technique was applied, and the following question was asked: what can be adapted in the procurement process in a PHEI, aiming to make it a sustainable procurement process?

*S2—Step 2: Theorical Background and Focus of Study*

In the second step, the legal basis for public procurement by the Federal Executive Branch was consulted in order to select the guideline for sustainable procurement and the public procurement modality.

In the literature review, a survey of the legal basis was carried out. Since the Public Higher Education Institutions (PHEI) are Federal Authorities linked to the Ministry of Education, the principles of Public Administration must be guaranteed according to Article 37 of the Federal Constitution: Legality, Impersonality, Morality, Advertising, and Efficiency (Brasil 1988). Therefore, Law No. 11079/2004 (general rules on public–private procurement) (Brasil 2004), Law No. 8666/1993 (bidding and contracts of the public administration) (Brasil 1993), and the Sustainable Bidding National Guide (CGU 2016), were raised and analyzed. This analysis served to understand the general public procurement criteria applied by the Federal Government.

Also, to define the purpose of the study, it was required to select the standard/guideline to be followed to adapt the public procurement process for sustainability. ISO 20400:2015 was defined as the base standard for adapting the PHEI procurement process. This standard aims to guide the application of sustainable procurement criteria in organizations, whether public or private (Betiol 2017), and it is considered as an effective way to companies contribute for sustainable development (internally and externally) (ISO 2015; João 2019). In other words, this standard seeks to improve environmental, economic, and social performance in procurement processes (Harris and Divakarla 2017). In addition, it has basic principles such as responsibility, transparency, ethical commitment, respect for interest groups, as well as laws, international standards, and human rights (ISO 2015), which makes it similar to Law No. 8666/1993 in its fundamentals and goals, making it suitable to use in this study.

Regarding the modalities of public procurement, PHEI has four procurement modalities, namely: E-procurement, only pre-registered bidders, Competition

and Differentiated Contracting Regime. This survey was conducted considering purchases made by PHEI in 2017.

In this year, a total of 113 PHEI approved procurement processes were surveyed. Thus, the E-procurement modality was selected because it presented 27 processes approved with a financial limit not exceeding R$80,000.00 (eighty thousand Reais), corresponding to 24% of the total processes approved by PHEI.

*S3—Step 3: Data collect and Flowchart*

In the third step, the data collection of the selected process (E-procurement) was carried out in order to identify the flowchart of the public procurement process.

First, the data were obtained from the PHEI procurement manual, allowing the survey of the documentation required by the E-procurement modality. In addition, it was possible to understand the requirements for opening the bidding process, such as the Justification of purchase needs.

Despite the analysis of the PHEI procurement manual, it was not possible to identify in detail the steps of the procurement process. Therefore, it was necessary to analyze 27 processes approved in 2017 for the E-procurement modality with a financial limit not exceeding R$80,000.00 (eighty thousand Reais). This fact made the elaboration of the flowchart of the PHEI procurement process practicable.

*S4—Step 4: Results analysis*

In this step, the flowchart of the PHEI procurement process was analyzed. Thus, the activities and documents of the PHEI procurement process were analyzed and detailed in order to verify possible considerations of items connected to sustainability. Thereby, the sustainable practices applied by PHEI were identified, providing a basis to support the preparation of the improvement proposal.

*S5—Step 5: Improvement proposal*

The last step of this study was performed considering three items: the guideline provided by ISO 20400:2015 for sustainable procurement process identified in step 2; the laws applicable to public procurement processes in Brazil raised in step 2; and the detailing and analysis of the existing PHEI procurement process carried out in steps 3 and 4. Based on these three items, opportunities for improvement were identified, as well as an action to improve the PHEI procurement process analyzed was suggested.

## 3 Results

This stage of the study was divided into two sections in order to facilitate the presentation of the results.

In the first section, the current procurement process at PHEI is detailed and the existence of a sustainability approach is analyzed in this process.

In the second section, the proposal for a new sustainable procurement process for PHEI is presented, based on the current procurement process, considering items already identified in the first section, and ISO 20400 guidelines for sustainable procurement.

## *3.1 Current PHEI Procurement Process*

The stages of the PHEI procurement process under study are presented in Fig. 2. Through the presented flowchart, it is possible to understand which agents are responsible for the procurement process.

According to Fig. 2, the procurement process in this modality of E-procurement starts with purchase needs. The demand for the purchase arises from a specific need of a demandant unit. This unit can be a laboratory, a department, a coordination, among others.

Given the consolidated demand, the purchase order is formalized by demandant unit through the opening of the procurement process. This process must contain the documents, as shown in Table 1.

After the instruction of the process, it follows to the Expense Originator. He gives his agreement to the process and forwards the process to the responsible department for purchases. This department analyzes the documents of Table 1 and it approves or not the continuity of the process. In the case of non-approval, the process returns to the demandant unit for adjustment. In the case of approval, the process is sent for financial analysis.

The Financial Department checks the availability of financial resources and it returns to the responsible department for the purchase. Upon this return, the responsible department attaches the checklist and it forwards the process to the Administration Department. This department has the function of approving or not approving the purchase. When this approval is made, the process is forwarded to the Bidding Commission, which checks the process documents, attaches the bidding ordinances, obtains the certificate of compliance from the Administration Director, and at the end attaches and publishes the E-procurement notice.

With the publication of the E-procurement notice, companies interested in offering the goods for PHEI must win the bid. This occurs by company that complies with the requirements established in the document Term of reference (Table 1) and offers goods at the lowest price.

In a general analysis of the PHEI procurement process, there is a significant decentralization of activities and there is a department that guides and is responsible for the functions of Bids and Contracts. In addition, the PHEI issues Service Orders that help the internal community to understand the process.

Despite the PHEI owns a Bidding and Contracting Department and Service Orders to help internal community, the existing procurement process is quite bureaucratic, depending on the analysis and approval of several internal departments. However, when talking about sustainability, little is addressed in this procurement process,

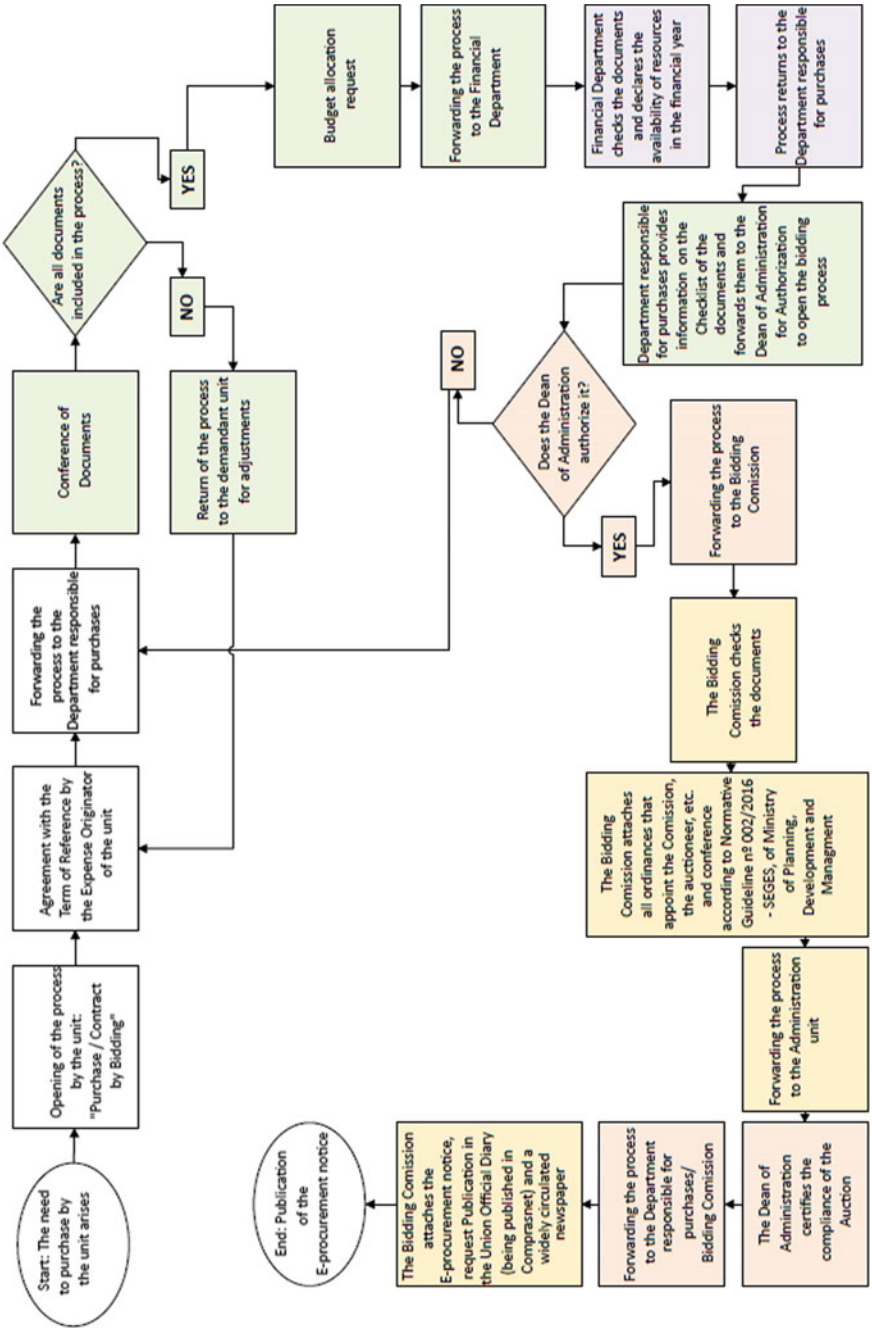


**Fig. 2** E-procurement flowchart until the publication of the public notice. *Source* Based on the PHEI Procurement Manual (2019)

**Table 1** Documents required for the demandant unit to initiate some purchase in the PHEI

| Document | Description |
|---|---|
| Memorandum the opening of process | The procurement process starts on the processing platform by Memorandum. Thus, the bidding is requested in the E-procurement for immediate acquisition, in order to meet the demand of the unit—considering the procurement planning made in the previous year |
| Justification of purchase needs | In the justification is essential that the activity developed by the demandant unit be described. This unit should also describe what are benefits brought by the purchase, and how quantities requested were estimated. Finally, if there is a grouping of items in batches, this unit should explain why the decision was made |
| Spreadsheet of needs | In this spreadsheet is necessary to list all materials and the respective technical specificities as well as quantities requested. Total materials must be acquired within 60 days after the bidding approval |
| Declaration of non-targeting | The document certifies that the demandant unit does not violate the Bidding Law |
| Market price research | At this point, the demandant unit must perform price research from three different suppliers. The demandant unit will still have to calculate the average, median, and, finally, the reference unit value or it can choose the lowest price quoted. Currently, according to Normative Instruction No. 05/2014-SLTI/MOP, the main platform is the "Price Panel", but if there is direct research with suppliers, the e-mail must be attached in the process |
| Reference price calculation spreadsheet | This spreadsheet is a compilation of information. It has items, quotation unit, three budgets obtained in the previous step, average unit values, and the total average value for each item. Furthermore, the sum of the maximum quantity to be admitted for contracting must be included |
| Declaration of the market price research | Declaration of responsibility for data informed in the previous step and adequacy considering the parameters used |
| Information on quotas for Micro and Small Enterprises (Decree 8538/2015) | Declaration of conformity with current legislation considering the exclusive participation of Micro and Small Enterprises in the event. This is applied to the bidding limit until R$80,000.00 (eighty thousand Reais) |

(continued)

**Table 1** (continued)

| Document | Description |
|---|---|
| Term of reference | This document contains the entire order reference. That is, object and justification of the contract, specification and estimated budget, sustainability criteria used in the contract planning, delivery times and addresses, guarantees, exchanges, contractor and contractor duties, inspection and management procedures, criteria for accepting the object, maximum global value allowed for the acquisition, and administrative sanctions |
| Approval of the term of reference | Signature of the ordering authority of the demandant unit, in order to accept and certify the process |

*Source* Based on the PHEI Procurement Manual (2019)

considering its three pillars (environmental, social, and economic). In addition, it can be said that the majority approach involves the economic bias.

This economic bias is addressed in documents of the process instruction by the demandant unit, such as: Market price research, Reference price calculation spreadsheet, Information on quotas for micro and small enterprises, and Term of reference. These documents have the economy and efficiency criteria of public spending. In addition, this bias also appears when the Expense Originator approves the forwarding of the bidding process to the responsible department for the purchase. At this moment, there is a weighing of the unit needs in relation to the financial and purchasing planning carried out in the previous year. Then, the Bidding Commission will set up the E-procurement notice considering all the regulations in force, in order to maintain values compatible with reasonableness, economy, and efficiency. It should be noted that the entire process is inspected by internal and external regulatory agencies, before and after contracting, to ensure the principles of Public Administration.

The environmental bias is addressed superficially in the following documents of the process instruction by the demandant unit: Spreadsheet of needs and Term of reference. In this Term of reference is recommended to adopt some sustainability criteria, such as: to verify the impact of the product on natural resources, the origin of the product, efficiency, useful life, and if there is an environmentally legal origin of natural resources. In the document Spreadsheet of needs, the demandant unit needs to list product technical criteria, being, therefore, possible to contemplate environmental characteristics, such as: ecological seals, efficient use of water and energy, among other characteristics.

The social bias is addressed when using Decree No. 8538/2015 that prioritizes micro and small businesses in the bidding process, considering the global value of the notice (Brasil 2015). This leads to the inclusion of those who would not be able to compete with large corporations on the lowest price requirement, as they do not

have large productions and stocks. It is worth mentioning that the lowest price is the defining criterion of the winner according to Federal Law No. 8666/93 (Brasil 1993).

In a general analysis of the actions that involve sustainability in the PHEI procurement process, with the exception of the search for the lowest price and the prioritization of contracting micro and small companies, other actions in this process depend on the awareness and knowledge of the demandant unit. However, this often does not occur, given that the focus of the demandant is on purchasing and fulfilling the requirements of the product/service. That is, the demandant is usually focused on the main characteristics of the product/service (if he will do what is expected in the best possible way), and not on secondary characteristics. Delmonico et al. (2018) highlighted in his study that Brazilian Public Institutions own cultural factors as one of the main barriers, among them, the lack of awareness of sustainability by the employees of the organizations.

Thus, considering what was shown, it became possible to carry out the proposal to change the current procurement process of the PHEI to a new process that addresses more direct sustainability issues. This proposal follows the next section of the study.

### *3.2 Sustainable Procurement Process Proposal for PHEI*

In this stage of the study, the items of ISO 20400:2015 were considered, mainly Chapter VII, which shows the Sustainable Procurement Process. This Chapter shows the planning, the definition of procurement criteria, the aspects of responsibility, the contract management, and the contract review and control (Fig. 3). It is considered the driver of the operational part of the procurement process (ISO 2015). The other Chapters of the standard ISO 20400:2015 were considered in a complementary way for proposals to improve the PHEI procurement process.

In a general analysis of the current procurement process, it was observed that the flowchart of the PHEI procurement process, shown in Fig. 2, does not have structural problems. In other words, the legislation is followed, and the units involved fulfill with it, despite the process being relatively bureaucratic.

Thus, the first suggestion for improvement was to adapt the Planning of the procurement. In other words, it was proposed to adapt the documents required for the demandant unit in order to expand sustainability items.

Considering these documents, operationally, the Memorandum the opening of a process should be the last document to be added in this process since the demandant must list all the items that have been attached. This must happen so that he himself can verify the absence of documents. Consequently, he avoids the problem to be detected only in the Procurement Department, ensuring the velocity of the procedure.

Therefore, the process could start with the Justification of purchase needs, with such items included: activity developed by the demandant unit, benefits that the acquisition could result not only for this unit but for PHEI, and reasons for the quantity requested.

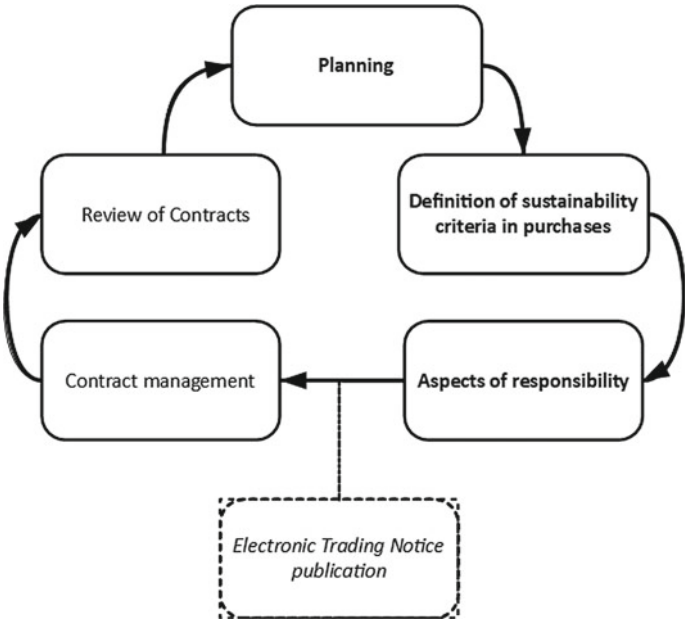


**Fig. 3** Procurement process: ISO 20400 and expectations for an PHEI. *Source* Based on ISO (2015)

The Spreadsheet of needs is a quantitative way of relating the materials and technical specifications. Thus, it is believed that there is no need for modifications of this spreadsheet, as well as the Declaration of non-targeting.

In the document Market price research, not only the consultation of price panel should be considered to make the budget, but the demandant should also consider the consultation on the internet and by other government partners.

Finally, it can be said that the main document for the procurement process at PHEI is the Term of reference. In this document many requirements are required by the demandant and, mainly, it is the moment in that this demandant informs the importance of the purchase and endorses his responsibility. The model provided by PHEI for the preparation of a Term of Reference considers mainly: (a) Object (object of purchase); (b) Justification for the purchase; (c) Specification the item to be purchased and budget; and (d) Environmental sustainability (demandant must inform the environmental criteria used for the purchase) (PHEI Procurement Manual 2019).

Although there is a model document, it should be adapted in terms of sustainability issues. First, the model document only considers environmental sustainability. It should be revised to consider the three pillars of sustainability since the environmental criterion must not be the only one to be required in product analysis.

Second, this sustainability section should have a set of minimum criteria that can guide the demandant. For example, the PHEI may have a standard general spreadsheet with sustainability criteria. This spreadsheet must be completed by the demandant,

when appropriate, and these items can address environmental criteria (for example, energy performance, water performance, reused/recycled materials, presence of non-hazardous materials, among others), social criteria (for example, employee training, work practices, among others), and economic criteria (for example, average costs, employee expenses, product offerings by local companies, among others) (GRI 2015; A3P 2009).

Despite the suggestions made to improve the Term of reference, it is understood that leaving the responsibility to include sustainability only for the demandant can weaken the process in relation to this aspect. For example, Hegenberg (2013) conducted a survey at 37 Federal Universities in Brazil and demonstrated that on average 70% of the professionals at the demandant units were unable to specify products with a sustainable character. Therefore, it was realized the importance of human resources being developed, trained (Delmonico et al. 2018), and supported in the entire process—from planning to the operational phase.

In this sense, in addition to the documents change, the second suggestion for improvement refers to the inclusion of sustainability analysis by the PHEI procurement department. This analysis would be complementary to that made by the demandant, seeking to improve the selection of products that fulfill the minimum technical requirements. However, it is important that PHEI provides conditions for the continuous training of the employees of the procurement department in relation to sustainability criteria.

The third suggestion for improvement would be to structure an audit process for the procurement process, in order to analyze the efficiency of sustainable procurement and consequently to provide an indication of improvements.

A final suggestion for improving the PHEI procurement process would be to analyze the purchase databases, aiming to create purchase routines for items that have already performed well in the sustainability criteria in past acquisitions. This would help to reduce problems with the PHEI structure, as highlighted by Assandre (2015), who mentioned that the main barrier pointed out by the demandants of Higher Education Institutions in the procurement processes was the limitation of the Institutions in contingent and structure.

Finally, considering Fig. 2, contract management occurs after the approval of the notice. Thus, the analysis carried out in this research ends in the publication of the public notice, at which time all sustainable criteria must have already been met.

## 4 Conclusion

The research aimed to propose changes to the PHEI procurement process in order to become a sustainable procurement process.

Thus, it was possible to suggest the creation of clearer criteria considering sustainable products, in order to be able to evaluate practices and improve them. The standard ISO 20400:2015 was used to support suggestions for improvement.

Despite this, it was realized that the biggest problem in the PHEI procurement process is not found in the process flowchart or in the documents required for bidding, but in the institutional strategy. In this way, the planning of the implementation of purchases and the sustainable criteria were not developed in detail, causing internal dilemmas among the employees because they do not have adequate knowledge about the triple bottom line.

Finally, it was realized that PHEI implemented only part of the potential that sustainable procurement can have.

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# How the Perception of Employees Can Help to Address Management and Operation Challenges Towards More Sustainable Sanitary Landfills: A Case Study of Curitiba and Metropolitan Area


**Elaine Cristina Latocheski and Janaina Camile Pasqual Lofhagen**

## 1 Introduction

The increase in the amount of municipal solid waste (MSW) generated year after year, combined with more restrictive pollution control laws and growing concern about impacts on the environment, has stimulated the search for more sustainable and socially responsible solutions for waste management.

In Brazil, one of the main methods used for the management of MSW is its disposal in sanitary landfills, which makes the country strongly dependent on them. In this regard, relying on the perception of landfill managers and operators can help to understand the limitations found in this type of facilities, especially in relation to the treatment of leachate, identified as one of the main environmental challenges of landfills. Such understanding is important for greater control and efficiency of the final disposal of MSW. In addition, this comprehension about the main difficulties can allow the proposition of applied research and the development of more effective technologies, making the operation and management of landfills more sustainable and socially responsible by contributing to the minimization of the negative impacts associated with these units.

In this sense, this work aimed to know the perception of landfill managers and operators from Curitiba and its Metropolitan Area regarding their main difficulties of management and operation, especially those concerning the treatment of leachate.

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## 2 Solid Waste Management in Brazil and Dependence on Sanitary Landfills

Modern lifestyle, based on widespread consumption and industrialized societies, produces significant amounts of waste, usually solid or semi-solid. In this context, "solid waste" refers to all types of solid or semi-solid material resulting from human activities which are discarded. The term "municipal solid waste" (MSW), on the other hand, refers, in Brazil, to solid waste generated in urban residences or collected by urban street cleaning services.

In Brazil, an average of 1.035 kg of MSW is produced per person per day. In 2017, more than 78 million tons of MSW were generated, according to the Brazilian Association of Public Cleaning and Special Waste Companies—ABRELPE (Abrelpe 2018). The total amount of waste generated in 2017 in the country increased by about 1%, when compared to 2016 (Abrelpe 2018; Brazil 2019), while the population increased 0.75% in the same period (Abrelpe 2018). It is expected that in the coming years, the amount of solid waste generated per capita will increase even more, due to a higher population income and consequent heftier consumption habits (Campos 2014). However, if not properly disposed, solid waste can adversely affect human and environmental health. So, in order to seek more sustainable and socially responsible solutions for the treatment and disposal of this waste, its integrated management has been encouraged.

Integrated solid waste management (ISWM) is a set of techniques and technologies applied to the disposal of solid waste. ISWM aims to reduce negative social and environmental impacts related to waste disposal, as conceptualized by Tchobanoglous et al. (2002). According to the same authors, the steps included in ISWM are: reducing the amount of waste generated at its source, material recovery, reuse, recycling and composting, energy recovery (by processes such as incineration or methane generation from waste) and, as a lower priority option, yet still considered environmentally adequate, final disposal in sanitary landfills.

In Brazil, ISWM has been more encouraged since the publication of the National Policy on Solid waste (NPSW) in 2010. The NPSW (Brazil 2010) was established by Federal Law No. 12305/2010, and among its objectives are the non-generation, reduction, reuse, recycling and treatment of solid waste, as well as the final disposal of waste in sanitary landfills.

Although it is considered a milestone for the integrated management of MSW in Brazil, the NPSW has not yet been widely implemented in the country. MSW management in Brazil consists yet mainly of the collection and disposal of solid waste in landfills, even though this is considered the last resort (Alfaia et al. 2017). According to Campos (2014), there are also structural deficiencies in MSW management systems in Brazil, demonstrated by the large number of treatment, recycling and disposal units that have ceased to operate or have been abandoned in recent years.

Out of the total number of Brazilian MSW processing facilities, only 1.7% of them are composting units and 25.1% are waste sorting units (Brazil 2019). These data show that, even with NPSW and incentives for composting, reuse and recycling

actions, most of the MSW discarded in Brazil is sent to final disposal units, including sanitary landfills. In fact, out of the 5570 Brazilian municipalities, it is estimated that 2218 of them (39.8% of all municipalities) sent their MSW to sanitary landfills in 2017 (Abrelpe 2018), totaling 42,267,365 tons disposed of in them. It is estimated that 59.1% of the total mass amount of waste collected in the country in 2017 was destined to sanitary landfills (Abrelpe 2018). Therefore, it can be concluded that Brazil has a strong dependence on sanitary landfills (Costa et al. 2019), which justifies the proposition of technologies that can reduce the environmental and social impacts associated with them.

## 3 Main Negative Impacts Associated with Sanitary Landfills

In many countries, as in Brazil, sanitary landfills are currently considered the most appropriate solution for the disposal of MSW (Renou et al. 2008; Peng 2017). Studies comparing solid waste management alternatives have shown that landfills have important advantages over other methods (e.g. incineration) such as lower costs and ease of operation (O'Leary and Tchobanoglous 2002; Renou et al. 2008). In addition, landfills are considered to be safer when compared to open dumps or controlled landfills. However, sanitary landfills can cause negative environmental and social impacts. There is also an aggravating factor in this scenario: even after a landfill is deactivated, leachate, a wastewater, continues to be generated, requiring long-term treatment, typically for 30 years or more (O'Leary and Tchobanoglous 2002).

These impacts, such as environmental degradation, have been recognized both by authorities, who have tightened pollution control criteria, and by the municipalities and/or the companies that operate landfills and have voluntarily sought to adopt attitudes that make them socially responsible by contributing to a healthier environment (Renou et al. 2008; Peng 2017). This pressure from stricter environmental laws or from the voluntary willingness to adopt socially responsible and more sustainable actions, coupled with the strong dependence on landfills in Brazil, has brought technological challenges and demanded more effective ways of minimizing the negative impacts associated with these waste disposal units (Renou et al. 2008; Kamaruddin et al. 2015).

The most important negative impacts that can be caused by the disposal of MSW in sanitary landfills are related to the release of leachate, the wastewater generated in landfills, in water bodies (Renou et al. 2008; Peng 2017; Torretta et al. 2017). Leachate is a highly polluting wastewater, usually characterized by high concentrations of organic compounds, ammonia and inorganic ions. Leachate also presents a variability of characteristics over time, such as flow rate, concentration of different substances and biodegradability, which depends, for example, on the age of the landfill (Renou et al. 2008; Torretta et al. 2017; Costa et al. 2019). All of these factors can affect

the efficiency of this wastewater treatment, posing challenges for managers and operators.

The efficient treatment of leachate has been systematically pointed out as challenging for landfill managers and operators (Renou et al. 2008; Torretta et al. 2017; Costa et al. 2019). The complexity of leachate makes it impossible to recommend a single type of treatment for this wastewater. Several innovative treatments and combinations of techniques have been proposed by academics and research groups, however, there is still a lack of studies to evaluate the performance and applicability of these proposals in real landfills (Di Maria et al. 2018). Methods capable of reducing the cost of leachate treatment and increasing its efficiency should therefore be developed and tested (Renou et al. 2008; Torretta et al. 2017). In this context, landfill employees could help to highlight the steps involved in leachate treatment for which investments and research should be prioritized.

## 4 How the Perception of Employees Can Help to Address Management and Operation Challenges in Sanitary Landfills

In Brazil, the strong reliance on landfills as the main alternative for MSW management justifies investments and the search for technical and/or technological improvements in these types of units. The NPSW (Brazil 2010) has even among its objectives the adoption, the development and the improvement of clean technologies as tools to minimize the environmental impacts related to the treatment and final disposal of MSW.

For these objectives to be achieved and for waste management to be improved, the NPSW (Brazil 2010) points out among its instruments technical and financial cooperation between public and private sectors for the development and research on new products, methods, processes and technologies for management, recycling, reuse, treatment and adequate final disposal of waste and scientific and technological research. Technical and financial cooperation for landfill operation can even be a strategy for improving integrated MSW management, as suggested by Campos (2014).

In order to improve waste management, it is necessary, firstly, to be aware of the current limitations and demands for new research and technologies. In this context, knowing the perception of managers and operators who work in sanitary landfills, on which Brazilian solid waste management is strongly dependent, can contribute to the understanding of which challenges should be addressed first.

The authors could not find in technical and scientific literature recent work that sought to know the perception of Brazilian landfill employees. In this sense, this research therefore contributes to the expansion of existing knowledge about the challenges routinely encountered in the management and operation of landfills in

Brazil, based on the demands and perspectives of the main stakeholders involved, the landfill employees.

## 5 Methods

The perception of managers and operators who work in two landfills located in Curitiba and its Metropolitan Area was assessed through a semi-structured questionnaire, with open-ended and closed-ended questions, and non-directive interviews.

The landfills visited were the Curitiba's Sanitary Landfill, currently deactivated and located in Curitiba, Paraná, Brazil, and a landfill operated by a private company, located in Fazenda Rio Grande, Paraná, Brazil. For the first one, Curitiba's Sanitary Landfill, an operator of the leachate treatment plant and a manager were interviewed. For the landfill under the responsibility of a private company, the interview was conducted with an operator and a technical manager. Full names of respondents will not be disclosed, as agreed prior to the interview. Interviews were conducted between April 25 and May 2, 2019, during technical visits to both landfills. The questions asked which operations, among the ones performed frequently in a landfill (e.g. waste collection, waste disposal, leachate treatment, gas collection, drainage, landfill cells closure, etc.), are perceived by managers and operators of landfills located in Curitiba and its Metropolitan Area as the ones representing the biggest challenges and problems in these units.

From the answers and information collected during interviews with landfill managers and operators of Curitiba and its Metropolitan Area, data was grouped into categories related to the technical, operational and management limitations found in these facilities. Speech analysis was also performed based on the interview responses.

## 6 Results and Analysis

Before 1989, according to the manager responsible for the Curitiba's Sanitary Landfill, the municipality of Curitiba sent its MSW to a dump, later transformed into a controlled landfill, located next to the municipality of Almirante Tamandaré, Paraná, Brazil. However, the amount of garbage began to increase, following the demographic growth of the city and its Metropolitan Area. The concern with the community and the environment, especially regarding the leachate produced in the controlled landfill, led the City Hall of Curitiba to propose the construction of the Curitiba's Sanitary Landfill, which can even be considered as one of the first landfills in Brazil. Initially expected to receive MSW for 11 years and six months, the landfill was active for 21 years, from November 1989 to November 2010. During this time, the Curitiba's Sanitary Landfill has received about 12 million tons of MSW from Curitiba and 17 other municipalities.

The total area of the Curitiba's Sanitary Landfill is 1,015,000 $m^2$, being 439,540 $m^2$ designated for waste disposal. In 2010, at the time of the end of operation, the landfill received an average of 2400 tons of MSW per day. The landfill is managed by public administrators. Information was obtained from the website of the Curitiba Municipal Secretary of the Environment (Curitiba Municipal Secretary of the Environment 2019) and also during interviews. After the deactivation in 2010, the Curitiba's Sanitary Landfill became an area for environmental conservation. However, even if no more MSW is received, the landfill still needs to be maintained for at least 30 years after deactivation. The leachate treatment system remains operational and a team of operators constantly monitors it.

During the first phase, a study was initially made to choose the best area for the landfill, followed by a hydrogeological study, cleaning and preparation of the site, installation of waterproof layers and drainage system. The manager responsible for the landfill reported that this initial stage of construction posed a major management challenge, as several studies were necessary and, being one of the first landfills in Brazil, the technology involved was not yet well known at the time. As the landfill was being built, according to the manager, new technologies were tested, such as the use of new waterproofing materials to replace the previously installed clay layer. The interviewed manager also reported that as the amount of MSW sent to the landfill increased, a larger volume of leachate was generated. This fact required frequent modifications in the treatment system for this wastewater. Initially, the leachate was treated only in a facultative pond. However, due to variability in leachate composition, volume increase and process conditions, this method alone was no longer satisfactory. Thus, new complementary options were necessary, such as aerated ponds, activated sludge, physical and chemical treatment and wetlands.

Even if the landfill no longer receives MSW, it still requires monitoring and maintenance. The landfill still produces leachate, which needs to be properly collected and treated. Due to this, the landfill manager stated that the treatment of leachate, both during the landfill operation and after its deactivation, is one of the most challenging stages for the management of this type of disposal unit. Particularly for this landfill, the interviewed manager also reported that the geotechnical monitoring is an onerous step, necessary to ensure the geological stability of the massif on which the deactivated landfill is located. Therefore, geological studies are also important, but costly, according to the manager. Finally, it was reported that currently about 20 employees are responsible for the maintenance of the landfill. Services typically involve pruning and mowing, maintenance of landfill ducts and pipelines, and operation of the leachate treatment plant.

After the deactivation of the Curitiba's Sanitary Landfill, the municipality of Curitiba joined an inter-municipal consortium and started sending its MSW to a sanitary landfill operated by a private company, located in the municipality of Fazenda Rio Grande, Paraná, Brazil. This landfill serves, aside from Curitiba, other 23 municipalities. Its total area is approximately 2,600,000 $m^2$, with 620,000 $m^2$ intended for receiving MSW. The landfill receives an average of 2500 tons of waste per day (Gimenes and Hising 2017).

One of the employees interviewed in this sanitary landfill, when asked about the most demanding steps for its management, pointed to leachate treatment as being the most important and most challenging one. This manager justified his answer by saying that the leachate treatment, from a technical perspective, is a complex process and requires constant monitoring, as problems at this stage can generate huge losses to the landfill (such as fines, for example).

As both interviewed managers from the two landfills pointed to the leachate treatment as one of the main difficulties associated with these units, two operators of respective leachate treatment plants were also interviewed, in order to know what stage of the operation they perceived as more challenging. One of the operators works at the Curitiba's Sanitary Landfill, already deactivated, and the other at the landfill currently responsible for the disposal of the MSW of Curitiba and its Metropolitan Area. It is noteworthy, however, that the perception of these employees is restricted to the treatment of leachate, and not to the management of the landfills.

The first interviewed operator has been working in the landfill for approximately nine years. His tasks include measuring the leachate affluent flow, applying the required chemicals in one of the treatment units, monitoring the level of foam formed during the leachate degradation and system general maintenance. The operator reported that the main difficulties of his routine at the leachate treatment plant, in his perception, are electrical shortages. They are responsible for shutting down the treatment plant motors, interrupting pump activity and stopping aeration for the biological process. When this happens, the operator informed that it is necessary to be alert and promptly activate the manual control of power generation, so that the treatment system does not stop working. He also said that another demanding responsibility is to monitor the leachate during treatment. He cited as an example what can happen in rainy days: on these occasions, the leachate sometimes arrives at the treatment plant with too much sludge, which can lead to clogs and cause the treatment process to fail. Therefore, his function requires constant care and observance of several parameters to ensure that the leachate treatment system is properly maintained without interruptions.

The second operator interviewed works at the landfill in which the MSW generated in Curitiba and its Metropolitan Area is currently disposed. The employee's duties include monitoring the leachate treatment plant, staff training, performing chemical analysis to assess leachate treatment efficiency, among others. He reported that, according to his point of view, the most challenging stage of his routine is the monitoring of the pumps, especially those used in the leachate physical and chemical treatment stages. As these pumps are in direct contact with chemicals, they eventually suffer degradation and require fast repair so that the treatment process is not interrupted. Finally, according to him, his work requires constant care and frequent inspection, and involves operator experience to know when action is required.

## 7 Conclusion and Perspectives for Future Research

Brazil is dependent on sanitary landfills for the final disposal of its municipal solid waste (MSW). The National Policy on Solid Waste, created in 2010, recommends sanitary landfills as the most appropriate method for MSW final disposal and requires Brazilian municipalities to adopt these facilities. However, technical and financial difficulties are still observed, making it impossible for many municipalities, especially the smallest ones, to comply with legislation and implement integrated solid waste management. In this context, it is necessary to understand which are the main current limitations in order to propose measures and develop technologies that favor the installation and sustainable operation of landfills.

This research comprises two landfills located in Curitiba and its Metropolitan Area, in the state of Paraná, Brazil. MSW management in Curitiba had an important milestone in 1989, the inauguration of Curitiba's Sanitary Landfill, one of the first sanitary landfills in Brazil. Today, this unit no longer receives waste, but requires constant maintenance and monitoring. After its deactivation, the MSW has been sent to the landfill operated by a private company. Therefore, the choice of these landfills as a case study allowed encompassing the entire current MSW management of Curitiba and its Metropolitan Area.

When questioned, both landfill managers cited the treatment of leachate as the major challenge regarding the management of these MSW disposal units. If the treatment system fails, untreated leachate could be released in the environment under improper conditions, causing pollution and leading to severe fines. One of the employees also mentioned that another onerous management task is the geotechnical monitoring of the landfill, necessary for the prevention of accidents.

As leachate treatment was pointed out by managers of the two landfills as one of the most critical difficulties in the management of these facilities, operators of the leachate treatment plants were also interviewed in order to know the specific limitations of this stage. Both interviewed operators reported that, during their work routine, what requires more attention is the monitoring of the equipment necessary for the leachate treatment, so that there are no process failures which could lead to the release of untreated leachate in the environment.

Based on the perception of the employees who work in the landfills responsible for the final disposal of the MSW of Curitiba and its Metropolitan Area, it can be concluded that the treatment of leachate is, in fact, the main challenge to the management and operation of these units. Therefore, leachate treatment requires constant monitoring and control, as well as the search for technologies capable of avoiding negative environmental and social impacts associated with landfills. So, from the analysis of this case study, the authors suggest that research and development of technologies should prioritize the leachate treatment systems, aiming to increase their efficiency and stability.

Finally, it is recommended that future analyses seek to assess the perception of more landfill employees from different organizational levels for a more complete analysis. The method used in this research can also be applied for other landfills and

even for dumps or controlled landfills, although it is often difficult to find contact information for these units. One way to resolve this limitation is, for example, through the Diagnosis of Urban Solid Waste Management, produced periodically by the Ministry of Regional Development and the National Secretariat of Sanitation. This diagnosis is produced from answers given by operators of MSW final disposal units. In 2017, for example, 640 employees of sanitary landfills, dumps and controlled landfills answered the questionnaire. So, authors suggest that questions aiming to know the perception of these employees regarding the main concerns routinely faced by them in the installation and operation of the disposal facilities should be included.

Approximately 60% of Brazilian municipalities still do not have sanitary landfills, sending their MSW to open dumps or controlled landfills. Many of them claim a lack of technical and/or financial resources as impediments to adopting the NPSW and installing those adequate landfills. In this case study, for example, one of the managers pointed out the high cost of geotechnical studies as one of the major issues he faced in the landfill installation phase. In this context, applying the method used in this case study and knowing the difficulties previously faced in other landfills, both during installation and operation, can help in the decision-making process on priority investments for those municipalities that have not yet fit the NPSW and, consequently, not assumed more sustainable e responsible MSW management practices.

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# Comparative Analysis of the Sustainable Practices Based on Social Responsibility Guidelines of Personal Hygiene, Perfumery and Cosmetics Companies in Brazil


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## 1 Introduction

The concept of sustainability has been discussed by several industry areas, revealing changes in business objectives and commitment to the application of sustainable practices in operations (Hennings et al. 2015).

In view of worldwide pressure due to the increasing degradation of nature and the risks to human survival, both governments and businesses have had to invest in efforts to meet development goals (Boff 2012). In this scenario, organizations around the world are becoming increasingly aware of the need and benefits of socially responsible behavior, thus contributing to sustainable development (ABNT 2010) and the creation of value and well-being of the society (Voltolini 2011).

On the other hand, among the intense globalization and advancements of organizations, norms and guidelines are necessary for guidance on sustainability. Currently, there are several tools, actions, and indicators that can help companies to apply social responsibility to improve sustainable practices. Also, these norms used in a comparative analysis could provide a rough profile of the status of the sustainability and social responsibility in Brazilian companies of several sectors.

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In the Brazilian business market, one of the most prominent sectors is personal hygiene, perfumery, and cosmetics sector. The sector has 2629 companies regulated by the National Health Regulatory Agency (ANVISA), according to the Brazilian Association of the Industry of Personal Hygiene, Perfumery and Cosmetics (ABIHPEC 2016).

Besides, Brazil is the fourth country in the world that consumes the most products in this category, moving around the US$32.1 billion in 2017 (6.9% of world consumption) (ABIHPEC 2017). This sector is also responsible for generating 36 billion reais in remuneration along the chain, with 80% destined for women (ABIHPEC 2016).

In this context, organizations in this sector could surely contribute positively to the generation of wealth and benefits, bearing in mind that the concept of sustainable development must be continuously engaged in the business environment. Consequently, these companies would be aware of their environmental, social and economic impacts on the planet and the local community, focusing on taking actions to solve the problems.

Thus, this study aimed to compare the sustainable practices suggested by ISO 26000 and Global Reporting Initiative (GRI) of the four companies that have greater representation in the Brazilian market of personal hygiene, perfumery, and cosmetics—Unilever, Grupo Boticário, Avon and P&G—with the practices of a reference company in the sustainability of this same market—Natura. In addition to the main objective, this research emphasizes the importance of data disclosure by companies in order to disseminate information about corporate sustainability and monitor targets. It also encourages comparative analysis in companies in other sectors, providing structural guidance for the comparison with the results of future research.

## 2 Methodology

The methodological approach of this research is exploratory and descriptive, which discusses the sustainable practices applied by personal hygiene, perfumery and cosmetics companies identified in their main communication channels. After defining the analyzed sector in this article, this study was conducted in the city of Curitiba—Paraná, Brazil, between July 2018 and December 2018, taking into consideration the following steps to be met:

- Step 1—Selection of the analyzed companies;
- Step 2—Selection of the comparison criteria;
- Step 3—Comparative analysis of sustainable practices;
- Step 4—Analysis of companies in the Brazilian market;
- Step 5—Conclusion.

The first step carried out in this study was the definition of criteria for choosing personal hygiene, perfumery and cosmetics companies and a reference company for benchmarking. As criteria, the companies that have the greatest influence in the Brazilian market in this sector were selected to verify the level of development of sustainable practices.

After selecting the companies, the sustainable practices applied were identified and analyzed based on sustainability reports, magazine articles, news on the company website and articles. Besides, to ensure the assertiveness of the results, self-promoting advertisements were not used.

In the second step, the ISO 26000 standard and GRI report were selected since they are recognized and provides guidance on sustainable practices by companies worldwide. The main criterion of choice was the comparability and the scope of the practices contained in the normative. The GRI report is globally applied to report sustainability practices and the ISO 26000 standard is internationally recognized as the standard to be followed.

Thus, in the third step, a comparative table with the sustainability criteria, separated in environmental, social, economic and governance areas, was built to compare the practices recognized in the companies with the practices observed in the benchmark company. The benchmarking process served to identify best practices in products, services, and processes to indicate recommendations for improving practices in these organizations (Ramos et al. 2018).

Finally, in the fourth and fifth steps of the study, the results of the quantitative analysis were presented and discussed, as well as limitations and recommendations for future work.

## 3 Results and Discussion

### *3.1 Selection of the Analyzed Companies*

To select the companies compared in this study, it was considered the representativeness of each company in the Brazilian market. These companies are widely recognized by consumers and, as a result, could provide more substantial impacts on society through the improvement of sustainable practices.

According to Exame (2012), after analyzing Euromonitor data from the same year, the companies that have the largest economic influence in the personal hygiene, perfumery and cosmetics sector in Brazil were Natura, Unilever, Avon, P&G, and the Grupo Boticário.

In 2017, according to Euromonitor (2017), Natura kept leading the personal hygiene, perfumery, and cosmetics market, followed by Unilever, Grupo Boticário, L'oreal, Colgate Palmolive, Avon, and P&G.

Similar to the data provided by Euromonitor, Valor Econômico (2018) published a list of the 1000 largest companies in Brazil and, for the sector analyzed in this study, Unilever ranked first (44th overall ranking), followed by Natura (66th overall ranking), Avon (136th overall ranking) and P&G (286th overall ranking). L'oréal, Colgate Palmolive and Grupo Boticário are not in the ranking. However, Grupo Boticário is a privately held company and does not publish net revenue, used for analysis in the list.

For this reason, the companies Unilever, Grupo Boticário, Avon and P&G were selected because they represent the largest share in the Brazilian market.

Concerning the sustainability benchmarking company, an international reference in sustainable practices was researched. Forbes (2018) published an article about the most sustainable companies of 2018, which were ranked by the Canadian magazine "Corporate Knights", that publishes "The Global 100" annually. Corporate Knights have reviewed the financial and sustainability reports of more than 6000 companies in several countries around the world, and the first ranked company in the personal hygiene, perfumery, and cosmetics sector was Natura (14th overall ranking), followed by L'oréal. (84th overall ranking) and Johnson and Johnson (92nd overall ranking).

Natura also received in 2017 the Sustainability Company of the Year Award from Exame (2017) and the World's Most Ethical Companies Award (Carta Capital 2018).

Therefore, due to the recognition and positive evaluation, both nationally and internationally, the company chosen to be benchmarking was Natura.

## *3.2 Selection of the Comparison Criteria*

The comparison criteria for the development of this research were found in the ISO 26000 guidelines (ABNT 2010) and the Global Reporting Initiative (GRI 2016).

The ISO 26000 norm has been recognized as a "milestone of global cooperation" (Ward 2011), taking into account, it was the first effort at normative to develop multi-stakeholder standards (Balzarova and Castka 2012).

As well as ISO 26000, GRI is considered a highly relevant reference to sustainability reports (Hourneaux et al. 2014), considering that it provides a comprehensive framework of the principles, disclosure standards, indicators, and protocols (Alazzani and Wan-Hussin 2013). Besides, GRI has been widely applied for corporate strategies and practices (Levy et al. 2010).

Into ISO 26000, actions according to the seven main themes (organizational governance, human rights, work practices, environment, fair operating practices, consumer issues, and community development) were selected. In the GRI, the report indexes were raised for the universal topics of general standards applied across all companies and for specific ones addressing economic, environmental and social issues.

To maintain the purpose of the article and focus only on the sustainable practices of toiletries, perfumery and cosmetics companies, the criteria for company identification, sustainability report formalization and criteria not applicable to companies in this sector were not considered.

About common actions and initiatives, data and information were researched in sustainability reports of the evaluated companies. Then, the sustainable practices used by the respective companies were distributed into common criteria adopted by the standards found in the previous step: environment, social, economic and governance.

Environmental practices are those that the company applies in order to reduce the impacts caused throughout the life cycle of the products (ABNT 2010).

Regarding social practices, these involve actions focused on human rights, work practices, consumer issues (ABNT 2010), and community involvement through social projects in local population development (Lourenço and Schöder 2003).

Next, economic practices of social responsibility are related to the impacts of the organization on the economic conditions of its stakeholders and economic systems – local, national, and global (GRI 2016).

Finally, sustainable governance practices involve rules, principles, purposes, and values to guide the management of organizations (Andrade and Rossetti 2007), such as accountability, competitive practices, anti-corruption practices, responsible political involvement, and management systems (Instituto Ethos 2017).

Thus, the comparison of the results of the respective companies was performed and it was verified the sustainable practices already applied according to the criteria of the analyzed areas.

### *3.3 Comparative Analysis of Sustainable Practices*

The comparative table containing the criteria is shown in Appendix 1 and includes the environmental, social, economic and governance practices followed by Natura, Unilever, Grupo Boticário, Avon and P&G.

In the first column, the comparison criteria that were consulted in ISO 26000 practices and the GRI report are presented. Next, the companies were compared with Natura, used as a benchmark.

The company only met the criteria when it was evident in its report, exposing the detailed results. On the other hand, regarding the criteria that were not met, it was possible to conclude that the companies do not perform the practices or do not inform it in their report.

The information used in the Tables 2, 3, 4, and 5, in Appendix 1, was obtained from sustainability reports relative to 2017, except for the Grupo Boticário, which has the latest update available on its website relative to 2016.

### *3.4 Analysis of Companies in the Brazilian Market*

To summarize, the largest companies operating in personal hygiene, perfumery and cosmetics in the Brazilian market, expressed concern to align the company's growth with sustainable development.

The companies have on their websites a space dedicated only to the disclosure of environmental and social practices. Also, most companies provide their sustainability reports. However, the international companies, Unilever, P&G, and Avon, do not provide the full report on their Brazilian websites, only the compact versions or income statements. Consequently, the information applied in this study was consulted in the sustainability reports available on its international websites.

More importantly, corporate social responsibility information was accessible and easy to understand, facilitating the dissemination of practices to engage other companies.

The results obtained from the analysis of company practices (Appendix 1) were organized and quantified according to the total number of criteria that companies met (Table 1).

As presented in Appendix 1, 217 practices were raised, which most of them were related to Governance, Social and Environmental practices.

On the other hand, the study presented by Amaral (2004), which aimed to analyze indicators and sustainability reports of Brazilian oil companies, showed that economic performance results were further informed considering the economic indicators are required to be published.

It is known that environmental measurements have a wide variety and depending on the country may be a requirement, whereas there were few initiatives for social performance measures (volunteering) and governance was not yet discussed. The divergence of the results shows advancement in the theme of 2004–2018, mainly for the indicators focused on social and governance criteria.

**Table 1** Quantitative results of the attendance criteria of the ISO 26000 and the GRI report for the companies

| Criteria | | Natura | Unilever | Boticário | Avon | P&G |
|---|---|---|---|---|---|---|
| *Environmental* | | | | | | |
| ISO | 32 | 32 | 31 | 27 | 25 | 26 |
| GRI | 29 | 27 | 20 | 11 | 10 | 17 |
| Total | 61 | 59 | 51 | 38 | 35 | 43 |
| *Social* | | | | | | |
| ISO | 37 | 33 | 31 | 26 | 22 | 31 |
| GRI | 34 | 25 | 28 | 11 | 6 | 20 |
| Total | 71 | 58 | 59 | 37 | 28 | 51 |
| *Economic* | | | | | | |
| ISO | 3 | 2 | 2 | 1 | 1 | 2 |
| GRI | 9 | 9 | 9 | 2 | 1 | 6 |
| Total | 12 | 11 | 11 | 3 | 2 | 8 |
| *Governance* | | | | | | |
| ISO | 43 | 41 | 37 | 25 | 33 | 29 |
| GRI | 30 | 25 | 25 | 11 | 6 | 11 |
| Total | 73 | 66 | 62 | 36 | 39 | 40 |

Furthermore, analyzing the frequency of meeting the criteria among the standards, it is noted that the ISO 26000 standards have higher compliance than the GRI. The behavior of the results is a consequence of the structure of ISO 26000 and GRI since ISO provides guidelines while GRI requires disclosure of data in a specific format. Moreover, the criteria of each scope of ISO and GRI are similar and interrelated, both numerically and in content. For this reason, the integration and standardization of sustainability norms and tools are necessary for sustainability assessment in companies and the dissemination of sustainable practices. In Appendix 1, the same or similar criteria in ISO and GRI were addressed, making this integration possible.

Subsequently, the percentages of compliance with the criteria of each company in each scope of sustainability and the total averages are presented (Fig. 1).

According to Fig. 1, Natura played the role of benchmarking and had an attendance level of approximately 90%, followed by Unilever, P&G, Grupo Boticário and Avon. Natura showed the best performance in environmental practices, with 100% (ISO) and 93% (GRI) of attendance and the worst performance in social practices, reaching 89% (ISO) and 74% (GRI). Despite this, the most GRI indices that Natura did not attend or reveal, were also not presented by companies in their reports.

In economic practices, Natura also had the best performance, meeting 2 of the 3 ISO criteria and 100% of the GRI requirements.

Concerning to the analyzed companies, without Natura, as Unilever and P&G are companies incorporated in many sectors and countries (have sustainability reports since 1999), they presented the highest sustainability performance. This fact may

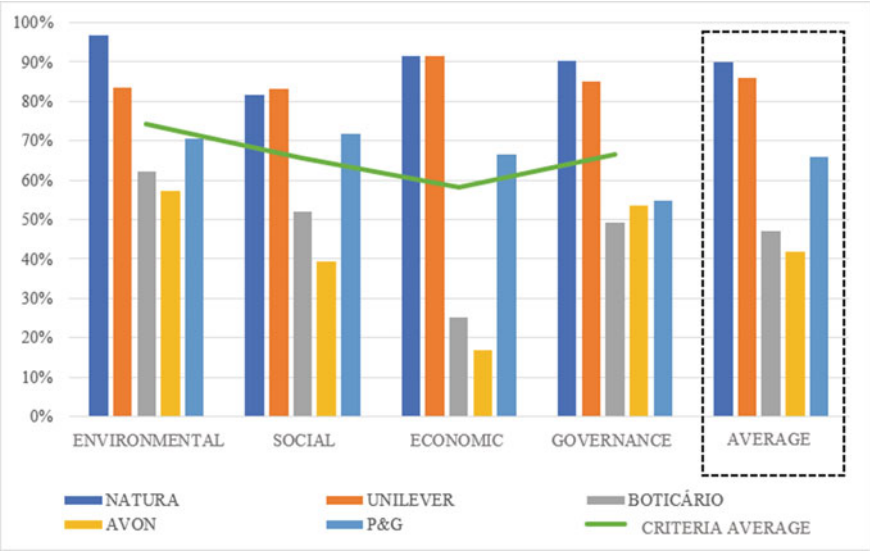


**Fig. 1** % of the attendance of each company for the respective sustainable areas

explain their performance compared to the companies Avon and Grupo Boticário, which exclusively operate in one sector.

The second national company analyzed, Grupo Boticário, still has shown a lack of attendance of the criteria and had the worst performance in governance. Nevertheless, the Grupo Boticário GRI report has 2016 as its reference year, which is outdated when compared to 2017. Furthermore, for other sustainability criteria, the Grupo Boticário had better performance than Avon. Consequently, some criteria were not required and that could be the main reason why the company did not satisfy several GRI indexes.

Another interesting point was the average attendance of the criteria that reached above 58% in the four areas. This reinforces the concern of personal hygiene, perfumery and cosmetics companies in the adoption of sustainable practices and its communication.

For example, governance is one of the essential indicators for assessing a company's commitment to sustainability. According to analysis, the average attendance of criteria by companies operating in the Brazilian market is optimistic (67%) even that improvements are required.

Concerning the companies' commitment to the environmental and social criteria, it was verified that the analyzed companies have goals to reduce greenhouse gas emissions, waste, energy and water consumption and waste generation.

Finally, economic practices averaged 58%. The explanation for this performance is the protection of economic information. For example, investment data, salary, and tax are not reported to maintain security and confidentiality.

## 4 Conclusion

Incorporating the sustainable practices included in the ISO 26000 standard and the GRI report is not a simple task and requires organizations' commitment to society, the government, and the environment. In general, according to the comparative analysis carried out in this study, although there are still areas that need improvement, companies achieved positive results in meeting the guidelines of ISO 26000 and GRI, showing concern regarding sustainable development.

A limitation of this research was the lack of standardization of corporate sustainability reports. For example, Natura was the only one that highlighted the GRI indexes in the report's content, allowing the easy identification of each criterion.

As a result of the lack of standardization and the subjectivity of company reports, comparing practices between companies can be an arduous task. Based on this, it is suggested the standardization of the sustainability reports, in order to present understandable and comparable information. Thus, besides allowing the monitoring of environmental, social and economic performance, the utilization of benchmarking to find the best practices would be promoted.

Despite this, the analysis serves as a guide to support decision-making since it highlights all the sustainable practices that the main companies in the sector implement, and practices that demand improvement actions. Furthermore, the information presented encourages the promotion of sustainable practices in Brazil focusing on the improvement of social responsibility. In this way, companies in the sector and other sectors could use such information to correctly organize and disseminate these practices.

## Appendix 1

### *Comparative Table of the Sustainable Practices*

See Tables 2, 3, 4, and 5.

**Table 2** Attendance of environmental practices of ISO 26000 and global reporting initiative

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| *Environmental* | | | | | |
| Identifies sources of pollution and waste related to its activities | ✓ | ✓ | ✓ | ✓ | ✓ |
| Records and reports significant sources of pollution | ✓ | ✓ | ✓ | ✓ | ✓ |
| Implements pollution and waste prevention measures using the waste management hierarchy. Ensures proper management of pollution and unavoidable waste | ✓ | ✓ | ✓ | ✓ | ✓ |
| Engages with local communities on current and potential pollutant emissions and wastes, respective health risks, and mitigation measures | ✓ | ✓ | × | × | ✓ |
| Implement measures to progressively reduce and minimize direct and indirect pollution under its control or within its sphere of influence. Develops and promotes environmentally appropriate products and services | ✓ | ✓ | ✓ | ✓ | ✓ |
| Publicly discloses the quantities and types of relevant and significant toxic and hazardous materials used by the organization. Also, it discloses the known environmental and health risks from these materials | ✓ | ✓ | ✓ | ✓ | ✓ |
| It does not use chemicals that are prohibited by national law, scientific bodies or any stakeholder | ✓ | ✓ | ✓ | ✓ | ✓ |
| Implement chemical accident prevention and preparedness program. Also, implements an emergency plan for on-site and off-site accidents involving workers, the local community, partners or other stakeholders | ✓ | ✓ | × | × | ✓ |
| Records and reports water, energy, and other resource consumption | ✓ | ✓ | ✓ | ✓ | ✓ |
| Implements efficiency measures to reduce the use of energy, water, and other resources, considering best practice indicators and other benchmarks | ✓ | ✓ | ✓ | ✓ | ✓ |
| Complements or replaces non-renewable resources with sustainable alternatives, renewable and low impact | ✓ | ✓ | ✓ | ✓ | ✓ |
| Uses recyclable materials and reuses water as much as possible | ✓ | ✓ | ✓ | ✓ | ✓ |
| Promotes sustainable procurement practices | ✓ | ✓ | ✓ | ✓ | ✓ |
| Considers the adoption of post-consumer responsibility | ✓ | ✓ | ✓ | ✓ | × |
| Promotes sustainable consumption | ✓ | ✓ | × | × | × |
| Identifies sources of Greenhouse Gas (GHG) emissions and defines the limits of their liability | ✓ | ✓ | ✓ | ✓ | ✓ |
| Measures, records and reports its significant GHG emissions using well-defined methods in internationally agreed standards | ✓ | ✓ | ✓ | ✓ | ✓ |
| Implement optimized measures to reduce and minimize GHG emissions under your control | ✓ | ✓ | ✓ | ✓ | ✓ |
| Analyzes the amount and type of fuels used within the organization and implement programs to improve efficiency and effectiveness | ✓ | ✓ | ✓ | × | ✓ |
| Practices energy savings by purchasing or developing energy-efficient products and services | ✓ | ✓ | ✓ | ✓ | ✓ |
| Implement measures to offset remaining GHG emissions | ✓ | ✓ | × | ✓ | ✓ |

(continued)

**Table 2** (continued)

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| Identifies possible negative impacts on biodiversity and ecosystem services and takes actions to eliminate or minimize these impacts | ✓ | × | ✓ | × | × |
| Establishes and implements strategies for the management of soil, water and ecosystems that promote their conservation and sustainable use | ✓ | ✓ | × | ✓ | ✓ |
| Take steps to preserve endangered endemic species or habitats that may be negatively affected | ✓ | ✓ | ✓ | ✓ | ✓ |
| Incorporates the protection of natural habitats, wet or flooded areas, forests, protected areas and agricultural land in the development of buildings and constructions | ✓ | ✓ | ✓ | × | × |
| Uses products from suppliers that adopt sustainable technologies and processes | ✓ | ✓ | ✓ | ✓ | ✓ |
| Avoids the use of hazardous chemicals in product development (carcinogenic, mutagenic, toxic for reproduction or bioaccumulative) Products containing these chemical elements are clearly labeled | ✓ | ✓ | ✓ | × | × |
| It provides socially and environmentally beneficial products and services considering the entire life cycle to reduce negative impacts on society and the environment | ✓ | ✓ | ✓ | ✓ | ✓ |
| Creates products and packaging easy-to-use, repair or recycle. Also, as much as possible, it offers or suggests recycling and disposal services | ✓ | ✓ | ✓ | ✓ | ✓ |
| Provides for the consumers reliable, consistent, truthful, accurate, comparable and verifiable scientific information about environmental and social factors related to the production and delivery of their products or services | ✓ | ✓ | ✓ | ✓ | × |
| Provides information for consumers about products and services like health impacts, country of origin, energy efficiency, ingredients, animal welfare aspects (including animal testing), maintenance, storage and disposal of products and packaging | ✓ | ✓ | ✓ | ✓ | ✓ |
| Uses reliable and verified labeling systems. Examples: green seal and audit activities, used to communicate positive environmental aspects of products and services | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Global reporting initiative* | | | | | |
| Reports the weight or total volume of materials used in the production and packaging of primary products and services during the reporting period, separated by renewable and non-renewable materials | ✓ | ✓ | ✓ | × | ✓ |
| Reports the percentage of raw materials that are recycled materials in the production of primary products and services | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reports the percentage of raw materials that are materials recovered in the production of primary products and services. It also discloses how the data were collected | × | ✓ | × | ✓ | ✓ |
| Reports the types and the total fuel consumed in the organization coming from non-renewable and renewable sources | ✓ | ✓ | × | ✓ | ✓ |
| Reports the amount of energy used for electricity, heating, cooling, and steam generation. It also reports the total energy consumption | ✓ | ✓ | × | ✓ | ✓ |

(continued)

**Table 2** (continued)

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| Reports energy consumption outside the company | ✓ | ✓ | × | × | × |
| Reports the types and amount of energy that has been reduced through conservation practices and efficiency initiatives | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reports the total amount of water drawn from surface areas (lakes, rivers, sea), underground channels (water channels), rain collection and plumbing, provided by the government | ✓ | ✓ | × | × | ✓ |
| Reports whether water sources are from preserved areas, whether they have biodiversity value and the value of these sources to the local community and indigenous peoples | ✓ | × | × | × | × |
| Reports the total volume of water recycled and reused by the organization and the ratio of the recycled or reused volume of water to the volume of water withdrawn from the environment | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reports the existence of a protected area near its location and informs the type of operation, the exact location, the position about the protected area and the biodiversity value of the area | ✓ | × | × | × | × |
| Informs the nature of impacts on biodiversity resulting from the organization's activities, such as construction, pollution, etc. | × | × | × | × | × |
| Reports the size and location of all protected or restored habitat areas. It also reports whether the restoration has been approved by independent external professionals, the status of each area based on its condition at the end of the reporting period, and the standards and methodologies used | ✓ | ✓ | × | ✓ | × |
| Reports the number of IUCN Red List and national conservation list endangered species living in areas affected by the organization's operations, according to the level of extinction risk | ✓ | × | × | × | × |
| Reports direct GHG emissions, gases included in the calculation, the base year for calculating, source of emission factors, emissions consolidation approach, standards, methodologies, assumptions and/or calculation tools used | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reports indirect emissions based on GHG location, gases included in the calculation, the base year for calculating, source of emission factors, emission consolidation approach, standards, methodologies, assumptions and/or calculation tools used | ✓ | ✓ | ✓ | ✓ | ✓ |
| Report other indirect GHG emissions, gases included in the calculation, the base year for calculation, source of emission factors, emission consolidation approach, standards, methodologies, assumptions and/or calculation tools used | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reports GHG emission intensity rate, specific metric chosen to calculate the rate, types of GHG emissions included in the intensity rate and gases included in the calculation | ✓ | ✓ | ✓ | × | × |
| Reports the reduced GHG emissions as a direct result of reduction initiatives, gases included in the calculation, the base year of calculating, types of GHG emissions that have been reduced, standards, methodologies, assumptions and/or calculation tools used | ✓ | ✓ | ✓ | ✓ | ✓ |

(continued)

**Table 2** (continued)

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| Report the production, import, and export of ozone-depleting substances, substances included in the calculation, source of emission factors used, standards, methodologies, assumptions and/or calculation tools used | ✓ | × | × | × | × |
| Reports significant atmospheric emissions of nitrogen oxides, sulfur oxides, and others, the source of emission factors used, standards, methodologies, assumptions and/or calculation tools used | ✓ | × | × | × | × |
| Reports the total planned and unplanned discharges of water. It is reported according to destination; water quality (includes treatment method); reuse of water by another organization, standards, methodologies, and assumptions | ✓ | ✓ | × | × | ✓ |
| Reports the total weight of hazardous and non-hazardous waste, including disposal methods (reuse, recycling, composting, etc.) and how the waste disposal method was determined | ✓ | ✓ | × | × | ✓ |
| Reports the total number and total volume of significant spills recorded. It is reported according to the location, volume, material, and the impacts of the spill | ✓ | × | × | × | ✓ |
| Reports the total weight of hazardous waste transported, imported hazardous waste, exported hazardous waste and treated hazardous waste, the percentage of hazardous waste shipped internationally, standards, methodologies and assumptions used in the calculations | ✓ | × | × | × | × |
| Reports the bodies of water and habitats that are significantly affected by water discharge and/or runoff. For each body of water or habitat, it reports size, protection status, and biodiversity value | ✓ | ✓ | × | × | ✓ |
| Reports fines and non-monetary sanctions for non-compliance with environmental regulations | ✓ | ✓ | × | × | × |
| Reports the percentage of new suppliers that were selected using environmental criteria | ✓ | ✓ | ✓ | × | ✓ |
| Reports potential and actual environmental impacts of the supply chain, as well as preventive and corrective actions | ✓ | ✓ | ✓ | × | ✓ |

*N** natura, *U** unilever, *B** grupo boticário, *A** avon, *P** P&G

**Table 3** Attendance of social practices of ISO 26000 and global reporting initiative

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| *Social* | | | | | |
| Has a human rights policy for the organization and assesses how activities can affect human rights | ✓ | ✓ | ✓ | ✓ | ✓ |
| Decisions are based on human rights and the company contributes to the promotion and defense of human rights compliance | ✓ | ✓ | ✓ | ✓ | ✓ |
| The company does not establish a partnership or contractual relationship with a partner that violates human rights | ✓ | ✓ | ✓ | ✓ | ✓ |
| The company ensures that there is no discrimination in operations | ✓ | ✓ | × | ✓ | ✓ |
| Supports raising awareness among members of vulnerable groups about their rights | × | × | × | × | × |
| Contributes to redressing discrimination | ✓ | × | ✓ | ✓ | ✓ |
| Respects civil and political rights | ✓ | ✓ | ✓ | ✓ | ✓ |
| Promotes and supports education and engages in actions to improve access to education | ✓ | ✓ | ✓ | ✓ | ✓ |
| Offers products and services to low-income consumers | × | ✓ | × | ✓ | ✓ |
| Supports respect and viability of economic, social, and cultural rights | ✓ | × | ✓ | ✓ | ✓ |
| It does not use texts, audios, or images in advertisements that perpetuate stereotypes of gender, religion, race, disability, or personal relationships | ✓ | ✓ | ✓ | × | ✓ |
| Secures proper design of information contained in products and services, taking into account different consumer needs and respecting the different or limited capabilities of consumers | ✓ | ✓ | ✓ | ✓ | ✓ |
| Uses textual and internationally symbols of safety information to consumers | ✓ | ✓ | ✓ | ✓ | ✓ |
| Instructs consumers about the proper use of products and warns them of the risks involved during use | ✓ | ✓ | ✓ | ✓ | ✓ |
| Take action to prevent unsafe products for handling or storage | ✓ | × | ✓ | × | × |
| Promotes effective education that enables consumers to understand the impacts of choosing products and services. Advice on the importance of modifying consumption patterns is provided | ✓ | ✓ | × | ✓ | ✓ |
| Contributes to the fulfillment of society's right to access essential services | ✓ | ✓ | ✓ | ✓ | ✓ |
| Consults community representatives to determine priorities for social investment and community development activities | ✓ | × | × | × | × |
| Participates in local associations, aiming to develop the local community | ✓ | ✓ | ✓ | ✓ | ✓ |
| Encourages and supports people to volunteer in community service | × | × | ✓ | × | ✓ |
| Contributes to policy formulation, establishment, implementation, monitoring and evaluation of development programs | ✓ | ✓ | ✓ | ✓ | ✓ |
| Promotes cultural activities and recognizes and values local cultural traditions following human rights | ✓ | ✓ | ✓ | × | × |

(continued)

**Table 3** (continued)

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| Assist in the conservation and protection of cultural heritage | ✓ | × | ✓ | × | × |
| The company analyzes the impact of investment decisions on job creation and make investments that minimize poverty through job creation | ✓ | ✓ | ✓ | ✓ | × |
| Considers the benefit of direct job creation rather than temporary employment agreements | × | ✓ | × | × | ✓ |
| Considers participation in local and national training programs, including apprenticeship programs, programs targeting vulnerable people, continuing education programs, and skills recognition and certification systems | ✓ | ✓ | ✓ | ✓ | ✓ |
| Trains and create jobs for vulnerable groups | ✓ | ✓ | ✓ | ✓ | ✓ |
| Contributes to the development of innovative technologies that could assist in the socio-environmental obstacles in local communities | ✓ | ✓ | ✓ | × | ✓ |
| Partners with organizations such as universities and research laboratories to increase scientific and technological development with community partners, employing the local population | ✓ | ✓ | ✓ | × | ✓ |
| Considers the socioeconomic impact of entering or leaving a community | ✓ | ✓ | × | × | ✓ |
| Supports initiatives to stimulate the diversification of economic activities in the community | ✓ | ✓ | × | × | ✓ |
| Prefers the products and services of local suppliers, as well as contribute to the development of them | ✓ | ✓ | ✓ | × | ✓ |
| Consider appropriate ways to assist in the development of local entrepreneurs associations | ✓ | ✓ | ✓ | × | ✓ |
| It seeks to eliminate negative health impacts caused by any production processes, products, and services provided by the organization | ✓ | ✓ | × | ✓ | ✓ |
| Promotes health by contributing to awareness, access to medicines and vaccination, and encouraging healthy lifestyles | ✓ | ✓ | × | ✓ | ✓ |
| Avoids actions that perpetuate community dependence on philanthropic activities and continuous support from the organization | ✓ | × | × | × | × |
| Associates with other organizations, including government, companies or NGOs, to maximize synergies and adopt complementary resources, knowledge, and abilities | ✓ | ✓ | ✓ | ✓ | ✓ |
| *Global reporting initiative* | | | | | |
| Reports the total number and rate of new employee hires and employee turnover during the reporting period by age group, gender, and region | ✓ | ✓ | × | × | ✓ |
| Reports benefits afforded to full-time employees that are not provided to part-time employees | ✓ | ✓ | × | × | × |

(continued)

**Table 3** (continued)

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| Reports the number of employees by gender who were entitled to parental leave, were on parental leave, returned to work in the reference period after parental leave and were still employed 12 months after their return. It also reports return-to-work and retention rates for parental leave by gender | ✓ | ✓ | ✓ | × | ✓ |
| Reports the minimum number of prior weeks that employees are advised regarding the implementation of meaningful operational changes that could substantially affect them | ✓ | ✓ | × | ✓ | ✓ |
| Reports the level that each formal occupational health and safety committee operates in the organization and the percentage of employees whose work is controlled by the organization | × | × | × | × | × |
| Reports the types of injuries, injury rate, occupational disease rate, absenteeism rate, and work-related deaths for employees, except those whose work is controlled by the organization by region and gender | ✓ | ✓ | × | ✓ | ✓ |
| Reports whether there are employees included in occupational activities with high incidence and risk of particular diseases | ✓ | ✓ | × | × | ✓ |
| Reports whether formal (local or global) trade union agreements cover health and safety. If so, the percentage extent of health and safety topics that are covered by these agreements | × | × | × | × | × |
| Reports the average number of training hours the organization's employees performed during the reported period, by gender and employee category | ✓ | ✓ | ✓ | × | ✓ |
| Reports training programs to improve employee skills and transition assistance programs to facilitate continued employability and career end management | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reports the percentage of employees who regularly receive performance reviews and career development | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reports the percentage of people within the organization's governance bodies and the percentage of employees by employee category, by gender, age, and other diversity indicators (such as minorities and vulnerable groups) | ✓ | ✓ | ✓ | × | × |
| For each employee category, reports the ratio of the basic wage and the compensation of women and men | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reports the total number of incidents of discrimination during the reporting period, incident status, and actions are taken | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reports if the right to association and collective bargaining of the operations and suppliers may be at risk and the actions taken by the organization | × | × | × | × | × |
| Reports operations and suppliers at risk of child labor and actions taken by the organization during the reporting period to contribute to the abolition of child labor | ✓ | ✓ | × | × | ✓ |

(continued)

**Table 3** (continued)

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| Reports operations and suppliers at significant risk of forced labor and actions taken by the organization during the reporting period to contribute to the elimination of forced labor | ✓ | ✓ | × | × | ✓ |
| Reports the percentage of security personnel who have received formal training in the organization's human rights policies or specific procedures | ✓ | ✓ | × | × | ✓ |
| Reports the total number of recognized cases of violations involving the rights of indigenous peoples during the reporting period, status of incidents and actions are taken | ✓ | ✓ | ✓ | × | ✓ |
| Reports the total number and percentage of operations that have undergone human rights reviews or assessments by country | × | ✓ | ✓ | × | × |
| Reports the total number of training hours and the percentage of employees trained in human rights policies or procedures during the reporting period | × | × | × | × | × |
| Reports significant contracts and investment agreements that include human rights clauses | × | × | × | × | × |
| Reports the percentage of the operations with local community engagement, impact assessments and/or development programs | ✓ | ✓ | × | × | ✓ |
| Reports operations with significant actual and potential negative impacts on local communities | ✓ | ✓ | × | × | × |
| Reports the percentage of new suppliers that were selected using social criteria | ✓ | ✓ | ✓ | × | ✓ |
| Reports actual and potential negative social impacts identified in the supply chain and actions taken by the organization | ✓ | ✓ | ✓ | × | ✓ |
| Reports the total monetary value of financial and in-kind political contributions made by the organization, by country, and by recipient/beneficiary | ✓ | ✓ | × | × | ✓ |
| Reports the percentage of product and service categories that the impact on health and safety should be improved | ✓ | × | × | × | × |
| Reports the total number of cases of non-compliance with regulations related to the health and safety impacts of products and services within the reporting period | ✓ | ✓ | × | × | × |
| Reports the percentage of significant categories of products or services covered and evaluated for compliance with information and labeling requirements | ✓ | ✓ | × | × | × |
| Reports the total number of incidents of non-compliance with information and labeling regulations | ✓ | ✓ | × | × | × |
| Reports the total number of cases of non-compliance with regulations regarding marketing communications, including advertising, promotion, and sponsorship | × | ✓ | × | × | ✓ |
| Reports the total number of substantiated complaints received regarding customer privacy breach. The total number of customer data leaks, thefts, or losses | × | ✓ | × | × | × |

(continued)

**Table 3** (continued)

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| Reports significant fines and non-monetary sanctions for noncompliance with social and economic laws and/or regulations | × | ✓ | × | × | ✓ |

*N** natura, *U** unilever, *B** grupo boticário, *A** avon, *P** P&G

**Table 4** Attendance of economic practices of ISO 26000 and global reporting initiative

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| *Economic* | | | | | |
| Shares relevant information transparently allowing easy access and comparisons for consumer choice | ✓ | ✓ | ✓ | ✓ | ✓ |
| Operates transparently and provides pricing and tariff information | × | × | × | × | × |
| Considers the contribution to employee retirement and pension plans | ✓ | ✓ | × | × | ✓ |
| *Global reporting initiative* | | | | | |
| Reports the direct economic value generated and distributed (EVG & D) on an accrual basis, including the basic components for the organization's global operations. (Direct economic value generated: revenue, the economic value generated: operating costs, employee salaries and benefits, payments to capital providers, payments to the government, community investments, and retained economic value) | ✓ | ✓ | × | × | × |
| Informs the risks and opportunities posed by climate change that could lead to substantial variations in operations, revenues or expenses | ✓ | ✓ | ✓ | × | ✓ |
| Informs the estimated amount of the benefit and retirement plan, the percentage of salary that is the employee's contribution, and the level of participation in retirement plans | ✓ | ✓ | × | × | ✓ |
| Reports the total monetary amount of financial assistance received by the government during the reporting period, such as grants, investment grants, or tax incentives | ✓ | ✓ | × | × | ✓ |
| Reports the variation in the proportion of the lowest minimum wage compared to the local minimum wage | ✓ | ✓ | ✓ | × | ✓ |
| Reports significant investments in infrastructure and services in the economy and local communities | ✓ | ✓ | × | ✓ | ✓ |
| Reports examples of indirect economic impacts for the organization and their significance in the context of stakeholder priorities, national and international standards, protocols and policy agendas | ✓ | ✓ | × | × | ✓ |
| Discloses the percentage of the budget for buying from local suppliers | ✓ | ✓ | × | × | × |
| Discloses the total number of legal actions pending or completed during the reporting period. Reports anticompetitive behavior, violations of monopoly law and antitrust practices that the company was involved in, as well as the results of the actions completed | ✓ | ✓ | × | × | × |

*N** natura, *U** unilever, *B** grupo boticário, *A** avon, *P** P&G

**Table 5** Attendance of governance practices of ISO 26000 and global reporting initiative

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| *Governance* | | | | | |
| Creates strategies, objectives, and goals that reflect your commitment to social responsibility (SR) | ✓ | ✓ | ✓ | ✓ | ✓ |
| Demonstrates the leader's commitment and responsibility for decisions | ✓ | ✓ | ✓ | ✓ | ✓ |
| Creates and maintains an environment and culture in which the principles of social responsibility are practiced | ✓ | ✓ | ✓ | ✓ | ✓ |
| Creates economic and non-economic incentive systems for social responsibility performance | × | × | × | × | × |
| It provides a fair opportunity for under-represented groups to occupy leadership positions | ✓ | ✓ | ✓ | ✓ | ✓ |
| Balances the needs of the organization and stakeholders considering immediate needs, such as future generations | ✓ | ✓ | ✓ | ✓ | ✓ |
| Establishes two-way communication processes with stakeholders | ✓ | ✓ | ✓ | ✓ | ✓ |
| Encourages the effective participation of all levels of workers in social responsibility activities | ✓ | ✓ | × | × | ✓ |
| Balances the level of authority, responsibility, and ability of decision-makers across the organization | ✓ | ✓ | × | × | ✓ |
| Monitors the implementation of decisions to ensure that they are followed by social responsibility. Ensures the accuracy of the results | ✓ | ✓ | ✓ | × | ✓ |
| Periodically analysis the governance processes of the organization. Adjusts processes according to the results and communicates changes throughout the organization | ✓ | ✓ | × | ✓ | ✓ |
| Recognizes the importance of a secure job. Avoids the use of occasional or temporary work, except when it is short term or seasonal | ✓ | ✓ | × | ✓ | ✓ |
| Protects personal data and employee privacy | ✓ | ✓ | × | × | × |
| Ensures that outsourced organizations are legally recognized, providing good working conditions | ✓ | × | ✓ | × | × |
| It is not benefited by unfair, exploitative or abusive work practices. It also uses its influence to encourage other organizations to adopt responsible work practices | ✓ | ✓ | ✓ | ✓ | ✓ |
| Seeks to create jobs, development, and progress of the local population when it is established corporate headquarters in other countries | ✓ | ✓ | ✓ | ✓ | ✓ |
| Provides decent working conditions concerning wages, working hours, weekly rest, holidays, health, safety, maternity protection and the ability to reconcile work with family responsibilities | ✓ | ✓ | ✓ | ✓ | ✓ |
| Offers equal pay for jobs of equal value | ✓ | ✓ | ✓ | ✓ | ✓ |
| Offers fair working hours, maternity and paternity leave, daycare and other services that can help workers to achieve work-life balance | ✓ | ✓ | ✓ | ✓ | ✓ |
| Develops, implements and maintains a health and safety policy at work | ✓ | ✓ | × | ✓ | ✓ |
| Communicates safety procedures and requires workers to comply with safety standards | ✓ | ✓ | ✓ | ✓ | ✓ |

(continued)

**Table 5** (continued)

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| Provides safety equipment, including personal protective equipment for the prevention of occupational injuries, illnesses, and accidents | ✓ | ✓ | ✓ | ✓ | ✓ |
| Seeks to eliminate psychosocial hazards in the workplace that may contribute to the appearance of stress and psychological illness | ✓ | × | ✓ | × | × |
| It is responsible for health and safety costs in the workplace | ✓ | ✓ | × | × | ✓ |
| It provides for worker training, learning, and opportunities that aim to career advancement, to a fair and non-discriminatory | ✓ | ✓ | ✓ | ✓ | ✓ |
| Ensures that there is assistance for surplus workers to get a new job, training, and counseling | × | × | × | × | × |
| Establishes joint programs of workers and managers that promote health and well-being | ✓ | ✓ | × | ✓ | ✓ |
| Identifies the risks of corruption and implements and maintains anti-corruption and extortion policies | ✓ | ✓ | ✓ | ✓ | × |
| Ensures that the leadership sets an example of anti-corruption and supports the implementation of anti-corruption policies | ✓ | ✓ | × | ✓ | × |
| Makes employees, representatives, contractors, and suppliers aware of corruption and how to combat it | ✓ | ✓ | × | ✓ | × |
| Encourages employees, partners, representatives, and suppliers to report violations of the organization's policies and unethical and unfair treatment. Ensures privacy, support, and follow-up of the case | ✓ | ✓ | ✓ | ✓ | × |
| Conducts activities consistent with competition laws and cooperate with competent authorities | ✓ | ✓ | ✓ | ✓ | ✓ |
| Promotes employee awareness of the importance of enforcing competition laws | ✓ | ✓ | × | ✓ | × |
| Supports antitrust and antidumping practices and public policies that stimulate competition | ✓ | ✓ | × | ✓ | × |
| Integrates ethical, social, environmental, gender equality, health, and safety criteria into its purchasing, distribution, policies and purchasing practices to improve consistency with its social responsibility objectives | ✓ | ✓ | ✓ | ✓ | ✓ |
| Encourages other organizations to adopt similar policies without incurring competitive behavior | ✓ | ✓ | ✓ | ✓ | ✓ |
| Properly monitors partner organizations to preserve the organization's commitments to social responsibility | ✓ | ✓ | ✓ | ✓ | ✓ |
| Promotes fair treatment of the costs and benefits of implementing socially responsible practices throughout the value chain | ✓ | ✓ | ✓ | ✓ | ✓ |
| Provides complete, accurate and understandable product information | ✓ | ✓ | ✓ | ✓ | ✓ |
| Takes steps to avoid complaints by offering consumers appropriate options, such as returning products within an estimated time | ✓ | ✓ | × | ✓ | ✓ |
| Communicates to consumers after-sales service and technical support | ✓ | × | × | ✓ | × |
| Provides adequate and efficient technical support and advice | ✓ | ✓ | × | ✓ | × |

(continued)

**Table 5** (continued)

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| Protect personal data using appropriate security systems | ✓ | × | × | × | × |
| *Global reporting initiative* | | | | | |
| Discloses the number of employees hired (fixed and temporary, full time and part-time) by gender and region | ✓ | ✓ | ✓ | × | × |
| Describes the company's supply chain. Type of information: total number of suppliers, location, monetary value, and sector | ✓ | ✓ | × | × | × |
| Informs initiatives, principles and external letters that the company endorses | ✓ | ✓ | ✓ | × | ✓ |
| Releases a statement to the company's highest position about the relevance of sustainability to the company | ✓ | ✓ | ✓ | ✓ | ✓ |
| Describes the main impacts, risks, and opportunities to achieve sustainability in the company | ✓ | ✓ | ✓ | ✓ | ✓ |
| Describes the values, standards, and behavioral norms | ✓ | ✓ | ✓ | ✓ | ✓ |
| Describes how to behave legally and ethically, and organizational integrity | ✓ | ✓ | × | ✓ | × |
| Reports the governance structure, including the company's strategic governance committee and the committee that makes decisions on environmental, social and economic criteria | ✓ | ✓ | ✓ | ✓ | ✓ |
| Stakeholders are consulted on environmental, social and economic criteria | × | × | × | × | × |
| Informs the nomination and selection process for the company's strategic team and its committees, as well as the selection criteria | ✓ | ✓ | × | × | × |
| Informs how the company's strategic team avoids and manages conflict of interest | ✓ | ✓ | × | × | ✓ |
| Reports the role of the company's strategic team in the development, approval, and updating of the company's values, mission, strategies, and policies related to sustainability | ✓ | ✓ | × | × | ✓ |
| Reports actions taken to develop knowledge and awareness of the sustainability of the company's strategic team | × | ✓ | × | × | ✓ |
| Informs the processes for evaluating the performance of the company's strategic team in economic, social and environmental governance | ✓ | ✓ | × | × | × |
| Disseminates the role of the strategic team in identifying and managing environmental, social and economic aspects. It also informs the risks and opportunities, and if the stakeholders are consulted | ✓ | ✓ | ✓ | ✓ | ✓ |
| Informs the strategic team's role in analyzing the effectiveness of risk management for sustainability aspects | ✓ | ✓ | ✓ | × | ✓ |
| Informs the committee that reviews and approves the sustainability report and ensures that all indexes have been reported | ✓ | ✓ | ✓ | × | × |
| Reports the total annual compensation of the highest-paid employee in the company, and the average annual total compensation of all employees in each country where the company operates | × | ✓ | × | × | ✓ |

(continued)

**Table 5** (continued)

| ISO 26000 | N* | U* | B* | A* | P* |
|---|---|---|---|---|---|
| Reports the percentage increase in the annual total compensation of the highest-paid employee of the company and the percentage increase in the average annual total compensation of all employees in each country where the company operates | ✓ | ✓ | × | × | × |
| Informs the process that determines the compensation | ✓ | × | × | × | × |
| Reports stakeholder's of the organization | ✓ | ✓ | ✓ | × | × |
| Reports the percentage of employees covered by collective bargaining agreements | ✓ | × | × | × | × |
| Informs the approach to stakeholder engagement, including frequency and breakdown by stakeholder group | ✓ | × | ✓ | × | × |
| Reports the percentage of operations and risks related to corruption | × | × | × | × | × |
| Reports the total number of employees aware of anti-corruption policies | ✓ | ✓ | × | × | × |
| Reports the total number and nature of confirmed corruption incidents | ✓ | ✓ | × | × | × |
| Reports the total number of confirmed incidents of corruption in which employees were dismissed or disciplined | ✓ | ✓ | × | × | × |
| Reports the total number of confirmed incidents where contracts were broken or not renewed due to corruption | ✓ | ✓ | × | × | × |
| Reports legal cases of corruption against the organization or its employees during the reporting period | × | ✓ | × | × | × |
| Reports the percentage of "senior" positions held by members of the local community. It also reports the criteria for defining senior positions and community location | ✓ | ✓ | × | × | × |

*N** natura, *U** unilever, *B** grupo boticário, *A** avon, *P** P&G

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# Sharing Economy: Sensegiving of Strategic Decisions Towards Sustainability


**André Ricardo do Rosário Contani and Karina De Déa Roglio**

## 1 Introduction

The sharing economy changes business models and is present in different industries as, for instance, tourism, retail, health, finance, and mobility. A growing adherence of users is being further noticed, more specifically in the segment of urban mobility (Böcker and Meelen 2017). This is explained by the fact that the need for transport imposes itself over somebody's will of having their own means of transportation, and that is the reason why the logic of sharing finds its place. When such thought goes through financial intermediation, it becomes a service and provides room for economic exploration (Belk 2010; Martin 2016). According to Sorima Neto (2017), mobility represents a sector that managed at least R$3 million per day in 2017 in São Paulo and Rio de Janeiro, the two largest cities in Brazil.

Moreover, some special conditions arise in a conflicting context as, for example, when young people do not drive and do not intend to do so (Böcker and Meelen 2017). This is also the situation of drivers who modify the initial proposal of sharing their resources (Belk 2010) while renting vehicles from companies to operate this service. Such deviations are addressed by organizations in an attempt to strategically respond to these issues. Botsman and Rogers (2010) notice that, in addition to the economic aspects challenging the traditional sectors, sharing emerges as a positive outcome on social and environmental dimensions. Thus, decision-making aspects arise in the strategic direction towards the principles of sustainability (Böcker and Meelen 2017).

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This article focuses on communication as a discursive component of social practice and a strategic decision-making element. Hendry (2000) states that, since discourse is a part of social practice, there is the possibility of deviations in its construction and its meaning in social interaction, even when considering the symbolism present in the language. Some attributes of this perspective are present in this study, such as: (i) contextualization of strategic thinking with action; (ii) speculation on the relationship between practice and strategic management research; (iii) understanding of the multiplicity of definitions of business strategies raised in the literature; (iv) exploratory basis of the relationship between strategy and functional practices; (v) placement of strategic practices in political and historical contexts (Hendry 2000).

As a consequence, communication is employed in the process of influence of the construction of the other's meaning—the sensegiving (Gioia and Chittipeddi 1991). To achieve this purpose, symbols, images and other communication elements are used. Although the construction of meaning has been widely discussed (Maitlis and Christianson 2014), the processes of inducing the production of meaning stand out in particular, focusing on meaning to influence strategic change (Gioia and Chittipeddi 1991). Sensegiving, in spite of being a managerial prerogative, has elements that interact throughout the organization and may suffer resistance to communication efforts (Maitlis and Christianson 2014). Therefore, the change in strategy requires a discursive component of social interaction (Balogun et al. 2014). Consequently, organizational communication elements inform the decision-making content of a strategic movement.

Although the sharing economy has the potential to be a new pathway to sustainability (Martin 2016), organizations in developing countries may perform differently when it comes to social responsibility. There is a lack of studying and understanding issues in sustainability in different cultural settings, especially in regions not yet fully integrated as it happens in a number of areas in Latin America (Leal et al. 2018). Companies show recurrent attention concerning collective aspects as social responsibility implies the obligation of the organizations to the society (Smith 2003). Accordingly, regulation issues are representative of the tensions and pressures between private and public interests. On one hand, focusing on social responsibility initiatives provides a more sustainable world; on the other hand, regulatory disagreements impose difficulties to support the operations.

Thus, this study aims to analyze how the communication of regulatory issues is established as an element of sensegiving of the strategic decision regarding sustainability in the mobility sector of the sharing economy in Brazil. The scope of this study unfolds into three distinct moments: to characterize the decision-making process that leads to the attribution of meaning in face of the principles of sustainability; to describe the elements of the narrative created to influence the users and the means of communication used to disseminate the narratives; to analyze how the sensegiving is concretized in the decision-making process of formation of the sector's strategy. There is a close connection between sharing economy and social responsibility that also needs to be recognized.

The expected contribution is to deepen the knowledge about the consequences derived from a fully adoption of sharing economy, particularly in the context of uncertainty, based on the words of Martin (2016) that the uncertainty lies in considering the sharing economy as a mode of neoliberalism or as an authentic path to sustainability. This includes the statement that reasons alleged for criticizing this model are based on the lack of market regulation (Martin 2016).

## 2 Strategic Decision-Making Process as Sensegiving

### *2.1 Technological Context*

The institutional environment in which new technology-based businesses are established can be examined in a global context. Internationalization goes beyond geographic borders and simultaneously reaches different countries, despite varying degrees and modes of manifestation (Parente et al. 2018). The integration of different agents occurs rather than the subordination of some in relation to others. Furthermore, social and economic aspects are present in the process in a more intense way.

Studies show that the motivations for adhering to sharing economy services differ from each other (Davidson et al. 2018; Grybaitė and Stankevičienė 2016) and are even selfishly determined, moving away from the ideal of altruism (Belk 2010; Grybaitė and Stankevičienė 2016). In the United States, according to Davidson et al. (2018), this materialistic emphasis leads, given some conditions, to a more intense adhesion to the sharing economy. In India, however, the phenomenon occurs similarly, due to a different reason: while in the USA sharing is seen as a possibility of improving self-image and self-well-being through a hedonic experience, in India the sense is pragmatic through perceived utility. In Lithuania, a research conducted by Grybaitė and Stankevičienė (2016) reveals that other factors emerge, such as the perception that this is a way (i) to earn additional easy money; (ii) to support individuals or small businesses; (iii) to meet new people; and (iv) to get a different experience than other people had.

In the sharing economy context, urban mobility is highlighted through the development of new business models (Cohen and Kietzmann 2014). Several elements operate as guidelines for the formation of these new businesses, such as the orientation of network, transaction, and community (de Rivera et al. 2017), as well as the focus on value proposition, supply chain, customer interface and financial model (Cohen and Kietzmann 2014). In this sense, technology and social organization act on the capacity of the environment to meet these needs, seeking to equate sustainability to a sustainable path (Johnson et al. 2018). The principle of sustainability is understood from the social, environmental and economic dimensions (Johnson et al. 2018). These are domains whose origin refers to the concern with the development that is maintained over time and the satisfaction of present and future needs (WCED 1987).

The discussion of sustainability, given the landscape that the sharing economy modifies, advances to the reflection on its role in the scenario formed. According to Cohen and Kietzmann (2014), the clash between public agents and market-oriented organizations gains strength through the advent of the sharing economy. The advocates of sharing companies sustain that they are organizations that collaborate for economic opportunities, sustainable consumption, and a broader sustainable, equitable and decentralized economy (Heinrichs 2013; Martin 2016). Notwithstanding, critics use the lack of market regulation, the strengthening of neoliberalism, and incoherent innovation to sustain their beliefs that this model is not feasible (Martin 2016). This issue becomes sensitive when regulation can be used as a limiting agent of sustainability and have its development stimulated to foster barriers and economic pressures that conflict with the spirit of sharing (Belk 2010; Martin 2016). In this sense, values of altruistic nature can be lost, and it becomes necessary to develop strategies for their preservation.

## *2.2 Decision-Making*

Decision-making is discussed with an explanatory principle whose objective is not only to make a description of reality, but also to recognize the process of interpretation and construction of meaning into a reality within a community (Chia 1994). Chia (1994) aimed to deconstruct the foundations on which the previous perspectives are based and establish a new theoretical construction grounded on an interpretative process. The recall of the original concept of the term decision as an incision allows the researcher to adopt a new ontological position. This phenomenon can be understood as a flow of experiences that suffers a rupture, moment in which there is an opportunity to make sense of the decision (Chia 1994).

Although the relations between politics and power have been widely discussed in the literature (Eisenhardt and Zbaracki 1992), some peculiarities of this configuration in the decision-making plan of organizations deserve to be highlighted. The power and interests of stakeholders conduct both the processes and the results of strategic decision-making (Child et al. 2010). In this sense, politics can be considered as the process of influence and power in the form of persuasion. When studying the political behavior of a decision, what should be considered are the previous conditions and the consequences on organizational performance (Child et al. 2010).

Nevertheless, moral ethos does not arise from individual principles: it is based on social relations among corporate agents (Jackall 1988). As one ascends the hierarchical levels, Jackall (1988) points to the need to acquire symbolic dexterity and readily mold oneself to a legitimate reality about what should be done. Instrumental rationality guarantees to ambitious managers the legitimacy to lead public opinion towards a convincing way of interpreting their actions.

Likewise, the morality outside the organization differs from internal practices, as bureaucracies constitute a socially accepted morality through manipulation of interests before public opinion. In other words, management decisions take into account

the receptivity of social elements outside the organization. In this aspect, in bureaucratic dimensions that acquire relevance, both social identities and moral aspects become issues translated from public relations (Jackall 1988). However, there are times when decision-making processes are not what they seem to be, resulting in the constitution of facades (Abrahamson and Baumard 2008). Specifically, reputation facades lead and reinforce the legitimacy of organizations, while demonstrating positive principles of their activities (Abrahamson and Baumard 2008).

The gerund added to "strategy" indicates the movement and the possibility of meaning and resignification, forming the strategizing (Jarzabkowski et al. 2007). Thus, the strategy is reflected in the individual or organizational conduct and determines the positioning of the activities continuously under construction. As a collective and distributed activity among the most varied agents, the concept of strategizing presupposes the use and practical manipulation of resources that form strategy over time (Jarzabkowski 2005). For Whittington (2006), this procedural character of the strategy is reflected in three constitutive and, although related, independent elements: praxis, practices, and practitioners.

The praxis is characterized by covering both individual human actions, as well as the conducts institutionally defined in the social, economic and political field (Jarzabkowski et al. 2007). It is an activity situated at different levels: from the micro to the macro, the concept of praxis can be operated in an institutionalized manner as well as in a fluid mode. In this sense, the concept ensures transit between the various levels of analysis. For instance, one can evaluate praxis by behavior from an individual's particular perspective of an organizational process as well as consider it as a behavior reflected in an institutionalized way in the business sector.

In another dimension, the practices refer to the flows of activities with routine characteristics in which associated behaviors follow a certain pattern of conduct. The guiding element of the action is configured from the interconnection of behavioral, cognitive, procedural, discursive, and physical resources. It does not mean that routines make organizational practices immutable; on the contrary, although the collective organization shapes certain structures, the practices can be combined and altered according to their use and their dynamics in the flow of activities. As a means of strategy analysis, the practices can be used to examine the mode of construction and development of the strategy and its pathway, as well as observe the effects on the configuration of the praxis (Jarzabkowski et al. 2007).

Practitioners are the components that enclose the constitutive triad of strategizing and represent the actors who conduct the activities. As a unit of analysis, the individual incorporates the agency and mobilizes resources that promote and integrate practices and praxis (Jarzabkowski et al. 2007). Practitioners thus present themselves as definers of strategic activity, which includes the scope of who they are, how they act, and which practices are put into action.

The same ontological position applies to organizations, forming the context in which Weick (1995) presents the concept of organizing. The verb denoting action, plus the verbal form of gerund indicating the current time, represent the sense of constant flow and transformation that makes up the organizations. The actions in the organizational domain reproduce the institutional logics while leading to a new

composition (Scott and Davis 2007). Being a collective construction, the organizations have an environment of shared meaning among the participants. The dynamism of the transformation process provides opportunities for the construction of meaning, at the same time in which languages and symbols proper to the community are reproduced under a modified meaning.

In an attempt to integrate all these concepts, based on the interactive proposal of strategizing, the idea of deciding arises (Villar et al. 2018). Just like the concept that preceded it, deciding deals with practices—called intertwined decisions—whose decision-making takes place in praxis, and are performed by participants. Since it has a less broad scope, the decision is incorporated into the strategizing and differs from it by having the decision as a focus object (Villar et al. 2018). The decisions in this perspective approximate to the strategic element when acquiring the fluid characteristic of the continuous becoming of the social practice (Rese et al. 2017), constituting an occasion for signification (Weick 1995).

## *2.3 Construction of Meaning*

The conversation establishes itself as the most important driver of conservation of reality (Berger and Luckmann 1991). Any major change in the environment in which one lives and interprets will require new processes of socialization. The social behaviors reflected in individual habits are part of the intersubjective process of sensemaking. In the conception of Weick (1995, p. 17), following the ontological basis of the continuous becoming, sensemaking can be understood through seven properties: "(1) Grounded in identity construction (2) Retrospective (3) Enactive of sensible environments (4) Social (5) Ongoing (6) Focused on and by extracted cues (7) Driven by plausibility rather than accuracy".

Although the definition of meaning is socially negotiated, when the communication is made through no face-to-face interactions, the pattern of conduct and the very construction of meaning can be modified. A property of the sense making process begins to have a moderating effect: the extracted cues, illustrated by the organizational communications. Even if a certain situation does not prove to be true, it can modify the meaning given to the ethically divergent conduct (Weick 1995). Moreover, an opportunity to attempt to influence the meaning attributed occurs (Gioia and Chittipeddi 1991).

The sensegiving process carries the same sensemaking properties so that the characteristics and the notion of meaning are continuously expressed (Gioia and Chittipeddi 1991). As a concept, sensegiving derives from the understanding of meaning as socially constructed. Hence, the direction to which the meaning is driven will depend on the characteristics that the organizational communication informs. The intersubjective nature of sensegiving imposes the argumentative and persuasive plausibility of the narratives present in the communicative process. The translation of routines and micro-activities occurs through extracted cues left throughout the

various interactions to compose a socially accepted meaning (Weick 1995). Therefore, another order of explanation is needed in addition to the one that considers phases of change and patterns of interpretation, in order to include the set of small actions (Rouleau 2005). With this in mind, the regard is approximate to the micro-level by the understanding of the fluidity in the construction of meaning.

The sharing economy, as a new way of acting and doing business, is inserted as a context that illuminates the aspects of sustainability aligned to an expectation of novelty in the services provided. Thus, the organization's strategic effort is directed towards achieving the sustainability ideal. The daily micro-actions are manifested as expressions of the decision in the processual perspective articulating practices, practitioners, and praxis. As a result of this process, narratives are formed as ways of directing the collective sense, establishing sensegiving. Accordingly, the organizational strategy, reflected in the communicational practices, is conducted throughout the different moments of interaction.

## 3 Methodological Procedures

This investigation assumes that the researcher must be equipped with a vivid and perceived reality in order to understand the world (Schwandt 1998). As the nature of the phenomenon demands a relational interpretation, qualitative methods allow the construction of knowledge considering the complexity of reality. Consequently, a qualitative approach was adopted, bearing in mind its main characteristic of inductive generalization (Creswell and Creswell 2018).

Considering the objective of this study, the cases of the three largest companies in the urban mobility sector of the sharing economy operating in Brazil have been investigated: *Uber Technologies*, *99* and *Cabify*. Together, they represent at least 92% of the national market when examining the number of mobile application downloads (CADE 2018). The American company *Uber Technologies*, established in 2010, started operating in Brazil in 2014, in Rio de Janeiro. The company operates in more than 100 Brazilian cities (Uber 2018). Founded in 2012, *99* is a national company initially conceived to hail taxi services and operates with ridesharing in 1704 cities (99 Tecnologia 2018). *Cabify* started in 2011 in Spain, entered the Brazilian market in 2015, in São Paulo. The company offers its services in 8 cities in the country (Cabify 2018).

The data collection was carried out in equal manner in all three organizations. All information gathered in this study was originally in Portuguese and was translated to English only for reporting purposes. This study was conducted from November 2018 to July 2019, considering communications made in the period from 2015 to 2018 (reflecting only the concomitant operation of the three ridesharing companies) with the keywords *regulation* (*regulamentação*; *regulação*), *regulatory* (*regulatório*), and *legislation* (*legislação*) present on the official websites, blogs, newsroom, and fan pages of the companies on social media plataforms such as Facebook, Twitter, Instagram, and Youtube. Although used by the three companies, the corporate-focused

social network LinkedIn was eliminated from this investigation for having a unique global profile of companies, making it difficult to analyze the specific communications for Brazil. Similarly, the *99* company's blog was removed due to having exclusively management content. The contents originally in non-textual versions such as audio and videos had their utterances transcribed for analysis. Moreover, to facilitate mentioning in this report, all documents were organized and numbered following the format I#0 in which I represents the initial letter of the company's name and 0 refers to a sequential number. A total of 393 communications were obtained—301 from *Uber*, 66 from *99,* and 26 from *Cabify*—which were grouped according to their content in Table 1.

After collection, content analysis was performed given its characteristic of being able to predict or infer about a phenomenon that is not directly observable (Krippendorff 2004). Thus, documents and textual media were examined with the aim of looking for patterns, consistencies, and correspondence that together were part of the construction of meaning (Stake 1995). Coding techniques were used and conducted according to the conditions that emerged from the data (Saldaña 2016). Thus, the decision-making aspect underlying the communications was analyzed in order to establish the meaning and interpretation of these elements.

## 4 Results and Discussion: Sense Giving Materialized in the Strategic Communication

When it started operating in Brazil, initiated by *Uber* in mid-2014 (Uber 2018), the ride-hailing made through technological devices did not have specific regulations considering the specificities of the urban mobility sector. The earliest communications, dated from 2015 to early-2016, demonstrate the attempt to affirm the lawfulness of the service provided, insofar as there was no regulation. This fact is reinforced by the high frequency with which the word legality is used in communicative practices, in order to associate the sense of legitimacy to organizational practice. Only *Cabify* presented a different position, affirming, at a posterior time, its option to expand the operation in cities only when a regulation was formulated and fulfilled.

Notwithstanding, the following moment reveals the strategic decision of not denying regulation. On the contrary, organizations format the discourse that it is necessary to regulate. The stated motivations follow the plausibility (c.f. Weick 1995) of beneficial arguments, such as less pollution and more quality of service, and avoid discussing the controversial issues of tension or competition with taxi services. The direction towards regulation is perceived as a way to ensure the safe operation of mobile applications and the positioning becomes clear: "we support regulation" (documents C#7, C#25). Terms such as "embrace" (document U#213) are also used, as is the notion of "positive regulation" (document U#213). The obligation of certain requirements contributes to the consolidation of the sector and, even with the emergence of new competitors, the earliest established companies have a

**Table 1** Quantity of communications found

| Media | Keywords | | | | | | | | | | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | regulamentação (regulation) | | | regulação (regulation) | | | regulatório (regulatory) | | | legislação (legislation) | | | | | |
| | Uber | 99 | Cabify | Uber | 99 | Cabify | Uber | 99 | Cabify | Uber | 99 | Cabify | Uber | 99 | Cabify |
| Facebook | 34 | 8 | 7 | 6 | 0 | 1 | 0 | 0 | 0 | 6 | 0 | 3 | 46 | 8 | 11 |
| Twitter | 27 | 24 | 6 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 30 | 29 | 6 |
| Instagram | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Youtube | 8 | 23 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 11 | 24 | 2 |
| Driver Website | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| Rider Website | 0 | 0 | – | 0 | 0 | – | 0 | 0 | – | 0 | 0 | – | 0 | 0 | – |
| Newsroom | 111 | 4 | – | 23 | 1 | – | 4 | 0 | – | 6 | 0 | – | 144 | 5 | – |
| Blog | 39 | – | 5 | 19 | – | 0 | 1 | – | 0 | 9 | – | 1 | 68 | – | 6 |
| Total | 220 | 59 | 20 | 53 | 3 | 2 | 5 | 0 | 0 | 23 | 4 | 4 | 301 | 66 | 26 |

*Source* The authors

competitive advantage over those that start operating later, configuring a negative effect of regulation raised by Martin (2016). As regulation may refer to meeting restrictive requirements, some rules might become specific to serve and benefit a given company or service.

The economic aspect of sustainability is present when, for instance, one of the companies states that the constant change in the legislation of the city of São Paulo is "preventing the more efficient use of cars and leaving the bill to the consumer" (document U#214). The strategy is reflected in the intention to make the reader—and also a potential user—aware of the economic consequences of changing the rules of the ride-sharing services. The discourse is concentrated in increasing the cost of mobility, with visible consequences to user spending. It suggests the existence of virtual conflict between the public (regulator) and private entities, as pointed out by Cohen and Kietzmann (2014). The prevalence is on the user's perception of each entity, and the political involvement might translate into good organizational decisions (Child et al. 2010).

The environmental dimension of sustainability is revealed in the stimulus to leave the vehicle at home in order to reduce the traffic in cities. The statements comprise the notion that using mobility services of the sharing economy removes the exceeding vehicles from streets. Nonetheless, the impediment of its use via regulation can imply the increase "of traffic, pollution, and urban chaos" (document U#8). According to Weick (1995), the discourse must be plausible to make sense, thus the appeal to the fear of urban disorder is aligned with the notion of sustainability that is intended to be presented as a solution.

The massive use of the hashtag #JuntosPelaMobilidade (meaning #TogheterForMobility) is constant in the communications of the three organizations and reflects the social dimension of sustainability. There was a joint action of these companies to unite efforts to press for the rejection (or approval with amendments) of the bill no. 28/2017, which ended up being consolidated in Law no. 13.640/2018. In the approved version, the law establishes the regulation of individual private remunerated passenger transportation. It seems that the very union and mobilization of companies reinforce the intended behavior of cooperation and collective doing. Therefore, the social character of the construction of meaning that is expected to be directed is then developed (Gioia and Chittipeddi 1991).

Moreover, the content produced jointly represents the strongest characteristic of the strategic coordination of these organizations. For this purpose, a website (www.juntospelamobilidade.com) was created to promote the #JuntosPelaMobilidade campaign in which a common text and video are presented starring the main executives of each company to mobilize the community of users. Such explicit union of mobility organizations aimed to generate engagement and popular pressure, in harmony, to prevent that the regulation was harmful to business, at the same time as it encompassed social responsibility. The appeal was not for the commercial interests of the companies but directed to the negative repercussions on the habits and benefits already consolidated, as well as in reducing the advances on urban mobility. Granted that this process was not explicitly mentioned, the conduct of the executives

directs the user sensemaking through extracted cues by the various interactions, correspondingly with the conception of Weick (1995).

In general, data seem to demonstrate that company websites tend to have more generic communications with a more commercial appeal not explicitly distinguishing the condition of the user as a driver or rider. While some messages have a clear appeal to the driver, communications are slightly directed to a reader who qualifies as a passenger. The material conveyed through official social media—as well as the newsroom of websites—is rather different, with a preponderance for passenger-focused discourses aimed at increasing their engagement. Such a characteristic can be a reflection of the possibility of interaction in social media. Thus, there is an occasion for resignification by the characteristic of the continuous becoming of sensemaking and sensegiving (Gioia and Chittipeddi 1991).

The term "modern" associated with "regulation" (documents C#9, U#15, U#16, U#119, U#122, 9#5) denotes the attempt to build a sense of novelty and make ride-sharing applications desirable. Together with other aspects, such as reliability (social dimension), fewer vehicles on the street (environmental dimension) and financial earnings (economic dimension), they complement the narrative composition that conducts the meaning towards the principles of sustainability. While praxis and practices are embodied in the micro-actions (Jarzabkowski et al. 2007), the decision carries the guiding element of strategy in the sharing economy. Thus, sensegiving is concretized in the decision-making process that produces the strategy of the mobility sector. In short, organizational communications reflect several decision-making aspects. Moreover, the multiplicity in the composition of communications unfolds the possibility of the users' sensegiving process.

## 5 Closing Remarks

Aligned to the objective of this work, which was to analyze the communication of regulatory issues, the results pointed to how sensegiving is present in the strategy of mobility organizations of the sharing economy. Sensegiving is shown as a strategic element of construction of meaning of users and organizations in the sector to acquire legitimacy before the community under examination. Moreover, this study intended to develop the interpretative mode as a form of analysis of the phenomenon of the sharing economy.

Accordingly, research has the potential to shape the future ethics of social structures and practices (Markham 2018). It is up to scholars to research and face challenging issues relevant to the organizational environment (Rynes 2002). Findings also suggest that the organizational practices are directed to sustainability and social responsibility discourses. However, such communication, when not reflected in conduct, may result in the formation of organizational facades. Thus, the derived social contribution is settled at raising awareness about ethics and citizenship in urban mobility.

The understanding of sensegiving as a reading of the sector's strategy is feasible and allows an opening for analysis in other sectors. The full adoption of sharing economy actually adds to the business environment, inasmuch as it requires a change of thinking, a different way to relate with consumers and a change in culture. Social practices become directly influenced in a positive way: people learn to share. This is a key element. It is not enough to consider sharing economy as a new mode of neoliberalism or poor sustainability.

The urge to share services in the opposite way tends to be influential to economic forces, regardless of market regulation. Since it reduces individualism, because people learn to continuously share and improve it as a condition for success, it allows for the belief that it is worth trying to proceed in this practice. People's behavior is unpredictable, however. This is why permanent research is necessary, to follow to what degree the sharing attitude is really firm. The following themes emerge for future research: urban mobility; social responsibility; sharing economy as employment opportunity; individualism and ethics in current market activities; sharing economy opportunities in non-developed areas, among others.

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# Social Responsibility as a Competitive Advantage for Companies: A Sustainability Research in Paraná's Cooperatives in Brazil


**Manoela Maria Caron Moura and Ubiratã Tortato**

## 1 Introduction

Currently the corporate world has a fundamental role in ensuring the preservation of the environment and in defining the quality of life of communities and their employees (Alves et al. 2010), because, in addition to contributing to nature and communities, corporate sustainability is a channel for consumer awareness (Wappa 2016).

It is noteworthy that companies are perceived as differentiated by their customers when they invest in quality, but also develop projects that minimize environmental impacts and raise the quality of life of surrounding communities (Consultoria Iso 2018). According to Mello and Mello (2017), there is a frequent pressure for greater transparency in business, so social responsibility emerges as a more disciplined attitude of companies in their actions. This responsibility becomes indispensable in the current scenario, since the strategic decisions of large companies involve both economic and social consequences, as they are interconnected (Pessoa et al. 2009).

In this sense, it is important to highlight the role of companies in the social responsibility area. According to Porter and Kramer (2006), there is an interdependence between companies and society, since practically all activities in a company's value chain affect the communities in which the company operates, which can have positive or negative consequences. Because of this, organizations need to be aware not only of their economic and legal responsibilities, but also of their ethical, moral and social responsibilities (Veloso 2006).

Regarding the adequacy of companies to these social responsibility actions, it can be observed that a company can be socially responsible in several ways, regarding

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its labor practices, the environment and human rights, fair operating practices, in the customer service, as well as the participation and development of the community in which the organization operates (Sbcoaching 2019). Porter and Kramer (2006), emphasize that it is important to adapt corporate social responsibility with the business strategies of each organization, rather than thinking them in a generic way, thinking that all sustainable change will have positive results regardless of the company. Briefly, it can be stated that investing in environmental management can reduce production costs in the medium and long term because it avoids waste and inefficiencies in the consumption of energy and raw materials, as well as improving the image of the company and its products. to consumers (Young 2007).

Note the important practical contribution of this article as it has as its subject of study the cooperatives, which are organizational models of great representativeness in the market. According to the Ocb System (2018), cooperatives around the world are already present in over one hundred and fifty countries and generate 280 million jobs, in addition to having 1.2 billion members. In this sense we emphasized the importance of Paraná, which is the state of Brazil where the cooperatives employ the most. They generate 101,228 jobs and, in terms of revenues, the 220 cooperatives of Paraná had an income that represents almost 18% of GDP from the state (Folha De Londrina 2019). Among the cooperative sectors, the agricultural sector was chosen, due to its prominence in the market, which is due to the number of units, there are 61 institutions in Paraná and, also, due to its revenue, which is the highest among the cooperative sectors. The theoretical contribution of the study is also observed, since it brings the analysis of literature from several countries, offering an international view on the subject and, as a main point, relates the issue of competitiveness and sustainability with the cooperatives, a relationship that had not yet been addressed in the publications found, paving the way for new research that also studies the cooperative business model.

This study was divided between introduction, methodology, results and analysis of literature review and online search and, finally, its conclusions. It has two main objectives: to elaborate a literature review in order to understand what is being studied about this theme around the world and to verify, through the websites of agricultural cooperatives in Paraná, which social responsibility practices are adopted in the processes and routines of these organizations. It is noteworthy that due to the difficulty in finding articles that bear the term “social responsibility”, it was decided to work on this issue focused on sustainability.

## 2 Methodology

This paper was organized into two stages, literature review and online verification regarding the adoption of sustainable practices.

The realization of the two stages lasted five months, from June/2019 to November/2019.

In order to elaborate the literature review of this article, we searched for publications in the "Scopus" journal base. Although the article deals with the issue of social responsibility as a competitive advantage within cooperatives, if these three issues were addressed in the search for publications, the number of studies found would be extremely reduced. Thus, in the literature review the keywords "SUSTAINABILITY" AND "COMPETITIVE ADVANTAGES" were used. Thus, it was possible to understand the relevance of sustainable practices as a form of competitive advantage and, after that, search these practices in the cooperatives' web sites. Recalling that the keyword "sustainability" was used, instead of social responsibility, since this article already contemplates social responsibility thinking about sustainability. Moreover, if the term "social responsability" had been used, the number of publications would be almost nil.

Due to the large number of journals found, the search was divided into six stages:

- Initially the search was done with the terms "sustainability" AND "competitive advantage"
- In the second stage, restrictions were imposed regarding language (Portuguese and English), time (2014–2019), type of publication (articles only) and research area (Business, management and accounting).
- As there were still many publications, those published in the Journal of Cleaner Production were selected because of the relevance of this journal.
- It was defined that the terms "competitive advantage" and "sustainability" should be in the Keywords
- We analyzed the number of times articles had been cited, in which case only those with more than ten citations were chosen.
- Finally, we analyze the abstracts more deeply in order to investigate if the articles really related to the topics sought.

In short, the search for literature review consisted in the following filters: search for specific terms (sustainability and competitive advantage), language and time selection, management and business restrictions, type of publication, requirement that articles had been cited more than ten times and that the terms sustainability and competitive advantage were included in the keywords of the articles.

To carry out the second stage of the research, information collected on the cooperatives' websites was used, looking directly for activities related to social responsibility (sustainability). Once this was done, the information was described in the Word tool, identifying each cooperative, whether they had social responsibility practices and, if so, what those practices were like. The list of cooperatives can be found at https://www.paranacooperativo.coop.br/ppc/index.php/sistema-ocepar/2012-03-08-14-53-53/2011-12-09-10-57-09/consulta-por-ramo.

Due to the high number of cooperatives found and the limited research time, it was decided to analyze the cooperatives that operate internationally. Thus, all agricultural cooperatives of Paraná that operate with foreign trade were selected, being a total of seventeen cooperatives.

## 3 Results

Regarding the results found in the literature review, in the first search stage, 1674 articles were found. Secondly, when four more restrictions were applied, regarding language, research area (business, management and accounting), time and type of publication, 358 publications were found. By restricting to the journal, Journal of Cleaner Production, the number of articles dropped to 36. When it was specified that the terms "sustainability" and "competitive advantage" should appear in the keywords, 18 publications were found. Subsequently, when selecting only articles that already had more than ten citations, 7 articles remained. But, despite all the filters, one of them did not fit the theme sought, so the discussion of this work was based on 6 articles from the Scopus database.

The articles analyzed are in the Table 1:

Analyzing the results referring to the online search in the cooperatives websites, it was observed that eleven, of the seventeen cooperatives analyzed, provide information regarding the actions of social responsibility and sustainability. The other six cooperatives do not provide information on the topic.

Analyzing the results related to the literature review, it can be observed that the articles found spread all over the world, without predominance of a specific country. The main themes studied were efficient practices, industrial ecology, sustainable performance and competitiveness, sustainable practices and financial performance and adoption of supply chain management practices, always relating these themes to competitive advantage.

Beginning the discussion with the article from Alves and Medeiros (2015), it is noted that small changes in daily life can generate large savings. By analyzing a small company, these authors concluded that changes such as repair of the hydraulic system where there were leakage points, replacement of taps for alternatives that restricted the flow of water, installation of reservoirs to store rainwater, installation of transparent tiles to take advantage of Sunlight, purchase of energy-efficient fluorescent lamps, and collection of materials for external recycling can lead to improvements in the company's financial income. With the adoption of these changes, the company's productivity has increased and employee well-being has achieved significant results. This has led to significant revenue growth and cost savings. An important point raised by the authors is the participation of staff and owners throughout the implementation and evaluation of new practices.

The second article, from Sullivan et al. (2018), deals with industrial ecology and sustainable development. According to these authors, industrial ecology is very important for business strategy and sustainable development as it brings to companies concepts such as innovation, partnerships and strategic positioning. Industrial ecology also aims at the efficient use of energy and resources, a fact that was considered relevant for adaptation in changing environments, where companies often find themselves, and the authors comment that the efficient use of energy and resources

**Table 1** Articles analyzed

| Article name | Authors | Language | Location |
|---|---|---|---|
| Eco-efficiency in micro-enterprises and small firms: a case study in the automotive services sector | Jordania Louse Silva Alves, Denise Dumke de Medeiros | Inglês | Brasil |
| Is sustainability a competitive advantage for small businesses? An empirical analysis of possible mediators in the sustainability financial performance relationship | Silivia Cantele, Alessandro Zardini | Inglês | Itália |
| Supply chain perspective on competitive strategies and green supply chain management strategies | Sini Laari, Juuso Töyli | Inglês | Finlândia |
| Using industrial ecology and strategic management concepts to pursue the sustainable development goals | Kieran Sullivan, Sebastian Thomas, Michele Rosano | Inglês | Austrália |
| An empirical study on the relationship between sustainability performance and business competitiveness of international construction contractors | Yongtao Tan, J. Jorge O choa, Craig Langston, Liyin Shen | Inglês | Chinae Austrália |
| Transforming sustainability challenge into competitive advantage: Multiple case studies kaleidoscope converging into sustainable business models | Sandra Naomi Morioka, Ivan Bolis, Steve Evans, Marly M. Carvalho | Inglês | Brasil e Estados Unidos |

*Source* Authors (2019)

are areas where business can gain a competitive advantage as it reduces the organization's dependence on finite resources. Secondly, in addressing sustainable development, Sullivan et al. (2018), perform a textual analysis, noting that the concept 'sustainable' is associated with 'innovation', 'employment', and 'technology', while the term 'development' is associated with 'knowledge' and 'partnership', terms that have relevance to business as well as governance. These authors identified through their analysis three broad areas in which the principles of industrial ecology can lead to sustainable competitive advantage for business: resource efficiency, innovation, and adaptation. In this sense, it is indicated that innovation can lead to competitive advantage for businesses by opening new markets, products and business models.

Continuing the literature review, the article by Tan et al. (2015), studies the relationship between sustainable performance and commercial competitiveness. The authors state that sustainability is considered as a driver for companies to maintain their long-term business success. This statement stems from the fact that sustainability has become a source of competitive advantage in the market as it can lead to higher revenue growth and new business opportunities, and for this to happen, organizations must integrate sustainability into their management and be the 'pioneers' in new technologies and innovations while complying with sustainable development. Finally, the authors comment that the relationship between the economic and sustainable performance of companies is already being studied by many researchers and presents positive research results, indicating that sustainability brings benefits that lead to business success.

In the article from Cantele and Zardini (2018), the authors found that the social, economic and environmental dimensions of sustainability positively affect competitive advantage, followed by corporate reputation, customer satisfaction and organizational commitment. The central role of competitive advantage has highlighted the need to think strategically about sustainability, which means including these topics in strategic and operational management in order to achieve financial benefits. Thus, sustainability has a strategic relevance in the survival and development of companies. The authors stress that when applying sustainable change within companies, the satisfaction of different stakeholders must be considered.

Analyzing the fourth article, Laari et al. (2017), deal with the adoption of sustainable actions and the relationship with suppliers. It is observed that companies adopt sustainable practices due to strategic motivations and pressures from various stakeholders. In this sense, these strategic motivations refer to the search for a better image by the company towards its customers. According to the authors, adopting sustainable supply chain practices is a way of differentiating products and services and minimizing the risk of potential losses if suppliers' environmental performance is poor. In this sense, this article also addresses the issue of environmental performance by suppliers, stating that working with suppliers who are also pursuing sustainable development generates a cooperative relationship between customer and supplier, leading to long-term collaboration and competitive advantage.

Marioka et al. (2017), mention that sustainability should be connected across the organization, addressing the issue of collaboration, citing that sustainable development is only incorporated if all its points are in harmony. Sustainable aspects must also be in line with human resources, corporate governance and organizational culture. In addition, there is a connection between supply chain, operations and marketing through "systemic thinking". But above all, for this connection to exist, it is important to empower employees to be involved in the cause, especially those with direct customer contact, within an open, flexible, and innovation-driven organizational culture. In addition, the authors point out that shared decision-making, well-being at work and transparency in activities encourage sustainable development.

Starting the second analysis, referring to the discussion of social responsibility actions,

**Table 2** List of social actions disclosed by cooperatives

| Cooperatives | Social activities |
|---|---|
| Agrária | It has activities related to reducing the number of accidents of its employees; Distributes an informative comic book to municipal schools; It links the environmental theme to its strategic planning; It has working groups related to environmental issues; It seeks to disseminate good environmental practices among its employees; It has a fire brigade prepared to respond to environmental incidents; It implements the concepts of reduction, reuse and recycling in its environmental and industrial daily life; Uses renewable energy sources (biomass and wood); It counts on the optimization of its resources; Performs collection of recyclable waste in rivers; It has activities focused on employee welfare |
| Aurora | It has activities related to environmental protection, waste and risk management; Search for the welfare of its employees; It has actions that allow involvement with the community (does not explain how these activities are) |
| C. Vale | Practices actions of collection of pesticide packaging, recovery of riparian forests, planting of trees; Raises students about the use of the environment; It has structures for waste treatment; Has programs to reduce water consumption; Offer programs for youth improvement; Allows access to new technologies promoting personal growth of members; Offer training to its employees; Provides courses for cooperative women to improve household incomes by encouraging them to enter the labor market; Assist entities that assist the elderly and children |
| Coamo | It has a sustainability report, but could not be accessed |
| Coasul | It makes public school students aware of the conservation of the environment; already carried out environmental actions aimed at river cleaning; assisted in the technical study for plant acquisition and planting; performs various actions aimed at improving its members |
| Cocamar | Encourages reforestation of environmental preservation areas; It has a group of disabled people who produce seedlings of native species and distribute them to members, public agencies and the community; Offer cultural activities to its employees; Encourages children to play sports and in the meantime inserts these children in lectures on teamwork and cooperativism; Encourages the donation of warm clothing by its employees |
| Cocari | Collects empty packaging; Promotes the planting of native seedlings by children from the municipal school system; Promotes farmers' awareness of environmental preservation; Produces seedlings of native species to distribute to farmers; Promotes the restoration of mines located on cooperative property where water sources can be found; Offer MBA courses to their members; Offer social actions involving students and teachers from the region; Collects toys for donation to needy children; Providing employment opportunities for young people selected through the selection process; Encourages cooperation through sport by approaching young people in a sports and social aliance |
| Copagril | Count with actions related to the collection of packaging; has plans for the control of environmental pollution; promotes the management of electricity consumption |
| Coopcana | Works with suppliers that contribute to the minimization of environmental impacts; promotes tree planting; implement reforestation programs; rely on the separation of recycled materials |
| Integrada | It has programs that encourage the reading of children in public schools; promotes the education and citizenship of many children in Paraná; Collect and distribut toys for needy children; Plant native trees on river bank and does reforestation in degraded areas and releasing fish |

(continued)

**Table 2** (continued)

| Cooperatives | Social activities |
|---|---|
| Batavo | Counts with coat campaign; donates milk box to needy people; conducts activities with school students promoting social, economic and environmental awareness; provides access to the regional community to attend cultural activities |

*Source* Authors (2019)

Table 2 shows the list of cooperatives that disclose the social responsibility actions practiced.

In general, it is noted that many of these actions address the three pillars of sustainability, with social, environmental and economic practices. The vast majority of actions involve the awareness of young people and children, a very important aspect that promotes the knowledge of future generations. Most awareness programs involve partnerships with schools located in the community where cooperatives are located. These partnerships also involve teachers and, in the case of some of the cooperatives, there is the selection and training of young people from these schools so that they can work professionally within the cooperatives. These social actions are extremely important as they promote the social and economic improvement of the communities living around the cooperatives.

Other actions that stand out in the economic and social area are the issue of offering courses for the insertion of women in the local labor market and the training of employees and access to technology. This is very relevant in order to enable the population to enter the market and the local economy, a beneficial factor for the cooperatives themselves and the general population.

The cooperatives' concern with the well-being of their employees is remarkable, as they promote various actions in order to insert them in cultural activities and also to train them professionally. Citing the issue of professional training, it is also noteworthy that the cooperatives analyzed maintain the concern to perpetuate their work and bring good returns to their members. In this sense, the greater the economic growth, the greater the social development of the cooperatives, as one will boost the other.

The preference to work with socially responsible suppliers was another highlight. This is very important when thinking about an organization's value chain, as this will ensure that all its processes will be sustainable.

In general, it is observed that the social responsibility actions found are more focused on the environmental pillar, such as tree planting and seedling distribution, but that social and economic practices are also very relevant, through the donation of toys, food and warm clothing and also other practices involving the community and employees, as already mentioned in the previous paragraphs.

The Bom Jesus, Castrolanda, Coopavel, Copacol, Cotriguaçu and Lar cooperatives, also analyzed in the article, do not disclose social responsibility practices on their web sites.

## 4 Conclusion

At the end of this article, it is possible to evaluate the main points of emphasis of this study. Looking at the search made on the cooperative websites, there are many common actions among the cooperatives, such as tree planting, awareness campaigns, measures to promote the well-being of employees, donation campaigns, among other common measures, which their main focus is on improving the community and local economy. A positive point in this analysis is that of the seventeen cooperatives investigated, eleven carry out and disclose in their homepages the actions taken in favor of society and the environment. Regarding the literature review, the articles converge in dealing with how sustainable practices should be implemented, with the collaboration of all employees and instilling the idea in the organizational culture; how sustainable development adds to competitiveness, as it improves the image of the organization and leads to better revenues and cost savings; about how important it is to have collaboration throughout the supply chain, working with trusted suppliers; and how innovation, coupled with sustainability, can open new opportunities and new markets.

The positive relationship that exists between research on web sites and the literature review is noteworthy, since many of the activities practiced by cooperatives involve the participation and well-being of employees and the awareness of all members of these cooperatives, a fact widely explored by research analyzed. This relationship is made explicit by practices such as disseminating environmental guidelines to employees, seeking to reduce the number of accidents at work, offering courses to employees and their families, among others.

As a suggestion for future research, an increase in the number of articles analyzed in the literature review dealing with the same topic and an "on the spot" verification of sustainable practices is indicated, in order to confirm what was seen in the online search, since the research on web sites may not faithfully demonstrate the development of these actions and that, perhaps, some institutions develop activities in this area, but do not disclose them on their websites.

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# Deployment of Sustainable Development Framework in Export Manufacturing Firms for the Common Good


**Usama Awan, Mohammed Khurrum S. Bhutta, Janne Huiskonen, and Andrzej Kraslawski**

## 1 Introduction

United Nations reports on SDGs suggest that the developing world is meeting the challenges of sustainable development by pursuing programs designed to promote the well-being and good health, decent work, economic growth, and encouraging equal opportunities as well as reducing inequalities (United Nations 2016). Many of today's industrial, environmental, and social issues have had an impact on the natural environment. Since 2015, sustainable development provides a case for the development of human well-being and natural environment while less attention has been given to social sustainability issues in inner-firm relationships (Awan et al. 2018a). Rapid changes in the global economic environment have made industries much more aware of the importance of sustainable development (Li et al. 2014). The most serious challenges facing the developing countries include the reduction of health and safety risks to workers in the working environment resulting from poor quality of energy management systems which results in catastrophic accidents inside premises often caused by electric installations as well as ensuring equality in the workplace and solving wage-related issues. The management of health and safety issues, workplace infrastructure, equal opportunities, and child labour add on to the challenge of sustainable development. Besides, developing countries should focus on the development of socially sustainable policies, promoting health and safety, developing and maintaining energy management systems, and promoting equal opportunities in all spheres and social growth to ensure long-term sustainability.

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As a result, much of the manufacturing sector has emphasized inter-firm relationship along with an intensified focus on coordination and cooperation to demonstrate more performance outcomes (Gimenez et al. 2012).

Ivery (2010) stresses that a leader's behaviour has got a significant impact on achieving performance outcomes. The reason is that leaders are expected to motivate others to work together and, most importantly, they manage the transition in the organisation. So far, most previous studies on transformational leadership focused on establishing conducive supply chain environment, transformational leadership and its positive influences innovation and performance (Aragón-Correa et al. 2007), supply chain ( SC) leadership for environmental sustainability (Clifford Defee et al. 2009), transformational leaders and their understanding of supply chain relationships (Clifford Defee et al. 2010), improving the supply chain performance (Birasnav et al. 2015), but they did not explore the transactional leadership interaction in the supply chain relationship context. Transformational leadership affects organization-focused idea generation by employees because both can inspire followers to pursue collective values and make commitments (Deichmann and Stam 2015). Transactional leaders are defined as "the exchange relationship between superior and subordinate, and its purpose is to meet the expectations and gratify the interests of each party" (Bass and Avolio 1994). To maintain the effectiveness of inter-firm relationship management, supply chain leader behaviour is considered a key source of achieving desired outcomes (Gosling et al. 2017). Thus, the effectiveness of inter-firm governance mechanism seems to be a challenge and relatively little research has been devoted to the identification of the factor that explains influences on different types of governance mechanism in supply chain relationship (Awan et al. 2018a). To date, there is limited evidence on how transactional leadership style effectively translated into aligning inter-firm relationship.

Recently, (Birasnav et al. 2015) have explained the importance of the leadership style of operations managers for effective performance management. Kurucz et al. (2017) found that leadership positively relates to sustainability. Jang et al. (2017) also noted that leadership style is positively related to the performance. Leadership is viewed as being capable to facilitate coordination and expand activities to provide a valued relationship and facilitate complex inter-firm relationships. There is evidence in the literature that manufacturing industries have a prominent role in perpetuating unsustainable patterns of environmental degradation. To change the situation, they need to apply sustainability principles to address global environmental challenges (Bamgbade et al. 2017). Recent studies have traditionally focused on the impact of leadership style on corporate social responsibility (CSR) (Du et al. 2013), no previous research has examined how different leadership styles influence the effectiveness of inter-firm relationship for corporate sustainability.

Hence, while the inter-firm relationship comprises an important part for the management of sustainability issues, most research studies on leadership have stayed away from taking into account the transactional leadership style. This study addresses these gaps by investigating how transactional leadership can significantly moderate the relationship between inter-firm governance mechanism and the firm's social

performance. This study takes into account behavioural characteristics of a transactional leader (TRN) such as being task-oriented, relational oriented, change and passive oriented that built upon the recent trait–behavioural conceptualisation of leadership proposed by Derue et al. (2011). Our theorizing suggests that transactional style leaders respond to problems as they arise.

## 2 Differentiating/Distinguishing Between Sustainability and Corporate Social Responsibility

It is worth mentioning that corporate responsibility concept emerged in the 1950s while sustainability emerged in the early 1980s. Corporate responsibility and sustainability might shift strategic orientation towards the accomplishment of the greater common good (Bansal and Song 2017). "*Corporate social responsibility (CSR) and corporate sustainability (CS) aim to balance economic prosperity, social integrity, and environmental responsibility, regardless of whether they conceptualise environmental issues as a subset of social issues or as the third element of sustainability*" (Montiel 2008) (p. 260). Corporate sustainability emphasises the role of the firm's processes and procedures, such as overall beliefs, long term product solutions and strategic planning (Jansson et al. 2017). The term corporate responsibility compromises any kind of a supportive organization (Marcus et al. 2011), corporate reputation, image, stakeholder relationships (Du et al. 2010), and risk reduction (Godfrey et al. 2009). In contrast to this, sustainability focuses on rewarding companies who reduce environmental damages, engage into stakeholder relationships (Donaldson and Preston 1995), make corporate social commitments (Bansal et al. 2014; Awan et al. 2018a), and develop ecological foundations and resilience (Whiteman et al. 2013).

Corporate responsibility (CR) is defined as "*attenuated business attentiveness and can impart to the utilization of indigenous people*" (Banerjee 2008). Subject-matter literature describes CSR as "commitments to both social and environmental practices." (Bansal et al. 2014) (p. 950). In the sustainability literature, (Montiel 2008) (p. 259) argues that "*CS (corporate sustainability) scholars tend to argue that the economic, social, and environmental pillars are interconnected*." (Montiel 2008) (p. 259).The social dimension must be strategically aligned with the overall sustainability performance and corporate goals and strategy (Awan 2019). Generally, the conceptualization of responsibility and sustainability presented them as relatively distinct (Bansal and Song 2017). According to Dieterich (2018), sustainability is the key to future economic growth. However, despite the promises of innovative practices, social performance being the next step of corporate sustainability (Schaltegger et al. 2012). Social sustainability for manufacturing firms rests on broader organisational practices (Awan 2019). Socially sustainable performance is a bottom-up practice that helps in understanding sustainable development system, a powerful tool for analysing the complex system of sustainability performance (Awan et al.

2018b). Sustainability in corporate responsibility is being recognized as a double-edged sword to spur sustainable development in the global world. It has also been argued that sustainability might create better opportunities for future generations by minimizing harms inflicted by the economic development of the natural system (Bansal and Song 2017). The literature provides evidence supporting the idea that corporate sustainability practices (CS) overlap with corporate responsibility (CR). Corporate responsibility may include or exclude sustainability philosophy. Given the importance of the social issues in literature, the most important dimensions related to them include: workplace accidents (employee absenteeism), fair work practices (number of new jobs created by the adoption of new technology) and community development. Socially sustainable development is an important factor concerning not only sustainable development but also the issues related to human development in all facets of life and development of a socially sustainable system.

## 3 Literature Review and Hypothesis Formulation

The debate over the socially sustainable development issues has been inextricably associated with the wide-ranging discussion about the type of governance suitable for firms. Manufacturing firms face these challenges in both domestic and international arenas for growth that is as socially, and environmentally friendly as possible and respective harnessing of opportunities offered by the governance mechanisms. Governance mechanism ensures that firms can cope with social sustainability supply chain issues (Gimenez et al. 2012). Previous research explored the relationship between contractual and relational governance in governing business transactions and reducing conflicts or opportunism (Jap and Anderson 2003; Poppo et al. 2008; Huang et al. 2014); relationship effectiveness (Wagner 2011; Cao and Lumineau 2015) and commitment (Sancha et al. 2016; Awan et al. 2018b). In relational governance (RG), the inter-firm relationship is largely regulated by the division of tasks, social norms and ties (Poppo et al. 2008; Zhou and Xu 2012). The contractual (transactional) governance means governing transactions through contractual safeguards (Ferguson et al. 2005). The governance context, in turn, is concerned with the characteristics of specific knowledge and exchange of information with other supply chain partners used to improve the firm's performance. For instance, (Formentini and Taticchi 2016) underscored the importance of linkages between the governance mechanism and corporate sustainability approaches for the improvement of sustainability initiatives.

Athaide and Klink (2009) governance approaches facilitate the exchange of information and build relationship bonds. Recently, (Formentini and Taticchi 2016) documented that both governance mechanism [transactional governance (TG) and relational governance (RG)] are important to control and implement sustainability initiatives with a view to improving sustainability performance. Existing inter-firm relationship literature suggests that, in order to achieve social performance, firms need to enact contractual governance (Awan and Kraslawski 2017). Previous empirical studies demonstrated a significant positive link between contractual and formal

governance and performance outcomes (Ivens et al. 2009; Venus Lun et al. 2015). Relational mechanism encourages collaboration, nurtures the pooling and utilisation of resources to achieve an advantageous position (Liu et al. 2009). Transactional governance means governing transactions through contractual safeguards. The concept of social sustainability is now garnering greater attention because we have realized that both internal and external supply chain practices need to be managed jointly. Social performance is defined as an "ethical code of conduct for human survival and outgrowth that needs to be accomplished in a mutually inclusive and prudent way" (Lafferty and Langhelle 1999; Sharma and Ruud 2003). Social performance requires "coordinated social interaction practices for the management" and development of a social and ethical code of conduct to meet existing and future generation needs (Awan et al. 2018b). As pointed out by Formentini and Taticchi (2016), formal mode of governance is usually adopted by those with limited resources operating in an uncertain environment to increase supplier compliance with the buyer's.

Hypothesis 1. Transactional governance is positively associated with social performance (H1a) and societal performance (H1b).

Hypothesis 2. Relational governance is positively associated with social performance (H2b) and societal performance (H2b).

Leadership in production firms explores the growing use of existing capabilities and maintaining a stable relationship with their varied customers. Governance mechanism is an important factor in the enhancement of the firm performance (Poppo and Zhou 2014; Cao and Lumineau 2015). Transactional leadership is particularly salient in the supply chain process (Hult et al. 2000). Moreover, several scholars have emphasized that research into the significance of leadership style in supply chain research is still at an early stage (Birasnav et al. 2015; Gosling et al. 2017). Transactional leadership inspires suppliers and focuses on learning sustainable practices to solve problems (Gosling et al. 2014). Clifford Defee et al. (2009) maybe the first to distinguish transactional supply chain leadership and define it as creative, able to influence the organisation and establish a relationship with other supply chain organisations. According to Deichmann and Stam (2015), transactional leadership strives to elicit organization-focused ideas. Transactional leadership style facilitates the organization of uniform supply chain process and procedure based on formal written agreements outlining social issues and reflects a better understanding about customer needs. Further, (Ewen et al. 2013) proposed that transactional leadership has got social astuteness and behaviour flexibility needed to respond to the needs of others and contributes to developing more trust. Therefore, it is clear that transactional leadership style may postpone certain operational activities in an uncertain environment in order to fulfil the contract (Birasnav et al. 2015) and focus on the implementation of sustainability initiatives.

Hypothesis 3. Transactional leadership moderates the relationship between transactional governance and firm social performance.

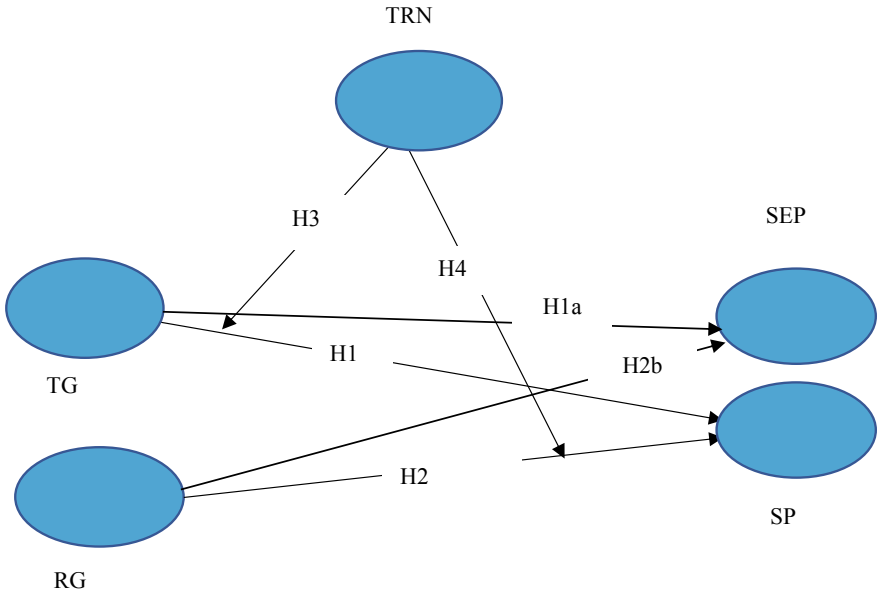


**Fig. 1** Conceptual framework

Hypothesis 4. Transactional leadership moderates the relationship between relational governance and firm social performance.

Our conceptual framework (Fig. 1) depicts the relationship between the governance mechanism and transactional leadership.

## 4 Methodology and Data Analysis

A 7-item transactional leadership constructed by Hult et al. (2000) was employed to measure the leadership style on a seven-point Likert scale ranging from 1 'completely disagree' to 7 'completely agree'. Translational governance was assessed using the measure constructed by Heide and Stump (1995), Ferguson (2005) and relational governance (Lusch and Brown 1996). The overall social performance was assessed on a five-item measure adopted by Kleindorfer et al. (2005), Awaysheh and Klassen (2010) and societal performance items adopted by Lai et al. (2012). The survey items are presented in Appendix 1.

Of the 224 responses, 42% were given by general managers and 40% by managers and others. The distribution of the number of years of experience was evenly spread with 20 p.c. experienced between 2 and 5 years, 25.3% between 5 and 10 years, and 38 p.c. between 10 and 15 years. The common method bias has an important implication in data analysis that might lead to unreliable interpretation. The procedure of Podsakoff et al. (2003) was adopted to minimise the biases and independent and

dependent variables were put in random order and presented on the different pages of a questionnaire to ensure internal consistency. Hence, in addition to this, the anonymity of the respondents and firms was also given consideration. Table 1 shows the evaluation of the model while Table 2 shows the means, standard deviation, and correlations among the constructs.

SPSS version 23.0 and AMOS version 24.0 were used for data analysis. Kolmogorov–Smirnov (KS) test was used to check the normality of the data. All the variables of the data were normally distributed; the value of Z-test was within the range of −2.56 to 2.56.

The results of the structural model also show that 36% of the variance of leadership and 62% of the variance of social performance are explained by the independent variables, which suggests the model satisfactorily fits the path model. Common

**Table 1** Evaluation of model

| Items | Factor loadings | t-value | Items | Factor loadings | t-value |
|---|---|---|---|---|---|
| Transactional governance (TG) AVE:0.706, CR:0.905 CR:0.872 | | | Societal performance AVE:0.771, CR:0.881, CR:0.824 | | |
| TG1 | 0.793 | 9.44 | SEP1 | 0.886 | 8.49 |
| TG2 | 0.766 | 9.67 | SEP 2 | [e]0.534 | – |
| TG3 | 0.915 | 12.55 | SEP 3 | 0.802 | 10.77 |
| TG4 | 0.879 | 11.30 | SEP 4 | 0.942 | 13.34 |
| Relational governance (RG) AVE:0.578, CR:0.845, CR:0.795 | | | Translational leadership (TRN) AVE:0.761, CR:0.927, CR:0.912 | | |
| RG1 | 0.682 | 6.15 | TRN1 | 0.946 | 10.80 |
| RG2 | 0.776 | 8.27 | TRN2 | 0.804 | 11.73 |
| RG3 | 0.822 | 10.88 | TRN3 | 0.811 | 12.67 |
| RG4 | 0.754 | 8.36 | TRN4 | 0.920 | 13.26 |
| Social performance (SP) AVE:0.594, CR:0.854,CR:0.853 | | | | | |
| SP | 0.729 | 9.04 | | | |
| SP | 0.754 | 9.54 | | | |
| SP | 0.739 | 9.33 | | | |
| SP | 0.681 | 6.55 | | | |

[*]*AVE* average variance extract, ***CR* composite reliability, ****CA* Cronbach's alpha, [e]Item deleted during confirmatory factor analysis due to low loading

**Table 2** Mean, standard deviation and correlations

| Factors | Mean | S.D | SP | TG | SEP | RG | TRN | FS | FA |
|---|---|---|---|---|---|---|---|---|---|
| SP | 4.62 | 1.22 | **0.770** | | | | | | |
| SEP | 4.35 | 1.24 | 0.39** | **0.878** | | | | | |
| TG | 5.11 | 1.34 | 0.43** | – 0.37** | **0.840** | | | | |
| RG | 4.85 | 1.26 | 0.29** | 0.14* | 0.24** | **0.760** | | | |
| TRN | 4.76 | 1.44 | 0.36** | – 0.21** | – 0.13* | 0.32** | **0.872** | | |
| FS | 2.18 | 0.83 | 0.07 | 0.04 | 0.053 | 0.16* | 0.04 | 1 | |
| FA | 19.26 | 8.01 | 0.05 | 0.12* | 0.021 | −0.11* | 0.09 | 0.35** | 1 |

*SD* standard deviation, *TG* transactional governance, *RG* relational governance, *SP* social performance, *SEP* societal performance, *TRN* transactional leadership, *FS* firm size, *FA* firm age
**Correlation is significant at the $p < 0.01$ level
*Correlation is significant at the $p < 0.05$ level, a logarithm of all employees and number of years in business

method variance was tested using Harmons's (Podsakoff and Organ 1986) single-factor analysis; the results reveal that single factor explained 29.4% of explained variance suggest common method variance was not an issue for data analysis. Multi-group analysis (MGA) and moderated regression analysis (MRA) methods are most commonly used to test the effects of moderators. MRA is widely used, but this study chose MGA since the relationship among several measures, and latent construct is analyzed (Baumgartner and Homburg 1996). The structured equation modelling (SEM) approach was used to estimate the parameter of the path analytic model. The fit statistics of measurement model are ($\chi 2$/df ratio = 1.64, $p < 0.01$; "goodness-of-fit index" [GFI] = 0.945, "comparative fit index" [CFI] = 0.952, "incremental fit index" [IFI] = 0.949; root mean square error of approximation [RMSEA] = 0.061). In order to avoid potential multicollinearity issue, "variance inflation factors" (VIFs) associated with each of the predictors' range from 1.03 to 1.94, with a mean of 1.36, well below the cut off value, which indicates no multicollinearity issue to this data set. Adopting (Preacher and Hayes 2008), we examined the moderation analysis using PROCESS MACRO. To test the moderating effects of organisational learning, we used process macro developed by Preacher and Hayes (2008) based on a multiple regression analysis used with bootstrapping, following the guidelines of Hayes and Preacher (2013). We performed a moderation analysis corresponding to model 2 of Preacher and Hayes. The moderating effect was tested with 5000 bootstrap samples with 95% bias-corrected confidence interval (CI) (Hayes and Preacher 2013).

## 5 Results and Discussion

The structural model depicted in Fig. 1 was tested using SEM and the standardized path coefficient β was obtained. The results reveal that TG impacts social performance

($\beta = 0.34, p < 0.05, t = 5.27$), whereas TG has got a negative but significant impact on societal performance (SEP) ($\beta = -0.19, p < 0.01$). RG positively associated with SP ($\beta = 0.22, P < 0.05, t = 3.534$) and SEP ($\beta = 0.30, p < 0.05$) respectively. As shown in Table 3, the interaction effect between TG and TRN was positive and significant SP ($\beta = 0.12, p < 0.05$). TG based governance has a strong positive effect on SP when leadership impact is high. Transactional leadership impact is positively related to social performance ($\beta = 0.19, p < 0.01$). This demonstrates that transactional leadership moderated the relationship between contractual governance and social performance.

The results show that the interaction between TG and TRN ($\beta = -0.17, p < 0.01$) is significant and negatively associated (affects) with SEP. Transactional leadership impact is negatively related to societal performance (SEP) ($\beta = -0.11, p < 0.01$). This reveals that the association between contractual governance and societal performance is negatively moderated by transactional leadership style. Findings also showed that TG had a significant negative effect on SEP when transactional leadership effect is high ($\beta = -0.55, p < 0.01$) but its effect was non-significant when leadership style impact was low ($\beta = -0.08, p > 0.01$). A negative association between contractual governance and societal performance diminished with the increase of transactional leadership. The results suggest that social performance outcomes in South Asia are more strongly related to transactional governance than relational governance. Firms may feel more secure when a relationship is governed by the transactional approach. However, findings show that transactional leadership is directly related to enhancing social sustainability. The task-oriented nature of transactional leadership makes it important to understand that managers of the firms should lead the relationship with the partner with clear punishment and incentive system to foster the performance (Locke et al. 2009). The results also illustrate that the role of the transactional leadership in improving the social performance increases in importance as high level of social performance can only be achieved when transactional leadership is not involved in the relational governance.

The interaction between RG and TNL is negatively related to the social performance ($\beta = -0.13, p < 0.05$), but not significantly related to the societal performance ($\beta = -0.04, p > 0.05$). The results show that relational governance contributes to

**Table 3** Relationships between variables (direct effect and interaction effect)

| Structural path | Coef. ($\beta$) | Level of significance | Conclusion |
|---|---|---|---|
| TG → SP | 0.34 | $p < 0.05$ | Supported |
| TG → SEP | −0.19 | $p < 0.01$ | Not supported |
| RG → SP | 0.22 | $p < 0.05$ | Supported |
| RG → SEP | 0.30 | $p < 0.05$ | Supported |
| Interaction TRN x TG → SP | 0.19 | $p < 0.01$ | Supported |
| Interaction TRN x RG → SP | −0.13 | $p < 0.05$ | Not supported |

social performance when transactional leadership is weak, while no such improvement in the social performance occurs when transactional leadership style is strong. The reason is that the transactional leader increasingly engages in task activities and control of the defined operation and remains active in routine and traditional works. The findings confirm that managers should consider the style of the leader in governing the supply chain relationship when deciding which governance mechanism should be used to manage social sustainability. Furthermore, before implementing the contract, the decision-maker must be aware of the leadership style (Blome et al. 2017).

## 6 Conclusion

The findings of this chapter conclude that translational leadership (TRN) is essential to improve overall social performance. This study contributes to the accomplishment of UN sustainable development goal No. 17 by indicating that to advance performance in sustainability, more efforts on inter-firm engagement are needed and cross border partnerships are required. Previous studies typically focused on leadership style and its effects on corporate social responsibility; this study differs from other studies as it explores the impact of transactional leadership style on sustainability performance. It suggests that transactional leadership style should be taken into account in the overall corporate sustainability strategy of a company. Therefore, the study argues that a relational view of governance is not relevant to manufacturers-exporters, because transactional leadership style among the key decision-makers may not play a key role in expected performance outcomes. Finally, it is concluded that transactional leadership attempts to balance stakeholder interests and relationships but also seeks to reach agreements with long term focus on reducing environmental damages with improving processes and procedures. However, a broadened social sustainability vision of transactional leadership may allow the organisation to more effectively align with the changing demands of partners on social issues and capitalise on integrated practices for achieving sustainable development goals.

Our results highlight the importance of roles that transactional leadership plays in the improvement of corporate social performance. This study has contributed to much needed empirical evidence concerning the role of leadership styles in corporate sustainability. Within firms, transactional leadership delivers/ensures/guarantees high corporate responsibility and acting to achieve the greatest benefits for the organization and use supply chain process knowledge to act in the interest of key organisational stakeholders as well as enhance organizational social performance. This study advances the understanding and bridges leadership literature with corporate sustainability to provide empirical evidence on the transactional leadership effect on the relationship contract governance and sustainability performance. The results support the view that transactional leader is likely to exhibit sustainable leadership by, among others, promoting social performance with contract governance that advances the well-being of an individual and society and decreases environmental damage.

Thus, the transactional leader is better placed to carry on bargaining and framing the terms of social initiatives in a way that improves the inter-firm relationship, influencing such behaviours would probably increase social performance outcomes. It argues that transactional leadership style is an integral part for improving social sustainability performance. Our findings reaffirm previous findings that transactional leadership (TRN) style is important in realising effective partnership among different actors in cross border-relationships. Transactional leadership styles are important in improving and promoting social sustainability. This research provides new insights concerning transactional leadership behaviours in a supply chain process through which it impacts sustainability outcomes.

Implications and Future Research Direction

The study contributes to theory and research in leadership by arguing that transactional leadership behaviour is effective because it helps in selecting adequate active and passive behaviours that appropriately address the needs of the supply chain partners. First, we address calls for more research intended to find out whether a focal company leadership drives changes in supplier development (Morali and Searcy 2013). Our theorising suggests that transactional style leaders respond to problems as they arise and management by exception serves as a critical tool for inter-firm governance mechanism (RG). That, in turn, allows encouraging suppliers to achieve standards and implement sustainability practices. Second, transactional leadership should involve the effectiveness of inter-firm governance. The export-manufacturing firms in developing countries, who are interested in improving social sustainability performance, should use a moderate level of transactional governance and rely heavily on transactional leadership to manage and control the supply chain relationship. When both foreign partners/managers do not know each other well, transactional governance can be advantageous for achieving positive social sustainability outcomes.

The findings of the study enforced the need to achieve SDGs in the context of export manufacturing firms by using the flair contract governance and transactional leadership style. The following are policy implications in achieving SDGs in the context of export manufacturing firms, that is, the manufacturing industry in Pakistan severely affected by a lack of trust from the buyers. Realizing the importance of inter-firm relationship, export manufacturers should work hard to combat contract ineffectiveness by using transactional leadership behaviours and promoting contract governance. It is evident that a buyer–supplier relationship improves social performance. Hence it is imperative to promote transactional leadership behaviour that improves the buyer–supplier relationship and helps in improving health, safety and labor standards in a way to sustain social performance. Thus, the executive needs to provide training and development opportunities to their managerial staff in developing transactional leadership behaviours and sustainability orientations. Managers should explicitly model the relationship and consider their interdependency to gain the full picture of how they both work together. The findings of the study can also

provide benefits to manufacturers and owners who wish to sustain their social performance and should further develop training programs to foster the effectiveness of leadership style in their firms.

The findings also indicate that the customer must be aware of the mindsets and practices of the South Asian exporting firms and incorporate and adapt social issues that reflect local institutional environment into their contracts. They also offer implications for the policymakers and institutional officials. Policymakers should endeavour to build a legal system on social issues to support manufacturing industries in these countries in collaboration with international institutions. However, managers should be aware that transactional and relational governance have their roles in enhancing sustainability outcomes. Managers could rely more on transactional leader's styles/in transactional governance. Eventually, foreign managers may be able to safeguard the relationship. When both foreign partners/managers do not know each other well, transactional governance can be good in South Asia for achieving positive social sustainability outcomes.

Further research is needed to identify the characteristics of leadership style that enhance social performance. Another potential future research area is the use of attention-based view on human resource management and relationship marketing domain. Accordingly, when top management signals their attention to relational activities in inter-firm governance mechanism, they highlight the importance of these activities and shape organisational goals. The sample size is small as data were collected from single respondents, future studies might find it beneficial to seek a response from multiple respondents per firm. A future research study that includes data collection from both sides would enable cross-validation of the effects of governance mechanism. Thus future research might consider replicating this study in other Asian countries. This comparison would facilitate understanding the ways in which leadership impacts social sustainability performance in various cultural contexts and identifying ways in which specific country culture influences governance mechanism and leadership behavioural emotions and intentions.

## Appendix 1

Constructs and measures

| Construct | Items | Measures |
|---|---|---|
| Transactional governance (TG) | "To what degree do you agree or disagree with the following statements<br>(1—Strongly disagree, 2—disagree, 3—Somewhat disagree, 4—Neither agree nor disagree, 5—Somewhat agree, 6—Agree, 7—Strongly agree)" | |

(continued)

(continued)

| Construct | Items | Measures |
|---|---|---|
| | TG1<br>TG2<br>TG3<br>TG4 | "We have formal written agreements outlining social issues"<br>"We have formal written agreements outlining how to Handel technical requirements"<br>"We have formal written agreements that detail the rights and obligations of both parties"<br>"We have formal written agreements that precisely state the legal remedies for failure to perform" |
| Relational governance (RG) | "To what degree do you agree or disagree with the following statements (1—Strongly disagree, 2—Disagree, 3—Somewhat disagree, 4—Neither agree nor disagree, 5—Somewhat agree, 6—Agree, 7—Strongly agree)" | |
| | RG1<br>RG2<br>RG3<br>RG4 | "Our customer is involved early in the development of social initiatives"<br>"Our firm has a mutual understanding of how to carry out solutions for failure in the protection of social issues"<br>"Our firm has a mutual understanding of how to settle down issues with our customer on the social protection of our workers"<br>"Our firm has a mutual understanding with customers the actions to be carried out when there are accidents at worker place" |
| Social performance (SP) | Please use the following scale to record an answer for each statement listed below (circle an answer for each item) 1—not at all, 2—a limited extent, 3—slightly improve 4—Neutral, 5—a moderate extent, 6—a great extent, 7—a very great extent" | |

(continued)

(continued)

| Construct | Items | Measures |
|---|---|---|
| | SP1<br>SP2<br>SP3<br>SP4 | "We have Improved safety and health of existing employees"<br>"We Improved the quality of life and basic health of the local community"<br>"We have improved the employee level of satisfaction with policies"<br>"We have improved employee occupational health, safety and labour conditions" |
| Transactional leadership (TRN) | Please use the following scale to record an answer for each statement listed below (circle an answer for each item) 1—Strongly disagree, 2—Disagree, 3—Somewhat disagree, 4—Neither agree nor disagree Agree 5—Somewhat agree, 6—Agree, 7—Strongly agree" | |
| | TRN1<br>TRN2<br>TRN3<br>TRN4 | "They let us know what is expected of us in the supply chain process"<br>"They encourage the use of uniform procedures in the supply chain process"<br>"They decide what shall be done and how it will be done in the supply chain process"<br>"They maintain definite standards of performance in the supply chain process" |
| Social performance (STP) | Please use the following scale to record an answer for each statement listed below (circle an answer for each item) 1—not at all, 2—a limited extent, 3—slightly improve 4—Neutral, 5—a moderate extent, 6—a great extent, 7—a very great extent" | |

(continued)

(continued)

| Construct | Items | Measures |
|---|---|---|
| | STP1<br>STP2<br>STP3<br>STP4 | "The provision of employment opportunities by our company has been continuously increasing in the past three years"<br>"The expansion of the product/market of our company has been continuously increasing over the past three years"<br>"The level of recognition of the need to protect the environment in "our company has been continuously increasing in the past three years"<br>"The level of employee rights of our company has been continuously increasing in the past three years" |

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# Discussion of New Product Development Process Sustainability Based on the Supply Chain in the Context of Industry 4.0


**Joanine Facioli Urnau and Osiris Canciglieri Junior**

## 1 Introduction: New Product Development, Supply Chain and Industry 4.0

Currently, the complexity of the operations of the industries and the speed of changes required by consumers, force companies to have and seek even more agility and assertiveness in what will be provided. In addition, the concern to minimize negative environmental impacts on products and processes has become essential to intensify competitiveness and be more efficient. In the context of industry 4.0, known as the fourth stage of industrialization, production needs to adapt to the constant fluctuations in demand between products, making it necessary to optimize production based on the communication of IoT tools and improving the human machine interface—HMI (Kafermann et al. 2011).

Inserted in this subject, regarding the relation of the development of new products and the ***Supply Chain Management*** (SCM), it is extremely important to launch the products in shorter life cycles, increasing the product design to reduce waste in the development until in terms of distribution, as well as changes in materials and processes (Santos et al. 2017). Thus, the general objective of this article is to propose a discussion involving the themes supply chain (SC), ***New Product Development*** (NPD) and Industry 4.0 in order to analyse the interaction of supply chain management in product development and vice versa, aiming at a more aligned and sustainable operation. Thus, this research seeks to bring understanding of how good management

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of these areas can contribute to the whole process, contextualizing the benefits from birth stage of an item until its final production and shipment to the customer. The work emphasizes the importance of how this relationship helps to reduce waste in the process, with a more assertive development, generating fewer losses, including financial (decrease development samples, raw material and machine settings). In addition, the alignment with well-defined from the beginning of product development is possible to prepare the entire chain and its suppliers, bringing signings or need to open new factories or suppliers close to the business.

Among the specific objectives, this study sought to identify existing models in the literature, published in high-impact international journals, peer-reviewed, with no restrictions on their years of publication and dealing with the supply chain and the product development process.

Thus, this work is organized in the introduction and contextualization of these two major areas, followed by the presentation and verification of the evolution of the main proposals of the subject, and concluding with the presentation of the gaps between this relationship of NPD and SC, and proposing other research opportunities. in that area.

## 2 Methodology

To seek to analyse the interaction of supply chain management in product development and vice versa, in the context of industry 4.0, some articles were selected through a search on the Capes/MEC Journal Portal. This Portal has a wide national and international database referenced of various materials. As a tool, keywords were used as filters to direct the search, crossing related words from the main pillars (product development and Supply Chain), such as: product development process, supply chain management, supply chain design and integrated design. Some methodological principles developed in the research developed and structured in the studies by Mattioda et al. (2015), Szejka et al. (2017) and Uemura Reche et al. (2020), but with adaptations to the present subject addressed.

As a result, 36 were crossed combinations of related words, which led, after more superficial analysis 480 articles related to the subject of work, and who have gone through more refinements to reach the most relevant. Thus, a comprehensive literature review was conducted, since they were not set filters for the years of publication, which resulted in articles with publication date to 2019. The research began in 2018 lasting until 2019, where it was possible to investigate the extensive background articles found.

The research is exploratory because it is directed at a question or problem that is not much addressed or that there is a lack of previous studies (Collis and Hussey 2005). For the keyword research it was planned to verify the relationship between the searched keywords and the subject. It is also qualitative, as it examines articles published around the subject previously, including selection of supply chain

models related to the development of new products and vice versa, published so far in international journals.

## 3 Sustainability Oriented New Product Development and Supply Chain in Industry 4.0

In the last decade, supply chain management has become an area that has gained more attention from companies and research. Conceptually, broadly, the Supply Chain Council defines it as, "every effort involved in the production and delivery of a final product or service, from the supplier to the supplier" (Appelqvist et al. 2004). In practice, the objective is to coordinate and synchronize processes, activities and the entire infrastructure linked to it.

Considering the immensity of tasks that the supply chain is responsible for, Supply chain management appears to perform this strategic management by evaluating the relationships of the chain, aiming to achieve competitive advantages and customer satisfaction. A successful supply chain requires coordination between multiple processes and, in many cases, the management of independent companies that work to provide a product or service to the end customer (Lee and Whang 1998). Based on this, in recent years, research has focused on increasing the responsiveness of supply chains, making them agile. An agile supply chain is one that can change and adapt quickly to new circumstances, for example, new markets and new realities, (see, for example, Gunasekaran et al. 2008; Vonderembse et al. 2006). Thus, recognizing the strategic nature of supply chain design, he feels almost compelled to integrate it with the development of products and processes (Fine 2009).

As an important point in this process, the development of new products is one of the keys to the success of the Supply chain, as it is the process of moving new products from generating ideas to introducing them to the market, including product design, market research and product analysis. marketing (Cooper 2001; Ulrich and Eppinger 2008; Liker 2004). Ulrich and Eppinger (2008), also put the development of new products as a process that comprises sequential steps or a set of activities starting with the perception of a market opportunity and ending with the sales, production and delivery of a product.

This relationship between product design and supply chain has been the subject of some research work in recent times (Fisher 1997; Randall and Urich 2001). Fisher (1997), for example, presented recommendations for combining the product and supply chain by raising questions such as "What is the right supply chain for your product?" and making suggestions on how to work with modular products aligned with a supply chain that was aligned with the market. Fine (2009) discussed the importance of integrating the supply chain to the development of products and processes, with suggestions for manufacturing, purchasing and supply decisions to be made simultaneously with the product architecture. Novak and Eppinger (2001) had the result that it is necessary to outsource products of less complexity in complex systems,

also suggesting greater coordination between product purchase and design, in order to maximize profit and improve the company's performance. Salvador et al. (2004), studied how the supply, manufacturing and distribution network should be configured for different levels of customization of product architectures. In addition, Fixson (2005) stated that the coordination mechanism between product, process and supply chain is not fully known, but that the product architecture can serve as a coordination mechanism.

In addition to these studies, there was also research that followed the work of Fisher, who had his model tested empirically by Selldin and Olhager (2007), who evaluated the structure in a Swedish context and observed that a correspondence between product and supply chain does not translate necessarily in higher performance, and Lo and Power (2010) researched and found that the association between the nature of the product and the supply chain strategy, as proposed by Fisher (1997) that it is not clear.

Carrillo and Franza (2006) argue that the NPD process should assist in the ramp up of SC processes and other activities that support the commercialization of the newly developed product. The representatives of the SC process must be involved from the beginning of the product development process (Van Hoek and Chapman 2007). In addition, when it comes to product design, process design and supply chain design, the literature brings 3DCE, which is based on simultaneous engineering, and which assumes that products and processes must be designed simultaneously, involving multifunctional teams in the beginning of the process, which may include suppliers and customers (Birou and Fawcett 1994; Blackburn et al. 1996; Swink 1998; Koufteros et al. 2002).

While it is widely accepted that product design decisions and their associated supply chain are interrelated, it is not clear how they interact with each other (Zhang et al. 2008). Research that simultaneously focuses on the coordination of both NPD and SC in order to bring new products to the market is scarce (Carrillo and Franza 2006; Van Hoek and Chapman 2007; Hilletofth et al. 2010; Marsillac and Roh 2014). It is necessary to consider the rate of renewal of products and business models in the supply chain processes to be aware that the supply chain in the NPD process due to the occurrence being more frequently.

As this relationship covers a very wide range of processes, whether internal or external, to be coordinated, it is hard work to ensure that this alignment is done correctly and effectively. Understanding and coordinating the interactions between people and systems is challenging in complex and dynamic environments. However, this relationship needs to undergo refinements and adjustments in order to achieve its proposed result. Currently, with the advancement of technology, new systems and programs appear to improve and guarantee the success of this interaction. In the midst of this context, industry 4.0 appears, which for Kafermann et al. (2011) "this becomes a new level of organization and management of the value chain throughout the product life cycle".

This aims to optimize the product based on the communication of Internet of Things tools, as it allows the connection between objects, environments, systems, among others, and can be accessed remotely, allowing the automation of industrial

processes. It also seeks greater interaction between the Home Machine interface (HMI) and changes in business models, which consequently contributes to changing the forms of interaction in the value chain. To make this all possible, data management (Big Data) is of great importance, as it must deal with important and confidential data, which uses approaches to capture, manage and analyze information.

Permeated in this context, the development of new products and supply chain has aid based on technology and data management to ensure effective interaction. Swink (1999), comments that a supply chain integrated with the management structure, in which each entity can have visibility of other parts of the supply chain, allows the potential for a better production decision (support to product innovation or focus on quality) and, therefore, cost reduction and response time reduction.

Another important gain that this integration allows is in relation to sustainability. Dealing with well-designed flows, with well-structured products and aligned with the chain since its briefing, it is possible to avoid errors and unnecessary expenses, be it financial or misused inputs. Employed effectively, product design as a tool, it can optimize the performance of supply chains and value, reducing logistical interactions, which consequently generates positive implications for the environment, for example, carbon footprint and energy reduction, ensuring at the same time social efficiency—greater social recognition by customers/end users for the social and environmentally responsible performance of a company (Gerlitz 2015).

## 4 Models, Frameworks and Researches on Supply Chain and New Product Development in Industry 4.0 Context

From the search for articles through the CAPES Journal Portal, using as keywords the development of new products and supply chains, as well as their variables, it was possible to analyze existing models in the literature related to these. Through the research it was possible to use a set of studies and their proposals for models and frameworks, enabling the verification, identifying, the contributions and the relevant gaps, of each one for this present study, in which we will discuss below. The interaction of supply chain and product development is generally related to the management and monitoring of many variables. Several authors have raised several important points in this context.

In the article "A product centric examination of PDSC alignment decisions at the nexus of product development and supply chains" (Dirk and Stavrulaki 2004), it presents a conceptual model that synthesizes the theory of previous works, researched by the author, to identify the main dimensions the alignment between product design, SC strategy and market conditions, to lead to the introduction of effective new products (NPIs) (Fig. 1). The model indicates that the intensity of the interface—a measure of the relational strength between product components—is of specific importance and should be clearly incorporated as a parameter in product design decisions at the project level.

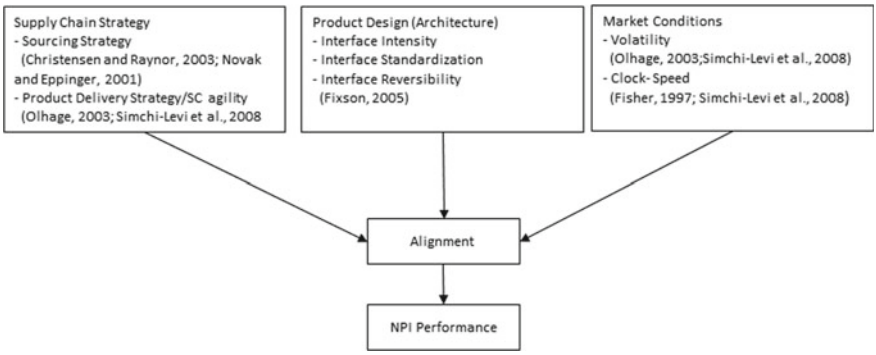


**Fig. 1** Conceptual model (Dirk and Stavrulaki 2004)

The study has limitations because it is a cross-sectional study and conducted only at the project level. However, it contributes to the understanding that design at the project level is a key alignment dimension for product design decisions, as well as the intensity of the interface and the supply strategy, and between the intensity of interface and clock speed, improves NPI performance. The framework developed by Pero et al. (2010) presents a structure that explains how the variables of new product development and the supply chain are related to each other and how they affect performance, seeking both strategic and operational issues in the supply chain (Fig. 2).

The work presents the limitation of not being able to measure the impacts of variety in the supply chain network, in addition to applying only one case study, which leaves the results very restricted. As a contribution is the discovery of the

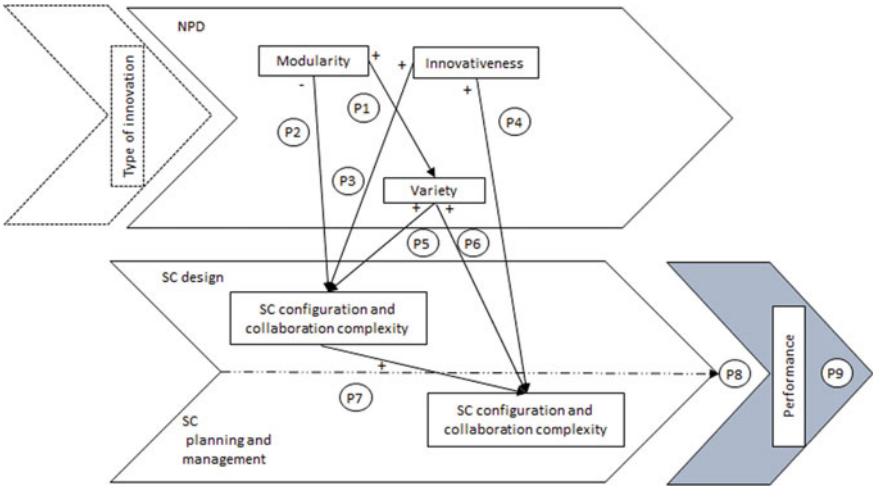


**Fig. 2** Detailed framework (Pero et al. 2010)

variables that matter most in this relationship. When associated with the product, the features that were taken into account were variety, modularity and innovation. As for the supply chain, the complexities of configuration, collaboration and coordination are the variables that matter. In addition, it was found that innovation has a more representative effect than variety in the complexity of the supply chain.

In the article "R&D—Production integration in the early phases of new product development projects" (Jukka 1999), the objective was to investigate the use of mechanisms for cross-functional integration in the early stages of new product development. Figure 3 shows the four categories of integration mechanisms identified by the author, based on the review of other works. The first category of rules, procedures and plans are mechanisms detected in the case studies focused on the integration of impersonal means. The second milestones and design reviews are essential reviews of the project milestones, as well as the third category of individual integrators and the last category of formal cross-functional project management teams.

This study focused on investigating the use of modern tools and methods (QFD to structure the process) to improve the effectiveness of the new product development planning process. As a negative point, the research did not have a strict control group and was not of a more participatory nature, which made it difficult to fully discover the role of informal cross-functional integration. In addition, only successful projects

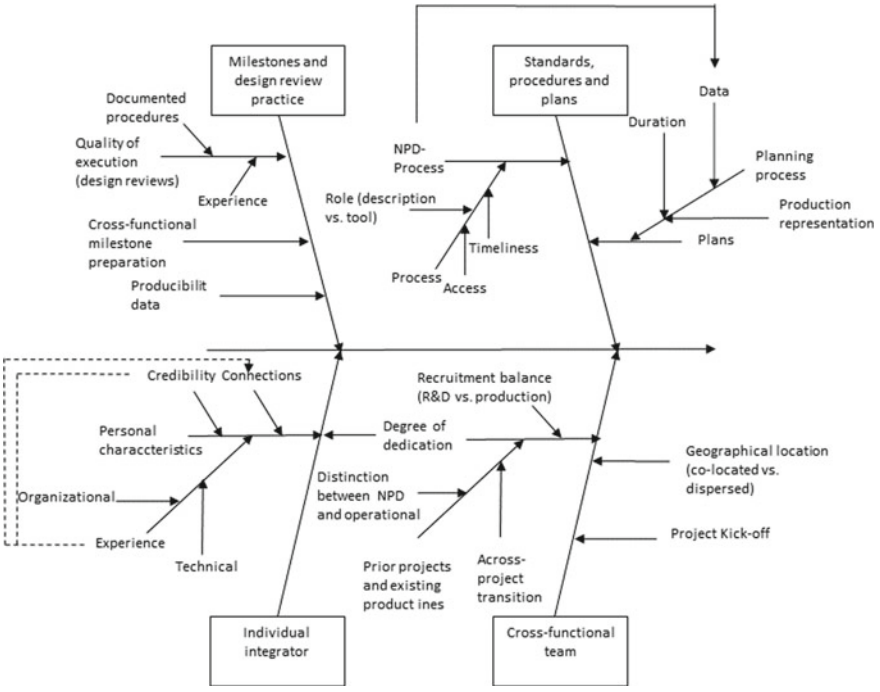


**Fig. 3** Research framework of integration (Jukka 1999)

were used to serve as a sample and the lack of data prevented the construction of the Framework.

Tolonen et al. (2017), in the article "Supply chain capability creation—The creation of the supply chain readiness for a new product during product development process", explains about the ***Supply Chain Capacity Creation Process*** (SCCC) as a sub-process of the supply process new product development (NPD), based on the gate model proposed by Cooper (2001). In the Fig. 4, it is clear that in the early stages of product development, SCCC's main focus is on product design, while in later stages SCCC's activities focus on creating supply chain capacity itself. Thus, it is also possible to define the product design guidelines and related goals and the main performance indicators, leaving the Supply chain always integrated since the beginning of the design process. As a limitation of the work, there is the exclusion of the concept of product design from design par excellence (DFX), to keep the focus on SCCC, which may already make the model biased, since DFX allows the systematic and economical use of existing SC processes for new products and related activities. In addition, the study did an empirical analysis of a single case. However, the contribution was the introduction of a new SCCC sub-process as part of the NPD process, in which it reduces the supply chain costs related to the new product, due

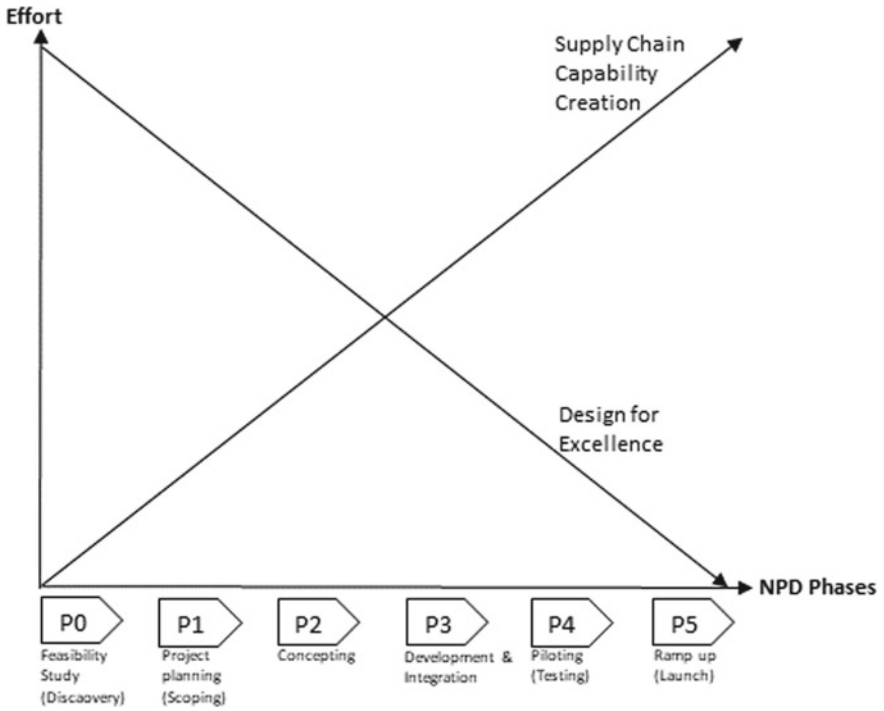


**Fig. 4** SCCC model (Tolonen et al. 2017)

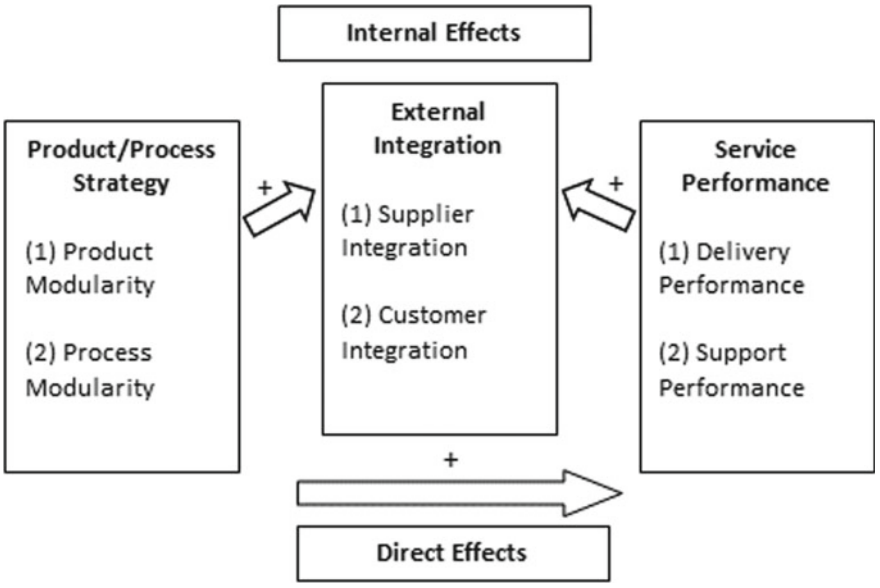


**Fig. 5** Research model (Droge et al. 2017)

to better new product design and the systematic preparation of the SC to accelerate the new product.

In the article "Does supply chain integration mediate the relationships between product/process strategy and service performance? An empirical study" by Droge et al. (2017), product and process strategies are modelled to stimulate socialization (external relationship), which in turn influences the performance of the service. In Fig. 5, the supply chain integration consists of the external relationship, the supplier with the customer, product and process strategies that are represented by the modularity of the product and process and service performance is composed of support and delivery performance.

The research was limited in relation to the sample size, which can mean relatively large standard errors, as well as the application in a single industry. As a contribution, the work added the literature when considering the performance of specific dimensions related to services. It was also possible to generate insights related to modularity and the importance of the strong role of modularity strategies in the integration of the chain. The article "Product-process-supply chain: an integrative approach to three-dimensional concurrent engineering" presented by Ellram et al. (2007), addresses simultaneous three-dimensional engineering (3DCE) and the problems that currently prevent the adoption of 3DCE. Figure 6 shows the interface points between product, process and supply chain design, in addition to the main problems between these major areas.

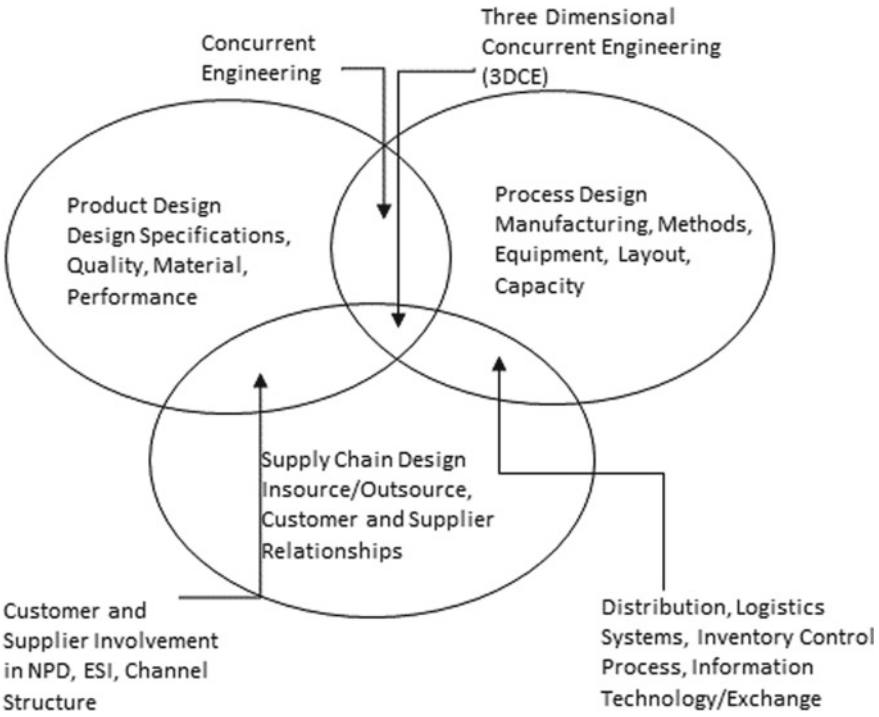


**Fig. 6** Research framework, modified from Fine (Ellram et al. 2007)

The research presents the restriction of not making an application and not providing a model to be followed. However, the article helps to understand the effective use of 3DCE as a very useful theoretical lens and the need for support from top management for this result. It proves that ignoring one of the three elements of 3DCE does not make it disappear; it simply confuses the effects of 2-D initiatives. Following a 3DCE approach will result in more successful results in terms of NPD and traditional new product objectives. In the models presented above, selected during the study, it can be highlighted that there are several articles with different models and lines of reasoning. The selection made during the course of this study identifies the articles with the greatest potential to assist in the development of the topic but does not rule out the importance of application in other areas of knowledge.

## 5 Final Discussion of Results of Models, Frameworks and Researches Found in the Literature

Through the researches carried out and when studying the interaction between the development of new products and the supply chain, we can emphasize that most of

the focus is on modularity or outsourcing, choice and relationship with suppliers, focus on alignment and insertion of senior management in the process, and in the real understanding of how this relationship should occur. In addition to these issues, there are others related to this integration that may assist in the present study. Although the research topic has several recent publications, none of them present or address a model that is comprehensive enough to guide companies in their product development processes integrated into the supply chain.

In addition, as it is a relatively new term, the context of industry 4.0 is not being addressed emphatically in research. The models presented generally explore only part of the process that encompasses the process as a whole and this results in the difficulty of achieving the sustainability of the production chain. Table 1 presents the issues identified and most addressed in each of the models and frameworks of the works cited. With that, it is evident the number of different subjects that are emphasized in the research and how vast this relationship is.

Therefore, the main objective of the study was to identify the relevant models and the gaps in the literature. The process of developing new products must be in the context of supply chain management and vice versa. The integration of the two areas and the care for the whole allow for a much more sustainable and aligned chain. When studying the interaction between the development of new products and the supply chain, in the context of industry 4.0, the importance and complexity of what it is emphasized. As one of the main sources, we highlight the gaps in the literature, in relation to a complete model that deals with the development of new products and supply chain, and consequently brings a more sustainable chain.

It is also necessary to highlight that with this bibliographic review it is clear the importance of the relationship between the supply chain and the development of new products, and how this relationship can facilitate the production process and later on the product distribution on the market. Management and alignment make the chain much more prepared for the progress of the process, in addition to being able to rely on the technology of industry 4.0, avoiding inefficient use of the resources and people involved. Thus, sustainability in this case is based on saving energy, raw materials, people, pollutants and time used, even assisting in logistics for distribution.

The research brought this attention to the subject and what can be useful for future research to serve as a basis for new developments. In addition, for future work it would be important to go deeper into the subject and search for more tangible applications that are closer to the reality of companies. As highlighted, there is a lack of work focused on the 3 points of product, process and design of the supply chain.

Finally, the present study has limitations, since the research was structured in order to map and search for models that presented the key words in the title, in the summary and in the keywords, which makes it possible to have other studies that were not presented in this work. Finally, it is possible to conclude that the study of development models for new products integrated into the supply chain, in the context of industry 4.0, is relevant and fundamental, as this approach will contribute and guide companies in the search for success in their developments within a agile and sustainable chain.

**Table 1** Subjects most addressed in the research cited

| | Supplier | Variety | Modularity | Involvement of coordination | Effectiveness/cost | Capacity | Involvement client/market | Processes | Team integration | Systems |
|---|---|---|---|---|---|---|---|---|---|---|
| A product centric examination of PDSC alignment decisions at the nexus of product development and supply chains | | | √ | √ | √ | | √ | | | |
| A framework for the alignment of new product development and supply chains | | √ | √ | √ | | | | | | √ |
| R&D—Production integration in the early phases of new product development projects | | | | √ | | | | | √ | √ |
| Supply chain capability creation—The creation of the supply chain readiness for a new product during product development process | | | | √ | √ | √ | | √ | | |
| Does supply chain integration mediate the relationships between product/process strategy and service performance? An empirical study | √ | | √ | | √ | | √ | √ | | |

(continued)

**Table 1** (continued)

| | Supplier | Variety | Modularity | Involvement of coordination | Effectiveness/cost | Capacity | Involvement client/market | Processes | Team integration | Systems |
|---|---|---|---|---|---|---|---|---|---|---|
| Product-process-supply chain: an integrative approach to three-dimensional concurrent engineering | ✓ | | | ✓ | ✓ | | | ✓ | | |

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# (Non-)compliance with Public Finance Laws, Sustainability and Social Responsibility: A Critical Analysis of the Use of Mining Taxation in Canaã dos Carajás (Pará, Brazil)


**Thiago Leite Cruz**

## 1 Introduction

Governments, industries and universities are increasingly engaging with policies, practices and studies that promote social, environmental and economic justice. Such trends reflect the emergence of the Sustainable Development paradigm, a complex and multifactorial concept that is not limited to environmental issues, but rather should involve social and economic dimensions as well, especially in industrial activities such as mining, which has substantial impacts (Leff 2009; Prno and Slocombe 2012).

Solow (1991) analyzed different attempts to conceptualize and deal with sustainability. As an Economist, Solow (1991) came to a pragmatic conclusion, stressing that Sustainability should not imply the absolute non-use of resources to maintain their integrity throughout generations. Rather, sustainability should promote the rational use of resources to address our current needs, while generating long lasting benefits and alternate resources to the future generations, so the use and depletion of specific resources in the present should not harm their survival and wellbeing.

In fact, Solow (1991, 1991) indicates it is not desirable—or even possible—to leave some resources untouched, such as metals and ores which are crucial for some nations and businesses. In Brazil, mining production had a share of 4.69% on GDP in 2017, totaling over US$300 billion; and in 2018 the country exported US$49.8 billion in mineral production, equivalent to 20.8% of total exports (MME 2019).

Silva et al. (2014) and Cruz et al. (2020) indicate that Brazilian mining industry generates thousands of jobs, improves urban infrastructure and contributes to improve quality education and construct health facilities. Nevertheless, such industry is often

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criticized because of the use of non-renewable resources, environmental impacts, conflicts between companies and local inhabitants, and increasing social disparities in towns affected by its activities (Cabral et al. 2011; BBC 2019).

La Rovere (2001) highlights that international pressures from global financial institutions led Brazilian government to strengthen environmental legislation. Thus, there are national laws that encourage and oblige companies to conduct several studies and implement projects to identify and mitigate environmental impacts before, during and after the implementation of their projects in Brazilian territories.

Some industries are subject to specific taxation. Based on their mineral production, mining companies must pay the Financial Compensation for Exploration of Mineral Resources (CFEM) to National, State and Municipal governments. The CFEM is very important for Brazilian economy, as it collected over US$980,000,000 in 2019 (ANM 2020a). This taxation is collected by National, State and Municipal governments, which should invest it to promote local wellbeing and economic diversification, to compensate the temporary exploration of mineral resources in their territory (Brasil 2017a, b). After all, non-renewable resources such as minerals and ores shall be depleted someday, and the local economies will need new sources of income.

IMF (2002) considers that governmental involvement with sustainability must not rest solely in environmental issues. It should extend even to treasury, which has finite economic resources that should be sustainably managed. Considering the relevant sums of CFEM collection and its crucial long-term importance for local economies and social wellbeing, its investments should be guided by sustainable financial principles (Cruz et al. 2019).

The municipality of Canaã dos Carajás is located in the northern Brazilian state of Pará. It is the second largest collector of CFEM and the largest recipient of investments in mining industry nationally. Considering the largest iron ore mine in the world is located there and has just started operations, CFEM collection shall increase rapidly (Duddu 2018; ANM 2019a).

Mining operations in Canaã dos Carajás (Pará, Brasil) started in 2002, when copper, gold and iron ore deposits were found in the region. Previously, the municipality was a small farming settlement, whose economy was based mainly in livestock and agriculture (52% share of the local GDP, whereas industry had a share of 9%). But its social and economic dynamics changed very rapidly and intensely after mining exploration initiated (Cabral et al. 2011). With a population growth rate of 9% yearly between 2004 and 2015, its total population went from 11,139 to 33,632. In 2017, Industry had a 73% share on the local GDP (IBGE).

Despite improvements in economic dynamics, jobs generation and progress in national indexes of wealth, health and education such as the Firjan Municipal Development Index (IFDM) since 2004, local inhabitants are very dissatisfied with environmental impacts and poor standards of living in both rural and urban areas of the municipality (Cabral et al. 2011; Silva et al. 2014). Cruz et al. (2020) noticed that some residents are not satisfied with the current safety, social infrastructure and quality of life in the municipality, thus they do not feel the local government properly uses the large sums of taxes it collects.

Considering the huge importance of the municipality of Canaã dos Carajás (Pará, Brasil) and mining industry for Brazilian economy, and the contrast between high taxes collection and apparent social dissatisfaction, the present research has two main objectives. Firstly, it investigates the current social perceptions of the local government's use of mining taxation, using questionnaire surveys that were applied to randomly selected residents, assuring anonymity of the respondents. Solow (1993) stated that "Talk without measurement is cheap (p. 136)". Thus, it was measured in a Likert scale how much the citizens trusted the government to invest the mining taxes properly, and whether they agreed the urban infrastructure had improved with such investments.

Secondly, it checks whether the CFEM collected by the municipality is used sustainably and in compliance with the legislation. This investigation was based on bibliographical reviews of the pertinent laws, secondary data and previous studies conducted in the region, and analysis of the Annual Municipal Budget Law in Canaã dos Carajás.

This article is divided into five sections. The following section reviews the literature on sustainability, Law, public finance and the nexus between them. The third section explains the methodology that guided the research, and the fourth section presents and discusses the main findings. Finally, the fifth section presents the concluding remarks.

## 2 Sustainability, Social Responsibility and Public Finance Laws

The growing international concern with sustainability could be related to the acknowledgement that the depletion of important natural resources would seriously harm the economy and the environment, causing negative social impacts on many countries (Bosselmann 2015). The Brundtland Report in 1987 is a global landmark in sustainability studies (WCED 1987). Also known as "Our Common Future", the document recognized the multiple dimensions of sustainability: environmental, social and economic. Such document also encouraged national governments to complement international laws regarding environmental issues and sustainability, and urged them to manage natural and economic resources responsibly in order to improve social welfare in balance with nature in present and future generations.

Nevertheless, sustainability is more than an inspiring ideal to guide business, industries and policies. Bosselmann (2015) consider it an important legal principle. According to Dworkin (2002), legal principles should be explicit in written laws to properly regulate the creation and interpretation of norms, promoting justice and social fairness.

In fact, there are sustainability principles in the Constitution of several countries. In Portugal, natural resources are considered public property, therefore the government must protect them and ensure their appropriate use for social welfare (Canotilho

2010). The Constitution of Ecuador acknowledges Planet Earth as a subject of law, having the same importance as human beings (Gudynas 2014). The Constitution of Brazil (Brasil 1988a, b) commits the government to ensure social fairness, justice and development (article 3), while protecting the environment and using rationally its resources (articles 170 and 225) under a balanced, fair and well-structured financial system (art. 192).

Economy influences the use of natural resources in industry and foreign trade, and the standards of living in countries and states. Therefore, Marino emphasizes that all resources should be used sustainably, including the economic ones. The finite resources of the treasury should be used responsibly to produce positive net income and cash flows, thus ensuring the health of the public finance system and improvements to local quality of life (IMF 2002; Scaff 2014).

However, the effective establishment of sustainable long-term financial planning by decision-makers can be made difficult due to political and technical issues, especially in developing countries, where financial irregularities are common. In fact, Allen and Koshima (2018) noted that higher-income countries have lower levels of financial irregularities than low-income nations, what can be attributed to their more complex and robust financial reporting systems and budget execution. Although financial irregularities may include corrupt practices, Allen and Koshima (2018) emphasize the theme is broader and may involve budget management irregularities, such as payments and expenditures that violate financial regulations, exceed budget appropriation or are used for unauthorized purposes.

Thus, it should be a priority to strengthen financial sustainability and combat irregularities in countries and municipalities that rely on the exploration of non-renewable resources such as mining. Once the industrial exploration is over, so will be the taxes collection and the government shall need to find new sources of economic profit (Scaff 2014). In Brazil, there are specific laws that rule the use of mining taxation to promote sustainable economic growth, social responsibility and economic diversification (Cruz et al. 2019).

The Constitution of Brazil (Brasil 1988a, b) assures that municipalities, states and the federation shall benefit economically from the exploration of minerals and ores in their territories (article 20, 1st §). The Financial Compensation for Exploration of Mineral Resources (CFEM) is a tax that mining companies ought to pay to the Federation, states and municipalities that produce and are somehow affected by mining production. It was created by the Law 7990/1989. The Law 13,540/2017 defined the calculation bases, rates and percentages of tax distribution according to mineral substances and federative entities, based on the gross revenue (Tables 1 and 2).

The Law 13,540/2017 also recommends that federative entities should invest 20% of the CFEM in economic diversification, sustainable development and scientific and technological development projects, to reduce excessive economic dependence on mining activities (Enríquez 2018). The article 8th of the Law 7990/1989 and the article 26 of the Federal Decree 01/1991 strictly forbids the use of CFEM to pay public management debts, common expenses and human resources, as long as they

**Table 1** Mineral substances and their respective tax rate, according to Law 13,540/2017 (Brasil 2017a, b)

| Mineral substances | Tax rate (%) |
|---|---|
| Rocks, sands, gravels, gravel, ornamental rocks, mineral and thermal water | 1 |
| Gold | 1, 5 |
| Diamonds and other mineral substances | 2 |
| Bauxite, manganese, niobium and halite | 3 |
| Iron ore | 3, 5 |

**Table 2** CFEM distribution to federative entities, according to Law 13,540/2017 (Brasil 2017a, b)

| Federative entities | Tax distribution (%) |
|---|---|
| Federation | 10 |
| States and Federal District | 15 |
| Municipalities (where there is mining production) | 60 |
| Municipalities and Federal District (directly or indirectly affect by mining production) | 15 |

are non-related to public education. The only exception is education expenses—CFEM can be used in teachers' wages and expenses to improve quality education (Brasil 1989, 1990; INESC 2019).

Among the five municipalities which collected the highest total CFEM in 2019, the first two are located in the northern state of Pará: Parauapebas and Canaã dos Carajás (Table 3). The latter currently hosts the largest iron ore mine in the world, which has just started operations. Then, its CFEM collection shall increase in the upcoming years.

Currently, Industry has the largest share in the GDP of the municipality of Canaã dos Carajás (Fig. 1), and CFEM collection has reached over R$700,000,000.00 (around US$156,000,000.00) in 2019 (Fig. 2).

It is clear the municipality of Canaã dos Carajás is very dependent on mining industry. Therefore, the considerable collection of mining related taxation ought to be properly invested to improve future social and economic prospects in the municipality (Thomé 2009; Scaff 2014; Enríquez 2018).

**Table 3** List of highest CFEM collecting municipalities in 2019 (ANM 2019a)

| Five highest CFEM collectors in 2019 | |
|---|---|
| Parauapebas—Pará | R$1.156.139.681,25 |
| Canaã dos Carajás—Pará | R$706.068.474,12 |
| Congonhas—Minhas Gerais | R$284.157.465,30 |
| Itabira—Minas Gerais | R$241.078.393,45 |
| Nova Lima—Minas Gerais | R$197.805.274,30 |

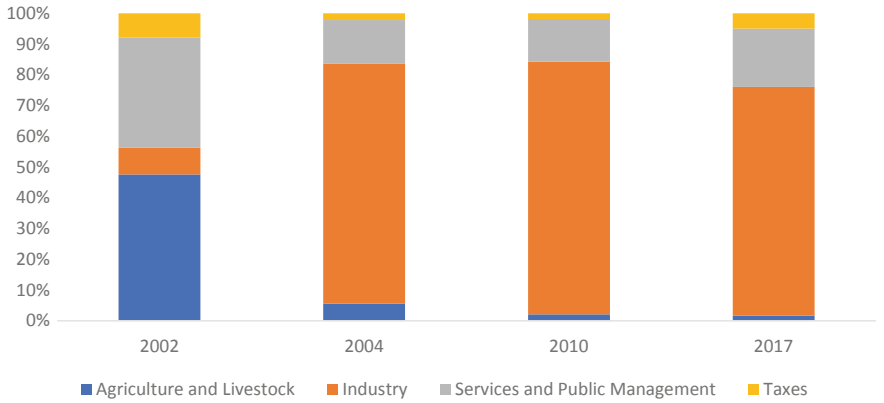


**Fig. 1** Contribution of each economic sector to the GDP in Canaã dos Carajás—Pará, Brazil (IBGE 2020a)

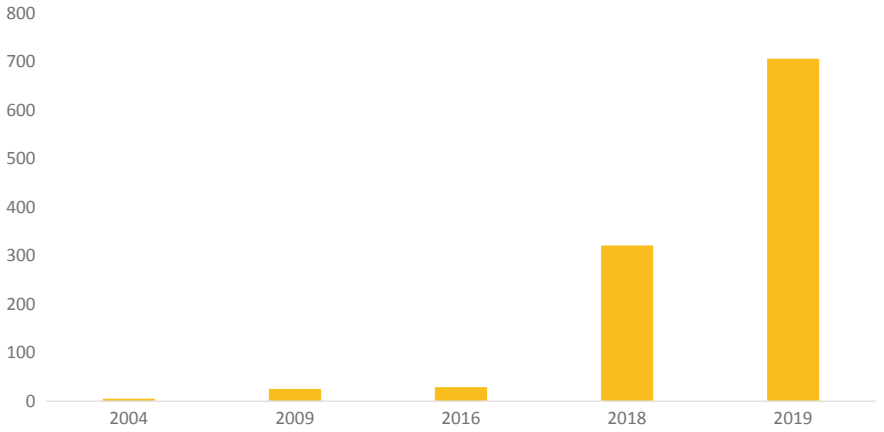


**Fig. 2** CFEM collection (in R$ million) in Canaã dos Carajás—Pará, Brazil (ANM 2019b)

## 3 Methodology

A survey was conducted to assess social perceptions regarding the government's use of mining taxation and the improvements on social infrastructure in Canaã dos Carajás. People were randomly approached in the streets, and asked to rate in a five-point Likert scale (1 = strongly disagree; 5 = strongly agree) two topics related to public management of mining taxes (*Local government adequately uses taxes from mining industry; Local government is transparent regarding the use of mining taxation*); and four topics related to improvements on social infrastructure due to the use of mining taxation (*Access to quality education has improved*; *Quality of the urban infrastructure has improved; Sanitation has improved*).

A total of 200 anonymous people participated in this study. The respondents belonged to ten different social groups that reflected the social diversity in the municipality: students; teachers; politicians; religious leaders; journalists; members of NGOs and trade unions; public service, private sector, industrial and rural workers. The sample margin of error was approximately 10%. The sample size would have been smaller, but sub-samples were taken for small social groups to make sure all participated in the study.

64.5% (129) of the respondents were men, and 35.5% (71) were women. The average age and its standard deviation were 33.8 and 12.17, respectively. Age varied from 18 to 71 years. The average years of education and its standard deviation were 10.62 and 3.2, respectively.

Data collection took place in February 2020. A descriptive statistical analysis was conducted using the IBM SPSS 23 software (IBM Corporation 2015). It assessed the mean average scores of both factors (trust in government's management and improvements on social infrastructure) and identified the percentages of each response in the Likert scale.

A bibliographic review was conducted on previous works that assessed the use of CFEM in Canaã dos Carajás (Pará, Brazil). The actual Annual Municipal Budget Law of the municipality, whose access is publicly available online, was also analyzed to verify whether the actual use of mining taxation follow the prohibitions and general guidelines indicated by the laws 7990/1989 and 13,540/2017, and the Federal Decree 01/1991 (Brasil 1989, 1990, 2017a, b).

## 4 Results and Discussion

The data analysis revealed a reasonable social dissatisfaction towards public management of mining taxation (Fig. 3). It was found that 68.5% of the residents explicitly declared not to trust the local government in the municipality of Canaã dos Carajás adequately invests economic resources from mining taxes. Furthermore, 67% of

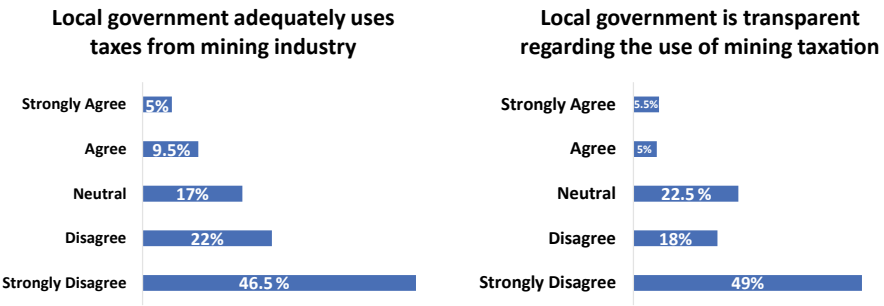


**Fig. 3** Results from the questionnaire surveys applied to the population of Canaã dos Carajás (Pará, Brazil), regarding trust on public management of mining taxes

the respondents complained about lack of transparency in government's activities involving collecting and investing mining taxes.

Transparency involving the investments of CFEM resources is mandatory according to Law 13,240/2017 (2nd article, § 13). Both the processes of collection and investments of the tax must be publicly available to let society, legislative and judicial organs control the government's management of such an important tax. However, the results indicate that the local government needs to be substantially more transparent regarding public finances, as almost 90% of the participants in this study were not satisfied with its current transparency.

In fact, the assessment of the Annual Municipal Budget Law of the municipality of Canaã dos Carajás confirms such results. Enríquez (2018), Cruz et al. (2019) and INESC (2019) pointed that the government in the municipality has only explicitly indicated the total amount of CFEM it collected and how it was invested in the Annual Municipal Budget Law of 2018. The municipality collects the CFEM since 2005, but only in 2018 its use was detailed and made publicly available. Until then, it was included among general expenses of the government and therefore could not be tracked.

Nevertheless, research on the Annual Municipal Budget Laws of the following years points to a major setback for transparency in Canaã dos Carajás. INESC (2019) and Angelo (2019) indicated that CFEM expenses were not described in the budget law of 2019, but could only be found in the government's transparency website. Local government followed trends from previous years and blended CFEM investments among general expenses in the budget law again. In 2020, no changes have been made to correct this contravention.

Thus, the present study could investigate the public use of CFEM just in 2018 (Fig. 4) and 2019 (Fig. 5). The shares for each investment sector indicated that lack of transparency is not the only contravention of the government in Canaã dos Carajás DNPM (2018) indicates that the municipality collected R$320,722,428.17 in CFEM tributes, but the Annual Municipal Budget Law of 2018 indicated only R$142,654,130.69 in investments from this taxation.

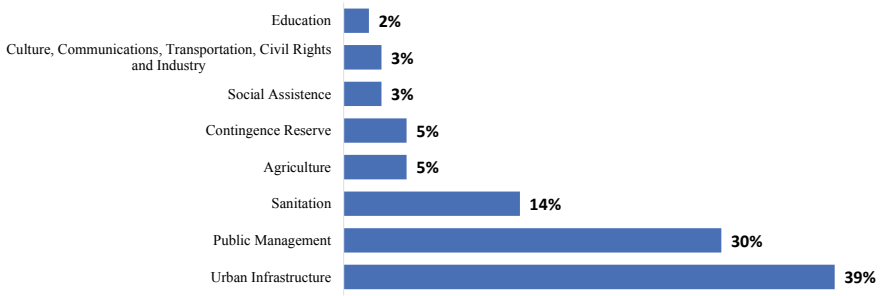


**Fig. 4** Total investments (%) of the CFEM in different economic sectors, in Canaã dos Carajás (Pará, Brazil), according to the Annual Municipal Budget Law of 2018. Adapted from Enríquez (2018) and Cruz et al. (2019)

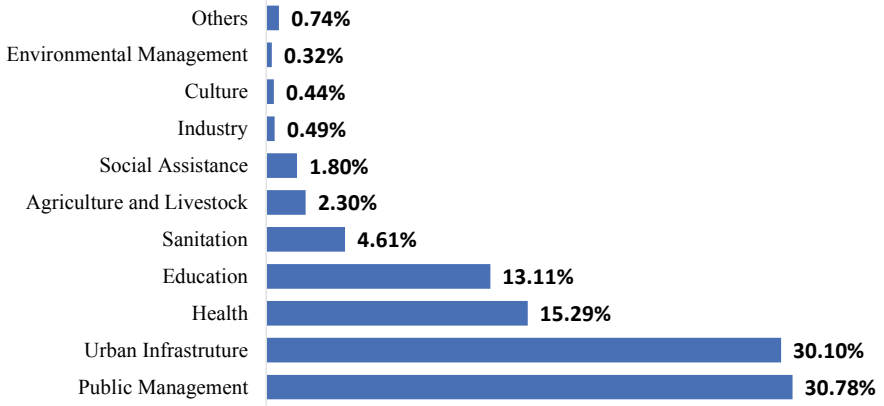


**Fig. 5** Total investments (%) of the CFEM in different economic sectors in 2019, in Canaã dos Carajás (Pará, Brazil), according to the transparency website of the government. Adapted from Angelo (2019)

Around 30% of the CFEM was used in Public Management expenses in 2018 and 2019, in clear discordance with the norms established by the 8th article of the Law 7990/1989 and the article 26 of the Federal Decree 01/1991. Enríquez (2018) and Cruz et al. (2019) indicated that it was used in government's amortized loans, besides other irregular expenditures. The purpose of the regulations is to forbid the use of this temporary taxation with expenses that shall remain after mining exploration is over (INESC 2019).

Urban infrastructure has received the largest share of the CFEM in 2018 (39%), and 30.10% in 2019, mainly in asphalt roads, pavements and constructions (Enríquez 2018; Cruz et al. 2019). Asphalt roads are very important for mining logistics, so the production can be properly and timely distributed, though some downtown streets still need paving, even after 18 years of mining exploration in town (Fig. 6). However, when asked whether the urban infrastructure was improving in town due to mining tax usage, 52.5% of the respondents explicitly agreed (Fig. 7). When data collection took place, some improvements in paving were being performed across downtown areas in an uncoordinated manner, negatively affecting businesses, traffic and people's physical accessibility in pavements (Figs. 8 and 9).

A small share (14%) was invested in Sanitation, and an even smaller share in 2019 (4.61%), but Canaã dos Carajás still needs significant improvements in that sector. The 2010 census indicated that 11.6% of the homes had access to adequate sanitation, 75.2% of the homes had mildly adequate sanitation, and 13.2% had access to inadequate sanitation systems (IBGE 2010).The latest data available online demonstrates that just 2.77% of the homes in the municipality have access to sewer systems, while rudimentary septic systems are present in 91.93% of the homes, and open sewers are present in 5.30% (Datasus 2013). In the questionnaire survey, opinions were very divided in this topic, as the respondents lived in different neighborhoods and their response reflected their personal views.

**Fig. 6** A downtown street in Canaã dos Carajás (Pará, Brazil) that needs asphalt construction. *Source* The author (2020)

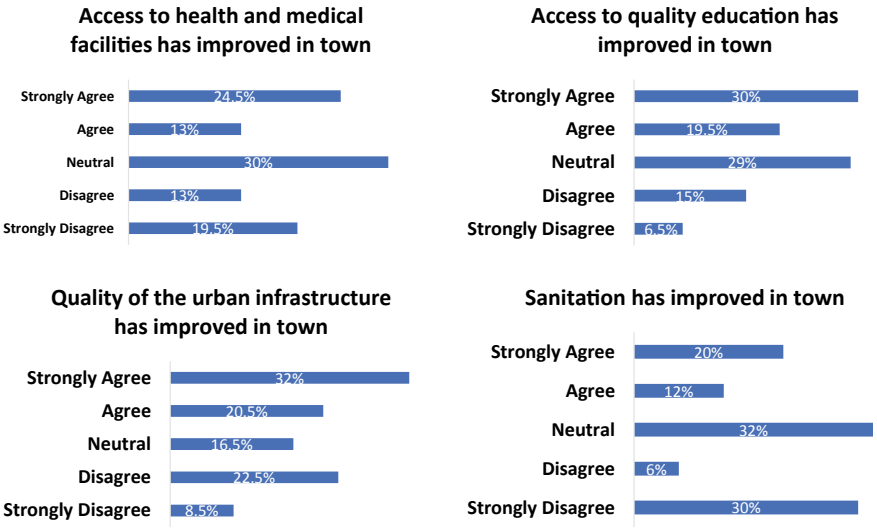


**Fig. 7** Results from the questionnaire survey conducted in Canaã dos Carajás (Pará, Brazil) with 200 participants from different social groups. The graphs indicate the percentage of respondents in each scale. It measured social perceptions on improvements in quality education; urban infrastructure and sanitation in the municipality


**Fig. 8** A downtown street in Canaã dos Carajás (Pará, Brazil), under repair. *Source* The author (2020)

**Fig. 9** Detail of a pavement in downtown Canaã dos Carajás, under repair. *Source* The author (2020)

On the other hand, the local government apparently do not value important sectors such as Social Assistance and Culture, Communications, Transportation, Civil Rights and Industry, which have been invested the small share of 3% of the total CFEM. Likewise, Agriculture had a share of 5%. Investing in those areas would increase economic diversification in Canaã dos Carajás in the long-term.

Once mining exploration is over and the CFEM is no longer collected, other industries and agriculture shall need to generate profits and increase revenues in the municipality, and provide income to its inhabitants. Such small shares of investments in key-sectors do not follow the guideline from the legislation, which recommends investments of at least 20% of the CFEM the municipality collects in sustainability of mining activities, scientific and technological development and economic diversification.

Education is another critical sector, receiving the smallest share of total investments from mining taxation in 2018, merely 2%. Fortunately, in 2019 such a share increased to 13.11%. Barro and Lee (2010), WEF (2016) and Grant (2017) emphasize the crucial role of education to promote economic growth and increase countries' and municipalities' capacities to create and transfer knowledge, technology and new products. Good quality education is also a precondition for long-term economic growth, besides leading to higher individual incomes (IIASA 2008). In fact, Unesco (2012) noted that the investment of just US$1.00 in education generates around US$10.00 to $15.00 in economic growth. But Grant (2017) highlights that investing in education is not enough per se, it is crucial to create job opportunities in public and private sectors and diversify the local economy. Then, a better qualified workforce shall indeed have brighter prospects.

Investing in education also contributes to people's empowerment, improvements in governance and corruption reduction (IIASA 2008; Grant 2017). Studies from Unesco (2010) associate further benefits from investments in education, improving health conditions such as reduction on child mortality, higher birth control and better parenting and self-care. Therefore, it would increase benefits from the investments in Health in 2019 (15.29% of the CFEM), which were higher than in Education.

Nevertheless, more people were pleased with the improvements in education than with improvements in health. 37.5% of the respondents agreed that Health had improved in town, while 32.5% of them disagreed. Despite the lower share of CFEM investments in Education, most people agreed (49.5%) that access to quality education had improved in Canaã dos Carajás, while just 21.5% disagreed. It might have reflected the increase on investment in this area in 2019. Additionally, the respondents resided in different neighborhoods in the municipality, therefore their responses reflected different social perspectives.

However, most respondents related such improvements in education and health to direct investments in schools and hospitals made by mining companies, not by local government. In fact, Cruz et al. (2020) demonstrated that mining companies improved social sustainability indicators in Canaã dos Carajás between 2008 and 2017, including education.

Thomson and Boutilier (2011) have already noticed that in underdeveloped countries and regions there are poorer social and urban infrastructures, and the local

inhabitants report lower trust on their governments. Therefore, mining companies are expected to provide what the government do not provide to the population: good quality education, health facilities and development oportunities.

In Canaã dos Carajás, the local government fails to meet the population's necessities regarding improvements in standards of living and sustainable development, as the results demonstrated the public finance of the municipality is not sustainable at all. There is only one project that specifically addresses sustainability issues, the Municipal Fund of Sustainable Development. It aims at stimulating entrepreneurship, attracting new businesses and industries and financing educational projects. It was created in 2017 but only in 2019 it started activities (Cruz et al. 2019; Gillet 2019). Such a project receives only 5% of the CFEM, which is 15% below the ideal according to recommendations by the CFEM related legislation. Some respondents are aware of the existence of the aforementioned Fund, but complained of excessive requirements to benefit from this initiative.

## 5 Conclusion

This study has found that the local government in Canaã dos Carajás violates the laws that regulate the use of CFEM, using a large share of this tax in public management expenses. Such a share would be more beneficial if invested in sectors that generate long-term improvements in local standards of living: education, health, sanitation, culture, economic diversification etc.

The survey questionnaires revealed that most citizens do not trust on local government's adequate management of the mining taxation. The analysis of the Annual Municipal Budget Laws of the municipality indicated a clear lack of transparency involving public finance, contributing to the low levels of social trust in government. To improve this, the government should be more responsive to the community it serves, enhancing transparency in public finance and committing to obey the law, by properly investing the CFEM.

The results also indicated mixed opinions regarding improvements in social infrastructure. Most respondents were dissatisfied with sanitation in town, even though they lived in different neighborhoods. Improvements in other topics (health, education and urban infrastructure) had more balanced opinions. Nevertheless, most respondents attributed such improvements to actions taken directly by mining companies, not by the local government.

Tax collection from mining activities shall be over someday, as mineral and ores are non-renewable natural resources. Therefore, it must be properly and sustainably invested to generate income in the long-term and improve life conditions in the municipality. In such a small town, the benefits from the adequate use of CFEM could be easily spread.

The legislature in Canaã dos Carajás should be more proactive, demanding transparency from the executive power in its annual budget reports and holding the government responsible for financial irregularities. The academic community should be

encouraged to investigate the political, social and economic factors that influence this matter, to contribute to improve local policies and share knowledge with the population. The government is supposed to serve the community. Therefore, citizens and companies must press the elected representatives, pleading for transparency, effective policies and long-term improvements in the standards of living. Other cities that may face similar problems should follow those steps, to enhance sustainability and accountability in governance.

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# The Importance of Green Supply Chain Management Approach in the Integrated Product Development Process


**Alda Yoshi Uemura Reche, Osiris Canciglieri Junior, and Marcelo Rudek**

## 1 Introduction

The life cycle of products has become shorter, which has challenged industries in terms of innovation and pressure over time. Consequently, product development activity in companies is also under pressure, intending to develop products in shorter terms, while adding to the growing demands of society, companies, and the environment.

The success of the new product development can be achieved if all stages of the supply chain are systematically linked to the perspective of sustainability, therefore, since the raw material until the end-users must have sustainable practices incorporated in their processes (Sinha and Anand 2018).

The relationship between product development and issues related to sustainability and GSCM had the largest number of publications in the period from 2011 to 2018 (Uemura Reche et al. 2020a). Thus evidencing the importance of approaching the theme in the last nine years.

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Currently, ISO 14001: 2015 aims to operate in environmental systems, it provides companies with practical tools for the management of environmental aspects, those that are related to the value chain, product life cycle, strategic issues, among others. Companies must have an ecologically correct performance through strategic environmental management, with a view to company sustainable development, practical environmental policy practices and demonstrate compliance with sustainable practices for customers and external organizations (ISO 2020).

Although there is an international standard that directs companies in the management of environmental aspects, as well as a large number of published studies on the themes IPDP and GSCM, further studies on the subject, are necessary. Since gaps in the literature can be highlighted concerning IPDP and GSCM to integrate the "operations factor" (Uemura Reche et al. 2020b).

This specific research field provided issues and also identify authors who have worked or are working on issues, methods and models related to IPDP and GSCM. The differential contribution of this paper was to present and a discussion about GSCM and IPDP which is a shortfall in the integration process between these two areas, specifically related to the "operations factor" involving green.

This study aims to present a theoretical discussion on the influence of a GSCM approach on IPDP. This study starts presenting published models of IPDP related to the "operations factor": green purchase, green manufacturing, and green distribution, themes related to the GSCM. Next, presenting guidelines for integrating the product design steps and "operations factor" to reduce the environmental impact.

## 2 Methodology

To search for models previously published in the literature about the influence of a GSCM approach on IPDP, a search was carried out on the Portal of CAPES, with keywords that addressed the topic.

For this article, the combination of words that presented the most effective in the search was: sustainability, product development, process, and green supply chain management. No filter has been established for the years of publication. The data from the systematic and bibliometric review and content analysis were presented in the article: Integrated product development process and green supply chain management: Contributions, limitations, and applications (Uemura Reche et al. 2020b).

This study, is an addition of a study developed before (Uemura Reche et al. 2020b), that followed steps:

1. Keyword selection to perform the research. The research began by combining the following keywords—IPDP, GSCM and Sustainability. Through the use of such keywords in the search for articles, it was possible to identify important bibliographical references related to the theme.

2. Database definition and choice, this study defined the Periodical Portal of CAPES, a Brazilian database of the Coordination for the Improvement of Higher Education Personnel of the Ministry of Education. The database offers access to full texts available in more than 45,000 international and national periodicals to various reference databases (including Cambridge Journals Online, Emerald Insight (Emerald), IEEE Xplore, Scopus (Elsevier), Science Direct, SpringerLink, Taylor and Francis and so forth). These databases range from references and abstracts of academic and scientific works, technical standards, patents, theses, and dissertations, among other types of materials, covering all areas of knowledge. It also includes a selection of important sources of scientific and technological information freely accessible database on the internet (Portal de Periódicos CAPES/MEC 2020).
3. Selection of journals and high-quality articles with affinity to the Topic, from the selection of these journals, only those with high impact factor (SJR > 1; Q1) and Q1 quartile were selected.
4. Inclusion and exclusion criteria definition and selection of the most relevant articles through the reading of all titles and abstracts. The articles that had relation with the GSCM and IPDP topics and models were considered as inclusion criteria.
5. Analysis of the most representative periods in terms of publication in the theme. This work sought to verify the most representative periods referring to the publications found.
6. Selection of the most relevant articles in the theme.

To continue the research and preparation of this article, a new search was carried out on the Periodical Portal of Capes, with the same words previously mentioned, to analyze publications from the second semester of 2018 and the year 2019. The search with keyword aimed to verify the relationship between the keywords searched before, as well as the relationship between the keywords and the subject of the article.

Regarding the research process, the qualitative method was used, as it is a more subjective method; it examines and reflects on the perceptions and understanding of social and human activities (Collis and Hussey 2005). The qualitative research was carried out through the reading and analysis of articles published in journals on the theme, as well as the selection of models, contributions, and limitations of studies that address the GSCM themes in IPDP published so far in international periodicals.

## 3 The Influence of a GSCM Approach on IPDP

With increasingly fierce competition in the market, companies seek every day to pay attention to the needs of customers in the product development process, to improve the market's flexibility and the product's competitiveness.

The process of developing a new product occurs when data on market opportunities and technical possibilities are translated into information assets for commercial production. For this activity, the importance of the design engineer's is highlighted,

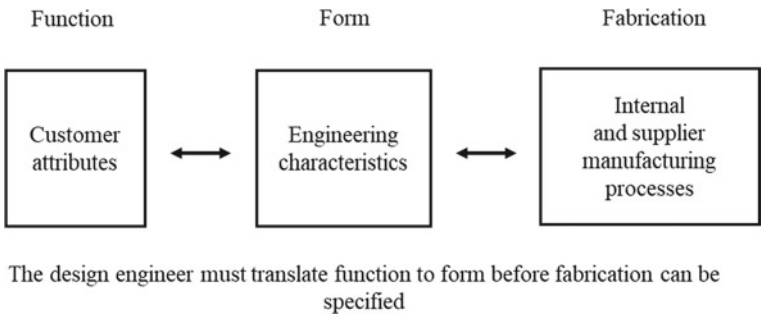


**Fig. 1** The design engineer's role in translating a functional description of the product to form and fabrication (Luh 2011)

which facilitate this translation process (Fig. 1). Design engineers must take an active role in the multifunctional translation process, related to *marketing vision*—required product functionality; *view of design engineer's*—product form and *view of internal and external suppliers*—product manufacturing processes (Luh 2011).

Thus, in the first moment, the marketing area clarifies the concept of the product and the features desired by customers. In contrast, designs engineer's that translate the features desired by customers into engineering features, that is, technical forms about the product (Luh 2011).

IPDP is a strategic activity for companies since it makes it possible to meet the needs of consumers, that is, market demands. Once emphasized on the importance of this activity, companies need to strategically manage the stages of product development: conception, design, and marketing of the product, to obtain a competitive advantage in the market (Ayağ 2016).

With the growing concern related to sustainable aspects, environmental issues must be considered in the IPDP. For this, the supply chain must be systematically linked to the perspective of sustainability. The incorporation of sustainability into the product is a combined responsibility of all members of a supply chain, from suppliers—raw materials to distribution—end users. When combined with the concept of supply chain and environmental concerns, the importance of the integration and practices of GSCM and IPDP is highlighted.

## 4 Models, Frameworks and Researches on GSCM and IPDP

Among the operation factors, the "green purchase" stands out, in this phase, raw materials and components of a new product will be purchased. In addition to the traditional buyer–supplier relationship, they can also cooperate in the development of new materials and products to meet the buyer's needs, including environmental and ecological products.

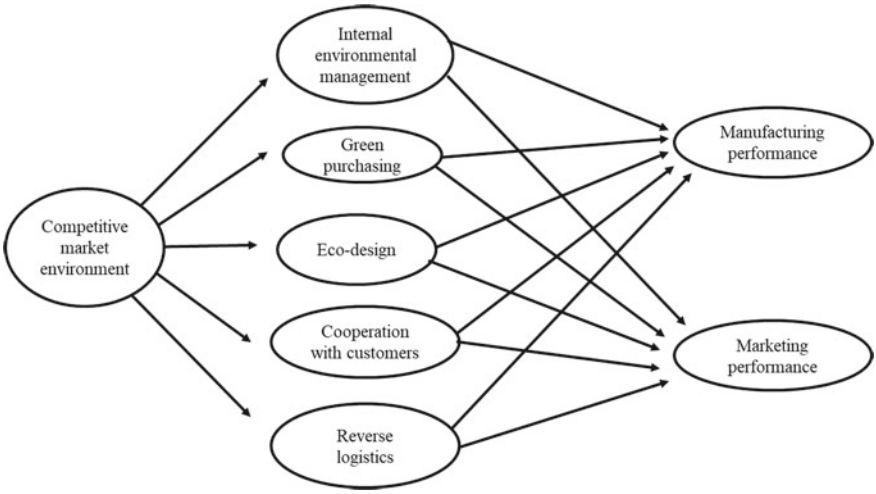


**Fig. 2** The hypothetical model (Choi et al. 2018)

In the article "Examining the inter-relationship among competitive market environments, green supply chain practices, and firm performance", the authors sought to understand which GSCM practices are influenced by the competitive environment (Choi et al. 2018). In addition to analyzing which GSCM practices improve the company's performance. The practices analyzed were: internal environmental management, green purchasing, eco-design, cooperation with customers and reverse logistics (Fig. 2). As a result, green purchasing stands out as the most effective practice among the five practices analyzed.

Based on the hypothetical model, the authors recommend future study possibilities considering the different performance categories, such as financial, public image, and brand recognition.

In the article "Top-management's role in adopting green purchasing standards in high-tech industrial firms" (Yen and Yen 2012), the authors explain the role of top management in green procurement and how this role is practiced in the high tech industry.

A theoretical conceptual model was developed to analyze the adoption of green purchasing by these managers (Fig. 3). As a result, it is observed that logistical integration with suppliers (H1), technological integration with suppliers (H2) and top management commitment (H3) positively and significantly influence environmental collaboration with suppliers. Environmental collaboration with suppliers (H4) and top management commitment (H5) also have a positive and significant influence on green purchasing.

Companies must provide and exchange operational and logistical information with suppliers. The companies can do it providing training on suppliers' products and collaborating in the development of new products or the introduction of new product lines. Therefore, top management can directly or indirectly influence the

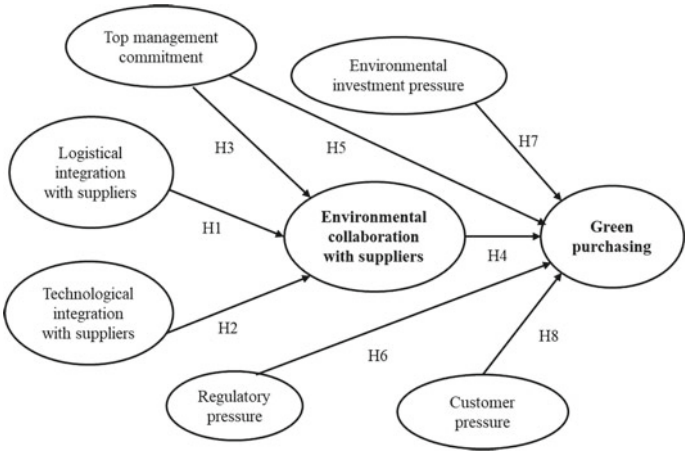


**Fig. 3** Conceptual model (Yen and Yen 2012)

process of environmental collaboration with suppliers. If top management does not proactively participate in environmental collaboration with suppliers, it is reduced, thus having a green purchasing influence.

From the evidence presented, it is insufficient to show that regulatory pressures (H6) and environmental investment pressures (H7) significantly influence green purchasing. Regarding regulatory pressures, the hypothesis is considered consistent once the importance of these factors has already been found in studies already published. As well as, the indifference of some companies concerning governmental legislation.

Considering environmental investment pressures, companies do not consider the environmental investment to be an onerous activity. However, through this investment, they seek improvements in performance, cost savings resulting from recycling, reuse, and environmental programs.

Customer pressure (H7) has a significant and positive influence on companies when it comes to green purchasing, driving members of the supply chain to environmental initiatives.

Top management commitment is essential for environmental collaboration with suppliers and to boost green purchasing, even when compared to regulatory pressure and customer pressure (Fig. 3).

As limitations, the authors suggest the application of this conceptual model in industries of other segments and other countries, since it was applied only in the electronics industry in Taiwan. The authors also corroborate by highlighting the importance of activities and decisions related to the purchasing process, as it is directly linked to the activities of research and development (R&D), quality management and sales.

Another published study is related to suppliers, that is, still dealing with the operation factor green purchasing. The article “Are supplier selection criteria going green?

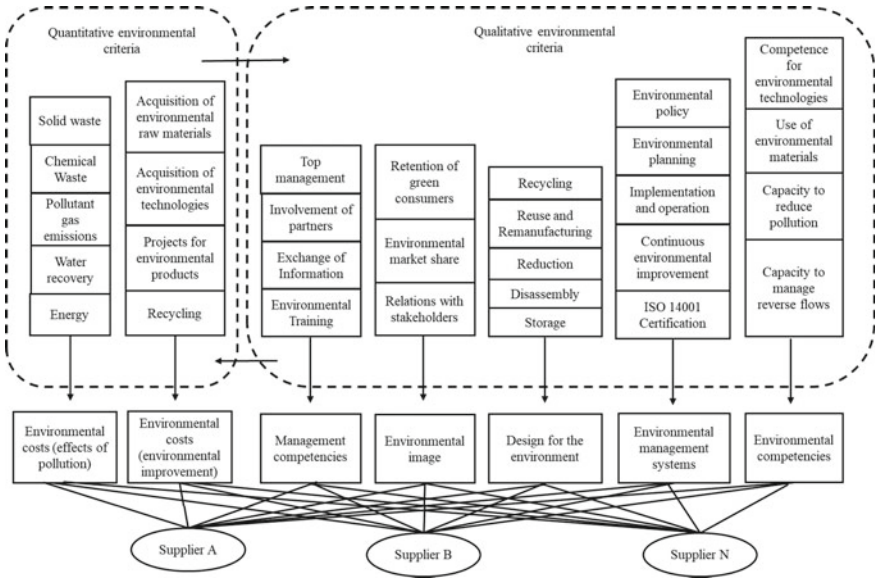


**Fig. 4** Framework for supplier selection based on environmental criteria (Jabbour and Jabbour 2009)

Case studies of companies in Brazil", it was analyzed whether Brazilian companies are considering environmental aspects for the supplier selection process, through interviews in five industries. In addition to analyzing whether there is any relationship between maturity in environmental management and inclusion of environmental criteria for selecting suppliers (Jabbour and Jabbour 2009).

In this article, an important adaptation of a framework stands out (Fig. 4), where the authors listed quantitative and qualitative environmental criteria for the selection of suppliers, the ones that supported the questionnaire applied to companies. Although the framework was not developed by the authors (Jabbour and Jabbour 2009), it constitutes an important bibliographic reference.

As limitations, the authors emphasize that the results of the case study cannot be considered a reality in all Brazilian companies. Thus, they suggest that future research be carried out related to environmental management and insertion of criteria for selecting suppliers; environmental performance of products and environmental performance of suppliers; availability of environmental information about suppliers and selection of suppliers with high environmental performance.

In the article "Applying hazardous substance management to supplier selection using analytic network process", the authors proposed a supplier selection framework based on hazardous substance management (HSM) using the analytic network process (ANP) methodology (Fig. 5). The framework has been tested in electronic companies (Hsu and Hu 2009).

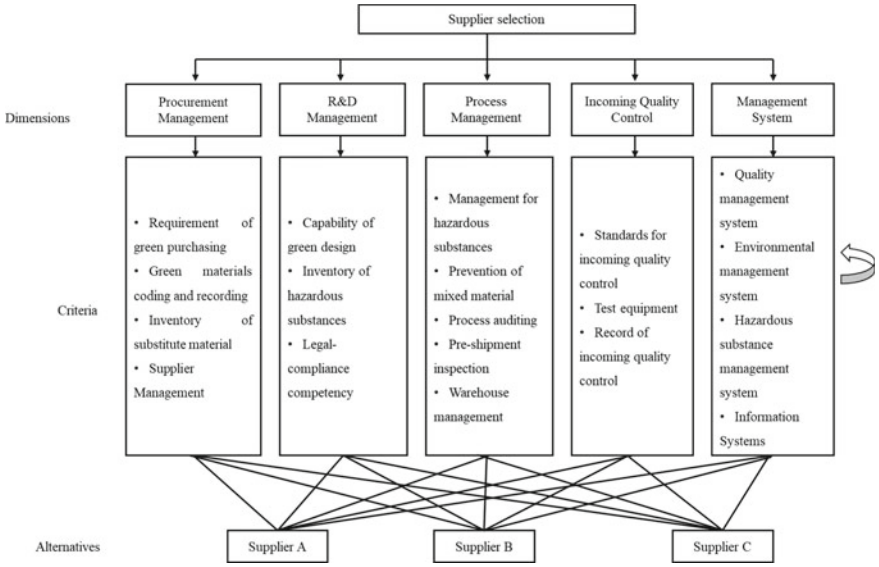


**Fig. 5** ANP-based model for selecting supplier to HSM (Hsu and Hu 2009)

Through the ANP, the authors were able to verify quantitative and qualitative criteria that can contribute to the decision process. Since there is a choice in the selection of suppliers, there are also interdependent relationships that can interfere in the process of evaluating and selecting suppliers. Companies can use the framework if they need to select HSM suppliers, following GSCM practices.

The model is relevant since it presents the selection of suppliers with an emphasis on HSM. Regarding the method used, through the use of ANP, it is possible to collect qualitative and quantitative data.

In the article "Environmental information from stakeholders supporting product development", environmental information related to the product development process was identified, collected and compiled, first, from the perspective of external stakeholders (Aschehoug et al. 2012). Next, compared to the perspective of internal stakeholders. In this way, it was sought to understand which environmental information (EI) and environmental expectations (EE) is available by external stakeholders, as well as to understand which EI and EE the internal stakeholders knew (Fig. 6).

External stakeholders were considered: government, customers, consumers, competitors, suppliers, media, non-governmental organizations (NGOs), community, financial institutions, academia, alliance partners, shareholders. As internal stakeholders, company areas were included: sales, marketing, product development, procurement, production, logistics, management and human resources (HR).

One of the results found by the authors stands out since they highlight the importance of product development. Such activity is highly dependent on information and must use EI and EE strategically. The development of a product must consider aspects

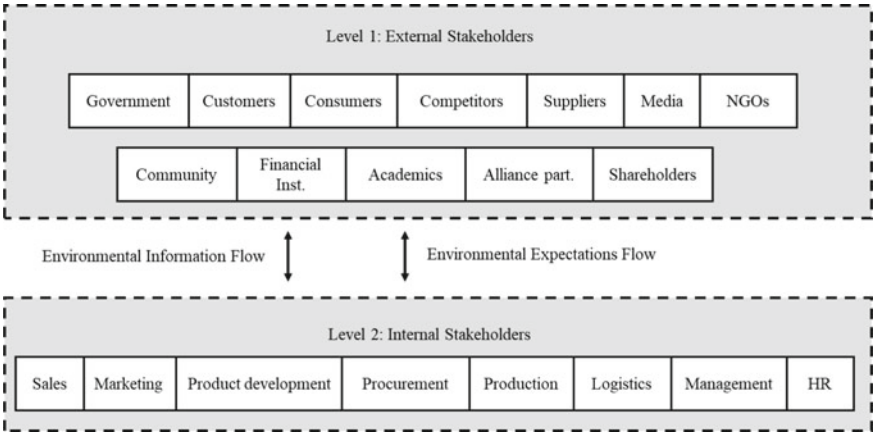


**Fig. 6** EI and EE flow among stakeholders (Adaptado) (Aschehoug et al. 2012)

related to functionality, quality, and cost, as well as add value to the customer, and as a result, increase the competitiveness of companies.

Therefore, after the presentation of the main models, those that have greater adherence to the present study also have gaps related to operations factors, that is, a large part of the models addresses GSCM with green purchasing and suppliers, but do not relate topics such as green manufacturing, and green distribution.

## 5 Final Considerations

This article presented a theoretical discussion on the influence of a GSCM approach on IPDP, presenting relevant research in the area. The present study is a continuation of a systematic and bibliometric review and content analysis of the article: Integrated product development process and green supply chain management: Contributions, limitations, and applications (Uemura Reche et al. 2020). The new study search on the Periodical Portal of Capes aimed to analyze publications from the second half of 2018 and the year 2019, through the contributions and limitations of the studies.

From this article on, the need to integrate the GSCM and IPDP approach is highlighted, enabling companies to develop environmentally sustainable products. Although there are many relevant articles published involving the two approaches, these occur in isolation. Thus, the need to propose a model that can integrate these approaches is highlighted. The five models presented in the article can be used as important bibliographic references for the development of a future model capable of integrating IPDP and GSCM.

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# Corporate Social Responsibility According to Employee Perception: The Case of an Energy Company


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## 1 Introduction

Corporate Social Responsibility has been gaining global importance, especially after the publication of the "Sustainable Development Goals" (Gunawan et al. 2020; Khalili et al. 2017; Martins et al. 2019a, b). Much of this importance stems from the pressure exerted by stakeholders, who demand processes, products and services with relevant societal impacts and an appropriate stance on environmental and social issues. According to Abedini et al. (2020) and Gomes et al. (2019), the inclusion of

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Corporate Social Responsibility guidelines in the strategies and routine of companies provides competitive advantages for organizations.

This study addresses the perception of concepts related to CSR by workers from an operational unit of an energy company and identifies the actions of the company that contribute to forming this perception. The perception of the internal public, an essential stakeholder, was obtained by simple association; workers manifested themselves regarding their opinions on what was a "socially responsible company". After the theoretical background was associated with the collected data, the different conceptions of CSR by workers on the object of study were identified. The theme choice is justified by the context and the presented objective, given there is a gap in the literature especially considering the point of view of organizational practices and scientific demands.

## 2 The Concept of Corporate Social Responsibility (CSR)

Carroll (1999) proposes a historical description of CSR processes that, although by no means definitive, helps to situate the evolution of such concepts, starting from the academic literature and going through the adoption of CSR practices by companies and international corporations. The author describes at least five distinct moments: (a) the beginning and development of initial concepts in the 1950s; (b) the expansion of literature on the subject in the 1960s; (c) the proliferation of definitions in the 1970s; (d) the research and search for related and alternative themes in the 1980s; and (e) the consolidation of CSR as a starting point for other studies in the 1990s.

Tenório (2015) states that corporate social activity arose at the beginning of the twentieth century with philanthropy. Thus, the concepts of CSR were confused with those of philanthropy. This scenario only began to change with the incorporation of social actions by companies, oftentimes aimed at workers themselves, who revolted in the face of long working hours and low wages (Waddock 2008). As such, these consequences of industrialization led Henry Ford to establish, in the 1920s, minimum wage and maximum working hours of eight hours a day on the automotive production line, attesting that his company had a social role with responsibilities to workers and consumers (Tenório 2015).

According to Carroll (1979), corporate social responsibility covers the economic, legal, ethical and discretionary expectations that society has of corporations, assuming that the economic component is inseparable from business performance.

However, the responsibilities of companies would not be exhausted in this sphere, since there would still exist three other equally important dimensions (Carroll 1999; Carroll and Shabana 2010): (a) legal liability: compliance with laws to ensure that products follow safety standards and follow environmental regulations established in the legal and institutional environment in which the business operates; (b) ethical responsibility: the decision-making by companies should be the result of ethical analysis and reflection, requiring decisions that broadly consider the effects of actions

and respect for the rights and interests of stakeholders; discretionary (or philanthropic) responsibility: it comes from the expectation that the company will contribute resources to the community by seeking to improve quality of life. Such actions would be a response to social expectations and represent voluntary action to address social issues.

In the 1980s, according to Carroll (1999), studies on scientific administration began to explore topics related to the role of companies in society, which focus on the issues already addressed by CSR. Drucker contributes by emphasizing that CSR should be seen as a process and not just as a set of rules, moral standards, or even performance and results, reinforcing the idea that businesses should align their social responsibilities to their opportunities.

In the late 1990s, the contribution of Elkington (2001) was important in the discussion related to CSR and sustainability. This was outlined through the concept of "triple bottom line". The literature emphasized the need for management to consider environmental issues able to cause complete degradation of ecosystems (such as use of natural resources, climate change, greenhouse effect, etc.) as well as social issues (such as income inequality, poverty, hunger, food shortages, epidemics) which could deprecate consumer markets and the needed social environment for prosperity.

Currently, the academic community acknowledges the importance of Elkington's (2001) proposition regarding CSR, namely the inclusion of social, environmental and economic impacts in the analysis of the company's operations. The concept of "triple bottom line" gained support both in academia (Bakker et al. 2005; Dahlsrud 2008; Alcañiz et al. 2010) and in business practices (European Commission 2001; Brazilian Association of Technical Standards 2010).

Mohan (2003) suggests that the notions of stakeholder management, sustainability and corporate citizenship would arise from the simple appreciation of certain aspects with the same grounds as "concepts addressed within the concept of business social responsibility" (Mohan, 2003, p. 288).

Carrol and Shabana (2010) conceptually define the basis of CSR, including economic development and compliance to law at least for American authors; European references tend to consider actions that go beyond legislation (Matten and Moon 2008). This concept also includes governance and ethics in organizations, in addition to voluntary action to address social issues.

Different arguments condemn or defend socially responsible practices. Tenório (2015) states that there is a wide range of motivations that might lead a company to adhere to CSR; they stem from company expectations in a post-industrial society that, among other reasons, might go beyond profitability and job generation.

The European Commission's Green Paper (2001) proposes a two-fold organization of CSR: one related to internal aspects, that is, organizational management such as human resources, environmental issues, compliance, accountability and other aspects related to personnel management, governance and SHE (Safety, Health and Environmental Management); and another related to external aspects that deal with social responsibility to external stakeholders, like investors, local communities, third sector organizations, suppliers, business partners, clients, competitors, the press, and others (European Commission 2001).

Furthermore, to develop the discussion on CSR practices with regard to stakeholders, it might be interesting to create a classification beyond the traditional differentiation between implicit (that is, conventions, requirements, values, norms and both voluntary and legally enforced policies) and explicit manifestations (mainly taking responsibility regarding stakeholders) that contemplates precisely how the development of such practices can be perceived by specific stakeholders.

For Matten and Moon (2005, 2008), although there are many differences between different markets for example, mandatory legal requirements in the European Union might be discretionary in the United States and other parts of the world it would be possible to distinguish two types of CSR practices. Implicit CSR would mean parameters and "formal and informal national requirements" (Matten and Moon 2005, p. 324) by means of which responsibility towards society is attributed to corporations, including values, standards and rules, expressed in codes and legislation, which would represent expectations regarding the social activities of the company. Explicit CSR in turn would refer to the aspects of the company itself that might lead it to fulfill some social expectation, such as CSR policies, voluntary and social investment actions, impact mitigation, and others.

## 3 Policies, Standards and Trends in CSR

Among the guiding principles for companies, the United Nations Global Compact is probably the most widespread one. Promoted by former UN Secretary Kofi Annan, this is part of the UN strategy to stimulate the adoption of CSR and sustainability policies by companies. This is turn would promote information exchange between the UN, companies, unions, third-sector organizations, as well as other stakeholders, in order to develop a more inclusive and more sustainable global market.

The Millennium Development Goals established by the UN in 2000, with the support of 191 nations, are also important guidelines. In its first version, eight measurable goals were set for 2015 in order to combat poverty, hunger, disease, illiteracy, environmental degradation, and discrimination against women. These principles were expanded in the 2030 Agenda, from 17 Sustainable Development Goals up to 169 goals to be achieved in the coming years (United Nations 2015).

A particularly relevant international standard regarding CSR is ISO 26,000, developed over five years and published in Nov 2010 by 600 experts and observers from around 100 countries. It organizes multiple questions related to social responsibility between seven major core themes (human rights; work practices; environment; fair operating practices; consumer issues; community involvement and development; and organizational governance) and many subthemes.

In Brazil, the NBR 16001—Social Responsibility—Management Systems—Requirements was published in 2004. It defined minimum requirements for CSR management systems, especially considering the organization's recognition, taking into account policies and objectives that consider legal requirements, stakeholder

expectations, ethical commitment, transparency, citizenship and sustainable development.

The norm is based on Elkington's (2001) three dimensions of sustainability (economic, environmental and social) as well as the management methodology known as PDCA, or Plan-Do-Check-Act (Associação Brasileira de Normas Técnicas 2010). The objectives required for a good CSR management system should consider: (a) good governance practices; (b) fighting piracy, tax evasion, and corruption; (c) fair competition; (d) rights of children and adolescents (including fighting against child labor); (e) workers' rights (including freedom of association, fair remuneration, basic benefits and being against forced labor); (f) promoting diversity and fighting discrimination; (g) commitment to professional development; (h) health and safety promotion; (i) promotion of sustainable patterns of development, production, distribution and consumption; (j) protection of the environment and the rights of future generations; and (k) social actions of public interest.

Throughout the history of CSR, the notion of corporative responsibilities toward stakeholders considering for example social issues within its scope of responsibilities is not fully agreed upon.

The works of Freeman (2010) were important to develop and popularize the theory of stakeholders, emphasizing the importance of taking such matters into account during management topics raised by groups affecting or affected by the company's operations. That is, it is necessary for management to be guided by a "principle of who or what really counts" (Freeman 2010, p. 413) for the organization, and that is beyond the interests of the owners or shareholders. By acknowledging that there are other stakeholders in the organization who have some legitimate right or objective with respect to the organization, modern corporations can use management tools to address them (Freeman 2010).

These issues are addressed in this study, as it engages with the theory of stakeholders and investigates perceptions, behaviors and responses of workers of a given company. Similarly to consumer and investor surveys, surveys with an organization's workforce should consider the particularities of this type of stakeholder, allowing to investigate not a purchase or an investment, but whether workers show a stronger commitment to the organization when they perceive the company as socially responsible.

## 4 Methodology

The main objective of this study is to map the perceptions of workers regarding the CSR of a large company in the energy sector in Brazil and identify the actions of the company that contribute to this perception. Thus, the research method can be classified as descriptive and exploratory. A questionnaire was applied to 50 workers of an energy company, working in an operations unit located in Manaus (AM), with data collection occurring throughout 2017. The addressed operations unit is part of a large company in the Brazilian energy sector that states its social responsibility policy

"is based on continuous and transparent dialogue with the local communities", in investment in social and environmental programs and projects, as well as management of socio-environmental aspects and prevention of impacts on the supply chain, while also promoting the knowledge and commitment of workers. The participants in this case study (selected non-randomly, and according to convenience) were aged between 30 and 66 years old (mean of 43 years and standard deviation of 12.5), most of them male (65.5%). The educational level of the sample is considered high (all with high school education and 63% had at least higher education), and 45% worked between 6 and 10 years in the company, 15% between 11 and 15 years, ten between 20 and 25 years, 20% between 26 and 30 years, and ten worked for more than 30 years in the company. Two-thirds work with operational functions, in full or partial confinement, and 36% under administrative regime. The answers to the tasks of free association were recorded, as well as the socio-professional questions answered by the participants, in order to allow the description of the sample.

Participants were instructed to write "words or expressions that come to mind when thinking of a socially responsible company". Participants were encouraged to issue as many responses as possible. No other instruction or direction was given during the task. This approach serves to capture both the most transversal and long-term ideas associated with CSR. The collected data were then subjected to content analysis (Bardin 1979; Krippendorff 1980). The 50 answers were analyzed in order to allow the process of selecting the text segments to be further analyzed. Initially, an emerging encoding technique was applied, that uses the to-be encoded data to create an encoding scheme, based on the transcription and skimming of the given answers (Bardin 1979).

After this analysis, we used as a thematic criterion the categories proposed by the Perceived Corporate Social Responsibility Scale (PCSR-Scale), a widespread instrument developed to investigate the perception of stakeholders on the variety of practices that companies might implement regarding socially responsible behaviors. The scale factors in 28 items related to CSR practices and have been applied or adapted to many different studies (Brammer et al. 2007; Valentine and Fleischman 2008; Turker 2009; Tziner et al. 2011; Duarte and Neves 2012; Singhapakdi et al. 2015). This is how the category system an analysis of structured content was set up with semantically coherent sets of registration units, each having a specific code to be applied during the encoding process.

Based on this, excerpts from the participants' answers were grouped; sections of the answers that referred to the same theme could be words, expressions or even entire sentences—that is, there was no maximum size for a record unit. As a contextual unit, the response of that particular participant was considered as a whole.

## 5 Data Collection

A questionnaire was applied to 50 workers of an energy company working in an operations unit situated in Manaus, AM, with data collection occurring throughout the year 2017.

The participants wrote between 1 and 12 answers each for a total of 149 different ones (mean of 2.98 responses per participant, with standard deviation 1.31) that were aggregated into the aforementioned 28 categories. One answer was eliminated from the sample because the worker stated that social responsibility has to do with when the company gives gifts to workers and the community, an item that was considered despite not being able to be classified into any thematic category addressed by the PCSR-Scale. Table 1 includes the list of categories and the number of participants who mentioned each category.

**Table 1** Classification of results according to the categories of the PCSR-scale

| Category | Mentions | % of sample (%) |
|---|---|---|
| Invests in social projects of third sector organizations | 26 | 52 |
| Develops environmental conservation projects | 15 | 30 |
| Supports cultural and educational initiatives | 13 | 26 |
| Invests and develops social actions in local communities | 13 | 26 |
| Develops internal rules that guide ethical behavior | 12 | 24 |
| Invests in environmental protection associations | 10 | 20 |
| Has a good reputation within the local community | 9 | 18 |
| Supports and encourages sporting activities | 8 | 16 |
| Collectively supports social causes | 7 | 14 |
| Supports professional integration of people with disabilities | 6 | 12 |
| It is a good place to work | 5 | 10 |
| Promotes gender equality | 5 | 10 |
| Strives to be profitable | 4 | 8 |
| Supports supply chain development | 3 | 6 |
| Strives to be one of the best companies in its field | 3 | 6 |
| Complies with labor legislation | 3 | 6 |
| Promotes work-life balance | 2 | 4 |
| Encourages professional development of its workers | 2 | 4 |
| Ensures job security | 1 | 1.6 |
| Ensures the timely payment of salaries and financial commitments | 1 | 1.6 |
| Offers gifts for workers, family and community | 1 | 1.6 |

*Source* The Authors (2020)

## 6 Discussion

Generally, for just over half of the participants in this study, there is a strong relationship between socially responsible action and investment in social and environmental projects. By analyzing the context of the company, it can be assumed that the visibility achieved by advertising linked to public selections of projects can contribute to such perception of CSR as investment in social responsibility projects.

A significant portion of the participants associated social responsibility to development of projects with neighboring communities or other communities directly impacted by the company's operations. An alignment between this kind of understanding to what is said on the company's social responsibility policy can be seen wherein the latter specifically prioritizes the process of community actions within the company's surroundings. This makes social investment one of the ways to work with local communities. The workers' understanding suggests that social investment in neighboring communities would be the most widespread way to ensure social responsibility in this operations unit, including mentions to a specific social project by five of the 26 interviewed workers that agree that investment on social projects expresses CSR.

There was also a perception that the company's social responsibility is related to investment in cultural or sporting projects. Although this is not a position of the company which, in its balance sheet, counts investments in cultural and sports sponsorships separately from CSR projects this distinction does not seem to be considered as important according to the workers' perception. Moreover, it seems to be the effect that the perception of investment in social and environmental projects, as well as cultural and sporting ones, have caused in an operations unit in the Amazon, which should be related to initiatives aimed at Amazonian communities or that act within that region, as well as the promotion of regional customs and culture.

The share of participants who related social responsibility to economic aspects (8%) was considered small, according to the CSR literature. In the mentions found, the notion that a socially responsible company must be able to meet its financial commitments without becoming indebted and generate social benefits in terms of jobs and taxes can be observed. A better evaluation of such social representation would require interviews to relate these perceptions with the evaluation of the company's economic performance.

None of the participants who mentioned economic aspects in their definition of a socially responsible company made any mention of investment in social projects; however, there was within this group of respondents some mention of the term sustainability. Just as the notion of investment in projects may seem like an extra expense, or unrelated to the company's business, among these workers, being profitable and financially responsible was acknowledged as important for the continuity of the company's operations.

Mentions of external CSR aspects which implies the relationship with external stakeholders, in particular local communities, third sector organizations and investors were more frequent than internal aspects aimed at human resources management,

human capital management, governance, as well as SHE (Safety, Health and Environmental Management) (European Commission 2001; Matten and Moon 2008). Among the most frequent perceptions related to internal CSR are the link between social responsibility job satisfaction (the notion that a socially responsible company must be a good place for work) and maintaining a good work environment, allowing to balance professional and personal aspects. There were also noticeable perceptions of CSR related to environmental management, ethics and transparency.

On the other hand, the less mentioned themes or notions were those related to relationships with suppliers (not a part of the company's CSR policies, which prioritizes this group as a value chain) as well as internal CSR that notably directly affect workers, such as job security and timely payment of wages. A possible explanation is that, given the company's history of punctual payments and its statute that guarantees relative job stability, such a matter may not generate much concern to the workers. Another hypothesis would be the understanding of these essentially labor issues as detached from the concept of CSR. As such, conducting further interviews with workers in order to determine why these aspects were not favored for their definition of social responsibility is recommended.

## 7 Conclusions

This study analyzed perceptions about the concept of CSR, exploring the meaning attributed to it by the workers of an energy company operating in the Brazilian Amazon. By quantifying content recording units and performing qualitative analysis of these data, we verified whether the perceptions of scholars and theoreticians met the perception of workers about what is social responsibility, and which dimensions are more consolidated in this workplace.

The results concerning the presented perceptions suggest the existence of different dimensions of CSR discussed in the literature on the subject. The most recurrent conception of CSR is related to the corporative support of social, environmental, cultural and sporting projects, and working with neighboring communities through support of social causes. Other often mentioned aspects were good environmental management, a good work environment, standards for ethics and transparency, as well as concern for social and environmental well-being. The notion that a socially responsible company would guarantee the respect and inclusion of people with disabilities and would strive to ensure gender and racial equity was also observed. Seldom mentioned were economic aspects (profitability and good business management) and labor issues such as remuneration, job stability and attention to suppliers.

Thus, aspects of external CSR were more often associated to social responsibility in this particular case compared to aspects of internal CSR. Furthermore, activities classified according to the theoretical framework as explicit CSR (actions taken regarding a particular group of stakeholders, especially communities) were also more frequent than implicit CSR (conventions, values, and policies introduced

voluntarily or by legal force), even in items that refer to the financial return and legal commitments made with regards to workers themselves.

Despite the growing debate around CSR, the effort to raise theoretical reference on representations and perceptions of stakeholders about the concept still deserves to be the target of a higher number of studies. In this case study, we explored the social meaning of CSR by analyzing qualitative data, thus contributing to the scope of qualitative investigations that examine how individuals define corporate social responsibilities in general (Maignan 2001; Matten and Moon 2008; Duarte and Neves 2012). The results suggest a multidimensional conceptualization of socially responsible corporations on the part of the participants, although the aspects of external and explicit CSR prevailed over the internal and implicit aspects in this specific case.

Aligned with definitions that propose the adoption of social and environmental considerations in business operations as an important part of corporate social responsibilities (Carroll 1999; Bakker et al. 2005; Dahlsrud 2008), it seems critical that current definitions of CSR consider how organizations manage their relationships with different stakeholders. However, in the evaluated case, the relationship or responsibility towards some of the stakeholders did not prevail, especially public suppliers; they were only mentioned once. Consumers, on the other hand, were not even cited. Given the emphasis stakeholder management receives in the literature on CSR, this may be unexpected. Just as surprising is the notion that the main target of socially responsible actions most often mentioned by the participants would be directed towards local communities and, secondly, the environment, even before the workers themselves. Also considered significant are notions that incorporate ethical and legal business responsibilities (Carroll 1999; Dahlsrud 2008), in this case covering both implicit (mandatory or non-mandatory) and explicit corporate responsibilities (Matten and Moon 2008).

In addition, the results of this study indicate that the dimensions proposed in the Perceived Corporate Social Responsibility Scale (PCSR-Scale) are relevant for workers in the Brazilian context, since all of them were mentioned at least once by the group of workers participating in the research. The less mentioned dimensions of the PCSR-Scale in the free association answers of the participants are those closer to the traditional representation of corporate responsibility (with prevalence of the economic aspects of profitability and management) as well as the responsibilities towards workers closer to economic and legal aspects, such as wage payment, stability and compliance with labor legislation.

However, it is worth noting that this is an exploratory and qualitative study that does not claim to argue statistical validity, or be extensible to any other companies or even other units of operation within the same company analyzed. In addition, the results did not provide support for socio-professional variations (position, level of education, age group). For such, a larger sample would be necessary, as well as the use of statistical analysis tools that were not applied in this study. Despite these limitations, the results may be useful for the management of this unit, since they allow a better understanding of aspects that workers relate to CSR, in addition to serving as a basis for future studies.

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# Approaches Towards Resource Efficiency (e.g. Energy, Water, Wastes, Materials)

# Mining Sustainability Practices in Latin America


**Alejandra Mallqui, Edson Pinheiro de Lima, and Sandro César Bortoluzzi**

## 1 Introduction

Advances throughout human history have been marked by the contribution of metals, from the Bronze and Iron Ages through the lead, copper and tin mines of the Romans to the Industrial Revolution. In today's technological age metals and minerals remain essential in almost all aspects of life; they enable farming, healthcare, communications, water and energy supply, transport, space technology and the construction of our cities (ICMM 2019).

Giurco and Cooper (2012) emphasize that minerals and metals have a key role in the prosperity of current and future civilizations. However, their use in future sustainable societies requires their production and use with greater ingenuity and wisdom to ensure that sustainability criteria and including social and environmental goals are served throughout the commodity life cycle.

Gomes et al. (2014) consider that the mining industry has many challenges concerning sustainability regarding their companies 'strategies and operations, given its extractive nature and the numerous social and environmental impacts related to their productive activity.

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With its abundance and variety of minerals, Latin America attracts much of the investment and exploitation worldwide. According to data from Mineral Commodity Summaries (2019), Chile is the main copper producer, Brazil the second iron, Mexico the largest producer of silver and Peru is among the first of silver, copper, gold, and lead. Also, the region remains one of the main mining reserves in the world, with outstanding participation in metallic minerals such as lithium (71.8%), known as "white gold", copper (36.5%), nickel (20.6%) and silver (34.8%). Only Brazil owns about 80% of the world's reserves of niobium, a mineral that is used to make the steel stronger and lighter, while Chile and Argentina are two of the main global lithium deposits.

Unquestionably, as commented by Escanciano et al. (2010), mining activities have important economic, environmental, labor and social repercussions at local and global levels and in the case of Latin America that has emblematic cases as Tía María in Arequipa, Peru, where protests by farmers in the area ended with violent clashes that left four dead and 300 injured in 2015. Another unfortunate case was the worst tailings catastrophe recorded to date. The inactive tailings deposit of the mining company Córrego do Feijão in Brumadinho, Brazil, collapsed releasing tons of waste that caused 257 deaths and irreparable environmental damage in 2019, just four years after a similar disaster occurred in the neighbor locality of Mariana in Minas Gerais, Brazil. In Mexico, it must be added to the presence of organized crime in the industry, especially in northern states, where there are alliances between mining and drug trafficking groups.

Therefore, exploring the current state of implementation of corporate sustainability activities (CSA) in the Latin American mining industry is an activity that must have constant academic attention. This type of study allows us to carry out an X-ray of how the Latin American mining sector is currently regarding corporate sustainability activities and how the challenges related to the adoption of sustainability management have evolved.

That said, the objective of this paper is identified and examine current dominant practices in the mining industry in Latin America. To achieve this objective, a multidimensional framework is applied to analyze and classify the implementation of these activities in three different angles: the types of corporate sustainability activities, the issues addressed, and the step of the value chain concerned. The research adopts a content analysis of sustainability reports from the main mining companies in Latin America. While one can argue that self-reported and most often voluntarily disclosed corporate sustainability activities cannot be equated with actual corporate sustainability activities, self-reported CSA can act as a proxy to determine corporate priorities and attitudes (Ihlen and Roper 2014; Sharma and Henriques 2005). Finally, it describes sustainability based on the projects that these companies are developing to build a sustainable operations strategic vision. The contribution of this study is to collect and identify the current situation of the implementation of Corporate Sustainability Activities in the main mining companies in Latin America. The paper is structured in five sections, in addition to this introduction. Section 1 corresponds to the theoretical foundations and Sect. 2 covers the methodological procedures

of the study. Subsequently, the analysis of results, new projects in developing and conclusion follow.

## 2 Literature Review

A systematic analysis of the literature was carried out to look at the best ways to classify and analyze the practices that form the sustainable operations of a mining company.

Wirth et al. (2016) carry out an analysis of CSR activities to ten copper producing mining companies where they analyze their activities and practices in small and medium enterprises. Where they indicate that the main copper producers carry out practices related to the health, safety, and education of employees, relationships with local communities, public health, environmental protection, and waste management.

Vintró et al. (2014) examine the adoption of environmental practices in small and medium-sized companies in the surface mining industry in Catalonia, Spain. Some examples of good environmentally sustainable were restoration plans in mine closure, annual declaration of waste, energy sources consumption control, mining source reduction, environmental goals definition, environmental emergency protocols, internal audits, energetic audits and cooperation with environmental NGOs.

Ventura and Saenz (2015) use a framework built upon a set of best practices in social responsibility by some of the largest mining companies in Peru. This model has three dimensions: economic, social and environmental. CSR (Corporate social responsibility) initiatives were found to be very similar across companies. Among the most frequent initiatives, water supply, and sanitation, environmental actions, and social development programs stand out.

Dery et al. (2019) undertake a systematic literature review of environmental policy measures and considers its broader implications for sustainable development in the context of gold mining in Sub-Saharan Africa. The practices found were related to the topics of mercury pollution abatement, stringent implementation of mining policies, stakeholder participation, human rights, green technologies, formalization of ASM, fair trade certification and environmental disclosure.

Ranangen and Lindman (2017) examine the Nordic mining industry's sustainability practices and to develop guidelines for such efforts. The summarized findings resulted in sustainability criteria guidelines for the Nordic mining industry: Corporate governance (stakeholder management, respect for laws and regulations, self-regulatory practices and management systems, risk management); Fair operating practices (Anti-corruption, responsible political involvement, fair competition); Economic aspects (Economic performance, indirect economic impact on society, procurement practices; Human rights (non-discrimination, freedom of association and collective bargaining, indigenous rights); Labor practices (Employment, training and education, occupational health and safety, diversity and equal opportunity, social security, labor/management relations); Society (Local communities, employment

creation, and skills, wealth and income creation, social investment); The environment (Sustainable resource use, energy, water, sustainable land use, emissions, effluents and waste, sustainable transport, biodiversity, climate change mitigation and adoption, recycling of metals).

Gomes et al. (2014, 2015) analyzed the management practices for sustainability based on ten principles for sustainable development in the mining industry developed by ICMM.

Fuisz-Kehrbach (2015) examines the current implementation status of corporate sustainability activities (CSA) in the mining industry, also proposes and applies a multi-dimensional framework to analyze the implementation of CSA from three different angles: (1) the types of CSA from philanthropic to entrepreneurial activities, (2) The issues addressed (e.g., health, safety, environment) and (3) The step of the value chain concerned, i.e., supply, production or product-related sustainability activities.

A general synthesis of the works found leads to the importance of adopting sustainable practices throughout the entire mining operations process. The environmental impacts and practices of mining have received more attention in the studies. The papers largely have a classification considering the economic, social and environmental dimensions and based on the principles developed by ICMM.

The content analysis that is carried out in this paper uses the framework proposed by Fuisz-Kehrbach (2015). It is a three-dimensional framework to analyze corporate sustainability activities in the mining industry.

## *2.1 Dimension 1: Types of Corporate Sustainability Activities*

The four types allow for two different perspectives: On the one hand, the four components can mark a maturation or professionalization pathway from corporate philanthropy to sustainable entrepreneurship. On this pathway, certain sustainability activities need to be conducted first, involving the development of certain resources and capabilities before heading to more ambitious sustainability activities (Hart 1995). Corporate philanthropy can be perceived as the least ambitious sustainability activity because donations and charity can be easily implemented and entirely separated from business, in contrast, to seriously integrating sustainability into corporate strategy (Chapple and Moon 2005). Sustainable entrepreneurship is on the far end of this pathway and is perceived as the most proactive and mature sustainability activity. It requires the company to fundamentally shift corporate culture and integrate sustainability considerations into business strategy, products, organizational processes and setup (Aragón-Correa et al. 2008; Hart 1995; Russo and Fouts 1997; Sharma and Vredenburg 1998; Shrivastava 1995). On the other hand, and apart from the sequential logic of path dependence, companies can apply the four types modularly and simultaneously side-by-side, depending on context (e.g., infrastructure development in remote and underdeveloped regions). This second perspective is nonjudgmental

and considers the four types as equitable also considering the growing professionalization and competitive relevance of strategic philanthropy (Fombrun et al. 2000; Godfrey 2005; Porter and Kramer 2002, 2006).

## *2.2 Dimension 2: Sustainability Issues Addressed*

One top priority sustainability issue in mining is workforce safety (International Mining 2019). Mining companies would increase safety disclosure as a response to stakeholder scrutiny on the hazardous work environment that regularly leads to serious injuries and fatalities (Coetzee and van Staden 2011). This supporting, Yongvanich and Guthrie (2007), as well as Deegan et al. (2002), found employee health and safety a widely reported and dominant disclosure element. Another important sustainability issue that receives growing attention in reporting is disclosure on social performance (Perez and Sanchez 2009). Apart from health, safety, and social issues also environmental aspects are said to dominate mining companies, information disclosure and would constantly evolve in comprehensiveness and depth (Deegan et al. 2002; Guenther et al. 2007; Perez and Sanchez 2009).

Also, the issue-dimension allows for a maturation perspective: Jenkins (2004) and Jenkins and Yakovleva (2006) portrayed a shift in the mining sector from addressing fragmented single sustainability issues, such as the aforementioned safety or environmental issues, towards more holistic approaches. Similarly, mining company policies would evolve from rather internally oriented health, safety, employee well-being, and environmental policies to overarching sustainability and CSR policies. This more integrated approach would consider the often-interwoven complexities of sustainability issues and account for reciprocal effects between different sustainability issues. To conclude, mining companies, CSA can be described to be addressing environmental, health, safety, social, and integrated issues.

## *2.3 Dimension 3: Components Across the Value Chain*

A third dimension in the framework covers the different steps of the value chain that corporate sustainability activities can address. In general, the value chain can be separated into three broad steps: Supply, production, and product (Guziana and Dobers 2013; Weinhofer and Busch 2013) (Table 1).

Research design is then presented stating how data is collected and analyzed.

**Table 1** Description of a three-dimensional framework of corporate sustainability activities (CSA)

| Dimension | Code | Definition |
|---|---|---|
| Type | Corporate philanthropy | Philanthropic engagement with no direct link to business activity ("patron"); ad hoc activity resulting in primary benefits for society and intangible benefits for the company (reputation) e.g., corporate volunteering, charitable contributions |
| | Corporate social responsibility | Altruistic and business accompanying behavior exceeding business goals; company as an active recipient of sustainability issues that evolve in collaboration with stakeholders; primary beneficiary is society and intangibly firm (trust) e.g., community development projects |
| | Corporate sustainability management | Sustainability in line with business goals; voluntary and compulsory, systematic management of core business ("issue manager") tangibly benefitting firm's financial bottom line e.g., energy efficiency, legal compliance, risk management, reporting, management systems |
| | Sustainable entrepreneurship | Full integration of societal and business goals; sustainability as core business; company as proactive developer shaping core business and markets tangibly benefiting firm's financial top line e.g., green product innovation |
| Issue | Environment | Activities related to the environment such as water, energy, waste, pollution, biodiversity, material stewardship |
| | Health | Activities related to health issues such as mining ventilation, silicosis, fatigue management, noise induced hearing loss |
| | Safety | Activities related to safety issues such as safety trainings, incident investigation, fatal risk standards |
| | Social | Activities related to social issues such as local community development, human rights, indigenous, human resources |

(continued)

**Table 1** (continued)

| Dimension | Code | Definition |
|---|---|---|
| | Integrated | Activities that cover more than one issue e.g., sustainability management systems or sustainability committee covering environmental, health, safety, and social issues or are not further specified |
| Value chain step | Supply | Activities related to external suppliers such as the development of local suppliers, safety training for contracted drilling and blasting team, requesting environmental standards from the producer of large haul trucks or earthmoving equipment manufacturer |
| | Production | Activities related to mining companies, own operations from exploration to mine closure such as waste management during the exploration phase, employee safety, rehabilitation of land after shut down of operations |
| | Product | Activities related to product,s use and end of life-cycle such as recycling facilities for metals and reuse of material |
| | Non-allocable (NA) | Activities that cover more than one step e.g., policy relevant for suppliers, as well as own employees or, are not allocatable to any specific value chain step e.g., charitable contributions |

*Source* Fuisz-Kehrbach (2015)

## 3 Research Design

The three-dimensional framework presented above is applied empirically through a content analysis of sustainability reports for seven Latin American mining companies, it was considered the last sustainability report published on its website (year 2018). This research design has been chosen because content analysis of corporate sustainability disclosure allows for a systematic and consistent investigation and is an appropriate research method to examine comparative positions and trends in reporting (Pellegrino and Lodhia 2012). Moreover, content analysis is the dominant and traditional research method to investigate the sustainability disclosure practices of companies (Coetzee and van Staden 2011; Fifka 2013; Parker 2005). Content analysis of sustainability reports is not without criticism due to the use of impression management tactics and the manipulative potential of voluntary corporate disclosure

(Cho et al. 2012; Laufer 2003; Milne and Gray 2007) and the threat to subjectively translate qualitative data into quantitative results (Deegan and Rankin 1996; Guthrie and Abeysekera 2006). However, sustainability reports are said to be representative of the corporate attitude towards sustainability (Ihlen and Roper 2014).

The seven cases are chosen considering the mining operations found in the countries with the greatest representation in Latin America. We consider Chile to be the main copper producer, Brazil the second iron producer, Mexico the largest silver producer, Peru that is among the first silver, copper, gold and lead producers and Argentina that together with Chile has the largest lithium reserves (U.S. Geological Survey 2019).

Another point to consider when choosing mining companies was that the sustainability report of the last year (2018) be published and that the scope of the report only covers mining operations in Latin America.

Table 2 provides an overview of sampled companies with background information on size (in sales) operating region, primary resource mined and report title and year.

The study applies a deductive coding approach (Eisenhardt 1989; Friese 2011). Table 1 was used as our agenda considering our coding base which has classified the code and definition of the three dimensions. The different components were codified in the sustainability reports and the number of individual corporate sustainability activities was counted.

**Table 2** Details of a company sample

| Company | Sales 2018 (mio. $) | Region of operations | Primary resource | Report name and year |
|---|---|---|---|---|
| Compañía Minera Antamina S.A | 3,426,578,751 | Peru | Copper, zinc, molybdenum, silver, lead, bismuth | Sustainability Report 2018 |
| Sociedad Minera Cerro Verde S.A.A | 3,061,900,000 | Peru | Copper, molybdenum | Sustainability Report 2018 |
| Antofagasta plc | 4,560,300,000 | Chile | Copper, molybdenum | Sustainability Report 2018 |
| BHP Billiton (Escondida, Pampa Norte) | 9,299,000,000 | Chile | Copper | Sustainability Report 2018 |
| Industrias Peñoles S.A.B de C.V | 4,314,049,841 | Mexico | Silver, gold, zinc, lead | Sustainability Development Report 2018 |
| Vale S.A | 2,988,000,000 | Brasil | Iron, Nickel, copper, and carbon | Sustainability Report 2018 |
| Pan American Silver Corp | 784,500,000 | Mexico, Peru, Bolivia, Argentina | Silver | Sustainability Report 2018 |

The reports were read line-by-line. Text sections (sentences or paragraphs in the text body, tables or graphics) that describe an actual sustainability activity were assigned to the three code categories and their components based on the pre-defined coding agenda. To avoid repetitive coding of the same activity all activities were tracked in a parallel Excel list. Descriptive statistics of CSA coding are analyzed using Excel spreadsheets.

## 4 Results and Discussion

Table 3 includes descriptive statistics for the analyzed sample. In total 471 CSA were coded on 557 pages of the report. The average report consists of 80 pages, ranging from 30 to 149 pages, and 67 sustainability activities with a spread from 44 to 93 CSA per report.

Concerning the types of CSA, Fig. 2 shows that the focus lies on corporate sustainability management (56% of coded CSA), which highlights the practices related to SHEC (safety, health, environmental and community) and governance which are those related to integrated policies, reportability, KPIs and risk management. This group also includes practices related to diversity and inclusion. Highlighting the commitment to increase and promote the presence of female employees, the average female presence in the mining companies of the study is 9.6%; being BHP the one with the highest percentage of 18% at the same time in June 2018 marked a milestone of gender equity with the appointment of the first general manager of a copper mining unit in Chile.

Only to a lesser extent on CSR (31%) which highlights the practices related to community education, local infrastructure, and local economic development. In this last point, all the companies studied promote the creation of employment and local purchases where they offer local suppliers support and support regarding bidding processes and reduced payment terms.

In entrepreneurial sustainability activities rank far behind (7%) which highlights the practices related to recycling and resource recovery, also corporate philanthropic (6%) which highlights the practices related to culture sponsoring activities (Fig. 1).

Mining companies, CSA cover a mix of different sustainability issues, i.e., integrated, environmental, health, safety, and social issues (Fig. 3). Social aspect clearly dominates with 47%, follow environment and integrated aspects with 24% and 17%

**Table 3** Descriptive statistics of corporate sustainability activities (CSA) codings

| Item | Total | Mean | Standard deviation | Minimum value | Maximum value |
|---|---|---|---|---|---|
| Number of report pages | 557 | 80 | 38 | 30 | 149 |
| Number of CSA codings | 494 | 71 | 16 | 50 | 96 |

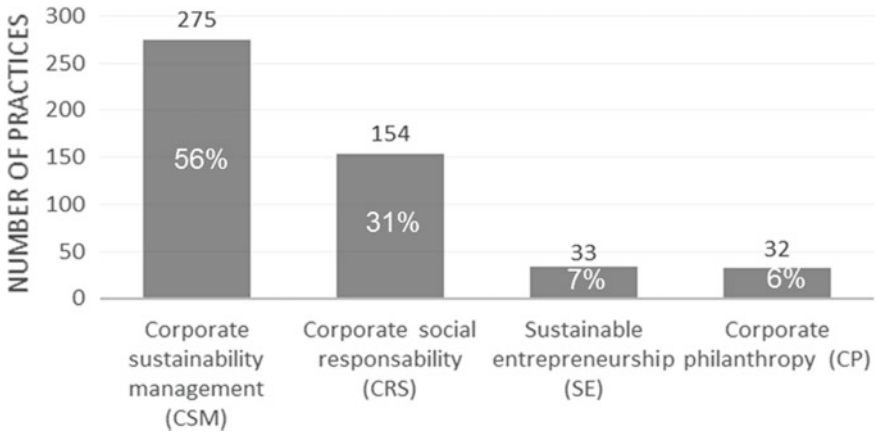



**Fig. 1** Distribution of corporate sustainability activities per type

respectively of coded CSA, whereas health and safety issues are mentioned by far to a lesser extent with 8 and 4%. It could draw attention that the health and safety aspects are low considering the importance that mining companies demonstrate in their sustainability reports included in most of it is considered part of their values. However, sustainability reports are largely targeted at the investment community that would be most concerned with environmental, social, economic and governance issues (Fuisz-Kehrbach 2015) (Fig. 2).

Concerning the steps of the value chain, practices are concentrated in the NA item (60%), which may correspond to activities that are not linked to the value chain or

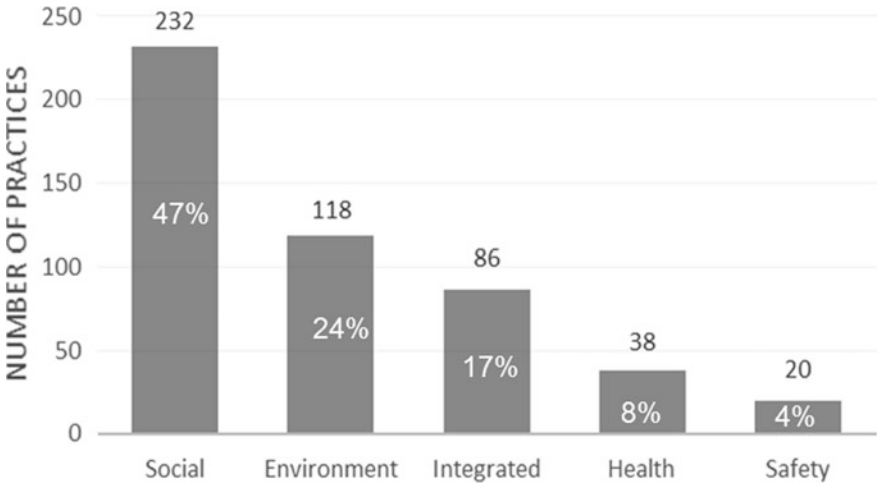



**Fig. 2** Distribution of corporate sustainability activities per issue

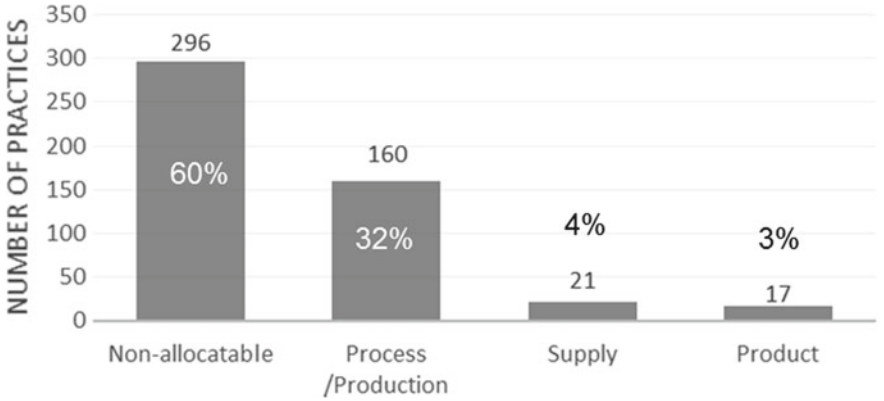



**Fig. 3** Distribution of corporate sustainability activities per value chain step

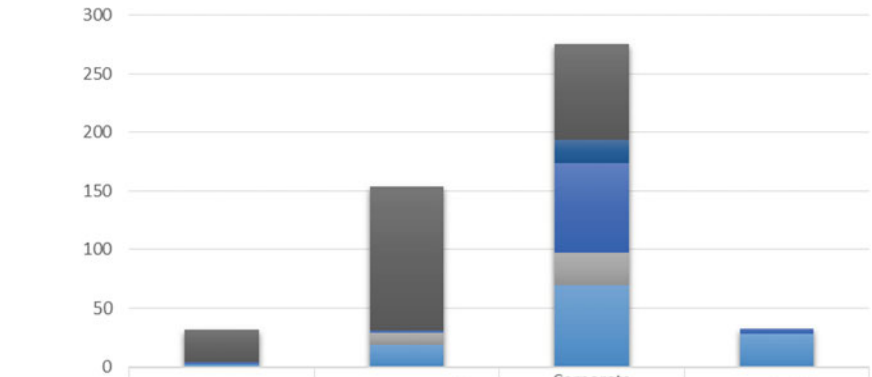
that cover more than one step, followed by practices related to the productive process with 32% and with minority values are the supply practices (4%) and product (3%) (Fig. 3).

Cross-tabulating sustainability issues against the types of CSA (Fig. 5) reveals that environmental issues are primarily approached with corporate sustainability management (69 of 118 mentions) and then with sustainable entrepreneurship (28 of 118 mentions), where the recycling initiatives and use of renewable energy sources are highlighted which includes wind, solar and geothermal. These sources of energy are typically used in the minerals industry, when economically feasible, to lower fossil fuel consumption, which in turn reduces greenhouse gas emissions (McLellan et al. 2012). This is the case of Antofagasta plc that, to reduce emissions, increased the power of the Minera Centinela solar thermal power plant, which uses solar energy in heating processes of the electro-obtaining plant.

The vast majority of health (28 of 38 coded CSA) and all safety issues are addressed by CSM too, whereas health issues notably cover also CSR activity (10 of 38 coded CSA). Social issues are nearly equally approached with CSR and CSM activities highlighting the emphasis on local economic development, community education or infrastructure activities. Integrated issues are primarily addressed with CSM what gives rise to more holistic approaches integrating sustainability into the core business through e.g., integrated sustainability management systems or sustainability policies.

It can also be noted that the issues of environment, safety, health have the majority of their activities concentrated in CSM, this is because some practices become "mandatory" when implementing an environmental management system (Vintró et al. 2014) or an integrated system of management (Fig. 4).

The cross-tabulation of value chain steps against CSA types (Fig. 6) shows a clear focus on production-related CSM activities (139 of 160 coded CSA). And well below in SE activities (21 of 160 coded CSA), in this last group we highlight the practices of carbon emission such as the construction and use of a mini pipeline in



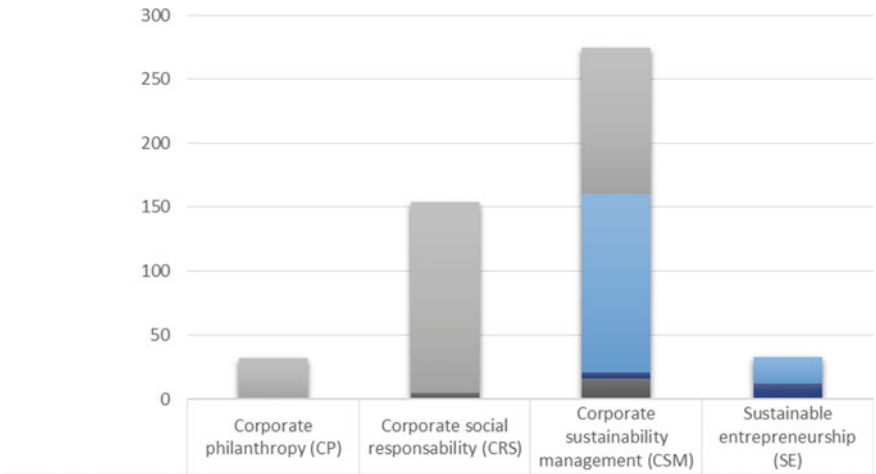

| | Corporate philanthropy (CP) | Corporate social responsability (CRS) | Corporate sustainability management (CSM) | Sustainable entrepreneurship (SE) |
|---|---|---|---|---|
| Social | 28 | 123 | 81 | |
| Safety | | | 20 | |
| Integrated | 2 | 2 | 77 | 5 |
| Health | | 10 | 28 | |
| Environment | 2 | 19 | 69 | 28 |

**Fig. 4** Cross-tabulation of issues against the type of corporate sustainability activities (in absolute numbers)

Antamina which is used to transport its production, the benefits include social and environmental issues, 304 km are traveled underground from the mine operations to the port, without truck traffic by road (avoiding traffic accidents and noise generation), with a closed transport circuit in pulp (no dust) that is permanently monitored. Its use has reduced the use of fuels, as well as the carbon footprint. Another related practice is that carried out by Vale implementing a truckles system (without the use of trucks) in S11D Eliezer Batista (Canaã dos Carajás, PA), where its production is transported through conveyor belts (approximately 47 km installed) which reduces fuel consumption, electricity, and greenhouse gas emissions.

Supply-related activities are approached by both CSR and CSM activities covering economic development in the communities surrounding the mine through local procurement as well as the systematic development of mining suppliers, sustainability standards through supplier training, programs and audits. The majority of product-related CSA (12 of 17 mentions) is covered by entrepreneurial activities such as recycling or resource recovery initiatives (Fig. 5).

Lastly, cross-tabulating sustainability issues against value chain steps support the dominance of proprietary production activities across all sustainability issues (Fig. 6). Interestingly, supplier-related activities largely center on social (18 of 21 mentions), whereas product-related activities cover primarily environmental aspects (13 of 17 mentions). In these activities include tailings management, according to Dudka and Adriano (1997), one of the biggest challenges faced by the international mineral extraction industry is the waste treatment and disposal, and the management




| | Corporate philanthropy (CP) | Corporate social responsability (CRS) | Corporate sustainability management (CSM) | Sustainable entrepreneurship (SE) |
|---|---|---|---|---|
| Non-allocatable | 32 | 149 | 115 | |
| Process /Production | | | 139 | 21 |
| Product | | | 5 | 12 |
| Supply | | 5 | 16 | |

**Fig. 5** Cross-tabulation of value chain steps and the type of corporate sustainability activities

of tailings dams have become the biggest natural environment problem in mines. On the one hand, the solid waste contains a large number of useful components, which is the potential resources; On the other hand, at present, abundant solid wastes are stacked in tailings dam since the relatively low mineral recovery rate and large tailings discharge.

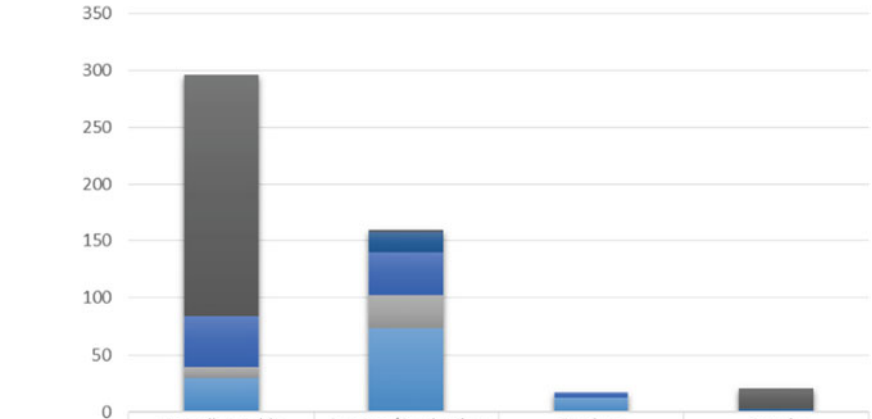
That is why mining companies have focused on developing practices and tailings management plans to meet this challenge, for example in Minera Centinela operates a tailings tank thickened with seawater without desalting. This innovation has been key to reaching new ways to deposit tailings, which allow recycling a greater amount of water and significantly minimizing the impact of this waste (Fig. 6).

Understood the present situation of mining sustainable operations, it could be discussed the best practices that are transforming mining operations.

## 5 Future Practices

Throughout the reading of sustainability reports, projects that organizations are developing to maintain and continue to build sustainable operations that are maintained over time were identified.

Among the most outstanding projects, we have that Antofagasta PLC in 2019 will begin the construction of a new seawater desalination plant in the Province of




| | Non-allocatable | Process /Production | Product | Supply |
|---|---|---|---|---|
| Social | 212 | 2 | | 18 |
| Safety | | 18 | | 2 |
| Integrated | 44 | 38 | 4 | |
| Health | 10 | 28 | | |
| Environment | 30 | 74 | 13 | 1 |

**Fig. 6** Cross-tabulation of issues against the value chain step (in absolute numbers)

Choapa which will serve as support for Minera Los Pelambres in periods of water scarcity.

Another of its projects is the Suppression of dust with electromagnetism, this proposal came from Innovaminerals, the innovation program of Antofagasta Minerals, to reduce the emission of dust through electromagnetic technologies; The pilot will be implemented in 2019.

Intending to mitigate accelerated melts as a result of climate change in snowy mantles and glaciers, the Innovation Board approved in 2018 a project consisting of the installation of removable covers of systems that include special textiles that delay melting. The Project is called "Glacier Coolers" the pilot will be implemented in 2019.

Vale, considering the facts that occurred in Córrego de Feijão, the company's leaders and technicians were mobilized to rethink, discuss and propose solutions for the future of the business. Among the immediate actions evaluated, is the tailings filtering and stacking project, as an alternative solution to the need to build new dams. In addition to reducing the use of dams, Vale is considering investing, between 2020 and 2023, approximately US $ 390 million in the implementation of dry stacking technology in Minas Gerais. The technique allows filtering and reusing the tailings water and enables the tailings to be piled, thus reducing the use of dams. Vale is also developing projects to reduce diffuse emissions (particulate matter) in its operating units by adopting measures such as the improvement of sprinkler systems and the use of dust suppressing products. In 2018, Vale, in partnership with the Federal University of Espirito Santo—UFES, developed and has already patented a

biodegradable dust suppressor product. This resin is produced by chemical recycling of PET (polyethylene terephthalate) waste and has a sealing feature, keeping material moisture in stockpiles, rail cars, and unpaved roads. This initiative contributes to the reduction of particulate solid emissions, providing improvement of air quality in the surrounding communities. In addition to the environmental benefits that this innovation will provide to operations, there is the social gain through the involvement of local waste picker associations in promoting the recycling of plastic waste, generating sustainability for the business.

The general most of the projects under development we find those related to tailing management, waste/emission management, and recycling and resource recovery.

## 6 Conclusion

The main objective of this study was to identify and examine the current dominant practices in the mining industry in Latin America, the results of this study show that mining companies carry out various practices that range from corporate philanthropic sustainability to sustainable entrepreneurship, highlighting the activities found in corporate sustainability management, while addressing different issues considering the environment, health, safety, social or integrated that cover their activities along the supply chain, where the concentrations of sustainable practices are related to the link of the productive process. Similarly, it highlights that most practices are social; this can be understood by the events of recent years as strikes, rejection of communities, tailings overflows, among others.

However, there are still points that companies have to address and focus their efforts on developing sustainable practices related to suppliers and final products, the latter being critical in the sense of handling, recycling, and reuse.

The contribution of this study is to collect and identify the current situation of the implementation of Corporate Sustainability Activities in the main mining companies in Latin America.

This application can guide corporate sustainability managers on their journey to the next sustainability frontier, providing a notion of what points to strengthen and what points to address. The continuous examination of how the mining industry advances in this trip will be essential to advance the findings of this study and follow the development over time.

As a suggestion for future studies, we recommend expanding the sample and comparing these practices with mining industries in other countries, to deepen the results and allow a deeper analysis to find factors that explain in depth the behavior of companies about the type of CSA. Replicate this study considering sustainability reports from different periods, to analyze whether companies are making improvements over previous periods and thus analyze the effectiveness of these practices since although companies have mapped the activities to carry out, the incidents and unfortunate events continue to happen.

This study is not without limitations. The underlying rationale of this study is that one can make an inference from sustainability reports on actual corporate sustainability activities. Consequently, those activities are neglected that are not reported through perhaps conducted. Another limitation of this approach is that it does not evaluate the impact of every single activity. Finally, the small sample size and the time interval analyzed.

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# Assessing the Use of Pine Chip Ash in Manufacturing Soil–Cement Bricks


**Rogério Expedito Restelli, Edson Pinheiro de Lima, and Fernando José Avancini Schenatto**

## 1 Introduction

Waste disposal is increasingly regulated and increasingly expensive. Therefore, it is suggested a business perspective on value recovery through reuse of the whole product (Kleindorfer et al. 2005). As Kleindorfer et al. (2005), internal strategies for the future should be focused on investment in capabilities to recover substances causing pollution, to develop substitutes to non-renewable inputs.

The recycling of waste is a prerequisite for sustainability since the generation of waste is inevitable in the industry. The potential benefits of recycling to society are, among others, the preservation of natural resources, energy-saving, reducing the volume of the landfill, reduce pollution, creating jobs, reducing the cost of environmental control by industry, increased durability and even foreign currency economy (Angulo et al. 2001).

Ayres (1989), suggests that companies must find better ways to convert waste from one industry to be used in other sectors. Among these stand out waste mineral ashes from different agro-industrial activities, these, have high percentages of silica and other oxides, which can then be used as a pozzolan. The pozzolan property is its ability to react with the calcium hydroxide released during the cement hydration

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process, forming stable compounds binding power, and silicates such as hydrated calcium aluminates (Oliveira et al. 2004).

This paper fits with the sustainable nature of the approach to Corporate Social Responsibility (CSR). According to Grajew (1999 apud Pinto 2006) CSR is an ethical management of the company, socially responsible in all its actions, in all its policies, in all its practices and relations, whether with the internal or external public of the organization. CSR refers to the objectives above shareholders where the company should take responsibility, including business ethics, ensuring labor rights, environmental protection, the development of philanthropy, donations for public welfare and protection of vulnerable groups. Included, therefore, the financial and economic responsibility, legal responsibility, environmental responsibility and ethical responsibility (Li et al. 2009).

Clark (2007) suggests that an economy can be maintained for sustainable consumption that includes sustainable products and industrial processes. Companies should pay more attention to environmental consequences, supported by public pressure and concepts of the triple bottom line (3BL) (profit, people and the planet), the literal translation of the English, profit, people and the planet (Kleindorfer et al. 2005). According to Kleindorfer et al. (2005), employees need to take pride in their work and they need to believe that their companies operate prudently and responsible to the planet, in addition to worrying about their health and safety.

In this scenario, the article seeks to evaluate the use of pine chips ash in the manufacture of soil–cement bricks, with the center of the problem being the concern about the current fate of these ashes. When will managers stop considering effluents and waste as passive and start seeing them as assets? According to Vaske (2012), wood is still one of most fuels used in some economic sectors of the country, resulting in a high volume of ash that is disposed of without specific control, jeopardizing the water table, contaminating soil and air. The sooner literary contributions address waste management issues, the sooner we will have enough information to prevent, guide, search for solutions and evolve as a whole for the sustainability of the planet.

The soil–cement brick is known in Brazil popularly ecological brick produced by compacting a mixture of cement and sand or various other types of materials such as waste and slag from steel mills, recycled aggregates of building rubble, waste from mining activities and other environmental liabilities arising from various activities (Aniteco 2019). Since they are produced by pressing and do not require subsequent burning, they are called green bricks (Castro et al. 2016).

As a basic premise was considered soil cement bricks fabricate incorporating PCA as an additional material and evaluate the results of its mechanical properties. Would it be possible with the PCA to reduce the use of non-renewable materials and finite in the manufacture of products such as soil–cement brick? The ash is a residue from a plywood industry, derived from burning pine chips. The burning of the chip generates the heating of the boiler waters, resulting in the steam required in the manufacturing process of the plywood sheets. This study deals with the PCA, however, many other industries generate ash, so that material can serve as support for more queries related to waste from other areas. Besides the possibility to study the same ash in several

other products. It is important to create opportunities for reflection, with a different look for each and every type of waste.

For better evaluation support was adopted a methodological procedure Product Planning and Development (PPD) identifying details and making use of tools and parameters already certified by the literature. This is intended to characterize the main materials (ash, soil, cement), incorporated in the raw material base of the brick different ash proportions (15, 30, 50%), starting from a formulation already practiced as the proportion of cement, and finally, evaluating the physicomechanical properties of the brick samples according to the current Brazilian technical standard.

## 2 Theoretical Framework

This applied research was experimental, that to Gil (2008), is to subject the objects of study to the influence of certain variables in controlled conditions and known by the investigator, to observe the results that these variables produce in the objects.

The experiment is contemplated in a sustainable perspective of PPD by Vasco et al. (2014) illustrated in Fig. 1, which shows how much innovation is present in the preparation of a product, and that before the macro environment, integrates environmental, economic and social needs as a parameter for the idealization of processes.

The PDP process of this study was reconciled with the concept of Cooper (1993), who developed the Stage-Gate-process, having a form of stages and steps for review and approve all moments of development. It is a process divided in stages, with pause spaces for contemplation of the results, so-called gates, the literal translation into Portuguese, gates. As shown in Fig. 2, adapted from Cooper (1993), in the stages are made evaluations, investigations, tests and in the gates, decisions are made for the purpose of whether the development of the product passes to the next stage. Three key points were considered fundamental to design a sustainable product: From the idealization with intensified reflections in the detailed investigations (literature review, as this study) and business analysis (analysis and discussion of results, as this study).

The samples were named Samples (A), they were prepared and molded in a hydraulic press with twelve tons of compression capacity (12t.), owned by the same

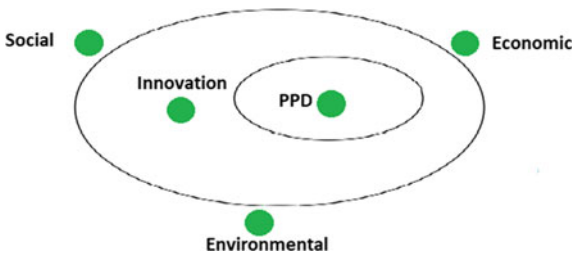


**Fig. 1** Perspective PPD sustainable. *Source* Prepared by the authors (adapted from Vasco et al. 2014)

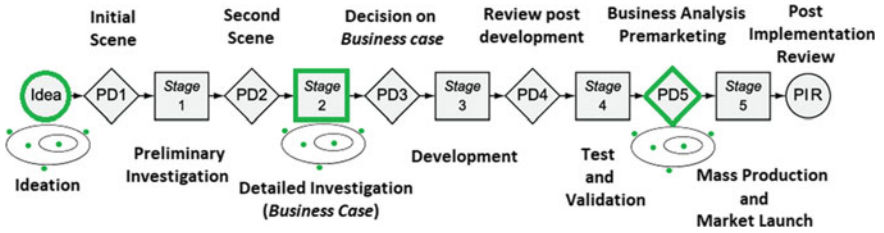


**Fig. 2** PPD model. *Source* Prepared by the authors (adapted from Cooper 1993)

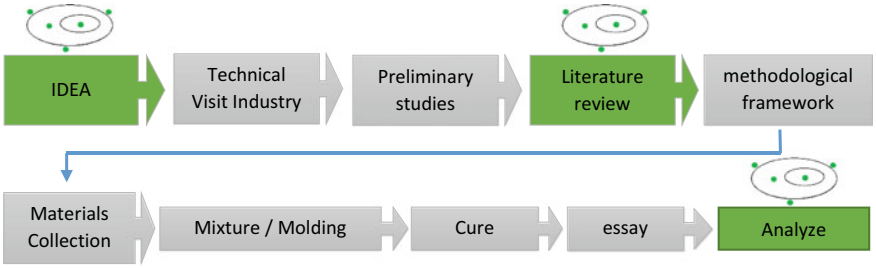


**Fig. 3** Flowchart of the PPD. *Source* Prepared by the authors

plant that grantor the soil and cement. The tests were developed in the research laboratory of the Federal University of Technology—Paraná, campus Pato Branco, equipped with a structure that allowed the execution of all the tests prescribed by the technical standards NBR 8491/8492 (ABNT 2012a, b) suitable for floor-type cement cast bricks.

Thus, based on the model of Cooper (1993), PPD procedures for the preparation of samples and testing conducted during the design are illustrated below in the flowchart of Fig. 3.

All flowchart stages were performed, recorded and documented on file for any requests and availability for future demands. The complete material can be important moving forward with the research or even to contribute further assessment on the subject by third parties.

The starting point of the study was on August 30th, 2019 from the preliminary idea to the analysis of the results it took one hundred and five days. The ash in the study is a residue of the industrialization process of plywood sheets in an industry in the city of Palmas-PR, which was previously discussed in the technical visit. Advances have occurred with documentary research for two months to carry out the collection of materials on October 30th, 2019. One day was enough to mold samples and it was patiently awaited the hardening of the cement before performing the tests in the laboratory on December 6th, 2019 the results were summarized and analyzed in the experiment that ended on December 13th, 2019.

## 2.1 Materials

According to Ferreira and Efren (1984), the most suitable material for producing soil–cement brick is sandy soil (60–80% sand). The soil can be defined as a non-consolidated material on the surface layer of the earth, easily disintegrating, containing various minerals in the forms of sand, silt and clays (Cebrace 1981). The soil used in this study comes from a deposit of sand from the city of União da Vitória—PR, material already used by default in a soil–cement brick factory in the city of Palmas—PR.

Portland cement is a fine powder that has binder properties, which when in contact with water hardens and no longer decomposes when exposed to water again (ABCP 2002). Portland cement is made of clinker and additions, clinker being its main component, present in all types of cement (ABCP 2002). In this study, we used a type of cement sold in some retail stores thus characterized as special, the CP-V type, distributed in bulk directly from the manufacturer to consumers on a large scale. This was provided by the brick factory.

Ash, like the PCA, which is a residue in most cases disposed of as fertilizer on fields by having certain nutrients. However, as Borlini et al. (2005), ash is a waste that even contains metals, those responsible for air pollution and also responsible for serious respiratory problems in the affected population. In the study Borlini et al. (2005), ash showed high amounts of calcium oxide (CaO), silicon dioxide ($SiO_2$), a certain amount of potassium oxide ($K_2O$), and also magnesium oxide (MgO). On the other hand, in the way of solutions according to Oliveira et al. (2004), the ash has pozzolan property and should contribute to binding power with similar reactions to cement.

The plywood manufacturing uses pine wood coming from reforestation, therefore considered a sustainable alternative for fence panels, buildings, and other purposes. The industry that cooperated with this research generates 3 $m^3$ of this residue daily and according to the Remade (2002) in this segment are associated in Brazil about 300 companies, which exponentially increases the total waste generated annually. Therefore, industry factories depend on the proper disposal of the PCA in order to make closed the whole process cycle.

## 2.2 Method of Water Absorption Test

After the curing period of the samples, the water absorption tests were performed according to the procedures of ISO 8492 (ABNT 2012a). The samples passed through the drying process in the oven at temperatures between 105 °C and 110 °C until the weight stabilized. With the mass density free of water, samples were immersed in a water tank for 24 h. Thereupon, lightly wiped with a towel and reweighed, recording the weight of the saturated masses.

The water absorption values are expressed in percentage and they were obtained by the following equation:

$$A = \frac{M2 - M1}{M1} \times 100$$

Being that:
A = water absorption (%);
M1 = mass of dry brick (g);
M2 = mass of the wet brick (g).
According to NBR 8491 (ABNT 2012b), the average value of water absorption of the samples should not be higher than 20% and the individual values of the samples should not be greater than 22%.

## 2.3 Method for Compressive Strength Test

To conduct the compression test samples should have seven days or more to cure. They are cut in half, joining the two halves in an overlapping manner and capping with Portland cement paste. After cured capping, occurs the immersion in water for 6 h, which are prepared for disruption, according to the requirements of ISO 8492 (ABNT 2012a).

The compressive strength is expressed in megapascals (MPa), where the value of the maximum breaking load expressed in Newtons (N), is divided by the area of the working face quantified in square millimeter ($mm^2$) according to the following equation:

$$ft = \frac{F}{S} MPa$$

Being that:
ft = Compressive Strength (MPa);
F = failure load (N);
S = load application area ($mm^2$).
According to NBR 8491 (ABNT 2012b), the average value of the samples should not be less than 2 MPa and the values of the individual samples should be not less than 1.7 MPa.

## 2.4 Mixture

The ash went through a screening process in a 4.8 mm mesh screen. Further, all the materials that make up the bricks, soil, cement, and PCA were weighed on a scale 5 g

**Table 1** Traces of the mixtures

| | Mix Base | | | | |
|---|---|---|---|---|---|
| SAMPLE | PCA | GROUND | SAND | CEMENT | ADDITIVE (ml) |
| A1 | 0% | 100% | 0% | 11% | 0 |
| A2 | 15% | 85% | 0% | 11% | 0 |
| A3 | 30% | 70% | 0% | 11% | 0 |
| ~~A4 *~~ | ~~50%~~ | ~~50%~~ | ~~0%~~ | ~~11%~~ | ~~0~~ |
| A5 | 50% | 0% | 50% | 11% | 180 |

*Source* Prepared by the authors

accurately defining the proportions of trace. For the trace of the raw material called base mixture, it was considered the proportional weight of ash and soil or sand and ash, then the proportion of cement relative to the total weight of the base mixture, as illustrated in Table 1.

For each sample mixtures were prepared independent traces as described, leaving the material in ideal conditions of compaction. Each specific trace was prepared following the same procedures where the components were manually mixed until a uniform mass coloration and good homogeneity. By following a manual mixing process, dry homogenization was initially carried out and only after reaching uniform color was water gradually added to the ideal point for molding.

## *2.5 Proof Bodies of Molding*

The molding is the process of giving the brick format, compressing the mixed material. It has transferred the contents of the first trace to the press and carried out the molding of parts with 12 tons of compression in a hydraulic press, which resulted in visually well-defined parts. Each batch of samples, the cleaning of the equipment was cautiously, avoiding interfering with residues of the previous trace.

The plot called A4* was discarded due to rejection of the ideal conditions for compaction, as it did not present enough agglutination power for molding. The attempt to add the maximum PCA gave rise to the batch A5, replacing the sandy soil (70% sand/30% clay) of pure white sand (100% sand) and 180 ml of the PVA binder additive, named only as an additive. The additive was used for a specific purpose for agglutination due to the absence of clay. According to PISAFIX (2019), PVA has a composition based on Polyvinyl acetate, which is a synthetic polymer, thermoplastic, tasteless and odorless.

## 2.6 Cure

The healing period is called the time required for the cement action, and for Mehta and Monteiro (2008), healing is nothing more than a set of factors that promote hydration of the cement, especially the humidity, time and temperature, in order to provide material strength. Therefore, the time required for the bricks reaches the point of full resistance. According to ABCP (2002), the cement is partially cured in 7 days and reaches its best performance from 28 days as in Fig. 4. Twenty-eight days was the time considered in the study, before performing the tests.

During this phase, samples were analyzed visually in order to realize inappropriate behaviors such as cracks, blemishes, or other types of faults or changes visible to the naked eye, as shown in Fig. 5.

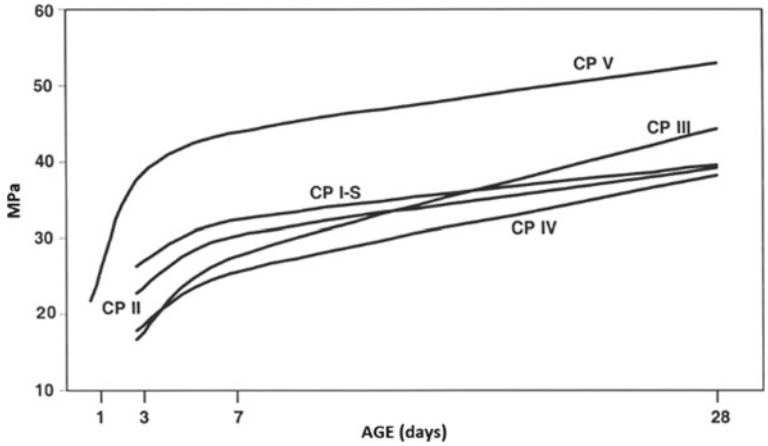


**Fig. 4** Age × MPa. *Source* ABCP (2002)

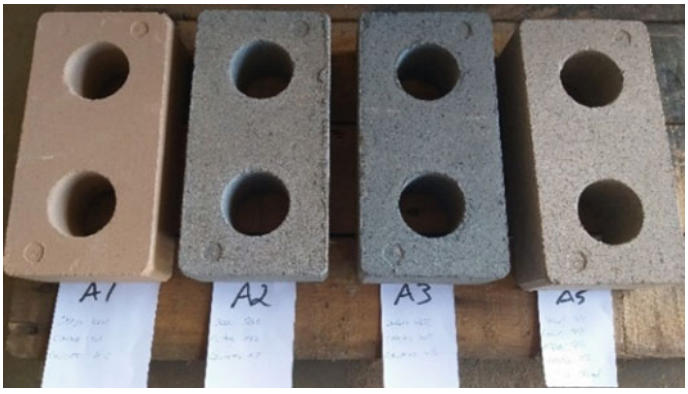


**Fig. 5** Samples in curing time/visual analysis. *Source* Prepared by the authors

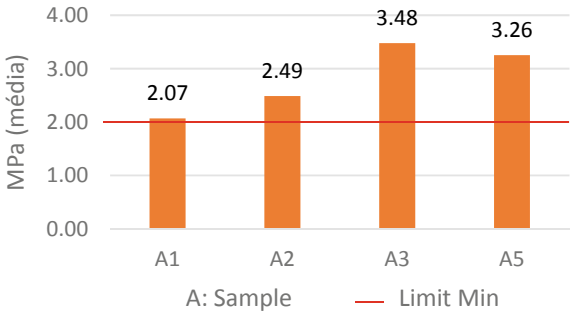


**Fig. 6** Results of compressive strength. *Source* Prepared by the authors

The sample A1 has the closest color tone of the natural color of the soil. The small amount of ash added in the sample A2 was sufficient to disfigure the originality compared to the reference sample (A1). It was visually clear the difference that the residue caused in the products.

## *2.7 Compressive Strength Test*

As illustrated in Fig. 6, the sample A1 with 0% PCA showed an average value of 2.07 MPa, the lowest result among all samples, but it is considered acceptable, according to the standard to be higher than 2 MPa. The sample A2 with 15% PCA showed an improvement of 17% in endurance performance with 2.49 MPa. The third sample A3 (30% PCA) recorded an average of 3.48 MPa, a 40% jump from the sample A1. Finally, the sample A5 (50% PCA) averaged 3.26 MPa in its specific trace with additive 36% stronger compared to the reference sample A1 (without PCA).

It is possible to analyze the chart with significant results difference. Because it is the same proportion of cement it is noted that the ash interferes, causing performance improvements in this parameter.

## *2.8 Water Absorption Test*

As illustrated in Fig. 7, the sample A1 obtained 12.08% water absorption, the best result based on the reference parameter that is 20%. The sample A2 has reached 28.41% absorption, followed by A3 25.98%, both by extrapolating the maximum allowable limit. On the other hand, PVA additive contributed to reduced water absorption in the sample A5, even though the greatest amount of PCA it is in this trace. The sample A5 reached 17.92% water absorption, a value acceptable for the commercialization of bricks.

Although resistance has been marked with the PCA addition, the absorption was accentuated in an inversely proportional way in samples A2 and A3. Increasing the

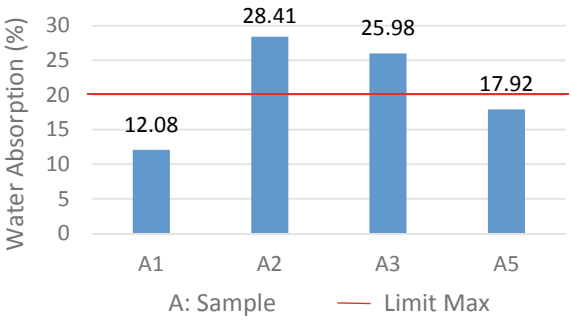


**Fig. 7** Water absorption results. *Source* Prepared by the authors

absorption of water is not a good indicator, but it is clear that there is an intensity relation for the dosages of the PCA until a possible balance.

## 3 Results and Discussion

The sample A1 with the commercial use trace already practiced in the market presents itself in the recommended levels by the standard in terms of the resistance and the best performance and the requirements of water absorption compared with other samples.

Both the samples A2 and A3, despite having the best resistance performances were disqualified for use according to the standard for presenting water absorption indices extrapolated to the tolerable limit for market practice.

Due to the low agglutination capacity of the sample A4, it could not generate molding therefore resulted in no specimen for analysis. The sample A5 was the only one with PCA that obtained consistent rates to the parameters established in the standard recommendations. Its resistance reached 3.26 MPa mark, 38% above the minimum requirement (2 MPa). The water absorption was also within the recommended below 20% for the average determined.

## 4 Suggestions for Future Studies

There is a need for experiments of the PCA with other types of binders waste such as mud tailings arising from mining activities, as well as disasters already committed (Mariana/MG, Brumadinho/MG) or replacing the sand for the residue of Civil construction and Demolition (RCCD) as well as glass dust, stone dust, and other wastes.

It is suggested further experiments on the PCA diversity of binder waste, replacing soil or sand for Construction and Demolition Waste (CDW) and glass powder, stone powder, among others.

It was restricted to the number of two specimens of average values in the tests. It is suggested further testing with 10 specimens per sample, 7 to break in the resistance test and 3 for the water absorption test.

It is proposed discussion and review of the technical standard NBR 8491, where in item 4.3.5 emphasizes on not discounting the area of the brick holes or the calculation of MPa. One sees a contradiction, given the fact that the item 5.2.1 indicates that the area calculation should be considered by the "Load area". The holes of the bricks are empty spaces that receive no charge, including the practical implementation of the walls.

It is suggested further studies related to the proportion of the traces with the actual density of each material. In the same order to increase the accuracy of results, it is suggested a review of optical microscopy and analysis of broken samples as the uniformity of the mixtures.

It would be of fundamental importance to explore standards indoor wall sealing materials, in order to promote research in the use of PCA product which limits water absorption are more tolerable, or where they are not considered. As the gypsum used for partition walls.

In view of the need to trace additive in the sample A5, there is an opportunity for economic feasibility analysis research, seeking cost parameters with reference to the conventional bricks for comparison.

Study groups have room to explore several variables of the same nuance. The present study provides a simple alternative to PCA, making room for a wide range of experiments with this undervalued waste. To the student's interest, research projects and product development with sustainable nature have numerous tools to support and/or resources.

In short, the branching of study possibilities is illustrated in Fig. 8.


**Fig. 8** Suggestions for future studies. *Source* Prepared by the authors

## 5 Conclusion

This paper generated content supported by sustainability, particularly in solid waste management and in the impact of the environment. Sure, that we are in deficit to the planet, we increasingly produce evidence and solutions to problems. The challenge of being present with this dialogue in daily life and popularize the measures to be taken should be overcome by actions and reports of this kind.

In order to evaluate the use of the PCA in the production of soil–cement bricks, all experimental requirements were implemented topic to topic. The formal record of the tests by laboratory materials allowed the accuracy of the data. The results are even more susceptible to interpretations allowing further analysis. The PCA showed better results with PVA binder additive and pure sand resulting from the washing of the soil of sample A1. In fact, in response to the problem of research, the use of PCA could reduce the consumption of finite materials in the manufacture of soil–cement bricks. Thus, the ashes should not be considered an environmental liability, but rather a raw material with a wide range of possible uses.

The A5 lot was an extra trace, not provided for in the study schedule. However, besides the importance of the aggregate empirical knowledge of the grantor company, there was mutual intention to correct the mixture using an additive, seeking the possibility of using the maximum amount of the PCA. Explored with more dedication new experiences can result in higher quality products.

The convenience to discard in the ground the PCA is still the obstacle to progress. It is primarily up to the managers, as of now, to act with the investigative awareness to solve environmental problems, turning their waste into assets. The way of considering this type of problem as a business opportunity connotes the degree of social responsibility of each organization. We are all responsible for the impacts, already stacked for future generations, so we hope that this content can help similar research with waste in other areas. In addition to the possibility of studying the same ash with other products, the importance of studying all types of waste that we generate is evident.

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# Nature-Based Solution in the Context of Sustainability: A Case Study of Artificial Reefs


**Patricia de Oliveira and Leandro Angelo Pereira**

## 1 Introduction

In view of the dimension and complexity of the socio-environmental problems, the urban issue is intrinsic with nature and cannot be approached in a dissociative manner. Urban problems combined with socio-environmental degradation, the complexity of the physical, biological realities that constitute and produce urban spaces, imply a profound review in the way of thinking and planning (Lima 2008).

Reducing the risk of environmental disasters, improving human well-being, promoting a green and socially inclusive economy, transforming social and environmental challenges into innovative opportunities, making natural capital a source of prosperity (Cabral 2017) is the intent of Solutions based on Nature—NbS, this initiative presents the possibility of facing the various problems existing in society with nature as part of the solution.

In this sense, NbS can be classified as green infrastructure (urban environments), or blue (marine environments), which in turn corroborates the effectiveness of investments in NbS, since their approaches can offer the main or only viable solution, in most cases, the green and gray infrastructure (conventional engineering) can and should work together. However, in order to be integrated in this context, an environmental decision-making process in resource management is required (Fini et al. 2017; UNESCO 2018).

Therefore, the research permeates for a strategic analysis of a single case study, consisting of an explanatory study, located on the Paraná Coast, the REBIMAR

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Program, executed by the MarBrasil Association with sponsorship of the Petrobras Socioambiental program (Yin 2010).

## 2 Contextualizing the Nature-Based Solution

Nature-Based Solution (NbS) aims to adhere to nature as a strategic resource, enabling its inclusion in demands arising from gray infrastructure (MEA 2005).

The NbS show the processes that support its inspiration and/or imitation, and may involve both the conservation concomitant with the rehabilitation of a modified or artificial ecosystem and adhering to macro or micro proportions in the environment (UNESCO 2018).

Environmental, social and economic challenges are related to NbS, improving existing solutions, in the sense of imitating inferior organisms, using resources from nature and excluding methods that can genetically alter nature. In the same way as your concept according to the European Commission:

> It is based on and supports other closely related concepts, such as ecosystem approach, ecosystem services, adaptation/mitigation based on ecosystems and blue infrastructure. They all recognize the importance of nature and demand a systemic approach. Approach to environmental change based on understanding the structure and functioning of ecosystems, including human actions and their consequences. (EC 2015, p. 24)

In this sense, NbS works with other concepts, articulating its implementation in favor of ecological and social sustainability, with a focus on the benefits for individuals and their environment in addition to striving for human well-being, they excel in the zeal of natural capital, if appropriating the complex processes of the system itself, in order to achieve beneficial results of a social and environmental nature. Thus, NbS adheres to complex nature services and can be classified as environmental/ecosystem services. (Lafortezza et al. 2018; EC 2015).

According to Resolution 069 on the definition of nature-based solutions (2016) recognizing its genesis in the negotiation of the United Nations Climate Changes (UNFCCC) in 2009 and considering a milestone for IUCN—International Union for Conservation of Nature, it is culminated in definition of NbS as "actions to protect, sustainably manage and restore natural or modified ecosystems, which address society's challenges effectively and adaptively, while providing human well-being and benefits for biodiversity (IUCN 2018, p. 0.1).

This Resolution still establishes the general objective of the NbS:

> Support the development of society and safeguard human well-being in a way that reflects cultural and social values and reinforce the resilience of ecosystems, their capacity for renewal and the provision of services; Nature-based solutions are designed to address major social challenges, such as security, climate change, water security, human health, disaster risk, development. (IUCN 2018, p. 2)

Actors such as governments, organizations and academies are looking for work to find alternatives that can mitigate the environmental, economic and social challenges

caused by industrialization, alleviating the challenges of society. Actions characterized as NbS, aim to develop resilient ecosystems and healthy environments, becoming potential in society by seeking to restore and balance nature (Lafortezza et al. 2018; Albert et al. 2019).

Therefore, nature-based solutions are contributing to sustainable development while they emerge as long-term livelihood strategies (Peter et al. 2017).

## 3 Applicability of NbS Practice and Its Local to Global Interface

Recent scientific research on the NbS practice uses examples based on evidence of strategies and solutions; supported by criteria that evaluate such practices; in global examples of such solutions, it has supported the strengthening of the NbS as a scientific pillar of alternatives (Reynolds et al. 2017).

Since the concept was coined by IUCN and CE, there is a whole movement in favor of measures and resources that support the sustainable issues rooted in the NbS. The Think Nature platform brings together subsidies that connect stakeholders who support the promotion of such solutions. This platform, in addition to supporting information, promotes scientific events that aim to guide, encourage, promote successful solutions, identify regulatory, economic and technical barriers, in addition to developing synergy with other NbS proposals, corroborating so that these practices are strengthened at the local level, regional, national and European Union (Think Nature 2019).

In Brazil, the Grupo Boticário Foundation, affiliated to IUCN, has contributed to the strengthening of NbS practices. In 2017, the Foundation promoted a "Call for Solutions based on Nature", which consisted of a call whose objective was to identify and recognize the demands that integrate nature as part of a solution.

Overall, Scott et al. (2016) states that Nbs have their ecosystem functions and as living systems are built and integrate the landscape, they outline four objectives for a nature-based approach:

(1) protection and urban regeneration through nature;
(2) restoration of ecosystem functions;
(3) infrastructure redesign with the integration of green and blue infrastructure and
(4) landscape resilience.

Therefore, by integrating with the ecosystem, according to type 3 (Eggermont et al. 2015), Nature-Based Solutions starts to shape the ecosystem from an integrated technology, contributing to the city's resistance, in addition to being in line with sustainability based on biophilic design (Blau et al. 2018).

Referring to the global expression, in the first instance it seems something intangible and not applicable (Bernardi 2008), however its geopolitical and economic aspects act on man and have transformed the way of life of humanity (Bernardi 2008; Chiavenato 1998).

With this premise, to think globally and act locally, the proposed context emerges as glocalization (Leff 2010; Bauman and Bordoni 2016). According to Bauman and Bordoni (2016, p. 149), "the phenomenon of glocalization is the particular combination of increased importance of localities (and in close connection) with the loss of the meaning of distances".

In this sense, NbS adheres to the aspect of glocalization, as they are based on local actions at various levels: in planning and design, in handling and management, and by reinforcing the elements of green infrastructure in cities, thus promoting the maintenance, improvement and recovery of biodiversity and ecosystems in urban areas, expanding the concept of green or blue infrastructure in cities (Cariñanosa et al. 2017).

However, NbS presents a relevant positioning regarding the local to the global interface, since to exist it requires the engagement of local actions, which can be considered as a space for the flow of localities, and from its local action, joint benefits emerge in scope. globally, this interface is an action already guided by the United Nations (UN) with regard to the establishment of the Sustainable Development Goals (SDGs).

## 4 Artificial Reefs as a NbS Model

Artificial reefs can be defined as structures located in the submerged, mimicking certain characteristics of natural reefs, characterized as a practice present in the marine ecosystem that comprises the management of environmental, ecological and social aspects, including the sustainable management of an ecosystem (Boaventura et al. 2008; Boina 2008).

On the other hand, according to Lima (2008), the natural reefs located on the coast, provide benefits to this ecosystem, since they act as a sink for the sea waves, leading to the production process of coastal protrusions, thus increasing the protection of the coastal zone.

In this sense, one of the premises of the implementation of the artificial reef is the maximum approximation of the modus operandi of the natural reef, imitating some characteristics of the substrates for the proliferation of biodiversity (Boina 2008).

However, taking into account that a reef environment is constituted from the organic substrate, consisting not only of corals, but also of algae, rocks, artificial structures such as concrete, steel, plastic, tires and carcasses of ships, or associations of these compounds (Hostim-Silva 2005; Boina 2008).

In this sense, the artificial reef becomes a dynamic environment, adding changes that converge in processes that change its initial characteristic, but result in benefits of environmental, social and economic scope (Alberti 2010).

Once implanted, it joins natural communities and consolidates itself in that environment. This justifies the importance of constant monitoring of this hybrid ecosystem, it is necessary to know the natural diversity of this environment since they

can be differentiated from the variations implemented by human activity (Pizzatto 2004).

In this sense, the artificial reef, configures a model of an NbS due to the framing in its principles, whereas in the perspective of the correlation of cases already practiced, the consolidation of an artificial reef as an NbS model.

However, these interfaces run through the environment, which in turn is vast and complex, and can be separated into two different layers: the largest layer is the general or macroenvironment, and the most immediate layer is called the task or microenvironment (Chiavenato 2012).

## 5 REBIMAR Program

The REBIMAR Program, characterized as a monitoring program, carried out by Associação MarBrasil with sponsorship from the Petrobras Socioambiental program, suggested the need to mitigate the environmental impact caused by trawling, causing the loss of local biodiversity, compromising a marine ecosystem and causing a certain dismantling of the ecological community considered important from an environmental and socioeconomic point of view (MarBrasil Association 2011).

The trawling practice is unsustainable and gradually depletes the target resource itself, the crustaceans, as such artifice, compromises the physical and biological integrity of the local ecosystem, expanding this practice to other areas, and in this context, increasing the environmental impact in the coastal zone (MarBrasil Association 2011).

The non-profit association, MarBrasil, which aims to seek alternatives and solutions for the conservation and sustainable use of the marine-coastal ecosystem, within the scope of the REBIMAR Program, the acronym that constitutes—Marine Biodiversity Recovery Program, installed in 10 points arranged parallel to the coast line (Fig. 1) around 300–400 concrete blocks in each group, totaling 3480 blocks, starting the loop in 2010 and concluding in 2012 (Rebimar 2014).

The concrete blocks launched in the marine area, were created from analyzes that did not conflict with water ph, made of cement and a pH neutralizing product and how much its structure, was created to promote the best fixation of marine organisms, having 50 cm long by 40 cm high and wide, weighing 120 kg, together and sedimented in the marine substrate, they work like small mountains on the seabed (P22_ON 2017).

Classified as a pioneer in the artificial reef program and receiving a license from IBAMA in 2008, he is committed to meeting the basic protocol for guiding and using artificial reefs in a responsible manner—IN nº 125 of October 2006 (MarBrasil Association 2011).

The REBIMAR program was sponsored by the Petrobras Socio-Environmental Program, from 2008 to 2016 the total amount invested in the REBIMAR Program was 6.9 million reais, so since 2009 the monitoring program has been carried out in accordance with the MarBrasil Association (2011) involving: fisheries monitoring;

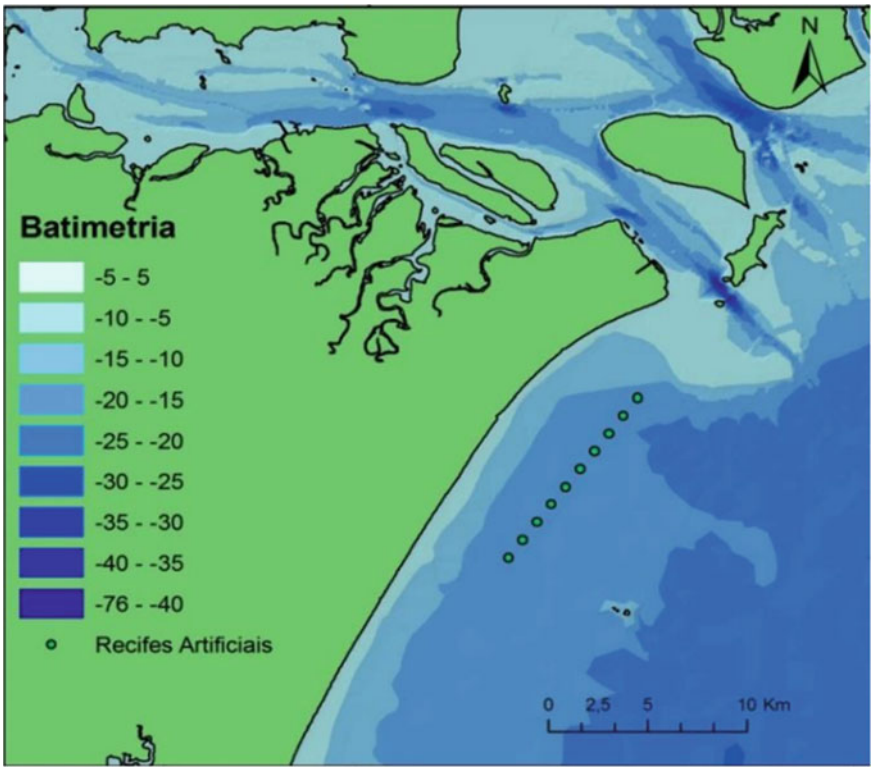


**Fig. 1** Location of the REBIMAR program's artificial marine reefs. *Source* Rebimar (2014). Technical-scientific report—Installation License nº 887/2012 regarding the launching of artificial reef structures along the coast of the State of Paraná (Process nº 02,017.005865/2005–21)

integrity and positioning of artificial structures; sedimentation processes; aquatic biota; and environmental education activities.

Presented as a structuring axis of the project, the socioeconomic environmental problem of industrial trawling for the marine ecosystem of the Coast of Paraná, presented loss of species of socioeconomic value, also affecting artisanal fishermen. The solution that represents the proposal mentioned above, consisted of building artificial cement reefs that serve as a place of refuge and increase the biodiversity of the marine environment in the Paraná Coast, which in turn guarantees the subsistence of artisanal fishermen (P22_ON 2017).

Faced with this alternative, allied to a water-related infrastructure, the services that support an NbS perform ecosystem services, among the co-benefits of an NbS, as a regulator of water formation and sediment flow through the system, including deposition to maintain coastal zones, and with the provision of biodiversity of economic value, guaranteeing the subsistence of artisanal fishermen. This NbS practice according to United Nations Educational, Scientific and Cultural Organization (UNESCO) is considered as blue infrastructure (UNESCO 2018).

## 6 Single Case Model: Artificial Reef

Therefore, the choice of the REBIMAR Program case was justified because it seeks to contribute to the strengthening of the Nature-Based Solution concept, adopting a methodology based on the interconnection of a gray infrastructure to the marine ecosystem, contributing to the mitigation of environmental demands, such as: degradation the marine ecosystem; and social and economic demands, such as: industrial fishing.

Covering the coast of the Paraná Coast, the REBIMAR Program, using the installation of artificial reefs as its main tool. Executed by the MarBrasil Association and FUNPAR (Foundation of the Federal University of Paraná), it has the support of the Federal University of Paraná, the Sea Studies Center of the Federal University of Paraná and the Federal Institute of Paraná—Campus Paranaguá.

It was featured on a national network, when shown on the Globo Mar television program, in the same year, received the ODM Brazil Award, being recognized for being a project that contributes to achieving the Millennium Development Goal 7 established by the United Nations in the year 2000 (MarBrasil Association 2011).

To analyze the data generated over the years of evaluation, the SWOT interpretation tool created by professors Kenneth Adrews and Ronald Christensen, from Harward Business School, and applied in the academic and business community, is used in a methodology based on the acronic SWOT, in which represents its variables (Razzolini and Zarpelon 2005).

Such methodology comes from the exact area, in which it recognizes the limitations of an institution and/or project, maximizes its potentials and opportunities and monitors its source points and opportunities, maintaining a plasticity with regard to being applicable in different projects and/or institutions different segments (Bicho and Baptista 2006).

Its variables can be identified as follows (Fig. 2).

| | **Contributes to the project and/or institution** | **Disrupts to the project and/or institution** |
|---|---|---|
| **INTERNAL ENVIRONMENT** | **Strengths:** Advantages that highlight the institution and / or project. | **Weaknesses:** Vulnerable points of the institution and / or project. |
| **EXTERNAL ENVIRONMENT** | **Opportunities:** Perception of opportunities arising from technology and relationships with governmental and / or non-governmental institutions. | **Threats:** Actions that present threats to surviving the institution and / or project. |

**Fig. 2** SWOT methodology. *Source* Porter (2004)

# 7 SWOT Analysis: REBIMAR Program

## *7.1 Internal Environment*

The elements that constitute the internal environment of an institution and/or project, are specifically allocated internally, and are for the fulfillment of its objectives (Montana and Charnov 2005).

It can be considered as the niche in which an institution and/or project establishes its domain, and it can also be considered as the task environment or operations of the institution and/or project (Chiavenato 2012).

In this sense, the internal environment variables analyzed in the REBIMAR Program are listed below:

### 7.1.1 Strength

- Protection against certain industrial fishing practices;
- Technical and scientific knowledge of the location of the proposed solution—(larval recruitment reefs;
- First project for the installation of artificial reefs in Brazil that has the installation license (IL) No. 496 issued by Brazilian Environment Institute (IBAMA);
- It has the basic protocol for guiding and using artificial reefs in a responsible manner—IN nº 125 of October 2006;
- The fauna biodiversity fouling in the artificial reefs is similar to the biodiversity found in the islands of the National Marine Park of the islands of the Currais (area located near REBIMAR);
- Strengthening environmental awareness in the community;
- Solid planning of the phases and their execution.

### 7.1.2 Weaknesses

- Resistance on the part of the fishing community at the beginning of the project;
- As it is a pioneering project, since it was the first reef installation license to be issued by IBAMA, many actions had to be created and learned during the project;
- Perennial need for a team with many professionals from different areas of knowledge.

## *7.2 External Environment*

Constituted by dynamism, the macroenvironment is the gathering of variables, such as economic, social, technological, cultural, legal, ecological and political demographics. Their influence on a project and/or organization causes impacts without any discrimination on different projects and/or organizations (Chiavenato 2012).

The macroenvironment is related to the external environments of the project and/or organization, and in this sense they act as external forces that somehow influence its functioning. It can also aggregate external actions related to sociological factors, including the situation and demographic trends, work ethics and personal values, cultural values; political factors; economic factors, including the economy, competitors and suppliers, customers; and technological factors, including the innovation process, technology transfer process and cutting edge technology (Montana and Charnov 2005).

In this sense, the variables of the external environment analyzed in the REBIMAR Program, are listed below.

### 7.2.1 Opportunities

- Recovery of biodiversity and fish stocks of economic value;
- Development of economic alternatives;
- Institutional partnerships;
- National highlight in 2012 on the Globo Mar television program;
- In 2012 the program received the ODM Brasil Award;
- Macro indicators—38 thousand hectares protected from industrial trawling; sighting of at least one threatened species (Mero—Epinephelus itajara);
- Structures that contribute to the conservation of the species already sighted Meros, Ephinephelus itajara (species threatened with extinction);
- Contribution to national legislation for artificial reefs, being created from REBIMAR's license application;
- Effective participation of artisanal fishermen, community leaders and representatives of municipalities such as Paraná Environmental Institute (IAP) and IBAMA;
- Adherence to the objectives of sustainable development.

### 7.2.2 Threats

- Interference with the monitoring program;
- Need for long-term monitoring for better comparative results;
- Constant improvement of the program, considering the need for new technologies;
- Dependence on investments.

### 7.2.3 Diagnosis

However, even with a greater nuance between strengths and opportunities, the program has a constant dependence on monitoring the area, whether for legal reasons (due to IBAMA's requirement to legally grant the IL—installation license), either for reasons of bioindicators, ensuring the effectiveness of the program.

Another point that has an important attention is the human resources, because the project survives and presents its effectiveness, because the active professionals, have their expertise applied to the program, therefore establishing a need for dependence due to the intellectual aspects of the participants, however new intellectual contributions should be considered due to the continuity of the project.

However, the program already consolidated, even presenting nuances between the different variables of the environment, explains that this practice is characterized as an eloquent NbS, jointly benefiting the environment, society and the economy, as it brings together the hydrological, social and ecological aspects in one structure. unique and consistent, adhering to the appropriate implementation at levels that are composed of (Cariñanosa et al. 2017; Pokhrel et al. 2018; Jagta et al. 2017; Triest et al. 2015):

1. Planning and design,
2. Handling and management,
3. Reinforcement of green/blue infrastructure elements in cities,
4. Acting at different scales including governmental and non-governmental actors.

## 8 Final Considerations

NbS, is considered as a technology that helps societies to solve their demands including environmental, or acting in an anthropic way in the environment in order to incorporate in nature some artifact that together with the systemic function of nature will consolidate itself as a sustainable aspect solution.

The great peak of NbS is due to its wide approach, which can be applied in different actions and in various fields, such as restoration, green infrastructure, blue infrastructure, management and protection to face social challenges. However, any nature-based solution generates benefits, whether for an ecosystem, or a city; society; or in the production of socioeconomic benefits.

In the case of the REBIMAR program, the benefit went to local biodiversity and the community of artisanal fishermen on the coast of Paraná, consolidating a solution that integrates nature in tackling problems related to industrial trawling in an unsustainable way, impacting both marine biodiversity in the region the community of artisanal fishermen in the region. In addition, to consolidate the program in a scenario that, even with instabilities, its potentials and strengths are perennial in providing social impact of great importance for the region, which can also be extended to national and global levels.

Interpreting by SWOT analysis, it was characterized by the predominance of forces, within the internal environment, by institutionalizing a non-innovative practice, since there are consolidated cases on a national and world scale, but in an innovative format, motivated by the choice of the installed marine area, and for the choice of the chosen material, considering its shape, composition and also because it is the first project to be granted environmental licensing. Scoring also in the other socioeconomic and environmental aspects, considering the reestablishment of the local biodiversity, passing through to stimulate the activity of artenal fishing.

The monitoring shows an increase in the biodiversity of species of economic value, at the points of installation of the reefs and the reduction of trawl fishing has also been identified.

Therefore, what is expected from NbS is the resolution or mitigation of demands, supporting natural processes to sustain an economy, recognizing natural capital, as well as the return in economic, environmental and social terms. Therefore, NbS can be an environmental technology with a significant social impact. NbS practices run through different perspectives, either to identify their concept or to evaluate such practices, however all efforts are focused on the search for strengthening this concept, since it enables applications through scientific knowledge, transforming them into technology, thus articulating, not in a unilateral man-landscape way, but in a multifaceted way in terms of perspectives (man-landscape-society), always striving for sustainable development and its three pillars: social, environmental and economic.

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# Reverse Logistics System to Support the Lamp Circularity: A Case Study in Irati—Brazil


**Robison Giovani Malucelli, Bruno Specht, and Marcell Mariano Corrêa Maceno**

## 1 Introduction

One of the biggest challenges faced by companies, according to Souza and Silva (1997), has been adapting competitiveness with environmental management, in other words, producing in an ecologically correct manner and with social responsibility. Although the industry tries to make this conciliation, solid waste management, resulting from the growing industrialization, remains a complicated environmental issue (Souza and Silva 1997). The increase in industrial production, justified by the increase in population density, results in an increase in products to be manufactured and consumed. Roth and Garcias (2008) explain that the economic development of society causes consumption to increase, consequently there is a high amount of solid waste to be discarded.

Industrialization has provoked a movement of resistance and awareness on the part of society in way that laws are being created in order to the present risks can be controlled (Melo 2012), as in the case of Brazilian Federal Law No. 12305, August 2, 2010, establishing the National Solid Waste Policy—PNRS. It was created to regulate environmental imbalances resulting from improper solid waste handling. Among its objectives are the non-generation, reduction, reuse, recycling and treatment of

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solid waste, as well as the environmentally appropriate designation of waste and the protection of public health and environmental quality (BRASIL 2010).

PNRS establishes that there is an obligation to structure and implement reverse logistics systems in post-consumer products, such as pesticides, batteries, tires, lubricating oils, fluorescent lamps and electronic products (BRASIL 2010). These residues included in the PNRS, if improperly disposed of, can cause difficult treatment environmental problems.

For the final destination of waste, it is necessary to apply available technologies to be transformed into inputs or new products and, after all the possibilities of treatment and recovery are exhausted, the waste must have an environmentally correct disposal. Reverse logistics is directly related to collection and return of these solid wastes, to be reused in several sectors in industrial sphere (BRASIL 2010).

Fluorescent lamps, for example, are made up of some materials that can be recovered and can be reused in industries or in the lamp factories themselves. Although recycling brings benefits to environmental management, the cost of recycling for lamps is still relatively high, considering that there are a large number of lamps that are discarded annually in each Brazilian municipality (Durão and Windmöller 2006).

Between 2000 and 2010, the city of Irati, located in the interior of Paraná, performed an average population growing rate of 0.71% per year, driven by the economic development of the city (IBGE 2016). This growth has been causing some problems for the town, as it hasn't been able to carry out programs for the collection of after consumption products, as presented in the PNRS, among them the lamps.

Based on the discussion presented, this study aims to propose a reverse lamp logistics system for the Municipality of Irati with focus on collecting lamps discarded in homes after the end of their operating life. The proposition of this collection system will cover the method of how the lamps will be stored, transported and destined, following the PNRS.

## 2 Theoretical Bases

On following topics, the concept of reverse logistics and its main regulatory standard in Brazil will be addressed, as well as the impacts of the disposal of lamps on the environment. Finally, information was collected regarding the return situation of fluorescent lamps in the state of Paraná.

### *2.1 Reverse Logistics and Environmental Legislation*

According to Motta (2011), logistics is characterized by the means of distribution of products to the consumer, seeking to meet the established deadlines with the lowest possible cost. It aims to meet the needs of the consumer, through the planning,

implementation and control of the flow and storage of goods, services and information from the point of origin to the point of consumption.

Lacerda (2002), on the other hand, states that the product's life cycle cannot end in delivery to the consumer. There must be a return to the point of origin, so that it is properly disposed of, repaired or reused. Therefore, it is necessary to understand the concept of reverse logistics, which is defined as the process of planning, operating and controlling the flow of logistical information related to after-sale and post-consumer goods to be reintegrated into the production cycle, for through reverse distribution channels, adding economic and ecological values (Leite 2003, pp. 16–17).

For Shibao et al. (2010), reverse logistics became popular due to the companies' interest in decreasing the environmental impact of the supply chain, through the reuse and recycling of products, aiming to reduce environmental pollution and the waste of inputs. Driven by consumers, the concern with the preservation of the environment resulted in legal actions carried out by inspection agencies (Chaves and Batalha 2006).

The PNRS was approved for the purpose of managing solid waste environmentally. One of the main focuses addressed by the PNRS is reverse logistics, already mandatory for some products, such as pesticide packaging, tires and batteries (Herbst 2017). Everyone's share responsibility in the production chain is also defined in PNRS, involving importers, manufacturers, distributors, traders and consumers. The holders of public services for urban cleaning and solid waste management are also responsible for minimizing the volume of solid waste, thus minimizing the impacts caused to human health and environmental quality. Also noteworthy is the recovery of solid waste discarded and collected through reverse logistics and the correct disposal of waste (BRASIL 2010).

Lamps and electrical products are the mainly harmful ones that still do not have the practice of structured reverse logistics, becoming a great challenge in the management of solid waste, since they are discarded in large concentrations. According to Ferreira and Gonçalves (2016), the estimated number of fluorescent lamps discarded in Brazil is 206 million annually.

## *2.2 Waste Lamps and Environmental Risks*

For domestic use, there are five main types of lamps: compact fluorescent lamps, tubular fluorescent lamps, light-emitting diodes (LED), halogen lamps and incandescent lamps. According to Zanicheli et al. (2004), they can be basically divided into two groups, lamps that are not potentially dangerous for the environment and lamps that are potentially dangerous for the environment. The difference between them is in its composition: harmful ones have mercury in their composition, as is the case with fluorescent lamps, while those that do not have mercury, such as incandescent lamps and LEDs, are harmless to environment.

Incandescent lamps are basically composed of glass and metal, having no toxic residues in their composition. According to Santos et al. (2015), this type of lamp

can be discarded in landfills, however, it is mentioned that it is not possible to recycle the glass, since the type of glass used in the production of lamps is different from conventional glasses. Halogen lamps are a type of incandescent lamp, differentiated only by having halogen elements (iodine or bromine) in their composition, however it isn't a potential risk to the environment (Zanicheli et al. 2004).

In the case of LED lamps, they have no glass, metallic filaments, mercury or other types of toxic substances in their composition. Disposal is facilitated for this type of lamp, approximately 95% of the lamp is recyclable, requiring no special treatment (Bez 2016).

Fluorescent lamps are considered solid waste and must be submitted to recycling or reuse of waste and after all types of treatment have been carried out, the waste must be disposed of correctly (Brazil et al. 2011). PNRS distinguishes between "solid waste" and "waste". Solid waste is, according to art. 3rd, item XVI, of the PNRS, "all material, substance, object or discarded goods that are the result of human activities in societies" (BRASIL 2010). On the other hand, waste is "solid residues that, after all the possibilities of treatment and recovery by available and economically viable technological processes have been exhausted, do not present any possibility other than the final environmentally appropriate disposal" (BRASIL 2010, art. 3, item XV).

For recycling of fluorescent lamps, it is necessary to apply technologies related to the treatment of mercury so that they can be reused. In Brazil, technologies are simple grinding, grinding with chemical or thermal treatment, by blowing and solidification (Bacila et al. 2014). After undergoing one of these decontamination processes, they can be reused in various industrial sectors. Glass, for example, can be used for the production of new lamps or for packaging non-food products. Phosphorus powder can be used in cement factories. Aluminum connections with their ferro-metallic components can be used in the aluminum foundry industry. Bakelitic insulation is the only one that cannot be recycled and must have an environmentally appropriate final destination (Durão and Windmöller 2006).

According to the Attorney's Office of the Republic of the Federal District through its Technical report No. 65/2006, fluorescent lamps, if intact, cannot pose a risk to the environment and human health. However, if fragmentation is caused, mercury vapor is released and remains for weeks. Moraes (2015) explains that because it is the most volatile of all metals, its main means of environmental contamination is through atmospheric emissions.

Pawlowski (2011) describes that mercury is a bio accumulative toxic pollutant and, after being released, it is not possible to remove it from the earth's surface. Mercury, when free in the environment, remains circulating between air, water, sediment, soil, and biota, taking other chemical forms with different levels of toxicity. If mercury meets water, it becomes methylmercury, the most toxic metallic form (Ministério do Meio Ambiente 2013). According to Moraes (2015), methylmercury, as a metal, has the properties of bioaccumulation and biomagnification, in other words, it is able to concentrate on living organisms and at various levels of the food chain, accumulating greater concentration at each trophic level.

### 2.3 The Reverse Logistics Situation of Lamps in Paraná

The environmentally correct destination of the lamps has been a problem for the cities of Paraná. Although the legislation requires that the material be returned to the industry that originated it, not all manufacturers end up recovering this waste. In cases like this, many wastes are sent to the landfill, since the City Halls do not manage the waste properly.

After the PNRS was approved, some of the cities started to worry about the reverse logistics of lamps, although there are still few cities that adopt the type of collection and incentive for the correct disposal of lamps. The small number of cities that practice reverse logistics has worried the State office for the Environment (Sema) of the State of Paraná, which came to meet in 2013 with representatives of 86 municipalities in Paraná responsible for 90% of the waste generated in the state, in order to avoid that recyclable waste ends up being sent to landfills and end up further contaminating the environment (Silva 2013).

The capital of the state is an example to be followed on the practice of collecting lamps. According to the Curitiba City Hall website (https://www.curitiba.pr.gov.br, retrieved on August 26, 2017), trucks have been available since 1998 that remain each day of the month in city buses terminals, where light bulbs and other types of toxic waste are received, which need treatments to be disposed of to an appropriate end. The Brazilian Association for the Management of Reverse Logistics (Reciclus), a non-profit civil organization, in 2017 implemented 8 lamp collectors in shops spread across the city of Curitiba and the metropolitan region. The organization plans to implement, still in 2018, another 10 points of delivery points in the State of Paraná (Paraná 2017).

The city of Londrina, located in the north of the state, has the help of some retail outlets to assist in the collection of post-consumer lamps, such as a pharmacy, supermarket and building material store (G1 PR 2014). According to the Londrina City Hall (https://www.londrina.pr.gov.br/, recovered on 03, September, 2017), the city has a Reverse Logistics Center, which after collecting and storing the products described in the PNRS, the product is classified by manufacturer and the plant then contacts the associations in charge of collecting its products and giving the correct destination. The academic community has also been concerned with the conscious disposal of light bulbs, according to the website of the State University of Londrina (https://www.uel.br/portal/, recovered on 07, September, 2017), in 2011, a portable equipment was carried into the University Campus to perform the decontamination of lamps and alerted the university community that the fluorescent lamp has hazardous waste and cannot be disposed of in the trash.

The city of Irati, according to the Department of the Environment, in 2010, was the second city in Paraná to put reverse logistics into practice, discarding about 3500 lamps collected by the Municipality. However, there have been no other reverse logistics practices since then. According to Sava (2017), reverse logistics was once again discussed by the Municipal Office of Ecology and Environment. In 2017, a meeting was held explaining the reverse logistics and the need to adapt to the

legislation. During the meeting, it was agreed that the commercial points that sell the lamp should start collecting these materials that have lost their useful life, adapting to the legislation.

## 3 Research Method

As a way of carrying out this study, six research steps were elaborated, detailed in topics 3.1–3.6.

### *3.1 Study Area and Problem Characterization*

The present study was carried out in the city of Irati, located in the southeastern region of Paraná, with 999.516 $km^2$ of total territorial area (urban and rural). The urban region of the city is divided into 19 regions, with a population of 60,070 inhabitants (IBGE 2016).

An interview was conducted with the person responsible for the Environment and Ecology sector in the municipality, and according to Lozinski (personal interview, March 24, 2017) the City Hall currently only provides the collection of organic and recyclable waste.

According to the interviewee, the town does not yet have programs related to the reverse logistics of lamps, batteries and electronic products. What ends up being a problem found in the Municipality, since the residents are not encouraged to consciously dispose of this waste.

### *3.2 Municipality Information*

As data on the number of homes and people in each region was not made available by the City of Irati, an estimate was made for each one.

Through a map provided by the Municipality, a division of the city was carried out in 19 regions. Using the software, a measurement of the built areas of the municipality was carried out, in order to determine the residential area of the town. Intend to obtain the data referring to the number of residents in each region, a new relative population was first performed taking into account the measured area. Finally, the new relative population was multiplied by the constructed area of each regions.

To estimate the number of houses per region, the number of populations per region was divided by the average number of inhabitants per household, made available by the National Household Sample Plan (PNAD) carried out in 2015 by IBGE.

### 3.3 Lamp Estimates (Consumption and Disposal)

In this study, it was considered that all households have electric lighting and that they have six average rooms per household based on the structure of a popular home.

Thus, to find the consumption of lamps by region, the number of houses by region, calculated in the previous item, was multiplied by the average number of rooms.

To discover the monthly disposal of fluorescent lamps, the ratio between the number of lamps by region and the useful life (in months) was performed.

### 3.4 Collection Points: Mapping and Structure

PNRS establishes that all agents in the chain, including traders and consumers, are equally responsible for complying with environmental obligations, correctly disposing the solid waste (BRASIL 2010). All points of trade in lamps, such as markets and grocery stores, building supply stores and electrical supply stores, were located and mapped to determine where consumers can dispose of their fluorescent lamps after consumption.

After mapping the lamp sales points, the maximum distance of five hundred meters of walking for residents to the nearest collection point was defined (Souza 2016). This value was adopted based on the distance considered feasible for a resident to walk to a bus stop, considering that the discarded lamp will be transported to the nearest collection point by people. Through the Google Earth Pro® software, circumferences of five hundred meters radius were established around each store with the objective of verifying the locations that are not being served by this ray. Some households did not enter this radius due to the distance from the collection point, which would force residents to walk greater distances than proposed. In this way, new locations were chosen to collect the lamps, such as the University, Schools, Nurseries and Churches.

For the post-consumer lamp to be collected in these locations, they must be intact. If fragmented, it is not possible for recycling or treatment to occur, as mercury will have already been released into the environment. For each collection point, a container was defined for the lamp to be well packed to be held into, both on site and during transport, in order to avoid fragmentation.

### 3.5 Collect's Routing

A survey of all the addresses of the collection points was carried out and the starting point and the final point of the route were defined. Through RoutEasy®, an online script, a shortest route that the truck could travel was simulated.

### *3.6 Proposed Reverse Logistics System's Estimated Cost*

There is a need to structure the collection points and the truck with appropriate containers for the storage of lamps. An initial investment is essential for the purchase of these containers for each collection point and for the truck. In order to estimate the cost of this reverse logistics system, the initial investment is determined by the purchase value of these containers. For monthly costs, labor, logistics, decontamination and lamp recycling costs are considered.

Manpower was established based on avoiding work overload and idleness. For this, an amount considered ideal for drivers and recyclable material collectors was raised.

For the logistical cost, fuel, maintenance, oil and tire changes were considered.

Finally, the decontamination and recycling process has a fixed price for each fluorescent lamp.

## 4 Results and Discussions

To be structured and proposed the collection system, it was essential to divide the study into two parts. In the first part, the data of the municipality were collected, in Sect. 4.1. In the second part, the entire reverse logistics system was proposed, according to Sect. 4.2

### *4.1 Estimated Consumption of Lamps*

The measurement of the built area of each region, performed using the Google Earth Pro software, is shown in Table 1. The residential area of the city is approximately 14.97 $km^2$.

With data referring to the demographic census carried out in 2016 by IBGE, a value of 4011.51 inhabitants/$km^2$ was found for the new relative population (IBGE 2016).

According to the National Household Sample Survey (PNAD) conducted in 2015 by IBGE, the southern region of Brazil has an average of 2.8 residents per household (IBGE 2015a, b). Table 1 shows the estimated number of houses in each region.

Based on the structure of a popular home, six were considered as the average number of rooms per household. According to the manufacturers, the fluorescent lamp has a useful life of 10,000 h. For a lamp that stays on for an average of six hours a day, it is estimated to last for 4 years and 7 months.

Table 1 shows the number of lamps discarded monthly.

Once the quantity of discarded lamps was estimated and, the division of the municipality into regions, it was surveyed which are the regions with the greatest

**Table 1** Estimated data by region of the municipality of Irati-PR

| Region | Constructed area ($km^2$) | Estimated population in 2016 (number of inhabitants) | Estimated houses (number of houses) | Estimated lamps (number of lamps) | Monthly lamp disposal (number of lamps per month) |
|---|---|---|---|---|---|
| Alto da Glória | 0.58 | 2339 | 836 | 5011 | 92 |
| Alto da Lagoa | 0.22 | 877 | 314 | 1879 | 35 |
| Camacuã | 0.34 | 1349 | 482 | 2891 | 53 |
| Canisianas | 0.86 | 3454 | 1234 | 7402 | 135 |
| Centro | 1.80 | 7207 | 2574 | 15,443 | 281 |
| Colina Nossa Senhora das Graças | 0.61 | 2456 | 877 | 5262 | 96 |
| DER | 0.54 | 2168 | 775 | 4646 | 85 |
| Engenheiro Gutierrez | 0.84 | 3353 | 1198 | 7184 | 131 |
| Fósforo | 0.94 | 3756 | 1342 | 8047 | 147 |
| Jardim Aeroporto | 1.06 | 4251 | 1519 | 9109 | 166 |
| Jardim Califórnia | 0.60 | 2427 | 867 | 5200 | 95 |
| Jardim Virgínia | 0.69 | 2765 | 988 | 5925 | 108 |
| Lagoa | 1.39 | 5584 | 1994 | 11,964 | 218 |
| Nhapindazal | 0.23 | 928 | 332 | 1987 | 37 |
| Rio Bonito | 1.59 | 6386 | 2281 | 13,683 | 249 |
| Riozinho | 0.20 | 822 | 294 | 1761 | 32 |
| Stroparo | 0.88 | 3537 | 1264 | 7579 | 138 |
| Vila Nova | 0.20 | 789 | 282 | 1690 | 31 |
| Vila São João | 1.40 | 5632 | 2012 | 12,069 | 220 |
| TOTAL | 14.97 | 60,070 | 21,465 | 128,732 | 2349 |

*Source* Author (2017)

disposal of lamps, carrying out a study of adding new collection points for these regions. A proposal for a lamp collection system was developed for the Municipality of Irati, as follows in Sect. 4.2.

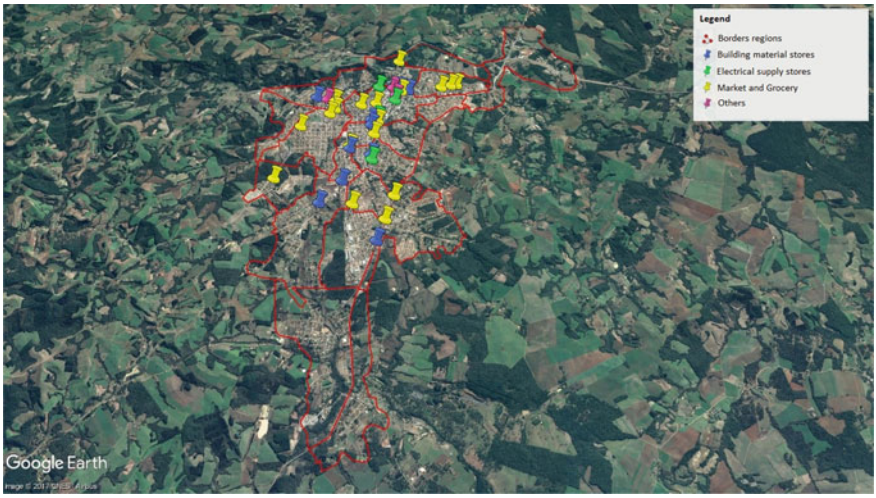


**Fig. 1** Distribution of defined collection points for the municipality of Irati-PR. *Source* Google Earth Pro/Author (2017)

## *4.2 Proposed Collection System*

Using a list made available by the Association of Merchants of Irati (ACIAI) and researching for stores in each neighborhood using Google Earth Pro® software, a mapping of all establishments selling lamps in the town was carried out, as can be seen in Fig. 1. The blue dots represent the building supply stores, the green dots are the electrical supply stores, the yellow dots depict the markets and grocery stores, the pink dots are general appliance stores. The areas enclosed in red are the divisions of each of the regions.

From the collection points already existing in the city shown in Fig. 1, some yellow color circles with a radius of 500 m were drawn. According to Souza (2016), this distance is considered viable for a resident to walk to the nearest bus stop. An equivalent distance was defined, since the lamps will be transported by the residents to the nearest collection point. Within each circumference are the residences served by the maximum distance limit stipulated so that the resident can return the lamp without having to walk greater distances. As the central region concentrates many collection points, some circumferences were defined that end up encompassing the entire region.

As can be seen in Fig. 2, there are many urbanized regions within the partitions of regions that are not being reached by the proposed radius of the collection point.

Due to the difficulty of coverage of all regions of the municipality, new collection points were defined for the installation of lamp receiving units, as shown in Fig. 3. These points were defined based on strategically located points in each region and which have great flow of people, such as Universities, Schools, Nurseries and Churches.

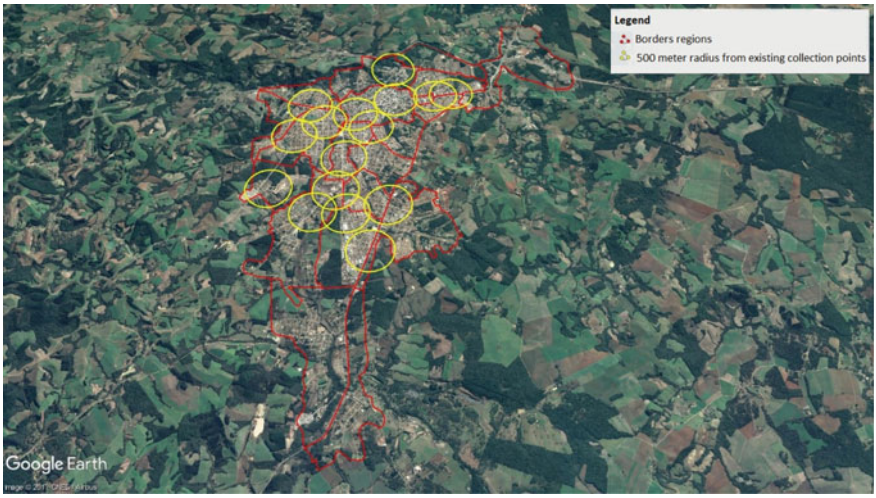


**Fig. 2** Estimate of current collection points in the city of Irati-PR. *Source* Google Earth Pro/Author (2017)


**Fig. 3** Proposal for new collection points in the city of Irati-PR. *Source* Google Earth Pro/Author (2017)

The addition of these new collection points resulted in a coverage of regions more distant from the central region, as can be seen in Fig. 4.

After defining the existing collect points and the new ones added, the next step is to structure them with packaging containers, checking if the capacity is met according to the estimated number of lamps.

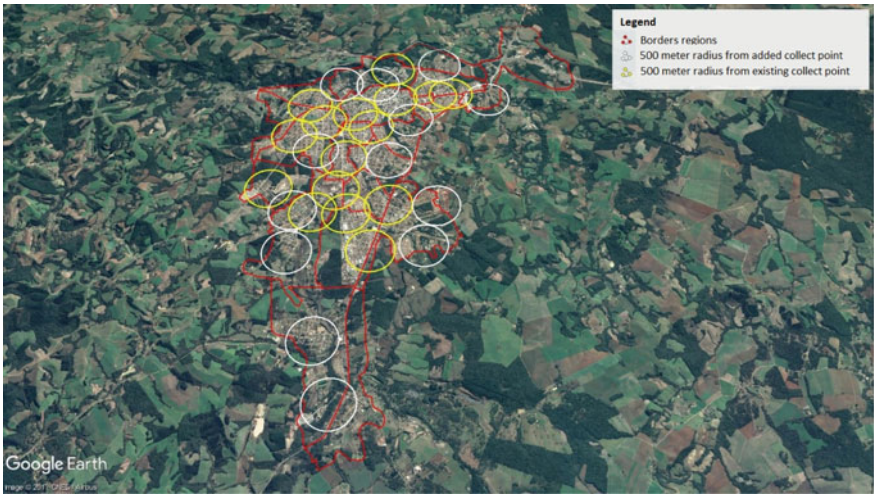


**Fig. 4** Estimate of current and new collect points in the municipality of Irati-PR. *Source* Google Earth Pro/Author (2017)

The suppliers MECA Coleta Inteligente and MetaGreen have containers and ecological boxes for the storage of lamps. Taking the price, size and quality of the product as a criterion, 55-L containers were determined to store compact lamps. And for the storage of tubular lamps, boxes that store up to 30 of each size. These sizes were defined according to the amount of collection points in each of the regions and according to the monthly discarded number of lamps calculated in Table 1.

The truck will return to the warehouse only when it passes through all defined collect points. The truck's capacity must be greater than the sum of the number of lamps discarded at each of the collect points. Based on the estimate, two 140-L containers and a box with a storage capacity of 150 tubular lamps of the same model as described previously would be required.

Due to the number of collect points and the demand for the service, it would not be possible to collect all lamps in just one day, therefore, the city was divided into two zones: the north zone involving 25 points and 11 regions, and the south zone, involving 23 points and 8 regions. Each week, the truck would make a route, alternating in each zone, to reach all points established by the routing in just one day.

Through RoutEasy®, an online script, the route for each zone was simulated. The starting point was defined as the headquarters of the Environment and Ecology's Office of the Municipality since the trucks are parked in the garage of this place. The final point was defined as a shed located behind the Environment's Office. Both are represented by the zero point within the figure.

Figure 5 shows the simulation of the northern route, with a total distance of 17.8 km.

The routing of the southern area totaled 25.9 km. The simulation of this route can be seen in Fig. 6.

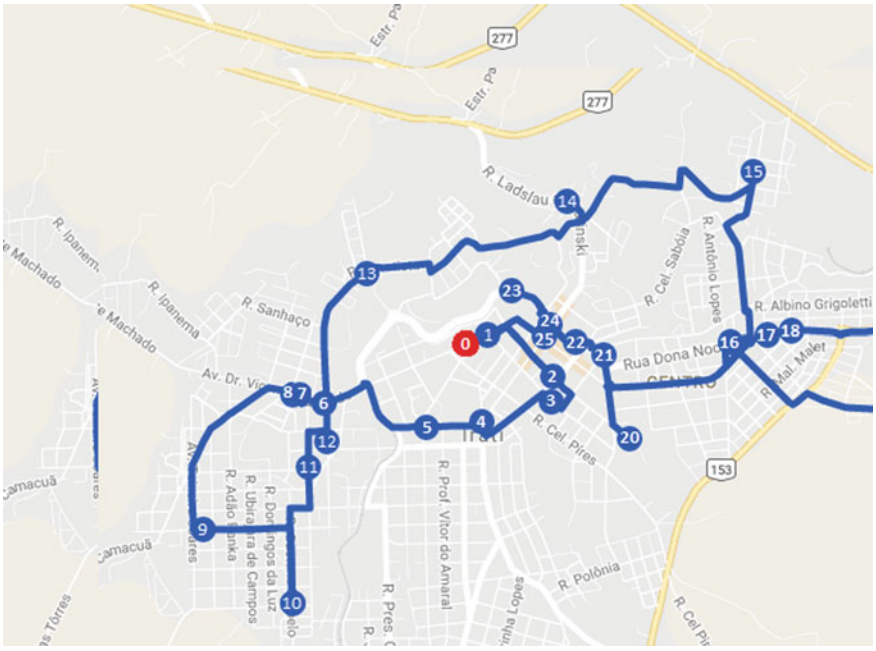


**Fig. 5** North zone routing. *Source* Google My Maps/Author (2017)

As each collect point needs a container to hold the lamps, 48 containers of 55 L capacity would be needed for compact lamps and the same number of boxes for tubular lamps, each with a capacity of 30 lamps. For the interior of the truck, two 140-L containers and only one box for tubular lamps is necessary. It is possible to observe the value of each container and each box of tubular lamps in Table 2. The initial fixed cost was estimated at R$31,513.00.

In order to carry out the work of moving and collecting lamps from the collect points to the truck, it would be more convenient a driver and two collectors of recyclable materials. Bearing in mind that only one collector of recyclable material would be overloaded not be able to perform the job correctly, and a number greater than three could be idle. Lozinski (2017) reported that two workers are used to collect recyclable materials in the municipality. Based on the routing carried out, the collection of lamps in each of the zones would take around 6 h to be carried out, leaving approximately 2 h to carry out the unloading of the lamps in the shed of the City Hall. In one month, the number of hours allocated for this job per person would be 36 h, equivalent to 20% of a 180-h working contract. Through the Transparency Portal of the City Hall of Irati (https://transparencia.irati.pr.gov.br:8086/portaltransparencia, recovered on September 28, 2017), it was possible to obtain the remuneration of the servers that would carry out the collection. The estimated remuneration for a truck driver was R$2043.06 and for each collector of recyclable material was R$1842.33. To calculate the labor cost, only the hours worked by the servers in

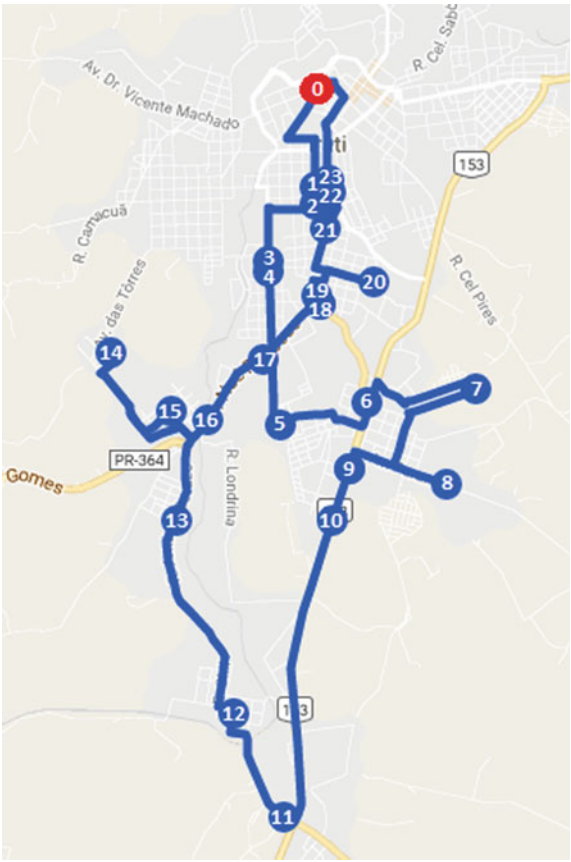


**Fig. 6** South zone routing. *Source* Google My Maps/Author (2017)

**Table 2** Cost of containers for collect points

| Supplier | Material | Quantity | Price | Cost |
|---|---|---|---|---|
| MECA Coleta Inteligente | 55-L container | 48 | R$277.00 | R$13,296.00 |
| MECA Coleta Inteligente | Box of 30 tube lamps | 48 | R$348.00 | R$16,704.00 |
| MECA Coleta Inteligente | 140-L container | 2 | R$385.00 | R$770.00 |
| MetaGreen | Box of 150 tube lamps | 1 | R$743.00 | R$743.00 |
| Total | | | | R$31.513,00 |

*Source* MECA Coleta Inteligente (2017)/MetaGreen (2017)/Author (2017)

the collection of the lamps were considered. Therefore, the cost of labor would be R$1145.55 monthly.

The Irati City Hall has a medium-sized truck that collects recyclable materials for the Municipality, the same could be used to collect the lamps. For the logistical cost, fuel, maintenance, oil change and tires were considered. The truck would travel

**Table 3** Monthly cost of the proposed reverse logistics system

| Type of cost | Cost |
|---|---|
| Labor | R$1145.55 |
| Logistics | R$89.15 |
| Recycling | R$2349.00 |
| Total | R$3583.70 |

*Source* Author (2017)

twice a month in each of the zones, totaling 87.4 km. The truck used runs around 4.01 km per liter. The best fuel price found in the city was R$2.99. The estimated fuel cost per kilometer was R$0.75. Machado (2016), in his study, estimated the value of R$0.27 per kilometer traveled for the remaining costs (maintenance, oil and tire changes). Thus, the logistical cost was R$89.15 monthly.

According to a company specialized in lamp decontamination, the price of R$1.00 was raised for each fluorescent lamp for the decontamination and recycling process. According to the monthly estimate, 2349 post-consumer lamps would be collected, generating a cost of R$2349.00.

Therefore, as can be seen in Table 3, the monthly cost would be R$3583.70.

It is noticed that a large initial investment is necessary for each collect point to be structured and to be able to accommodate the lamp capacity required. In addition, there is a monthly cost for the proposed logistics system, where the cost of recycling the lamp have the greatest share.

In the Transparency Portal of the Municipality of Irati, for the Municipality's revenue, the estimated value of R$161,720,470.14 can be found in the year 2017 until the month of November. Regarding expenses, the estimated budgeted amount is R$163,222,605.36 for the same period. It is noticed that the Municipality is in deficit, making it impossible to bear all costs. The search for alternatives and partnerships would be necessary for this proposed reverse logistics system to be funded and implemented.

According to the Ministry of the Environment (2017), reverse logistics can be carried out through sectoral agreements signed between the Government and the private sector, or also by Terms of Commitment signed by the Government with manufacturers, importers, distributors or merchants. Lozinski (2017) commented that he was looking for an agreement with merchants to enable the purchase of equipment for the recycling of fluorescent lamps, which could decrease the cost of recycling, responsible for the higher monthly cost.

## 5 Conclusion

The town's economic development causes the amount of waste generated to increase. It is necessary proper waste management to be carried out, in order to avoid environmental impacts generated by the mercury in fluorescent lamps. This study aimed

to assess the current situation of the Municipality of Irati regarding the disposal of fluorescent lamps and to propose a reverse logistics system for post-consumption lamps with a focus on collecting lamps generated in homes after the end of their life cycle.

Through the information gathered regarding the number of light bulbs, it appears that there is a considerable estimate of post-consumer lamps discarded monthly. The biggest concern is that these lamps have an environmentally correct destination in order to avoid negative environmental impacts. Thus, lamp collection programs are important for the Municipality, as well as the incentive for environmentally correct disposal.

With the existing collect points and the new ones added, each region of the municipality would have at least one collect point. The need for structuring with containers at each collection point is important, since large quantities of lamps would be stored and would avoid possible fragmentation.

Through the cost estimate, a large investment is perceived for the acquisition of containers for the collect points, as well as the costs of recycling the lamps, however if partnerships are established, it is possible to implement the reverse logistics system. An alternative would be that the residents themselves could help with recycling costs when delivering the lamps, until the recycling equipment is purchased, as mentioned by Lozinski (2017).

To encourage disposal, it would be interesting to create a reward system. This practice is already carried out in the capital of Paraná, according to the Curitiba City Hall. In 2015, the citizens who contributed most to the disposal of recyclable materials were rewarded with symbolic prizes, such as tickets for artistic activities in the municipality. Another interesting proposal would be to create a website that presents the closest collect point based on the location of each resident, as de Oliveira and Paschoalin (2014) proposed for the city of São Paulo. This could encourage the resident to take the post-consumer lamp for proper disposal, since it would show the existence of a collect point 500 m from each resident.

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# Corporate Responsibility in Practice: Co-processing Implementation of Municipal Solid Waste for the City of Campo Largo—Brazils


**Maria Luiza Mathieu Bernartt, Marcell Mariano Corrêa Maceno, and Walquíria Menna Brusamolin**

## 1 Introduction

For the past few years, the population has begun to be more concerned about sustainability and the environment. Countries, becoming aware of the real problem the world is facing, started to propose actions and agreements to improve this scenario in the future (PWC, SELUR, ABLP 2010).

The quantity and the characterization of the waste generated in each country may be related to its degree of industrialization (Magera 2003; Fé and Faria 2011; Pinhel 2013), besides that, waste can be an important economic indicator from its production and characteristics (Campos 2012). In Brazil this process is characterized by an accelerated industrialization and a high level of migration in the middle of the twentieth century. These migrations to urban centers together with the growth of the economy, increased the consumption, generating a greater quantity of waste (PWC, SELUR, ABLP 2010). The current scenario is a higher growth of waste generation than population growth. According to IBGE (2012), the population grows on average 0.9% per year and Municipal Solid Waste (MSW) is growing in a larger proportion, from 2013 to 2014 grew by 2.9% (Abrelpe 2014). In addition, health infrastructure in most cities is precarious and does not follow population growth (Meystre 2016).

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For Meystre (2016), in Brazil, waste management will succeed from a cultural restructure, bringing to the community the idea of shared responsibility. In 2010, the National Solid Waste Policy (PNRS) was instituted by the Law No 12305, which determines how to manage solid waste. This law brings the concept of Shared Responsibility, which is defined by the set of attributions to all involved with waste, with the objective of minimizing the quantity generated and, consequently, reducing its environmental impacts (Brazil 2010). It is an important law that helps to address various environmental problems in the country. One of its demands was the extinction of dumps by 2014, compelling the cities to dispose the waste in an environmentally appropriate way (PWC SELUR, ABLP 2010).

In this scenario of concern and environmental awareness, waste co-processing has been growing in the most developed countries since the 1970s (Votorantim 2014) and can become one of the solutions to waste problem in Brazil. MSW is increasing each year. One of the management alternatives to reduce the number of dumps and landfills is to send the rubbish to be co-processed in cement furnaces, reducing its impact and its environmental liabilities (ABCP 2016). This activity can be considered one of the most effective alternatives for the disposal of waste (Kihara 2008) and Brazil has a co-processing potential of 2500 tons of waste per year (ABCP 2016).

The co-processing of MSW brings benefits that other methods of disposition, such as landfills and incineration, do not supply, such as the lack of environmental liabilities, since the ashes are incorporated into the clinker. Furthermore, the cost of implantation and operation is not accounted for because it is incorporated by the cement plants. Finally, there is strict control over air pollutants, and has energy recovery of waste, seeking energy efficiency and savings of natural resources (Meystre 2016). However, there is a certain difficulty in using MSW in the co-processing process, since it needs to be transformed into Waste-Derived Fuel (WDF) before incorporated into the process. This must happen because MSW has very diversified characteristics and origins, making it necessary to carry out this prior treatment to meet the specifications required by the furnaces, such as energy efficiency (Meystre 2016).

Thus, the present study aimed to propose an alternative of co-processing of tailings of one recycling associations called ARLeV in the city of Campo Largo—Brazil. It is expected with this alternative to reduce the number of tailings sent to landfills, bringing economic and environmental gains to the municipality.

## 2 Waste and Co-processing

The Law No 12305/2010 establishes the National Solid Waste Policy (PNRS), which determines waste management as the set of actions that has direct or indirect connection with the stages of collection, transport, transshipment, treatment, and final disposal of waste, ensuring the greatest reuse and recycling, minimizing tailings (Brazil 2010). By its article 9, the priority in waste management is defined: Non-generation, Reduction, Reuse, Recycling, Treatment, and Environmentally Appropriate Final Disposal. It also says: “Technologies can be used to recover the energy

of MSW, provided that its technical and environmental viability has been proven and a toxic gas emission monitoring program has been approved by the environmental agency." It also establishes that each generator is responsible for its waste.

Tailings can be defined as solid waste that does not have any form of treatment or recovery, thus the only remaining alternative is the environmentally appropriate final disposition (Brazil 2010). According to Santos (2014), tailings reduce the eco-efficiency of the sorting facility, because its separation does not bring gains for the association, becoming an unproductive effort. In addition, this material can contaminate other items with potential of recycling and can bring vectors to the workplace. Santos (2014) still says that the quantity and quality of waste are determined by its separation in the generating source.

In Fig. 1 you can view the sustainability hierarchy, which indicates how to better manage waste. In this context, it is perceived that actions such as co-processing may be more appropriate than sending tailings to landfills.

Co-processing is an activity of the cement industries licensed by Resolution No 264/99 of the National Council of Environment (CONAMA) which consist on the manufacture of clinker, one of the main components of cement, through the thermal destruction of waste in furnaces. This activity does not generate environmental liabilities, which makes it an adequate solution for reducing environmental impacts, since it partially replaces the use of non-renewable raw materials, such as limestone, clay, and iron ore, by solid waste, such as MSW and industrial solid waste (ABCP 2016).

This activity brings economic and environmental benefits according to Ferrari and Kihara (2012), as it definitively eliminates the waste and preserves non-renewable

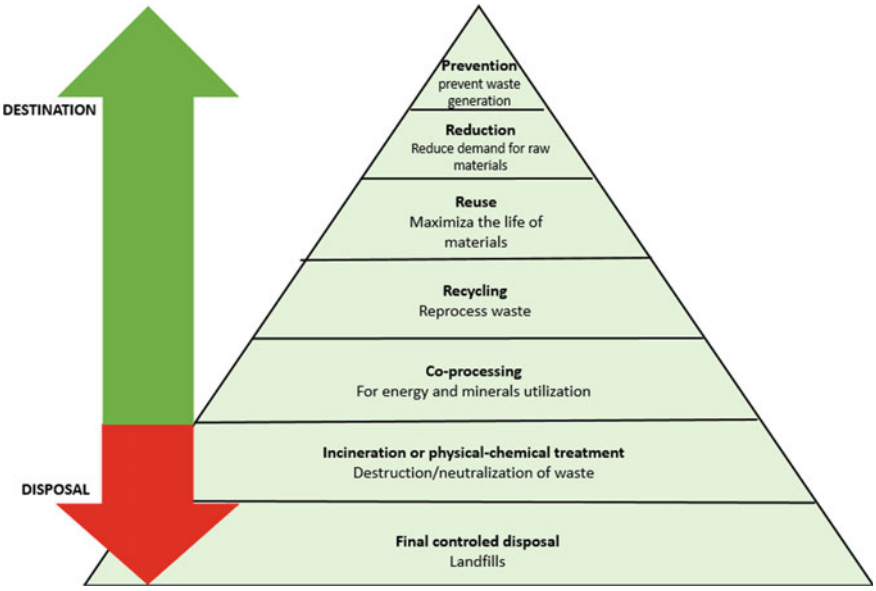


**Fig. 1** Hierarchy of the environmental sustainability. *Source* Adapted from ABCP (2016)

natural resources. In addition, it can receive a large volume of waste to be co-processed safely. This treatment technique brought greater competitiveness to cement plants, due to cost reduction in production with the replacement of non-renewable natural resources. The technique does not influence the quality of the cement produced and does not have significant environmental impacts, preserving health and safety (Ferrari and Kihara 2012).

Co-processing is an activity that has several controls that ensure product quality in the industrial process and the safety of the environment and employees. The activity should be very well monitored and requires specific feeding and handling systems, adequate areas of waste storage, and constant process monitoring (Votorantim 2014).

For the company to be able to perform this activity, it must be licensed meeting the requirements determined in Resolution CONAMA No 264/99 and comply with specific state laws. In Paraná, in addition to Federal Legislation (CONAMA), there is the Resolution No 076/09 from the Environment State Council (CEMA), which establishes "the requirements and criteria to request and issue Environmental Authorizations for co-processing of waste in cement furnaces, with the purpose of replacing raw material or energy use" (CEMA 2009). According to its article 4, MSW can be co-processed in the state of Paraná.

According to the Environmental Institute of Paraná—IAP (2018), the co-processing activity happens in Brazil since the 1990s and aims to make better disposal of waste, avoiding sending them to landfills and incineration. Figure 2 shows the mass of waste, in tons, co-processed in Brazil from 2000 to 2015.

Currently in Brazil, some industries already send their waste to co-process, but unlike MSW, its origin is known, and its composition is uniform. That is why MSW needs to be transformed into WDF (Meystre 2016). The use of WDF in co-processing replaces fossil fuels, bringing non-renewable resource savings. WDF is easy to handle, storage, and transport, because they have uniform size, and it is possible to mix with other fuels in different physical states. Other differentials are that it has a low production cost and a uniform chemical composition, which facilitates combustion control. However, there is a criticism about it, due to the disincentive to recycle. Transform the MSW that could be recycled into WDF goes in contradiction to the Hierarchy of Environmental Sustainability defined by the PNRS (Meystre 2016).

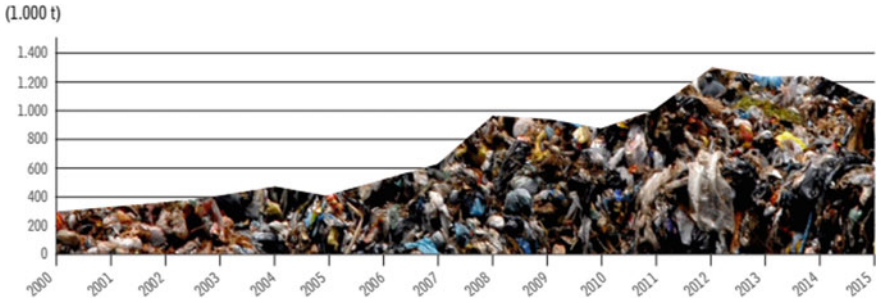


**Fig. 2** Evolution of co-processing waste (2000–2015). *Source* ABCP (2016)

According to the latest Solid Waste Panorama from Abrelpe (2016), 78.3 million tons of MSW were generated in 2016. It dropped by 2% compared to 2015. From the MSW collected (only 91.6% of the total waste generated) more than half were sent to landfills, equivalent to approximately 41.7 million tons, and part of these waste went to dumps, which were prohibited by law. Each Brazilian launches on average 1.04 kg of waste per day (Abrelpe 2016).

Abrelpe survey (2016) also showed that 3,878 municipalities have selective collection initiatives, representing only 69.62% of the municipalities. The Southern region has the highest percentage of municipalities with a selective collection. According to a study by IPEA (Applied Economic Research Institute) (2017) only 13% of the municipal solid waste collected is recycled.

In 2014 all dumps in Brazil should be extinguished under Law No 12305, established in 2010, and landfills should receive waste only after all other possibilities of recovery or treatment had been exhausted. With this measure, co-processing in Brazil gains strength because this environmentally appropriate solution is provided for by law (ABCP 2016) and becomes a good alternative for the disposal of waste, also can reduce the environmental impact of the areas of disposition and the environmental liabilities (Abrelpe 2016).

According to ABCP (2016), Brazil has a great potential for waste co-processing, estimated at 2.5 million tons per year. There are 57 industries that have furnaces with co-processing technology, in which 38 are licensed to perform the activity (ABCP 2015). In 2015, the research conducted by ABCP revealed that 1.07 million tons of waste were co-processed in Brazil.

## 3 Methodology

This study had the purpose to obtain an alternative solution for the disposal of tailings from the MSW of a cooperative by co-processing it. Thus, the research steps of this study are represented in Fig. 3.

Each step of the methodology performed is detailed next.

**Visit in Loco and Preparation of the Flowchart**: for the realization of this step it was necessary to visit 4 times the cooperative of recyclers "*Associação de reciclagem Lutar e Vencer*" (ARLeV), located in Campo Largo. In order to understand how the current system works, what are their needs, challenges, and limitations, a structured observation and interview with the President of the Association were made. For the interview, a questionnaire about the process were prepared before the visit (Appendix 1). For the observation of the activities, some visits were made to the Cooperative and to the city transshipment station to understand its operation in a more detailed way.

**Waste and destination data collection**: This step was also carried out at ARLeV during the visits mentioned above. From the interview with the president, it was possible to obtain information about the types and destinations of the tailings, as well as the average quantities and their buyers. In addition, a detailed analysis of the

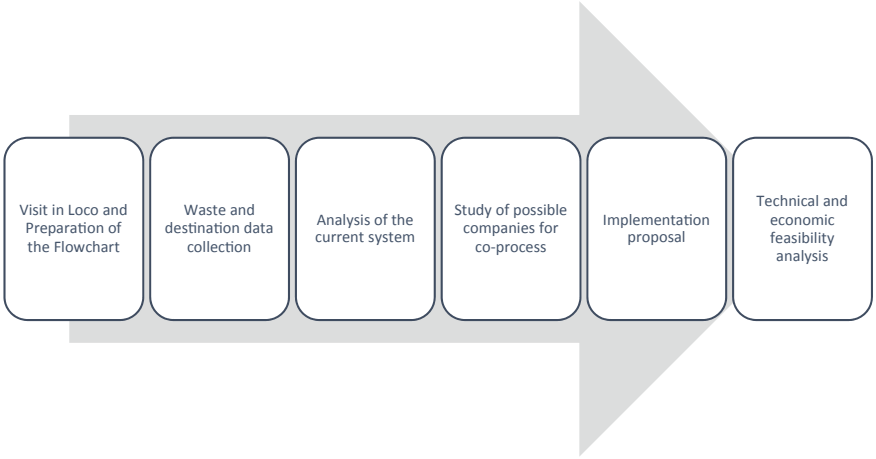


**Fig. 3** Research stages carried out for the preparation of the article

composition of tailings was made to discover what was being sent to landfill. This analysis was made in a fifth visit to the association through a gravimetric study. For this, a sample of 23 kg of tailings was collected and analyzed in order to categorize the materials present in the tailings mass. Therefore, it was possible to obtain the types of waste and their quantities in the cooperative material mass that is sold and sent to landfill.

**Analysis of the current system**: From the data collected in the previous two steps, it was possible to make a diagnosis of the current situation by analyzing the gravimetric composition of recyclable waste, as well as of tailings. Also, with the quantity of these waste made possible to obtain indicators of the quantity of waste received, recycled, and tailings. In the end, a comparison was made between the 4 associations of Campo Largo, through some data obtained from the Environmental Municipal Department (SMMA) Campo Largo, in order to estimate the municipality co-processing potential.

**Study of possible companies for co-process**: The Paraná cement companies were identified and analyzed to verify which would be the most appropriate and would have the best proposal for the pilot project. This step was made from a research on "Google Maps" in order to identify the potentials cement companies. The criteria selection were the distance from company to the cooperative, as well as the need of the company to be located in the state of Paraná, since transport between states in Brazil can result in legal difficulties for the transport.

**Implementation proposal**: for the implementation analysis of the project, participant research was made to have a closer relationship with those involved (municipality of Campo Largo, cooperatives, cement companies) and a better understanding of how the proposal could fit into their reality. It was identified how the pilot project would be executed. In addition, laws and data collected were revised to obtain an appropriate proposal. Campo Largo has 4 cooperatives and their data was obtained

from the SMMS Campo Largo. With that, it was possible to calculate the average of tailings that could be co-processed. This quantity was used combined with the data from ARLeV to prepare the feasibility analysis.

**Technical and economic feasibility analysis**: In this part, the technical and economic analysis of the project was made. For the technical analysis, a specialized company helped to analyze the material and the criteria of co-processing. Also, the process was analyzed to identify what needed to be changed and whether it would be necessary to hire more labor, acquire some equipment, change the infrastructure, as well as issues related to transportation. For the economic analysis, the gains that the association and city of Campo Largo would have were calculated from the landfill charges, distances from the cement company, autonomy and capacity of the truck and the value of diesel.

The proposal was prepared and presented to all involved, showing what were the necessary investments and the gains for the city. The studied area, Campo Largo, is presented in more detail.

## *3.1 Area of Study*

The study was carried out in the city of Campo Largo, located in Paraná (Fig. 4). The city has 127,309 inhabitants (IBGE 2017), with its main urban population, containing 21 neighborhoods (PMSB 2014). The municipality has a selective collection program since 2007, collecting domestic and commercial waste from the urban area and part of the rural area. It is estimated that in 2013 19,000 tons of household waste were generated. The collection is carried out by a third party company, CAVO—Services and Sanitation. Organic waste is sent directly to the landfill in Fazenda Rio Grande, Paraná, while recyclable waste is routed to 4 associations (ASSUR, ARC, ARAMA, and ARLeV) in Campo Largo, who separate recyclables and sell them to local buyers who recycle them (Santos 2014). It is estimated that in 2017 about 2245.66 tons of recyclable waste were sent to the city's associations. What is not separated as recyclable of these associations is sent to the landfill of Fazenda Rio Grande.

The city charges an annual garbage collection fee for the holders of the properties that are served by the service. In addition, there is a budget destined for this activity from the City hall for the SMMA.

The study was focused on one of the city's associations, the "Associação de Reciclagem Lutar e Vencer" (ARLeV). This association began informally by Claudia, who began in 2004 collecting waste from the city and separating them from her home. Some neighbors joined her later. In 2017 Claudia moved to a shed and the city helped her formalize her work, improving her conditions. That year, the association went to a larger space, of 799 $m^2$ of total area. She gained a treadmill, automatic press, and a forklift, providing improvement in the quality of the employees work. The association has 12 members, who work full-time. In 2017, it is estimated that it received about 565 tons of waste for screening (Projeto Elos de Sustentabilidade 2018).


**Fig. 4** Location of Campo Largo. *Source* Google Maps (2020)

## 4 Results and Discussion

### *4.1 Current Flowchart*

ARLeV flowchart was prepared from the on-site visit and the president's assistance (Fig. 5).

The flowchart of Fig. 5 is described in detail below.

**Waste collection**: Campo Largo municipality collects recyclable waste throughout its urban area and approximately 3% of the rural area. The collection is carried out by a third-party company, Cavo, which collects by 21 sectors, with 3 trucks of its own and directs them to 4 recycling associations: ARLeV, ASSUR, ARC and ARAMA, making a weekly rotation to deliver between them. The collection is performed on one shift during the day and the frequency of collection varies according to the region.

**Truck dumps waste on the floor of the shed**: ARLeV receives the waste from a municipal collection once a day, being on average between 1.5 and 2 tons. This waste is dumped by the truck in an area on the ground, inside the shed (Fig. 6). ARLeV's goal is to separate all the material dumped by the truck until another load comes the next day.

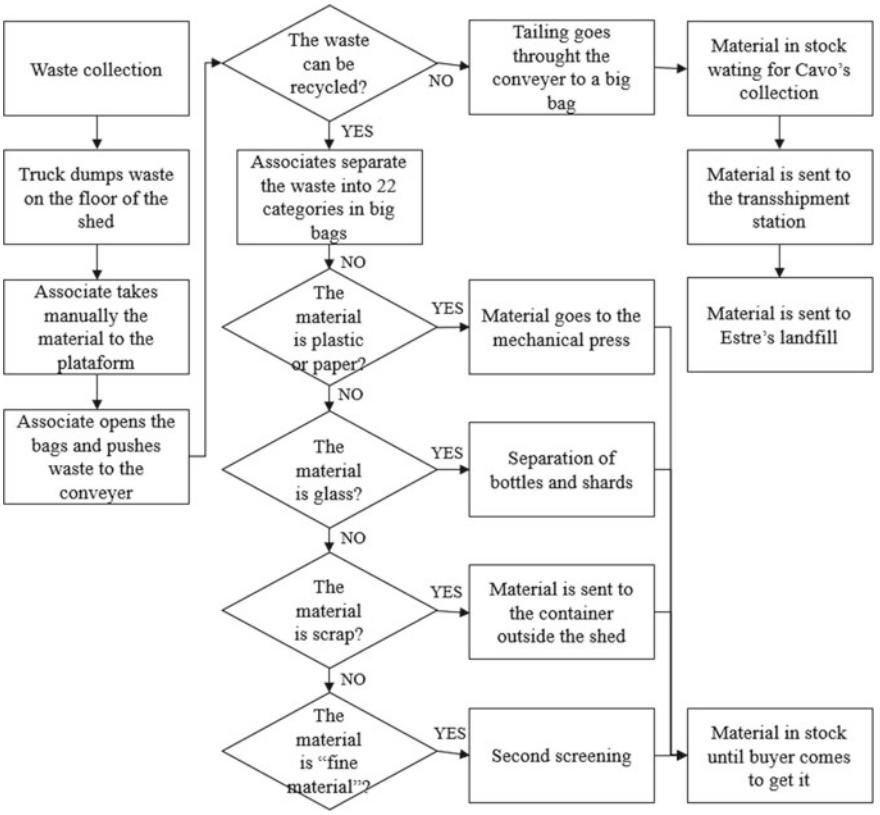


**Fig. 5** ARLeV flowchart

**Associate takes manually the material to the platform**: After the truck leaves the recyclable waste, an associate is in charge of taking this waste to a platform of approximately 1 m, which is connected to the conveyor. He puts the material on the platform according to the rhythm of the conveyor.

**Associate opens the bags and pushes waste to the conveyor**: Another employee stays on top of the platform opening the closed garbage bags to facilitate the screening stage and forwards the waste that are on it to the conveyor with the aid of a broom.

**Associates separate the waste into 22 categories in big bags**: eight associates stay along the conveyor (Fig. 6) to separate recyclable materials. Each separate as many items as possible and put them into big bags, which are large sturdy bags that are on a wheel holder to help relocation.

The waste classification is represented in Table 1. If the material is plastic or paper, 2 other employees are responsible for taking them into a mechanical press and turn them into bales. This improves their storage until the buyer collection (Fig. 6). If the material is glass, there is a second screening, in which the shards are separated from the intact bottles, which have a higher selling value. Scraps are packed in a container

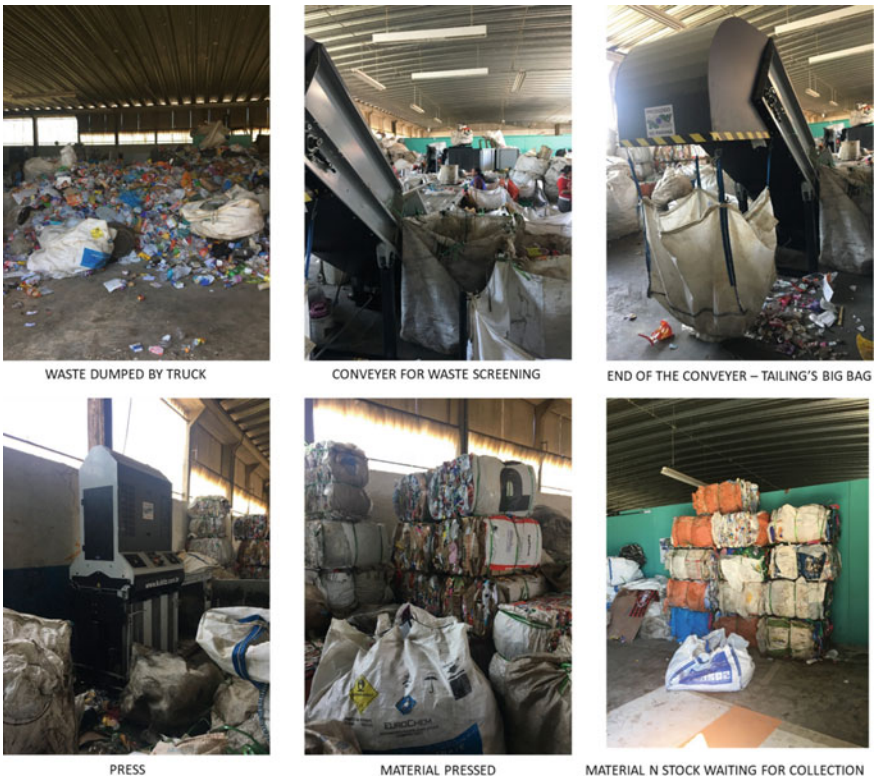


**Fig. 6** Stages of the process

that is located on the outside of the shed. And the noble materials, which are those that contain aluminum, such as electronics and cans that have a higher value, also have a second screening, performed by Claudia, and then are sold. All materials that are screened are stored until the buyer collects them (Fig. 6). Each buyer has a collection frequency (Table 1), which varies according to the predefined minimum quantity.

Materials that are not separated for sale are classified as tailings. These follow until the end of the conveyor and fall into a big bag, which after being full is separated in the storage area and awaits the collection of Cavo company to forward to Campo Largo transshipment station (Fig. 6).

At the transshipment station (Fig. 7), all tailings of the 4 associations are dumped in two containers along with the waste collected by organic waste collection. As soon as they are full, they are forwarded to the landfill, Estre Ambiental, in Fazenda Rio Grande by Cavo's truck. The station has a slurry treatment plant. This station allows reducing transport costs, as the landfill is located 52 km from the transshipment station. There are two possible routes that are used to take the material to the landfill, which are used depending on traffic (Fig. 8). As soon as the tailings arrive at the

**Table 1** Waste classification, description and frequency of collection by buyers

| Classification | Usual name | Description | Buyer | Frequency of collection in a month(un.) |
|---|---|---|---|---|
| Paper | Paper "terceira" | Low quality paper | Dambrosio | 4 |
| | Tetrapack | Milk and juice box | Dambrosio | 4 |
| | Journal | – | Dambrosio | 4 |
| | Magazine | – | Dambrosio | 4 |
| | White paper | – | Dambrosio | 4 |
| | Carton | – | Dambrosio | 4 |
| Plastic | LDPE color | Lona preta, saco de lixo, … | Sidney Cardoso | 1 |
| | LDPE transparent | Sacola transparente, papel filme, … | Sidney Cardoso | 1 |
| | PET green | PET bottle green and other colors | Sidney Cardoso | 1 |
| | PET white | PET bottle white | Sidney Cardoso | 1 |
| | PET óleo | Oil bottles | Sidney Cardoso | 1 |
| | PET lixo | Bottles that were already recycled (lower quality) | Capital | 1 |
| | HDPE color | More resistant plastic with color | Capital | 1 |
| | HDPE white | More resistant plastic white | Capital | 1 |
| | PP white | Hard and resistant plastic white | Capital | 1 |
| | PP black | Hard and resistant plastic black | Capital | 1 |
| | PP color | Hard and resistant plastic color | Capital | 1 |
| | PP transparent | Hard and resistant plastic transparent | Capital | 1 |
| | PVC | Pipes | Manoe-Isaplastic | 1 |
| Glass | Shard | Broken glass | Recitotal | 0.5 |
| | Bottles | Bottles conserved | Litropar | 0.5 |
| Iron | Scrap | Iron in general and batteries | Sucatas araucaria | 4 |
| Aluminium | Fine material | Electronics, cans | Sidney Cardoso | 4 |

(continued)

**Table 1** (continued)

| Classification | Usual name | Description | Buyer | Frequency of collection in a month(un.) |
|---|---|---|---|---|
| Tailings | Tailings | Polystyrene, wood, organic material, laminated plastics, soil, … | Cavo-estre | 4 |

**Fig. 7** Image of the transshipment station

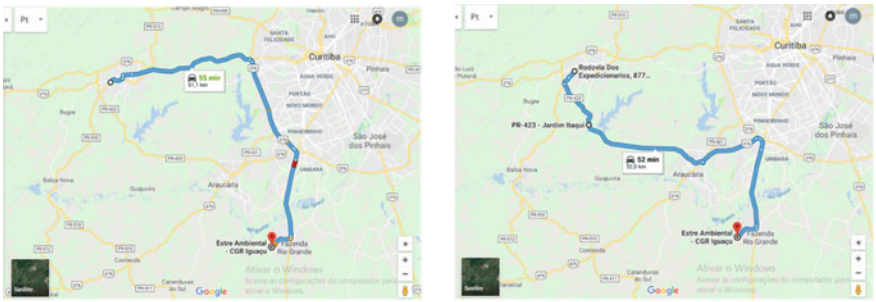


**Fig. 8** Routes from transshipment station to landfill. *Source* Google Maps (2018)

landfill, they are Estre company responsibility. On average, 3–4 tailings containers are routed to the landfill per day, and each container holds an average of 20 tons.

## *4.2 Waste Characterization*

The association does not have any control of the quantity of waste received and sold per month, nor the quantity of tailings sent to landfill. A study conducted by the SMMA Campo Largo, based on Cavo's reports on the estimated quantity of waste collected, showed that the quantity of waste that is collected by selective collection has a seasonal behavior, and in the summer months increases. However, for the elaboration of the present study, the data used was from samples that were weighted for a certain period of time and the average was considered.

### 4.2.1 Recyclable Waste Characterization

For the recyclable waste characterization, the association was asked to weigh the quantity of recyclable waste that was separated for one week. From these data, a daily average of how much was separated was determined (Table 2).

### 4.2.2 Tailings Characterization

A study was conducted to verify the tailings composition with the goal to analyze whether it met the prerequisites for co-processing. To perform this characterization of the tailings, a sample of 23 kg was analyzed and classified (Fig. 9).

Next, the proportion was calculated by the average quantity of tailings separated per day. The classification, the quantities per kg of the sample, and the monthly

**Table 2** Estimation of the recycled waste separated

| Description | Daily average (kg) | % |
|---|---|---|
| Carton | 179.1 | 16.7 |
| Glass | 165.1 | 15.4 |
| Plastic (PP) | 101.9 | 9.5 |
| Scrap | 95.2 | 8.9 |
| LDPE color | 87.6 | 8.2 |
| PET green and white | 75.9 | 7.1 |
| Paper “terceira” | 73.3 | 6.8 |
| Tetrapack | 57.1 | 5.3 |
| HDPE color | 55.9 | 5.2 |
| White paper | 49.78 | 4.6 |
| Magazine | 39.9 | 3.7 |
| LDPE transparent | 31 | 2.9 |
| PET “óleo” | 12.1 | 1.1 |
| PP cap | 11.9 | 1.1 |
| can | 9.9 | 0.9 |
| PET “lixo” | 9.34 | 0.9 |
| Fine material | 7.72 | 0.7 |
| Electronics | 5 | 0.5 |
| Journal | 4.6 | 0.4 |
| Total (kg) | 1072.34 | 100 |


**Fig. 9** Tailings sample in the composition of the municipal solid waste

**Table 3** Quantity of tailings generated daily

| Material | Description | Sample quantity (kg) | Day proportion (kg) |
|---|---|---|---|
| Cloth | Cloths, shoes, patch, … | 7 | 170.74 |
| Tailings | Food, toilet paper, soil, … | 6 | 146.35 |
| Glass | Shred and ceramic | 2.5 | 60.98 |
| Scrap | electronic, CD, … | 1.5 | 36.59 |
| Hard plastic | Dolly, hose, brush, toothbrush, toothpaste tube, plastic glove, … | 1.8 | 43.90 |
| Paper | Paper, carton, … | 1 | 24.00 |
| Soft plastic | – | 1 | 24.39 |
| Polystyrene | – | 0.5 | 12.20 |
| Foam | – | 0.5 | 12.20 |
| Wood | – | 0.5 | 12.20 |
| Laminated plastic | Crisps and cookies package | 0.5 | 12.20 |
| Dangerous | Batteries | 0.2 | 4.88 |
| Total (kg) | | 23 | 561 |

proportion of tailings generated can be observed in Table 3. This quantity of tailings represents 34% of the total waste received.

In addition to data collection within ARLeV, the information obtained with two other previously conducted studies was used to compare and confirm the results. One in Campo Largo itself, the ASSUR association and the other from an association of Minas Gerais. According to Santos (2014), tailings represent 34% of the total quantity of waste received by ASSUR association. And for Aguiar (2010), the average percentage of tailings that the Minas Gerais association sends to landfills is 32.2%. The results from both studies were similar to this study.

A big quantity of non-recyclables materials, such as organic, sanitary and hazardous waste was found in the tailing sample. According to Santos (2014), this fact is due to the generating source, which is incorrectly separating its waste, impacting the rest of the recycling chain. Materials with recycling potential have also been observed in the tailings, it may be there due to inaccuracy or carelessness in the screening process or because they are not sold as recyclable materials by the association due to several factors.

## *4.3 Current System Analysis*

Through the weigh-ins performed in ARLeV association and the analysis of previous studies conducted by Aguiar (2010) and Santos (2014), it was possible to verify that

**Table 4** Waste and tailings estimation

| Description | kg |
|---|---|
| Quantity os waste per year | 575,205.00 |
| Quantity os waste per month | 47,933.75 |
| Quantity of tailing per month | 16,297.48 |

from the total waste that is routed daily for screening, approximately 66% is sold as recyclable and 34% is considered tailings and are sent to landfill.

From data received by SMMA Campo Largo from 2017, the monthly and daily average of waste received per day was estimated, as well as the quantity of tailings that are sent to landfill (Table 4). About 48 tons are sent per month for screening in the association, in which 34%, corresponding to 16.3 tons of tailings, are sent to landfill.

Analyzing only the ARLeV material that is sent to landfill, the tailings, which total approximately 16.3 tons per month (Table 4), it is perceived from the gravimetric composition that about 73% can be reused for co-processing, which are the non-organic and non-hazardous materials (Table 5). This percentage is equivalent to approximately 11.9 tons of monthly material. In addition, a comparison was made between the 4 associations of Campo Largo from the data collected by the city in 2017. It is noticed that the 4 have similar behavior (Table 6), then for calculation purposes, they will be considered equal. Thus, the municipality potential for waste co-process is approximately 47.59 tons per month.

**Table 5** Sample data

| Description | kg | % |
|---|---|---|
| Quantity of tailings per day (kg) | 561.000 | 100 |
| Organic part of tailings (kg) | 146.35 | 26 |
| Dangerous part of tailings (kg) | 4.88 | 1 |
| Quantity of material that can be used for co-processing per day (kg) ARLeV | 409.77 | 73 |

**Table 6** Comparison among associations

| Association | Total waste received per year | Tailings quantity day | Co-processing quantity day |
|---|---|---|---|
| ARLEV | 575.205 | 561 | 410 |
| ASSUR | 564.792 | 551 | 402 |
| ARAMA | 475.583 | 464 | 339 |
| ARC | 630.081 | 615 | 449 |
| Average | 561.415 | 548 | 400 |

*Source* The Author (2018)

## 4.4 Co-processing Companies

In Paraná there are three large cement companies: Votorantim Cimentos, Cimento Itambé, and Supremo Secil Cimentos, however only the first two have licensed furnaces for co-processing. Supremo Secil Cimentos is in the release phase.

Votorantim Cimentos is a Brazilian industry that began in 1933 in São Paulo. It has a unit in Rio Branco do Sul, Paraná, which was inaugurated 68 years ago and is the largest cement plant in Latin America, being the first plant in Brazil to implement the co-processing of industrial waste in 1991. Currently, it receives more than 600,000 tons of waste for co-processing and is making investments for continuous process improvement. It is located approximately 34 km from Campo Largo's transshipment station. Cimento Itambé was founded in 1968, in the city of Campo Largo, Paraná. Its industry, inaugurated in 1976, is located in Balsa Nova, has a capacity of 2.8 million tons of cement per year, is also making constant investments to improve its operations. The industry is located about 9 km from the transshipment of Campo Largo. On the other hand, Supremo Secil Cimentos is a Portuguese 90-year company, which came to Brazil in 2003, one industry is located in Pomerode, Santa Catarina, and another, more modern, in Adrianópolis, Paraná, with a cement production capacity of 1.7 million tons per year. Its unit in Paraná is 40 km from Campo Largo transshipment station.

## 4.5 Technical and Economic Analysis and Implementation Proposal

The technical analysis of the material is validated by a report issued by a specialized company, in it, all the parameters required by CEMA 076/2009 were within the required limits (Table 7).

The company Revalore, which is also assisting the city of Campo Largo with the study of co-processing of MSW, sent a sample of the tailings of the 4 associations to

**Table 7** Analytical reports by specialized company

| Parameter | CEMA 076—maximum allowed value (mg/kg) | Analytical results report I* (mg/kg) | Analytical results report II** (mg/kg) |
|---|---|---|---|
| Mercury | 10 | <0.500 | <0.500 |
| Selenium | 100 | <0.500 | <0.500 |
| Chromium | 5.000 | 7.93 | 2.88 |
| Lead | 5.000 | 3.03 | 3.54 |
| Cd + Hg + Tl | 200 | <0.500 | <0.500 |
| As + Co + Ni + Se + Te | 5.000 | 4.09 | 1.41 |

analyze its composition by a specialized company. Two reports were made, with two samples, the first is all tailings except plastics, and the second is only for the plastics. All parameters in the two reports were within the permitted limits. Thus, the sample was approved, and the material is fit to be used for co-processing.

To introduce co-process in ARLeV, it is necessary to separate the tailings since initially it may present an organic part and sometimes hazardous waste. The work for the association would increase. It would be necessary that the same employees who perform the screening, also separate the tailings, taking out the organic and dangerous parts. Another option is at the end of the conveyor another member will be responsible only for the separation of the material that can be used for co-processing, letting the rest of the materials that cannot be co-processed continue on the conveyor until the tailings big bag, as it is the current case. It is also necessary to instruct them correctly, explaining what co-processing is, which materials are allowed and not allowed. No new equipment is required.

For the shipment of waste for co-processing, the company Itambé Cimentos proved to be more advantageous because it is the closest cement company, being 8.9 km from the transshipment station (Fig. 10). Thus, the city would save with this transport, which would pass from 52 km (distance from transshipment to the landfill) to 8.9 km (distance from transshipment to Itambé). That is a saving of 43.1 km per trip.

To perform the analysis of the gain, the following data were taken into account: distances described previously from the transshipment station to the landfill and Itambé, the autonomy of the truck being 2.5 km/l, the value of diesel R$3.30, the entry value per ton of material into the landfill of R$72.89 and the transport capacity of the container that is 20 tons.

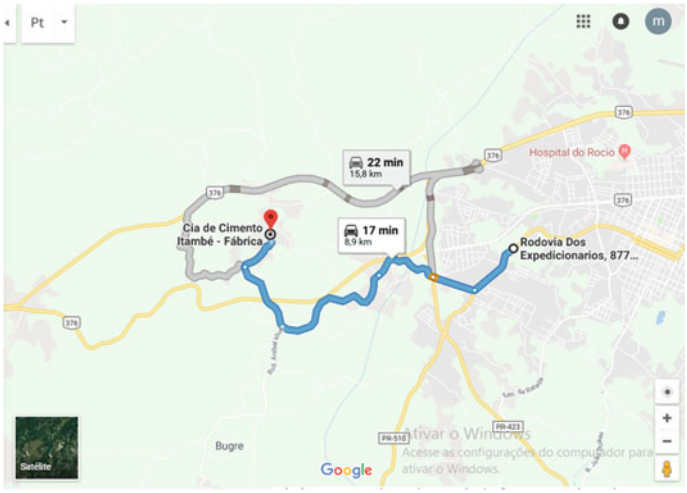


**Fig. 10** Routes from transshipment station to Itambé. *Source* Google maps (2018)

It is currently spent per year to send ARLeV's tailings to the landfill about R$15,597.47. With the implementation of the co-processing project, it was found that 73% of the material will no longer be allocated to the landfill. It will reduce the costs of both transportation and landfill charges. From the calculations, it was found that the total annual cost with the proposal would be R$2741.07. So, the city would have a gain of R$12,856.39, equivalent to savings of 82%, only with the ARLeV association. If the analysis were to expand to the 4 associations, the annual gain would be about R$51,425.57. This analysis can be verified in Fig. 11.

It is possible to note that the gains correspond to transport (fuel) and the landfill charges. Another requirement for the proposal to be implemented is that it will be necessary for the material destined for Itambé to stay in a reserved place in a separate container from the rest of the tailings that would be forwarded to landfill

| DATA | | |
|---|---|---|
| km to landfill | | 52 |
| km to Itambé | | 8,9 |
| truck's autonomie (km/l) | | 2,5 |
| Diesel price | R$ | 3,30 |
| Landfill charge (per ton) | R$ | 72,89 |
| Quantity trasported by 1 container | | 20000 |

| ESTIMATED TAILINGS * | | | Calculations explanation |
|---|---|---|---|
| Quantity of tailings sent to landfill per day (kg) | | 626,83 | - |
| Quantity of tailings sent to landfill per month (kg) | | 16 297 | - |
| **Quantity of tailings sent to landfill per year (kg)** | | **195569,7** | quantity of month * 12 months |
| Shipment to landfill per year | | 10 | Tailing quantity / quantity transported per trip |
| Distance covered to landfill per year (km) | | 1016,96 | Number os trips * covered distance |
| Amount of diesel spent per year (L) | | 406,78 | distance covered /autonomie |
| Costs with diesel per year | R$ | 1 342,39 | Litres * Diesel price |
| Costs with landfill per year | R$ | 14 255,08 | Quantity sent * Landfill charges |
| **Total cost per year** | **R$** | **15 597,47** | Summation costs diesel + landfill |

| PROPOSAL ESTIMATED TAILINGS * | | | Calculations explanation |
|---|---|---|---|
| Quantity of tailings sent to landfill per day (km) | | 103 | 27% of tailings |
| Quantity of tailings sent to Itambé per day (km) | | 458 | 73% of tailings |
| **Quantity of tailings sent to landfill per year (km)** | | **32266** | Quantity of tailings landfill per day * 26 days * 12 months |
| **Quantity of tailings sent to Itambé per year (km)** | | **142766** | Quantity of tailings Itambé per day * 26 days * 12 months |
| Trips to landfill per year | | 2 | Quantity tailings to landfill / quantity transported per trip |
| Trips to Itambé per year | | 7 | Quantity tailings to Itambé/ quantity transported per trip |
| Distance covered per year to landfill (km) | | 167,78 | Quantity of trips * km covered |
| Distance covered per year to Itambé (km) | | 127,06 | Quantity of trips * km covered |
| Diesel (L) spent per year to landfill | | 67,11 | km covered/autonomie |
| Diesel (L) spent per year to Itambé | | 50,82 | km covered/autonomie |
| Annual cost with diesel - landfill | R$ | 221,47 | Liters / Diesel price |
| Annual cost with diesel - landfill | R$ | 167,72 | Liters / Diesel price |
| Total cost with diesel per year | R$ | 389,20 | Summation landfill + Itambé |
| Total cost with landfill per year | R$ | 2 351,88 | Quantity sent to landfill * landfill charges |
| **Total cost per year** | **R$** | **2 741,07** | Summation landfill + Itambé |

| | | | |
|---|---|---|---|
| **ANNUAL GAIN ARLEV** | **R$** | **12 856,39** | Actual costs - proposal costs |
| ANNUAL GAIN ASSOCIATIONS | R$ | 51 425,57 | ARLeV's Gain * 4 |

**Fig. 11** Gain analysis through pilot project

at the transshipment station. For this transport, it will be necessary for the city to close an agreement with some carrier or Itambé itself. Thus, they oversee containers and their transport. As the distance traveled by truck to Itambé became smaller than the distance currently traveled to landfill, Cavo itself could carry out this transport service to Itambé, by a contract revision. Another proposal is that because the cement company would have a cost reduction when using MSW for co-processing, it is that it carries out the material, sparing the city from any new investment in transportation and save with this monthly cost. For this, appropriate negotiations will be necessary.

As much as the annual monetary gain is not so significant, there is a considerable environmental gain, as part of the tailings will be reused more intelligently, saving on raw material and non-renewable fuels for cement, and they will no longer be sent to landfills and stay there during years until its decomposition.

As previously commented, it is observed that part of the waste is not well separated by the generating source, both in the sending of organic materials for the collection of recyclable waste, and the sending of materials with recycling potential for the collection of organic. Therefore, in order to increase the gain, it is necessary that the population make a better separation of their waste since much material that could be recycled or co-processed is sent directly to the collection of organic waste, in which no screening is made before being forwarded to the landfill and, consequently, there is a big loss of material. Thus, if a more conscious separation is made, the index of recyclable materials with the potential for co-processing will also increase, the contamination of this waste will decrease, making this process easier and more efficient for both recycling and for co-process.

It is important to introduce the vision of "dry waste" and "wet waste" to the population, stating that "dry waste", however it has no recycling potential, can be used for co-process, and does not go directly to the landfill. The concept of co-processing must also be introduced to the population so that they can change their habits themselves and understand this new form of environmental aid. Thus, investment in environmental education for the community is very important, as it is from the disposal of waste in homes/commerce that the process is started, and if it is poorly done early on, the rest of the chain is affected.

## 5 Conclusion

Brazil is behind in recycling when compared to other countries. Not all cities have a waste selective collection, and when they have this service part of the population does not collaborate with the waste separation, which interferes directly in the rest of the process. Community education is necessary to increase awareness of the importance of screening at the generation source for the entire process. With better separation, associations could send more waste for recycling and allocate tailings for co-processing, avoiding sending material with potential use to landfill. In addition, the municipality can benefit, as they would increasingly reduce the costs of transport and landfill, which are the highest costs of this segment. Another benefit of correct

screening from the generating source when people send less organic and hazardous waste is that the association would become more efficient since currently, the separation of tailings does not bring gains for the association and some materials are contaminated which damages the work environment.

Many of the materials that are sent to landfill by the association are recyclable but do not have a market or their value is very low, making it disadvantageous to the association their separation since it depends on time and space. Co-processing these materials could be positive since cement companies could generate energy and replace raw material without generating ash, rather than sending the material to landfills. Sending this material for co-processing becomes a smarter alternative, bringing savings and reducing much of the environmental impact and liabilities.

One of the limitations of this paper was to obtain the exact data. Since the organization did not have any records, we had to do the study from samples. Another one is that the 4 associations of Campo Largo were not the same, but for this paper and calculations we considered them equal. Co-processing tailings proved to be a more sustainable and lower cost alternative compared to sending the waste to landfills. It brings advantages to the municipality of Campo Largo and for ARLeV association in addition to an 82% gain related to the cost reduction with transport and landfill charges. This gain was calculated from the quantity that is currently spent, R$15,597.47, and with the quantity that the association would spend on the implementation of the proposal, which is R$2741.07. It will be necessary to instruct recycling associations, so that they adapt to this new process and instruct the population on the correct destination of waste, increasing gains from co-processing even more.

## Appendix 1: Arlev Association Questionnaire

| Appendix 1 | Questions for ARLeV |
|---|---|
| 1 | What are the classifications of recyclables? |
| 2 | What are the destinations of recyclable material? |
| 3 | How much health residue is received? |
| 4 | What is the destination of the health residue? |
| 5 | How much tailings/organic? |
| 6 | How many lamps? |
| 7 | Total amount of residue received per day |
| 8 | Amount of plastic separated per day |
| 9 | Amount of paper separated per day |
| 10 | Amount of metal separated per day |
| 11 | Amount of glass separated per day |

(continued)

(continued)

| Appendix 1 | Questions for ARLeV |
|---|---|
| 12 | Do you receive cans of paint? |
| 13 | Do you receive batteries? |
| 14 | How often and time do you receive the waste? |
| 15 | How is the transfer of waste done? |
| 16 | How is packaging and storage done? |
| 17 | How long waste stays in the shed? |
| 18 | How often does buyer come for material? |
| 19 | Where does the truck leave the waste? |
| 20 | How is waste screening done? |
| 21 | What is the classified as tailings? |
| 22 | Do you have any control of the amount that arrives of residue and quantity you sell? |

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# Preliminary Product Development Approach for Discarded Materials Reuse—U-TURN Approach


**Felipe Augusto Zanin Contador and Osiris Canciglieri Junior**

## 1 Introduction

Waste production worldwide is growing exponentially in recent years (Abrelpe 2018). With the growth in consumption and early disposal, waste production is increased and combined with the lack of suitable disposal sites leads to a recurring problem—the incorrect disposal of the waste in the environment. A possible solution to minimise it is to use the 3Rs of sustainability, that is, to recycle, reuse and mainly to reduce the amount of the generated waste (Carrijo 2010).

To this end, the use of productive processes that aim at reducing and reusing materials becomes indispensable for any company that wants to reduce its environmental impacts (Pimenta et al. 2011). For the proper disposal of waste, mainly electronic products or residues from productive processes, several steps are necessary to ensure that the disposal is environmentally correct, without causing damage to the soil, the atmosphere, and the groundwater (Bonacella and Magossi 1996). These steps for proper disposal require a high expenditure of energy and financial resources, becoming a costly process and directly impacting all companies. An alternative to avoid these costs is the application of the sustainability 3Rs methodology, focusing on reuse and mainly reducing the amount of raw material.

In this way, productive processes that focus on reusing products that would be discarded are fundamental to ensure financial optimisation for businesses and sustainable growth at the ecological level. However, methodologies that ensure the reuse of discarded materials are still rare and are inserted only in large companies, which have

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a sustainable and innovative appeal, such as large electronics companies. Consumer goods companies of small and medium-sized do not have this idea disseminated and make mistakes for generating a high volume of waste with the premature end of the life cycle of their products. Besides, they use almost all of their primary raw materials in their production, that is, a material extracted directly from nature, from non-renewable sources.

In this context, the objective of this research was a conceptual proposal of an approach for product development that is based on the reuse of discarded materials, taking into consideration the entire production process, from its design phase to the end of the life cycle of the product, in a sustainable way, and that can be applied in the development of real products.

## 2 Sustainability—Research Background

The concept of Sustainability was first mentioned in 1713 by Hans Carl von Carlowitz in his book: "Economic forestry (Gacia-serna et al. 2007). The concept has been developing, and the current definition was created in 1972 in Stockholm (Sweden) at the United Nations Conference on the Human Environment (Unche). Conferences and treaties such as the "Paris Agreement" at the 21st UN Conference in 2015 established rules and targets. As economic development is driven by industries that are looking for innovation and consequently increasing their productive capacity, the way to continue developing is through a sustainable policy that supports development products and services within the concepts of sustainability (Ferrari de Sá 2017).

In this context, in 1994, the British sociologist Elkington (1949) created the concept: Triple Bottom Line, a model composed of three dimensions (pillars)—social, environmental and economic—that must act in an integrated way so that the concept is fully satisfied (Manzini and Vezolli 2005). To assist in this process, the International Organization for Standardisation (ISO), responsible for creating standards for trade and good management practices, developed the ISO 14000 for environmental management, which seeks to ensure ecological preservation and makes companies commit to the proposed guidelines (Ferrari de Sá 2017).

## 3 Product Development Process (PDP)—Research Background

The product development process (PDP) is a fundamental process for the global market. According to Silva (2002), product development is basically: "the effort made by a set of people from a company in the transformation of data on market opportunities and technical possibilities in goods and information for the manufacture of a commercial product." The product development process has positive points such

as aid in increasing product diversity, greater competitiveness among companies, greater product supply and consequently lower cost to the final consumer.

However, from an environmental point of view, some negative aspects should be highlighted such as reduced product life cycles, stimulating premature disposal and, therefore, an unnecessary increase in waste discarded in the environment. With the development of new products, it is possible to meet specific market segments, incorporating new technologies and adapting to new standards and legal restrictions (Rozenfeld et al. 2006). In their Unified Model, the PDP should include strategic planning activities at the beginning of the process and activities to monitor the production and withdrawal of the product from the market at the end of the development process. For this author, the main division of PDP activities is classified into only three macro-phases that comprise pre-development, development and post-development. To certify the product's quality it is necessary to analyse and search constant improvement in all process stages, which minimises defects, waste, unnecessary disposals and environmental impacts and because it is a complex process, several models were developed and proposed to structure product development.

## 4 Reuse of Discarded Materials and Reduction of Industrial Waste—Sustainable Production

Currently, products are designed aiming at manufacturing easiness, cost reduction and profit maximisation, but in return, they generate large amounts of waste (Barbieri 2007). According to the European Commission (2012), since 2007, they established a standardised document model that brings the environmental profile of the life cycle of each manufactured product, called EPD (Environmental Product Declaration), and each company should be responsible for its fulfilment. This document assists consumers at the time of their decision of which product to choose from different suppliers. Indicators such as life cycle time and percentage of reuse of discarded product materials are the indicators with the highest relevance in the consumer decision-making process in recent years (Del Borghi et al. 2007).

According to The Great Recovery Project (2012), four major guidelines can be applied together or separately, which contribute to the creation of sustainable products oriented to the maximum reuse of materials and minimal generation of waste. To achieve a level of production considered sustainable it is necessary to encourage aspects such as longevity, durability, repair potential, and upgrade possibility, reuse, remanufacturing and recycling from the early stages of product design. In addition, companies' business models would need to be reviewed, changing the ways of parameters visualisation, such as making the consumer a user of a shared product, eliminating scheduled obsolescence, and creating standardisations of design for disassembly.

## 5 Systematic Literature Review and Content Analyses

A systematic literature review was carried out and allowed the identification of 13 most relevant articles to the research composed of the three macro subjects previously addressed. The content analysis of the full articles of Kwangho et al. (2009), Rozenfeld et al. (2006), Ulrike and Ordoñez (2013), Lazo and Short (2012), Zaman (2014), Pacelli et al. (2014), Levino et al. (2018), Ordoñez and Jagdeep (2016), Ugaya et al. (2018), Li et al. (2018), Strömberg et al. (2019) pointed out their contributions and limitations. The analysis showed that sustainable production and the application of 3Rs in the industry is still restricted mostly to large companies. The research studied contributed to new perspectives of the implementation of methods and/or tools for the use of waste as raw material for new products or the reduction of waste improperly disposed of, but present limitations in their approaches are generally restricted to single or restricted materials or methods. Research opportunities were pointed out for the support of sustainable PDP using waste as raw material, evidencing the deficiency of an easy-to-understand approach that allows integrating in a sustainable way the entire supply chain, from the design phase to the end-of-life of products. In essence, the analyses provided the theoretical foundation for the development of the approach that is proposed in this article. It is still a preliminary approach as it needs further application. The proposed preliminary U-TURN approach aims at structuring, in a sustainable way, the Sustainable Products Development Process using discarded material/products as raw material.

## 6 Proposal of a Preliminary Product Development Approach for Discarded Materials Reuse—U-TURN Approach

The proposed product development approach, called U-TURN, aims to create new products reusing discarded product as raw material and taking into account the entire production process, from its design phase to the end of the product lifecycle. Moreover, it can be applied to different types of discarded products since its target is providing a full analysis and application of the discarded material/product reuse potentiality in new product manufacturing.

The proposed approach consists of 4 Macro Phases—Analysis of Discarded Product Reuse Potentiality, New Product Design, Sustainable and Cyclical Production Design, and Material/Product Collection Return. Each of the Macro Phases has steps that show the guidelines to be followed by users. The author used the Rozenfeld Unified Model (Rozenfeld et al. 2006) as the starting point of the approach's development.

The three first Macro Phases is focused on the product design and production process, concentrating on maximum material reuse and increase on the product life cycle, while searching for sustainable manufacturing processes. Reverse Logistics is

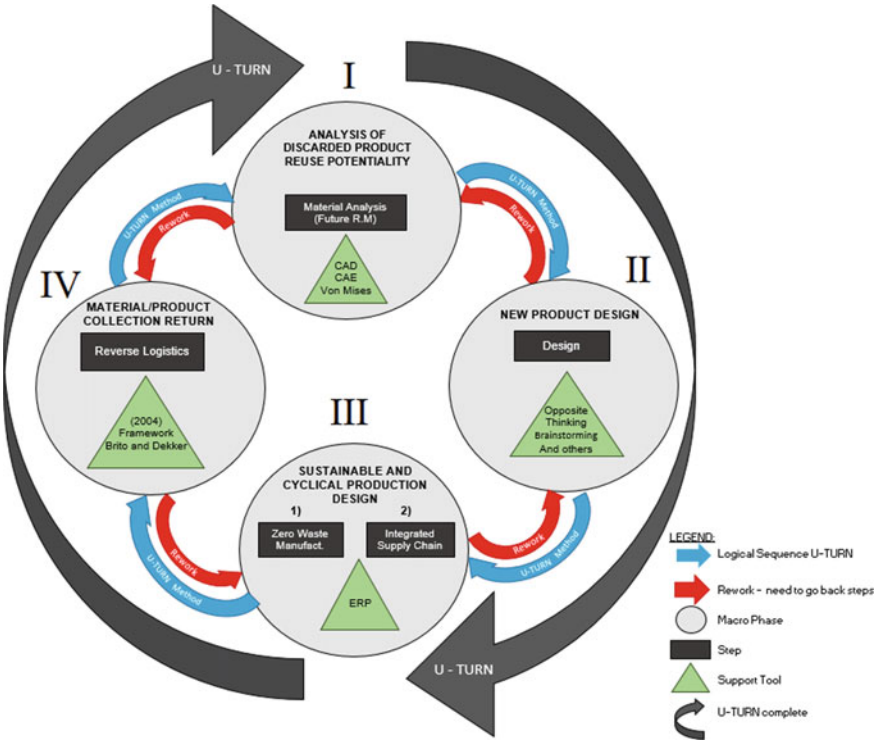


**Fig. 1** Proposed preliminary approach—U-TURN approach

characterised by efficient reverse logistics, which ensures maximum reuse of materials that would previously be forwarded to landfills. Figure 1 presents the proposed preliminary U-TURN approach. The black arrows indicate the completeness of the approach. The circles represent the Macro Phases of the development process, while dark grey boxes represent the Steps within the circles. The development flow of the U-TURN approach follows the sequence of I-II-III-IV that are listed above each circle. Arrows indicate the flow to be followed by the user: blue arrows are for the logic progress flow of the approach, and the red arrows indicate the flow to be followed if there is a problem in some step and it is necessary to return to the previous one, delimiting the rework step.

## 7 Macro-phase I—Analysis of Discarded Product Reuse Potentiality

The beginning of the U-TURN approach consists of the identification phase of the material potentiality reuse. The analysis of the reuse potentiality for the materials is

through tests in terms of resistance, malleability and applicability for the production of new products. The main tests to which the materials are submitted are tension and resistance, fundamental pillars to ensure that reuse will be efficient when introducing such materials again into the production line as raw material.

The tests are performed through tests assisted by computerised software, such as Computer-Aided Engineering (CAE) and Computer-Aided Engineering (CAD) that allow the structural design of a part, simulating and doing previous studies before the manufacturing of the products on aspects such as stability and strength (main factor for the U-TURN approach). Therefore, this first Macro Phase of the U-TURN approach will determine the material's resistance and other parameters, which are defining through various computerised tests whether the material can be reused, becoming raw material again in the production process.

## 8 Macro-phase II—New Product Design

The second Macro-Phase of the approach is responsible for defining the design of the new product meeting some minimum requirements to ensure that the U-TURN approach is applied at the end of its useful life. The minimum requirements comprehend the design focused on: (i) easy assembly/disassembly process and (ii) focus on the different new lives of the products.

A product with a design aimed at an easy disassembly process allows reducing manufacturing cycle time since with simple processes it is possible to disassemble, sanitise and feed the production cycle again, reducing the expenditure of energy and resources for making the old material/product a raw material again. In the development of a new product, the design phase should clearly aim at the maximum use of the material. In this way, a single material that would previously be discarded at the end of the life cycle of the first product will now pass through the phases of the U-TURN approach and will have 2, and even more new life.

Tools to support the ways of developing and channelling ideas are used to help the design team achieve these objectives. The tools preferentially used on the proposed approach are Brainstorming and Opposite Thinking. Brainstorming tool was chosen because it is a widely disseminated concept and easy to understand by all practitioners; and the Opposite Thinking tool is differential for the approach as it avoids rework, allowing wide discussion and exchange of information between the participants of the design team and enriches the original. Additionally, other support tools such as Scamper can also be used since they can contribute and help the design team in the new product design. This Macro-Phase of the U-TURN approach identifies the design of the new product through Brainstorming and Opposite Thinking tools, channelling ideas and making the final decisions on the new product design.

# 9 Macro-phase III—Sustainable and Cyclical Production Design

After the definition of the material reuse and new product design in the previous phases, Macro-Phase III develops the manufacturing project of the new product having as premises: (i) the zero (or minimum) generation of waste within the production line, and (ii) the connection of all supply chain, from production to the end of the product life cycle and its respective return (Reverse Logistics). This Macro-Phase was divided into two steps to facilitate the application of the approach.

## *9.1 Step 01—Zero Waste Manufacturing*

The manufacturing design of the approach was based on the P–V Analysis of (FUSCO 2003) to outline the layout of its production line with the premise of reuse of discarded materials/products for manufacturing new products with waste zero. The online production layout was adopted with minor adjustments so that the waste of materials is zero along the production chain of the proposed U-TURN approach. The most important adjustment is the creation of "collection points". Collections Point are large volume containers that must be located at a determined site on the physical arrangement of the production line, preferentially at the end of each phase or step. Alternatively, they can be allocated at a fixed spacing, such as every 20 m, ensuring that no scrap is properly discarded for its reuse.

The distance between one point and another, if it is not possible to place after each productive step, will be fixed, but the spacing will be different for each production process, because the more extensive the line, the greater the spacing may be, and the opposite being true.

For the effective approach's functioning, a person responsible for collecting materials from all these points must be designated. The material can be collected through a pallet style cart (platform) with tires. The period of between collections will depend greatly on the productive volume of each line but should be scheduled before the complete filling of the containers, ensuring that no scrap is disregarded. The collected materials/product will be sent to the first productive Macro-Phase, making the production waste into the raw material or disposing of it in the correct locations. Thus, it is expected that 100% of the productive scrap returns to the process, ensuring that no residue is discarded along the line.

## *9.2 Step 02—Integrated Supply Chain*

The second premise proposed by the U-TURN approach is to systematically connect all stages of the production chain of a product manufactured from waste disposal.

The support tool used in this step is the Enterprise Resource Planning (ERP) which ensures that the entire production chain is connected and that no action can be in disagreement with the basic premise of the approach, that is, to be a highly sustainable process, reducing the amount of waste intended for landfills.

The main step of the entire supply chain for the U-TURN approach is the return of the material/product to the company, that is, when the manufactured product reaches the end of its life cycle it is necessary its return to the production process. ERP helps to ensure the fulfilment of this premise, but as it is a complex and essential step, the author has defined a Macro-Phase only for the material/product return, called Reverse Logistics.

## 10 Macro-phase IV- Material/Product Collection Return

The process of returning the material/product at the end of its useful life is addressed in this Macro- Phase because it is of extreme importance for the U-TURN approach. The purpose of this Macro-Phase is to collect the product discarded by consumers and reinsert into the production cycle. To support this critical phase the proposed approach adopted the reverse logistics framework tool developed by Brito and Dekker (2004), which state that for efficient reverse logistics, it is necessary to identify key steps of the process through 4 questions: (1) Why; (2) What; (3) How; and (4) Who.

The development of U-TURN approach considered for:

1. *Why*—the companies that choose to use this approach in their design and manufacturing processes and will adopt reverse logistics as it will reduce the amount of waste discarded and, consequently, will profit because their raw material will come from the disposal of products.
2. *What*—3 characteristics of the products are relevant: (i) Composition; (ii) Deterioration Factor and (iii) Usage pattern. The product composition is important for determining the processes of their disassembly, sanitation and classification due to the number of components and materials of each product, as well as the way they are gathered. From the deterioration point of view, a study on the deterioration characteristics of products that may eventually cause malfunction determines whether there is sufficient functionality for further use, without requiring a new and long production process. The latter criterion is related to the pattern of the product's use by the consumer, to the location, and the intensity and duration of use.
3. *How*—The criterion defines how collection, one of the most critical steps will occur. This stage is crucial for the U-TURN approach because if a broad and easy access communication channel for the consumer to return the product, it will be discarded incorrectly.
4. *Who*—the type of user is also relevant, whether it is an individual or an institution (mass use) since such factors impact the location for collection or the

different degrees of effort for the final consumer effectively discard the product in a determine location or enrol in a program of scheduled collection program.

Given these points, the U-TURN approach proposes solutions for the material/products to be returned for their reuse as raw material. The U-TURN approach suggests solutions that although their implementation does not require a lot of effort by the companies, they can be highly efficient. The suggested solutions are:

- wide access communication channels for the final consumer to easily return the discarded product;
- fixed locations to receive these materials, such as Collecting boxes in markets, subways and places of a large flow of people;
- collection "door to door" through a 0800 channel, where the consumer informs the desire to dispose of the product, and the company through its own or outsourced fleet makes the collection.
- fixed collection routes, which would be informed to the customer at the time of purchase or even through the communication channels.
- application of a discount percentage on the purchase of new products for consumers who decide to take the product directly to the collection points.

Solutions on reverse logistics must be defined by the companies according to their strategic business field and can include different solutions from the proposed ones. The U-Turn approach is Cyclical, and for this reason, this Macro-Phase will feed with the discarded material/product the first one, where after the analysis it will enter a new production process or will be appropriately disposed of. This Macro-Phase ensures the effective material/product return, with a high number of products being inserted and reused in a new sustainable production cycle.

## 11 Final Considerations

The systematic literature review combined with the content analysis of the articles that are relevant to the theme of the study showed research opportunities for the support of sustainable PDP using residues as raw material, evidencing the deficiency of an approach that allows the integration of the entire supply chain. The literature review exploration revealed that the main relevant works are not broadly addressing all the requirements of PDP; in fact, the majority of them focused on specific issues of materials and/or products.

The approach proposed in this article, called the U-TURN approach, offers a methodological approach that considers the entire product development process with sustainable biases, which contributes to fulfilling the lack detected in the literature and to a new and comprehensive perspective of the Sustainable Products Development Process using discarded materials/products as raw materials. It was designed in 4 Macro-Phases: (i) Analysis of Discarded Product Reuse Potentiality; (ii) New

Product Design; (iii) Sustainable and Cyclical Production Design; and (iv) Material/Product Collection Return, connecting all stages, from the design phase to the return of products.

The proposed approach is oriented for cyclic production since it takes into consideration the manufacturing constraints and focuses on maximum reuse of discarded materials, allowing the same material to have two or more new lifecycles avoiding premature disposal in landfills. In this context, the authors believe that the novelty differentials of the U-TURN approach are: (i) the inclusion of the production process in a sustainable way, from its design phase to the end of the product lifecycle; (ii) it can be applied to different categories of products and types of materials; (iii) it contains a sustainable and cyclical approach to support the production; (iv) it was structured in such way to make easily understandable, and (v) it may ensure the effective reuse of discarded material/product in a new sustainable production cycle and this will contribute to reducing irresponsible degradation of natural resources of the planet.

Furthermore, the versatility of its application for different types of materials and the easy understanding of its operation reveals a high potential for adoption by companies including medium and small ones. Besides, the proposed U-TURN approach has the ability and potential to become an important tool on the application of Industry 4.0 concepts in the Sustainable Product Development Process as they advocate as much efficiency as possible in all its processes. The continuity of the research will be the implementation of U-TURN approach as an object of study, which will be applied in various segments of the Brazilian industrial sector.

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# The Social Construction of Natural Disasters: A Systematic Review of the Literature

**Lidia Mara Floriani and Edilberto Nunes de Moura**

## 1 Introduction

Populational growth, climate changes and unappropriate occupation of the lands use are factors more and more discussed on debates about environmental care and the natural disasters risk management, due to significant increase of adverse natural situations that devastate and punish vulnerable populations in several places around the world. The city as a stage to the urban events is related to the society and its set, with its composition and operation, with its constituent parts and its history, what we can call the specific features of the city (Lefebvre 1968), showing us how close the city and the society are, and how we can attribute part of the urban events to the society as the society develops along with the environment constructed.

One of the most important aspects that could compromise environmental and life quality is the overload in the use and occupation of the soil, being the excessive unregulated thickening one of the most important aspects to be considered in the environmental quality, seeing that the excessive concentration performed without a proper planning, causes adverse conditions that could compromise both environmental and life quality (Gonzales et al. 2013).

In order to organize urban growth and therefore decrease negative, and many times, devastating effects that growth *versus* environmental degradation causes to society, urban development public politics have been created to pursue the predominance of balance and a sustainable urban development, as it appears in the City Statute

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(Brasil 2001), which purpose is to introduce urban development politics to arrange full development of the city social duties.

As in the Statute, other public politics have been created with the purpose of reducing urban growth impact on the environment, however, nowadays it is observed that the accelerated and the disordered growth are two of the main factors that connected to populational growth and climate changes cause socioenvironmental risk factors that contribute to the construction of natural disasters.

The idea that natural disasters are triggered by natural disasters, but can also be considered as products of processes that involve social, economic and political factors is discussed by Cannon (2008), under the vision that this construction could be, somehow, innocent, in other words, unintentional by the society. So, intentionally or not, we can consider that all the disasters are socially built.

Thus, once we understand that natural disasters are socially built, and that its construction depends on the balance of many factors, betwen them social and environmental issues combined, it becomes deeply important to comprehend the current context of scientific researches related to the subject, trying to recognize the theme where this subject takes place and what are the main topics discussed on the material found, through a systematic review of the literature, in order to identify, very modestly, the state-of-the-art in the scene of the world's scientific researches.

The obtained results are going to demonstrate the current panorama of scientific researches related to the approached theme, considering different types of natural disasters in a worldwide geographic cut.

## 2 Theoretical Framework

The increasing urbanization in the cities has on it countless positive and negative effects, from the raising of new economic functions, service offers and urban sites consolidation, to the occupation of underdeveloped areas that are incompatible to human life´s conservation, situated downtown or in the borders of the city´s territorial occupation.

In order to understand this urbanization process it is necessary to mention Castells (1983) and both of the philosophical meanings found in the urbanization term analyzed by him: (1) spacial concentration of a population, within certain size and density limits, and (2) system of values, atitudes and behavior dissemination called "urban culture". According to the same author, urbanization is related to industrialization, by virtue of the cities holding workforce and also with the market offers attracting industries, that in turn develop employment and new service possibilities, at the same time the other way around is also important: where there are functional elements, especially raw material and means of transportation, the industry colonizes and causes urbanization (Castells 1983).

According to this vision, where urbanization is related to economic development, we can better understand the urbanization increase in the cities along with the urban problems rise due to the occupation of land. Being one of great urban problems in

Brazil nowadays, people living in areas considered vulnerable to natural disasters, causing environmental, social, economic and cultural losses.

And Mendonça (2010), says that natural events aren´t recent, but belong to our planet´s natural dynamics and have happened even before humanity, before urbanization, however, they have been exacerbated by the microclimates and local climates created by territorial occupation, mainly with the overload on the use and occupation of the soil, what according to Gonzales et al. (2013), is one of the main aspects that can compromisse environmental and life quality, seeing that the excessive concentration held without a propoer planning results in adverse conditions and would thus compromise environmental and life quality.

To address the concept of disasters, we must understand the rating provided by the Brazilian Civil Defense (2000), where the disasters are seen as results of adverse events, natural or not, about a vulnerable ecossystem, causing environmental, material and human damages (Mattedi et al. 2009). Lieber and Romano-Lieber (2005) see that the disasters should be classified as something more social than natural, not simple natural phenomena, questioning the society for what hasn't been done before, during or after it, what Cannon (2008) reinforces with the idea that natural disasters are triggered by natural disasters, but can also be considered as products of processes that involve social, economic and political factors, under the vision that this construction could be, somehow, innocent, in other words, unintentionally caused by the society, referring to a fact, or a series of facts that change the ordinary operating mode of a society (Mattedi and Butzke 2001).

Anyway, innocent or not, we may say that the vulnerability of the population exposed to natural disasters is intensfied by social factors, among them housing problems (Ajibade and Mcbean 2014) and that cannot be resoved based on resilience, seeing that the reading of resilience leads to a pre-disaster condition, that would recreate the causes of vulnerability provoking themselves a disaster (Jackson et al. 2017), being necessary to focus on the situations prior to the disasters, with something we can call the social construction of disasters, not only on the hability of reacting and recoreving, what according to Bang (2014) occures in several countries despite having a disasters management structure, they still have gaps among the theory, the constant principles of disaster management and its implementation per se, leading the governments to a more reactive than proactive approach, cooperating with the worsening of natural disasters socially constructed.

Hence, analyzing from the perspective that natural disasters are a result of risk factors socially constructed, and, therefore, cannot be attributed only to the environmental risk factors, we may conceptualize them as a public finding phenomenon that is vulnerable when it comes to the relation between government and society in front of the impact of a risk effect that could not be prevented or mitigated in time (Valêncio et al. 2009), where we can also conclude that the responsibility for the adverse events is not only environmental, but also of a system that involves the society as a whole, and its all segments, public or private, exposing weaknesses on the recognition, management and specially, on the relation between the public entity and the population.

Natural catastrophes are common events in all societies reality, regularly or not, and in all societies it represents a challenge (Mattedi and Butzke 2001). In Brazil, it could not be different, the natural disasters devastate the Brazilian population in many different ways, that historically have been intensifying because of mismanagement of river basins and poor urban planning, in soil sealing, densification, retention of the heat and air pollution, these facts contribute to causing such type of disaster at urban areas (Kobiyama et al. 2006).

# 3 Methodology

## *3.1 Objectives and Issues that Delimit This Research*

The main purpose of the research is to make a systematic review of the literature related to social construction of natural disasters, having as a premise the identification of the most important works developed in the scientific community about the subject, emphasizing articles that could bring discussions about pre-disasters features and data.

The focus was given to the natural disasters, since that is the keyword of the research, other types of disasters were not included on the research.

Some parameters have been used to delimitate the research to assure the mining of potential articles to composse the presente work:

1. The search was made on the Periodical Portal available through CAPES—Coordination for the Qualification of Higher Level Staff, associated to the Brazilian Ministry of Education, having the peer review system as a decisive criterion.
2. Since it contains current and social/tecnological subjects, the time window used was related to the last 10 years, so the selected works could be, somehow, recent.
3. Only articles in English have been selected, excluding books, synopses and other documents.

The Periodical Portal available through CAPES was chosen because it is one of the most important research tools in Brazil, gathering the world's scientific production at only one place, and possessed 48.325 magazines at the end of 2018 (Capes 2018).

## *3.2 Search Strategies*

### 3.2.1 Keywords Choice

The keywords were chosen according to the theme, so as not to be overly extensive or restrict, to enable the search into several concepts, works with different structures

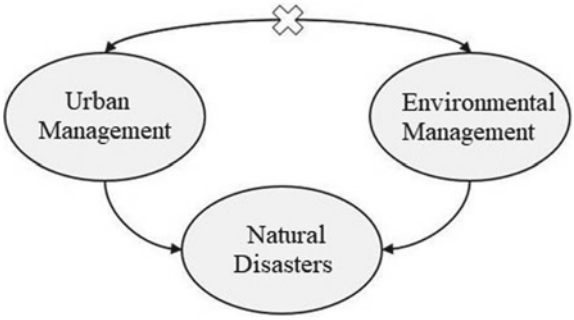



**Fig. 1** Keywords. Created by the author

and similar focus, since the urban management and the city itself, to the natural disasters indeed and the environmental management.

Initially three words were chosen to represent the objective of the research, they were: urban management, natural disasters ans environmental management, and later were interrelated generating the pattern combination to the research, as in Fig. 1:

It is possible to analyze on the Fig. 1, the words urban management + natural disasters and environmental management + natural disasters were combined, not having been combined the words urban management and environmental management, since that combination would lead to researches without the focus on natural disasters.

### 3.2.2 Derived Words Choice

After having done the interrelation of the kyewords, it was time to choose derived words for each keyword, that later were combined among each other, resulting 32 combinations, as shown on Fig. 2:

The derived words took into account concepts and themes that compond the keywords, focusing on natural disasters, social aspects and risk factors that cause adverse events.

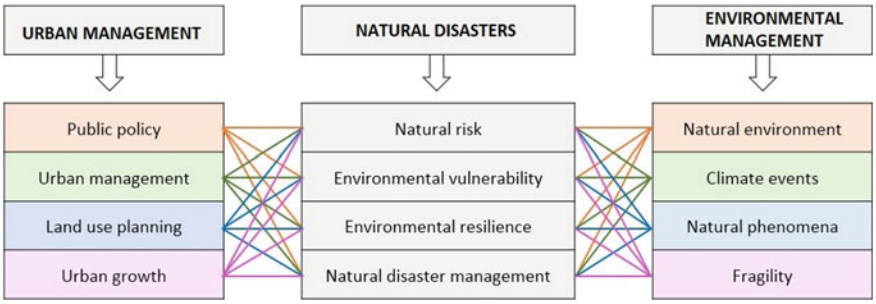



**Fig. 2** Derived words. Created by the author

### *3.3 Research Steps*

After choosing the keywords and its derived words, the research took four main steps to select the relevant works. Initially, 32 combinations were applied on the electronic portal respecting the enclosures, where 1730 results were found. Later an analysis was made on the title and the abstract of each article, looking for works according to the adopted topic, and that were unfailingly related to natural disasters, and then 214 results were found. At this stage all the works in different study areas, such as medicine and engeneering were discarded, focusing only at sciences and social sciences works.

The third step started by incorporating the 214 results into the software *Mendeley,* in order to delete all the duplicated articles, facilitating a transversal reading and then resulting 175 articles.

#### 3.3.1 Definition and Application of Exclusion Criteria

There was the application of exclusion criteria on the last step of the articles selection defined as a choice of works that would inform about natural disasters and its pre-disasters facets indeed, with the discussion of social and environmental risk factors in a perspective of construction of disasters, excluding the works that would only use the event as a factor for the development of researches with different focusses. The criteria were established taking into account that the social construction of natural disasters happens due to the sum of several social and environmental factors, the articles with the characteristics bellow were excluded:

1. Articles about post-natural disaster assessment programs and methods.
2. Articles on case studies of regions that suffered some type of natural disaster focusing only on measures taken after the event.
3. Articles about the socioenvironmental vulnerability as a assumption to create strategies to decrease natural disasters, without arguments about the role of vulnerability and other factors on the disaster's construction.
4. Articles about natural disasters, however, their focus was on the analysis of other disasters (Fig. 3).

## 4 Results

After applying the last filter 26 articles have been selected, matching to all criteria established, after synthesizing them on the table, it was possible to see the geographical location of the publications, what led to the following panorama: most of the articles were published in Europe, 26.92% in Netherlands (7 publications) e 23.07% in the United Kingdom (6 publications), followed by North America with 23.07%

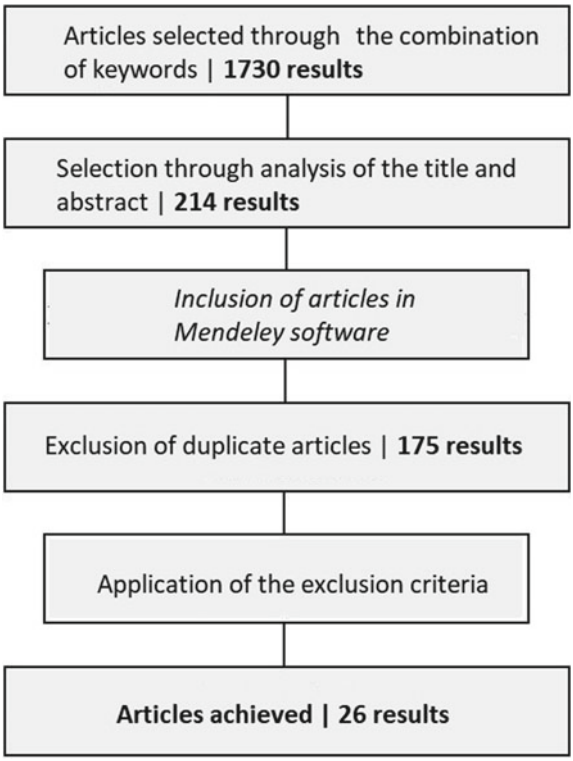



**Fig. 3** Steps of the systematic review. Created by the author

in the United States (6 publications). Brazil takes penultimate place with 7.69% (2 publications), as the Table 1 confirms:

Summed up on this global map, the distribution is divided between Europe, America (North and South) and Asia, and articles about this topic have not been found in Africa, Oceania and Antartida (Fig. 4).

The evolution on the topic through the years shows us an increasing discussion after the year of 2010, evolving until 2013 with its apex (according to the reserach made) declining in 2014, 2015 and 2016 where achieved one of the lowest scores, going up again in 2017 and maintaining that position until 2019, on the date of the research, as we can see on Fig. 5.

Among the several concepts and keywords adopted by the authors, the most constant keyword has been "vulnerability", that can be understood as a product of social inequality, factors that affects and shapes the susceptibility of a determined group to damage, at the same time that it is concerned to its responding capacity, and it could also include de inequality of space, regarding to the urban features of a certain place (Cutter et al. 2003). The following word cloud demonstrates the main keywords chosen by the authors to synthetize the researches (Fig. 6):

In addition to the concept of vulnerability, other important concepts have been chosen by the authors to synthetize the research made, among them we can mention

**Table 1** Authors, year of publication and original Country. Created by the author

| Author | Year | Country |
|---|---|---|
| Ibarrarán et al. (2007) | 2009 | Netherlands |
| Novelo-Casanova et al. (2010) | 2010 | Netherlands |
| Depietri et al. (2012) | 2012 | Germany |
| Pathirage et al. (2012) | 2012 | United Kingdom |
| Wang and Jiuh (2012) | 2012 | Taiwan |
| Aubrecht et al. (2013) | 2013 | Netherlands |
| Zhou and Zhao (2013) | 2013 | Netherlands |
| Hambati and Herbert (2013) | 2013 | United Kingdom |
| Malalgoda et al. (2013) | 2013 | United Kingdom |
| Ajibade and Idowu (2014) | 2014 | United Kingdom |
| Bang and Ngenyam (2014) | 2014 | United Kingdom |
| Lazarus and Naomi (2014) | 2014 | Romania |
| Mello et al. (2014) | 2015 | Brazil |
| Wahlström and Margareta (2015) | 2015 | United States |
| Szlafsztein and Fabian (2015) | 2015 | Netherlands |
| Gill and Malamud (2016) | 2016 | Germany |
| Mehiriz and Gosselin (2016) | 2016 | United States |
| Jackson and Guy (2017) | 2017 | United States |
| Carreño et al. (2017) | 2017 | United States |
| Kaufmann and Wiering (2017) | 2017 | United States |
| Franco et al. (2018) | 2018 | Brazil |
| Boccard and Nicolas (2018) | 2018 | Netherlands |
| Williams and Samuel (2018) | 2018 | Switzerland |
| Aksha et al. (2019) | 2019 | United States |
| Rehman and Sufia (2019) | 2019 | Netherlands |
| Sharifi and Ayyoob (2019) | 2019 | United Kingdom |

resilience, climate changes, danger, urban areas, floods, urbanization, risk, disasters management, among others.

Vulnerability, the most constant word on the researches found, is closely related to human and material losses, and it should not be seen as a simple natural phenomena, but as something that emerges in the social environment through what has not been done before or after it (Lieber and Romano-Lieber 2005), therefore, recognizing that natural disasters are the result of a sum of social and environmental risk factors, it is necessary to discuss about the concepts of social vulnerability and fragility, which are determinant factors in the process of social construction of the natural disasters.

According to Carreño et al. (2017), social fragility is assessed through variables related to the human being, as social integration, mental and physical health, both in individual and group level, what complements Franco et al. (2018), pointing that

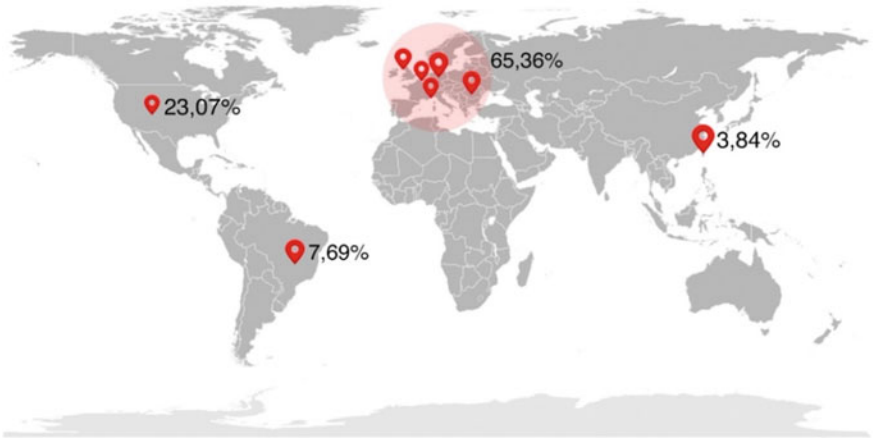
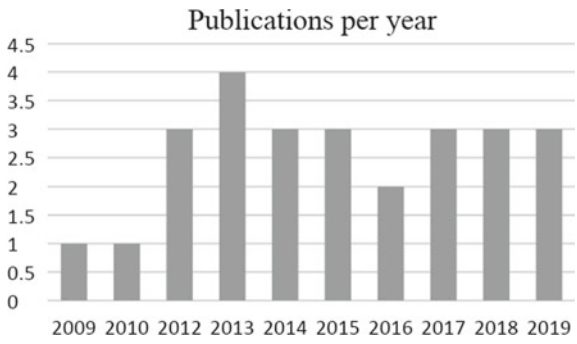



**Fig. 4** Publications by geographical area. No scale. Created by the author

**Fig. 5** Publications per year. Created by the author




an individual vulnerability, family or social group is related to their capacity to controll the forces affecting their well-being and the controll of assets and resources demanded to a better use of opportunities fostered by the government or society. Vulnerability can be manifested in physical, social or atitudinal way, with or without the community´s contribution, intentionally or directly to the community conditions itself, creating factors and situations that establish its vulnerability level (Hambati 2013), which could be deepen or enhanced depending on the actions taken.

In accordance with Ajibade and McBean (2014), housing problems are one of the major vulnerability aggravating existent, while they harm the poverty eradication, the social stability and full enjoyment of human rights, for example, the poorest population when out of options ends up settling at lowlands and floodplains, prone to floods, and suffers from the damages caused by the disasters, what supports Aksha et al. (2019), on the issue of a crucial need for identification of those vulnerable populations in order to decrease the natural disasters risk.


**Fig. 6** Main concepts adopted by the authors. Created by the author

Directly connected with the vulnerability, resilience may be seen as the hability of physically and financially recovering after na adverse event, such concept is criticized by Jackson et al. (2017), since the reading of resilience leads to a pre-disaster stage, recreating the causes of vulnerability that would result in a disaster itself, as a counterpoint to the concept explored by Carreño et al. (2017), where resilience is defined as an adaptive capacity of a social-ecological system to face and absorb negative effetcs as a result of the hability of antecipation, responding and recovering from harmful events, being its lack related to disability when it comes to facing and recovering after disasters.

Directly related to the vulnerability of communities victims of natural disasters, there was an attention on the part of the authors of the selected articles, to research and discuss about the management strategies related or not to public politics, on the mitigations of risk factors and on the reinforcement of resilience to face problems related to natural disasters, as well as when the lack of these same tools, as pointed out by Lazarus (2014), regarding to the lack of approach in the polictics scenario about stricter regulatory measures with engeneering projects in vulnerable areas, affecting the people subsistence and their access to share capital that establishes how ready they are going to be to deal with and recover from a natural disaster, contributing with Bang's analysis (2014), which mentions that many countries despite having a disasters management structure, still have gaps among the theory, the constant principles of disaster management and its implementation indeed, leading the governments to a more reactive than proactive approach, driving more efforts to post than pre-disasters.

## 5 Final Considerations

This research, despite having its enphasys reduced to a less far-reaching theme into risk management, has modestly contributed to recognize the state-of-the-art over social construction of the natural disasters, where with the help of a systemic review of the literature, the maturity of thinking about the subject became possible, on the use of criteria and choice of words that would conduct the unbiased and honest research, seeking the main objective of acquiring knowledge about what is being scientifically discussed related to the topic.

About the outcomes, a trend has been noticed on discussing topics related pre-disasters risk fator, the management and public politics, on the resilience strengthening and on the importance of social vulnerability as a decisive factor into the process of construction.

The presented research, as others related to the subject, contribute to the technical and scientifical reinforcement within the scope of advancement on the researches that compose the natural disasters topic, its construction and implications, discussing among social, economical and environmental factors that impact the community as a whole. However, other researches must be done to continue the process of comprehension of the phenomena that involve social construction of disasters aiming to bring new arguments and perspectives about such a relevant subject to the modern society.

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# Sustainability in Logistic Systems: An Analysis of Articles Published in the Main Event of Production Engineering in Brazil


**Vitor William Batista Martins, Rosley Anholon, Osvaldo Luis Gonçalves Quelhas, and Walter Leal Filho**

## 1 Introduction

Sustainability insertion in several areas has been gaining importance worldwide, mainly after the publication of the 17 Sustainable Development Goals proposed by UN (Gunawan et al. 2020; Khalili et al. 2017; Martins et al. 2019a, b). Much of this importance is due to the pressure exerted by stakeholders who increasingly demand environmentally correct and socially adequate production processes, products and services. According to Abedini et al. (2020) and Gomes et al. (2019), the insertion of sustainability guidelines in companies strategies and routine can provide competitive advantages for organizations.

Within the operations developed by the companies, logistical activities stand out. Wu et al. (2020) argue that these activities can greatly contribute to a more sustainable future, as long as they include actions in the economic, social and environmental

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spheres. Agyabeng-Mensah and Ahenkorah (2020) corroborate the aforementioned point of view.

The inclusion of sustainability in logistical operations is an issue that has been increasingly attracting the attention of academia and market professionals. Specifically in the academic field, Hong et al. (2018) argue that there are many gaps to be investigated regarding the inclusion of sustainability in logistical systems, mainly those related to understanding the social benefits generated. In fact, Leal Filho et al. (2019) expanded this opportunities analysis by stating that research related to the insertion of sustainability in business environment still needs to be analyzed in greater depth.

In this scenario, Production Engineering can greatly contribute to the inclusion of sustainability in logistics systems. The National Meeting of Production Engineering (ENEGEP), in Brazil, is characterized as an important forum for debates on this and other topics in the area. This event is organized by the Brazilian Association of Production Engineering (ABEPRO), an institution that represents students, professors, researchers and market professionals associated to Production Engineering field. ENEGEP is annually organized for over 30 years and involves an average of 2500 people, including students, professors, researchers and professionals from market.

Considering the context presented, this study aims to provide an overview of the themes most addressed by articles published in the ENEGEP annals in the area of sustainability in logistics systems, as well as to identify possible research gaps to be explored.

## 2 Sustainable Logistic

Sustainable logistics is characterized as one of the main trends in the development of activities that compose a company's operations (Seroka-Stolka and Ociepa-Kubicka 2019). This statement is corroborated by Karaman et al. (2020) who also mention that logistics sector has a considerable impact on the economic growth of countries and should be guided by the adoption of sustainable practices. Rashidi and Cullinane (2019) advocate the adoption of sustainable practices in logistical actions, highlighting that they currently depend heavily on non-renewable natural resources and fossil fuels, which significantly impact the environment.

The insertion of sustainability in logistics operations requires the development of an adequate structure to meet operational needs of distribution flows and to provide reverse flows of post-consumer products. Thus, it becomes evident that the inclusion of sustainability in logistics activities generates greater complexity in terms of management, requiring more qualified professionals (Lee et al. 2010). Additionally, according to Abbasi and Nilsson (2016), in order to promote a sustainable logistic system, it is necessary to develop activities with greater economic and social value and, simultaneously, to reduce negative environmental impact. Despite the reality

presented above, companies present relevant challenges in adapting their operations to sustainability standards (El-Berishy et al. 2013).

From the works of Tan et al. (2019), Wang (2019), Sadeghi and Haapala (2019), Govindan et al. (2019), it is possible to observe that, in general, the debates about the insertion of sustainability in the logistics systems are growing and considering an increasing number of sectors, which justifies the need for more events and research in the area.

## 3 Methodology

To achieve the objective presented in the introductory section, a systematic literature review was carried out following the guidelines proposed by Xavier et al. (2017). According to these authors, a systematic literature review should follow the following steps: (a) formulation of the research question; (b) location of studies; (c) selection and evaluation of studies; (d) analysis and synthesis; (e) reporting and using research results. These steps are presented in Fig. 1.

The proceedings of ENEGEP were consulted between 1996 and 2019. The main information collected were: title of the articles, authors, objectives and the research method adopted. Based on the information collected, sought to analyze how sustainability is being inserted in research in the area of logistics systems and what are the existing gaps plausible to be explored.

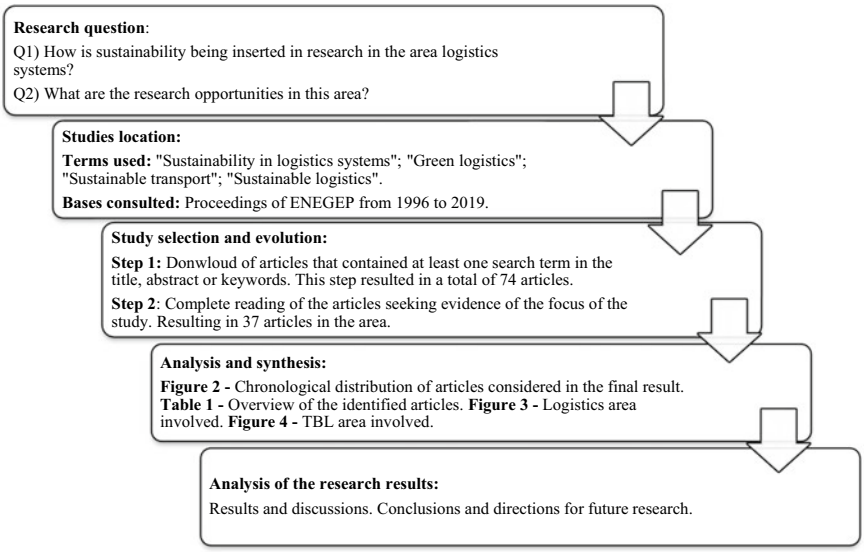


**Fig. 1** Flowchart of the methodological procedure used. *Source* Authors, adapted from Xavier et al. (2017)

## 4 Results and Analysis

Table 1 presents an overview of the studies published at the event. It is possible to identify the titles of the articles, authors, the objectives of the studies and the methodological procedure used in each article. As shown in Table 1, it is possible to notice that although the literature review considered the years between 1996 and 2019, the first occurrence of an article published at the event in the area of sustainability in logistic systems occurred only in 2002.

Analyzing Table 1, it is possible to verify that a large number of articles used case study as a research method, in total there were 18 articles out of the 37 considered.

**Table 1** Overview of identified research

| No. | Article title | References | Purpose of the article | Methodological procedures |
|---|---|---|---|---|
| 1 | Reverse Logistics in Hospitality. ISO 14,001 certified hotel case study | Cury et al. (2003) | The study investigated how Reverse Logistics (LR) can contribute to the development of Sustainable Tourism (TS) and consequently to sustainable regional development | Case study |
| 2 | Reverse logistics as a cyber agent | Felizardo and Hatakeyama (2002) | The study aimed to establish connections between reverse logistics, care for the environment and cybernetics, demonstrating the "man-society-machine" relationship for the sustainability and development of the current socio-economic system | Conceptual review |
| 3 | Reverse chains of Aluminum Cans and pet bottles in Baixada Santista | La Fuente and Robles (2005) | Analyzes and compares the reverse chains of aluminum cans and PET bottles, checking their structure, similarities and differences, aiming to contribute to the development of the recycling business | Semi-structured interviews and exploratory analysis of multiple cases |
| 4 | Application of the concept of social responsibility through port sustainability: a case study in the port of Santos | Chaud and Rodrigues (2006) | It analyzed the insertion of the concepts of corporate social responsibility in port management | Case study |

(continued)

**Table 1** (continued)

| No. | Article title | References | Purpose of the article | Methodological procedures |
|---|---|---|---|---|
| 5 | Vehicle routing as a tool for sustainable waste management | Cardoso and Azevedo (2007) | To present a routing and a schedule for the transport of materials resulting from industrial activities in the area of a steel mill's coking plant as a sustainable tool, aiming to minimize transport costs and environmental impacts, thus ensuring a sustainable management of the environment | Case study |
| 6 | Environmental, social and financial impacts of a reverse logistics policy adopted by a television factory—a case study | Miguez et al. (2007) | To show the environmental, social and economic benefits arising from the reverse logistics adopted by a television manufacturer that uses recycled raw material from screens and computer cones to manufacture its screens and cones | Case study |
| 7 | Critical analysis of policies for urban cargo in Brazilian metropolises | Sanches Junior et al. (2008) | Demonstrate how Brazilian cities deal with goods movement issues in the light of the national policies for sustainable urban mobility | Literature review |
| 8 | A study of reverse channels in a cartoned packaging company | Pereira et al. (2008) | To present the reverse logistics process, which makes it possible to recycle all types of material that make up a carton pack, respecting the concepts and techniques of the reviewed literature | Case study |
| 9 | Analysis of the reverse logistics network of solid waste from civil construction: building sub-sector in João Pessoa | de Melo et al. (2008) | Identify the destinations that construction companies in João Pessoa have given to each component of their solid waste, analyzing whether they make use of reverse logistics channels, thus seeking to contribute to environmental sustainability | Case study |

(continued)

**Table 1** (continued)

| No. | Article title | References | Purpose of the article | Methodological procedures |
|---|---|---|---|---|
| 10 | Design of industrial facilities and environmental sustainability | Bernardo (2009) | Check in the historical reference works on the subject, if the methodologies presented consider the preservation of the environment | Literature review |
| 11 | The production of Briquettes as reverse in timber in the municipality of Tomé-Açu | Pancieri (2009) | It analyzes the benefit of using sawdust in the wood for the production of briquettes and showing that reverse logistics must be directly linked to its production process in order to remain competitive in the market and promote sustainability | Case study |
| 12 | Reverse logistics as a tool for sustainability: a study on Tires | Freitas et al. (2009) | To present reverse logistics as a tool for sustainability, from a descriptive and exploratory research aimed at understanding the main techniques addressed for the proper treatment of tires, mitigating the problems that such products cause to the environment | Case study |
| 13 | The environmental issue in the implementation of port terminal: the case of Brasil Terminal Portuário—Btp | Robles and da Silva (2010) | Analyzes the importance of the environmental issue in the implementation of infrastructure projects based on the case study of the implementation of the BTP Multi-Purpose Terminal, analyzing the remediation alternatives in the "Lixão do Porto" area and identifying the strategy of BTP and investor groups to implement the terminal | Case study |
| 14 | Influence of the economic, social and environmental dimensions through the stages of the biodiesel purchase decision process: study with public transport companies | Gollo et al. (2010) | It aimed to carry out a theoretical review on consumption for the purchase of organizations considering sustainability and the model that contemplates the stages of the decision-making process | Case study |

(continued)

**Table 1** (continued)

| No. | Article title | References | Purpose of the article | Methodological procedures |
|---|---|---|---|---|
| 15 | Study of reverse logistics of the aluminum can | Farha (2010) | Conduct a study on reverse logistics of the Aluminum Can, aiming at the optimization of the can process, showing what this recycled consumer good represents for the beverage companies and when it is improperly released what is its environmental impact | Case study |
| 16 | Analysis of the reverse logistic system of lamps of public lighting in southern Cearense | de Brasil et al. (2011) | Analyze the reverse flow of lamps used in public lighting in the southern region of the State of Ceará, which bring as a fundamental component to their operation, mercury, a heavy metal potentially harmful to the environment and human health, especially when converted, together with these lamps, in post-consumer waste | Case study |
| 17 | Predisposition of purchase of food with sustainable packaging | Kohmann et al. (2013) | Analyze the purchase intention of food with sustainable packaging, whether this sustainability is obtained through biodegradable packaging, recycling or the application of reverse logistics | Survey |
| 18 | Sustainability and logistics in Brazil | Almeida et al. (2013) | To present the current conditions of transport modes in Brazil, as well as a more in-depth study about the sustainability of the means of transport used by the Brazilian industry in the flow of its productive capacity | Literature review |
| 19 | Analysis of sustainability principles in an electronic electronic waste wholesaler | Santos et al. (2014) | To analyze how the electronic waste management company is guided by environmental principles | Literature review |

(continued)

**Table 1** (continued)

| No. | Article title | References | Purpose of the article | Methodological procedures |
|---|---|---|---|---|
| 20 | Reverse logistics actions at fuel oil dealers | Cezarino et al. (2015) | Describe reverse logistics actions in the fuel resale sector. Specifically, it addresses the logistical movement of recycling used packaging of lubricating or contaminated oil (OLUC), oil filters, tow and other contaminated waste | Semi-structured interviews with content analysis of the responses |
| 21 | Green logistics: practices performed by Brazilian companies that presented gri sustainability report in 2014 | (Marques and Grande 2015) | Check if Brazilian companies oriented towards sustainability adopt green logistics practices | Documentary research and content analysis |
| 22 | Reverse logistics: application of the sustainable value model as an alternative to electronic waste | Junior et al. (2015) | Verify the alignment of the sustainable value model presented by Hart and Milstein (2004) in the management of electronic waste (e-waste) through the production engineering technique - reverse logistics | Case study |
| 23 | Sustainable logistics: green corridors and infrastructure for intermodality in porto de santos | Bueno and Hilsdorf (2016) | Analyze the conditions of port infrastructure necessary for a sustainable green corridor for intermodal transport to be implemented from the Port of Santos | Case study |
| 24 | Reverse logistics: analysis of cost management in the application of reverse logistics in a drink company | Cordeiro et al. (2016) | Demonstrate how reverse logistics can be used as a tool to develop the economic pillar of sustainability, demonstrating the feasibility of applying this concept | Case study |
| 25 | Upcycling and sustainability: the awakening of the fashion industry for reverse logistics | Vilaca et al. (2016) | It consisted of investigating how a company in the fashion industry in Rio de Janeiro uses the concepts of reverse logistics applied to the fashion industry | Interview and descriptive statistical analysis |

(continued)

**Table 1** (continued)

| No. | Article title | References | Purpose of the article | Methodological procedures |
|---|---|---|---|---|
| 26 | Reverse logistics of civil construction waste: opportunities and challenges in different countries | Moraes et al. (2017) | Analyze the challenges and opportunities for the implementation of reverse logistics for Construction Waste in different countries, comparing these challenges with the Brazilian reality | Literature review |
| 27 | Analysis of the reverse logistics of a refrigerator company: a case study | Calvo et al. (2018) | Conduct an analysis of the logistics, and its reverse direction, within of a company that works in the refrigerator assembly business, considered a reference national in this segment, located in the municipality of Três Lagoas-MS | Case study |
| 28 | Reverse logistics program: a proposal to collect support material from a direct selling company | Bandelow et al. (2018) | Propose a reverse logistics program aimed at direct selling companies | Case study |
| 29 | Methods used for data processing in research involving sustainability and supply chain management: literature review and gaps for future research | Martins et al. (2019a, b) | Aimed to carry out a systematic review of the literature presenting a current overview of the tools and methods used to treat the research data that relate the concepts and guidelines of sustainability with the supply chain management and, in addition, to identify the research opportunities in this area | Literature review |
| 30 | Analysis of scientific production and trends on performance in reverse logistics: a look at the social dimension | Pedro and Mendes (2019) | Analyze the scenario of worldwide scientific production on performance evaluation in reverse logistics with a focus on social aspects based on 100 articles from the Web of Science database published between 2010 and 2018 | Literature review |

(continued)

**Table 1** (continued)

| No. | Article title | References | Purpose of the article | Methodological procedures |
|---|---|---|---|---|
| 31 | Evaluation of reverse logistics of electronics products in a teaching institution | Silva et al. (2015) | Evaluate the reverse logistics process at the university Center of Patos de Minas (UNIPAM) | Documentary research and Survey |
| 32 | Sustainability and supply chain management in a steel cutting and bending industry: competitive indicators and advantages | Sousa et al. (2015) | The understanding of how sustainable management can be measured in a focal company in a supply chain | Case study and literature review |
| 33 | Reverse logistics and sustainability: a case study in a fishermen's association in the municipality of camalaú-pb | Santos et al. (2016) | Demonstrate how the process of using fish scales works using reverse logistics from the perspective of sustainability in an association of artisans | Semi structured interview |
| 34 | Reverse logistics as a strategic tool for cost and sustainability management in a company | Valentim et al. (2018) | Study Reverse Logistics as a cost reduction strategy with a view to profit, and also its importance in the socioeconomic and environmental impact | Literature review |
| 35 | Analysis of the reverse logistic system of automotive lubricant oil in Teresina-PI | Batista et al. (2018) | Analyze the collection of automotive lubricating oil made by the gas stations in Teresina—PI and its compliance with the legislation | Bibliographic review and semi-structured interview |
| 36 | Maturity model in sustainable logistics | de Souza and Rodriguez (2019) | Offer an overview of the existing maturity models and propose a unique MM model for sustainable logistics | Literature review |
| 37 | Corporate sustainability: a case study in a Vegan Footwear Company | Alves et al. (2019) | Analyze the relationship with sustainable practices in a footwear company in the city of Franca-SP | Literature review and interview |

*Source* Authors

It is worth mentioning that from this total, 1 article used case study with another research strategy (literature review), as can be seen in Sousa et al. (2015). Another widely used research strategy is the literature review (total of 11 articles), being used in some cases combined with interviews. Only 2 articles adopted survey as a research strategy, one of which used it in combination with documentary research.


**Fig. 2** Logistics area involved. *Source* Authors

Thus, through these findings, it is possible to verify several opportunities for research using different methods. There is no study using action research, for example.

Considering the objectives of analyzed articles, it is clear that most of them analyze issues associated with reverse logistics and green logistics through case studies. In this sense, research opportunities are identified, such as the development of specific models, tools and systems that allow enhancing the inclusion of sustainability in logistics activities.

Figure 2 shows the frequency of studies carried out by logistics area, considering those areas defined by Ballou (2004). These activities are classified into key and support activities. It is possible to notice that areas with the highest occurrence of registered studies are: cooperation product operations (12 occurrences) and transport (10 occurrences). Opportunities for carrying out studies in the areas of information maintenance, storage, packaging engineering and purchasing management are also evident. Regarding information management, Watanabe et al. (2018) and Zhang et al. (2016) highlight its importance for achieving sustainable goals. According to Comi et al. (2018), Kang (2018) and Singh et al. (2018) warehouse operations have great potential for improving sustainable aspects ranging from ergonomic issues to reducing the use of fossil fuels in machinery used in operations. From the point of view of sustainable packaging, Crainic et al. (2016), Gabriel et al. (2014) and Heßler et al. (2018) highlight the importance of using recycling inputs in packaging production and, in addition, promoting the reuse of packaging through reverse logistics strategies. Considering the purchase operations, Karuna et al. (2017), Kumar et al. (2018), Lo et al. (2018) and Miranda et al. (2019) alert to the importance of adopting sustainable strategies in the choice and definition of partner suppliers, aiming to promote sustainability throughout the entire production chain.

Regarding TBL concept, Fig. 3 shows the occurrences of articles by TBL area. Of the 37 articles analyzed, 17 focus exclusively on environmental aspects, followed by 14 occurrences that analyze the 3 areas of TBL together, these were the items with the largest occurrences observed in the sample of this study. Therefore, it is possible to identify the need for the development of studies that analyze the economic and mainly

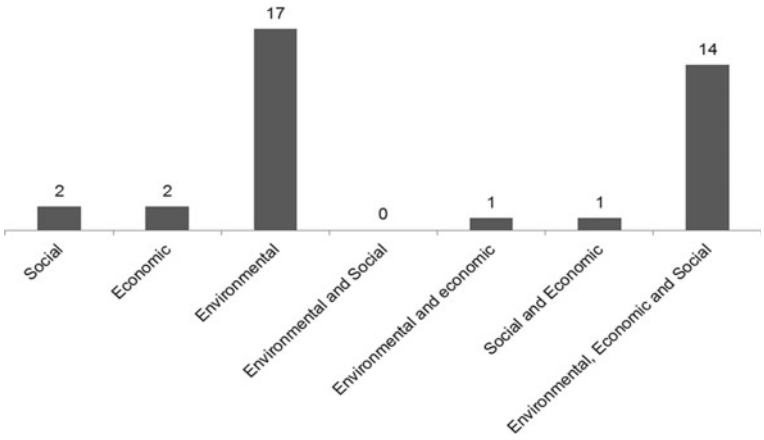


**Fig. 3** TBL area involved. *Source* Authors

social aspects in the area of inserting sustainability in logistics systems. According to Hong et al. (2018), research involving social aspects in logistical systems is important to clarify the understanding of the benefits generated in this context for both organizations and stakeholders involved in this objective.

In general, it is clear that the contributions of studies published in the context of sustainability in logistics systems in the largest Brazilian Production Engineering event are mostly contributions made through case studies and literature reviews. Therefore, there is a need to develop research that promotes practical contributions to logistics systems with regard to their suitability for meeting environmental, economic and social guidelines.

## 5 Conclusion

Considering the results presented, it can be concluded that the objectives proposed in this study were achieved. It was possible to observe that there is a concentration in the use of research strategies (case studies and literature review); in addition, it was possible to identify areas little explored in logistics and TBL plausible to be further investigated by researchers interested in the sustainable logistics theme. There are opportunities in the areas of information management throughout the chain, storage management, inventory management and purchasing. In relation to TBL, social aspects can be better explored.

Regarding the limitations of the study, the use of only one source of data can be highlighted, therefore, the results presented here do not correspond to the panorama of the sustainability area in logistics systems as a whole, but only to the annals of ENEGEP were considered. This article has two main implications for the theory. First of all, it provides a solid basis for the issue of inserting sustainability into logistic

systems and secondly, the literature review focusing on ENEGEP offered insights on the topic describing some challenges related to it and directing research into future events.

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# The Use of "Equator Principles" for Project Compliance: The Case of the Santo Antônio Hydroelectric Plant, Brazilian Amazon


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## 1 Introduction

Water is an abundant natural resource on Earth and one of the few energy production sources that does not contribute to global warming.

Energy from the harnessing of the hydraulic potential of river waters is a low-cost and renewable source. However, large hydroelectric plants have been great villains of development due to the exaggerated emphasis on the impacts they cause on people and the environment, which requires previous studies to understand and analyze the aspects of sustainability associated with these companies.

Therefore, organizations must follow guidelines to develop sustainable projects, considering the social, economic and environmental aspects involved in their business and operations (Peres Neto and Fantin 2014; Almeida 2017).

Equator Principles (EP) are a set of requirements composed of 10 socio-environmental principles applied in order to finance large projects, supported by financial clauses that limit their application to a minimum amount (International Finance Corporation 2015; Soppe 2004).

This paper discusses the use of financial mechanisms to promote social and environmental responsibility in organizations from the hydroelectric sector.

To achieve this, we verified the financing conditions applied to the Santo Antônio Hydroelectric Power Plant (UHE), in Porto Velho, using the Equator Principles.

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Our bibliographic and documentary research focused on documents and company reports.

The methodology has three phases. The first is verifying the research problem, namely the feasibility of financing the construction itself, by performing a bibliographic review and consulting documents concerning the construction. The second is the explanation of the Equator Principles, and the third is the analysis of the case study.

## 2 Hydroelectric Power Production in the World

Producing hydroelectric power involves the flow of the river, the amount of water available during a given period, and the gaps, whether natural, such as waterfalls, or artificially created. The structure of the plant is essentially composed of a dam, water collection and adduction system, powerhouse, and spillway, which work together and are integrated. The dam serves to interrupt the normal course of the river and allow the formation of the reservoir. In addition to "stocking" water, these reservoirs have other functions: they allow the formation of the necessary gap to create hydraulic energy, the capture of water in adequate volume, and the regularization of the flow of rivers in periods of rain or drought.

Table 1 shows the hydroelectric generation (TWh) by regions of the world, between 2008 and 2012. This table serves to show how this type of energy generation is spread around the world, reinforcing the importance of mechanisms that promote social and environmental responsibility in these activities.

Table 2 shows the installed capacity of hydroelectric generation in each country. China, Brazil and the United States lead in this type of power generation, reinforcing the importance of this discussion in Brazil.

## 3 Feasibility of the Construction Project of the Santo Antônio Hydroelectric Power Plant

To describe the economic viability of the construction project of the Santo Antônio Hydroelectric Power Plant in Porto Velho, the ten Equator Principles were analyzed, determining the conditions for its financing.

Compliance with the Equator Principles requires meeting an extensive list of socio-environmental requirements that are complementary and compatible. There is no possibility of complying with only specific requirements. As such, the Equator Principles expand the umbrella of the project's socio-environmental requirements, consolidating the range of requirements associated with it.

**Table 1** Hydroelectric power generation by regions of the world (TWh)

| | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| World | 3180.1 | 3234.1 | 3422.2 | 3489.0 | 3646.1 |
| Asia and Oceania | 940.1 | 971.3 | 1104.4 | 1122.4 | 1275.2 |
| South and Central America | 667.2 | 684.3 | 687.2 | 729.7 | 715.3 |
| North America | 667.3 | 664.9 | 644.8 | 727.2 | 684.5 |
| Europe | 563.6 | 559.9 | 615.2 | 539.0 | 596.1 |
| Eurasia | 234.8 | 242.1 | 243.5 | 239.7 | 239.9 |
| Africa | 95.5 | 98.7 | 109.5 | 110.0 | 113.0 |
| Middle East | 11.7 | 12.9 | 17.6 | 20.2 | 22.0 |

*Source*: Anuário Estatístico de Energia Elétrica [Statistical Yearbook of Electricity] (EPE 2015)

**Table 2** Installed capacity of hydroelectric generation in the world—10 largest countries in 2012 (GW)

| | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| World | 853.4 | 888.2 | 921.9 | 949.4 | 979.1 |
| China | 171.5 | 196.8 | 219.0 | 231.0 | 249.0 |
| Brazil | 77.5 | 80.7 | 82.5 | 82.5 | 84.3 |
| United States | 77.9 | 78.8 | 78.7 | 78.7 | 78.7 |
| Canada | 74.2 | 74.901 | 75.4 | 75.2 | 75.4 |
| Russia | 47.1 | 47.4 | 47.4 | 47.3 | 47.4 |
| India | 39.3 | 40.6 | 42.8 | 42.4 | 42.8 |
| Norway | 28.1 | 28.4 | 28.6 | 28.6 | 28.6 |
| Japan | 21.9 | 22.4 | 22.2 | 22.1 | 22.2 |
| Turkey | 13.8 | 15.8 | 19.6 | 17.1 | 19.6 |
| France | 18.1 | 18.2 | 18.4 | 18.4 | 18.4 |
| Others | 283.9 | 290.1 | 312.7 | 306.1 | 312.7 |

*Source* Anuário Estatístico de Energia Elétrica [Statistical Yearbook of Electricity] (EPE 2015)

## *3.1 The Equator Principles*

In 2002, the International Finance Corporation (IFC) and the bank Dutch ABN Amro, held a meeting involving senior executives to discuss investment experiences in projects that involve socio-environmental issues in emerging markets, where four banks presented their experiences. A second meeting took place in 2003, when the first bases of what they called "Greenwich Principles" were established (Amalric 2005). In May 2003, in Germany, a third meeting was conducted in which its name changed to "Equator Principles". As socioenvironmental guidelines, the 10 Equator principles (June 2013) refer to The:

1. Analysis and categorization based on the magnitude of risks and impact of potential socio-environmental factors;
2. Socio-environmental assessment;
3. Applicable socio-environmental standards;
4. Environmental and Social Management System and Action Plan aligned with the Equator Principles;
5. Engagement of interested parties;
6. Complaint mechanism;
7. Independent analysis (Independent socio-environmental consultancy for document analysis);
8. Contractual obligations;
9. Independent monitoring with information disclosure (Contracting of
10. independent socio-environmental consultant or third-party specialists);
11. Disclosure of information and transparency.

### *3.2 Financial Structure of the Santo Antônio Hydroelectric Power Plant (HPP)*

Due to the magnitude of the Santo Antônio HPP construction and its social, environmental, economic, and financial relevance, with notorious importance in the process of adding clean energy in the Brazilian electricity system, the only way to make the project viable was through project finance fundraising, considering a project structure based on meeting sustainability and financing parameters according to environmental requirements imposed by financial institutions and other stakeholders.

Project financial structure is determined by to the magnitude of the project and its favorable conditions of cash flow generation, in addition to the favorable conditions for segregation of risk between each of its participants and not having recourses against the investor.

For Bonomi and Malvessi (2008), financing projects in the modality project finance leads to an expensive financial and legal structure to establish rights, obligations, allocation of risks, previous conditions for disbursement, in addition to having all contractual instruments related to the company's financing. For such purpose, a detailed knowledge of all the risks of the project is mandatory and they must be allocated among all participants, respecting the different contracts within the scope of the company. The correct allocation and transfer of risks among the various actors are critical factors of financing success.

According to the International Project Finance Association—IPFA (2010), project financing is based on a financial engineering "non-recourse" or "limited recourse" situation where debt and invested capital are paid through the cash flow that the project can generate.

According to Borges (2005), project finance is a structured operation in which loans granted by creditors do not show solidarity by third parties (or have limited solidarity), and for this to happen, risk segregation is done through the Society of Specific Purposes (SSP), using the flow of receivables from the project as a basis for economic and financial analysis. Project guarantees are formalized from the assets connected to the financial structure.

The main participants of the project finance structure of the Santo Antônio HPP from the Society of Specific Purposes are as follows:

1. Granting Authority, which acts as a regulatory body, encharged with determining the rules to be complied by the Concessionaire, and must be respected for project financial structure;
2. Funders, responsible for structuring the resources for the feasibility of the project consistency with the financing contracts concluded with the SSP. Creditors act with the support of financial and legal advisors. Financial and legal advisors are independent advisors who instruct sponsors about the risks, contractual issues, techniques and sources of financing available in the market that can mitigate the project;
3. Investors, also known as sponsors, who will be responsible for equity contribution;

4. Consortium EPC (Engineering, Procurement and Construction), responsible for the construction of the project, in accordance with the bases of the EPC Contract signed with SSP. Design, engineering, machinery and equipment suppliers assume joint responsibility.

When defining the project financial structure, several actions towards finalization of the financing are conducted, involving several participants under the coordination of a Leading Bank of Finance, responsible for the unionization of resources needed with other banks, multilateral and export credit agencies, promotional banks and investors in general.

The structuring of financing for the Santo Antônio HPP construction was made with limited resources from shareholders (Limited Recourse), for Santo Antônio Energia (SAESA), as a Society of Specific Purposes (SSP), which allows to isolate the risks of the project from the risks of shareholders.

SAESA is a wholly owned subsidiary of Madeira Energia S.A (MESA), formed by Odebrecht, Furnas, Andrade Gutierrez, Cemig and a Holding Fund—FIP, having as shareholders Santander and Banif.

For project eligibility in the Project Finance modality, the Santo Antônio HPP must meet requirements related to:

1. When the project is completed and its operation has the capacity to generate cash according to the agreed grounds to allow for the payment of the contracted debt for the feasibility of the project;
2. When the risk matrix (identified and respective mitigating factors) has been mapped;
3. The project must be sustainable in the social, economic and environmental spheres, adhering to the Equator Principles.

Considering the size of the developed project, a risk management structure is necessary and applicable in all its steps. In projects based on Project Finance, this is a mandatory requirement for the following actions:

1. Risk assessment and analysis;
2. Allocation of responsibilities;
3. Determination of appropriate risk mitigation;
4. Risk management between specific parties;
5. Monitoring, reporting and dissemination procedures;
6. Testing and audit procedures.

These actions require considering mitigations of project risks in order to monitor precautionary signs, their respective controls, and planning of emergency actions.

Compliance with the imposed rules made the construction of HPP Santo Antônio particularly relevant regarding the growth of the socioeconomic status in the region, in addition to protecting the environment. The company, in addition to meeting the legal and mitigation impact commitments, fulfills a positive agenda in promoting social gains and economical for local communities.

One of its highlights is its management of potential impacts that cause indirect effects on the indigenous territories of the Karitiana and Karipuna peoples beyond

the territory of the Cassupa people in Porto Velho. The problems it might cause that could potentially affect indigenous peoples were initially identified by subsequent diagnosis and planning.

The support of Santo Antônio Energia helps to protect indigenous territories with the help of a local FUNAI office and the indigenous peoples themselves. The support program for these communities consists of emergency and action plans. In addition, the project has the support of indigenous peoples by establishing a very transparent relationship with their leaders (Santo Antônio Energia 2012).

## 4 Conclusions and Suggestion of New Studies

The findings of this paper were possible by performing a literature review, consulting the company's documents and the work spent on the construction itself, and verifying its case study.

The main limitations of this study are inherent to the chosen methods. This means the literature review does not cover all the possibilities of alternatives for financing the company considering sustainable finances. The description of the case study is biased in the elaboration of the analysis and in the description of the company's particularities, in addition to the researcher, participants, and the case particularities.

This study supports and guides organizational practices focusing on the compliance of companies to the Equator Principles by using the adoption of its paradigms.

The novelty of addressing the Equator Principles arose from focusing on the positive impacts on the environmental conduct of signatory banks, including their sustainable participation in the financial structure of projects that take into account environmental and social issues.

Moreover, it proposes a financing alternative that can be used to aid in the implementation and management of organizational practices.

Currently, organizational awareness is required for all project participants in which an environmental problem must be economically and socially feasible for a business. The three pillars of sustainability economic, social and environmental must be treated in a coherent and balanced manner.

In Brazil, the context for implementing the Equator Principles involves the growing market of Project Finance, which implies environmental, social, credit and image risks. The presence of foreign banks, some pioneering signatories, as well as the international financial corporation's performance in certain projects, financing from Multilateral Agencies and Export Credit Agencies motivated the introduction of social and environmental policies and practices in the development of projects, in addition to innovative technologies, increasing competitiveness, allowing for the sustainable feasibility of companies and consolidating the culture of sustainability.

For future studies, we suggest to evaluate the sustainability profile of the Santo Antônio HPP in its operational phase.

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# Community and Stakeholder Relations

# Production Performance Assessment at Different Levels: An Investigation Based on Literature Review


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## 1 Introduction

All Operations Management studies, specifically bibliographic research, allow us to learn how this field has unfolded and developed since its early days, when much of the work was descriptive, and structural equation models were almost completely unknown. (Taylor and Andrew 2009). In this evolutionary process, some themes are highlighted at various times, such as the production performance measurement that appears as one of the most representative topics of Operations Management from 1994 to 2003 (Pilkington and Fitzgerald 2006) and from 1980 to 2003. 2006 (Pilkington and Meredith 2009).

Until the first half of the twentieth century, performance appraisal was associated with budgetary and accounting controls. After the 1950s, performance appraisal systems were characterized by the intense use of financial indicators. Between the 1960s and 1980s, quality, timing, flexibility, and customer satisfaction metrics began to be measured (Ghalayini and Noble 1996; Nudurupati et al. 2011).

For Slack et al. (2018) measures of quality, time, flexibility and reliability are indices of production performance at operational level. Slack et al. (2018) also claim

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that production performance can still be assessed at the social and strategic level, where each level has specific performance indicators.

Thus arises the research problem: How did the evolution take place and what is the current scenario of research on measuring production performance? The overall objective is to identify, through a systematic literature review, which level of assessment (social, strategic, operational) prevails among scientific research and which assessment methodology is most commonly used.

Kaplan and Norton (1997) argue that "everything that is not measured is unmanaged". Thus, understanding the possibilities along this continuum can help managers identify the current position of their company and the attitude and approach transformations that will be required to advance to a higher stage in this management process (Hayes and Wheldingring 1985).

## 2 Theoretical Referential

Managing production is critical to the sustainable success of any organization, and this includes focusing on improvement, building "hard-to-mimic" skills, and an understanding of the processes that are the building blocks of all operations; Nevertheless, production management is judged by its performance (Slack et al. 2018).

In this evaluation process, you need to measure your efforts, quantify the action, ie identify the performance measures that will prove whether the operation is good, bad or indifferent (Slack et al. 2018). Other terms such as performance indicators are also found in the literature. For Gosselin (2005) performance indicators can be defined as the physical values used to measure, compare and manage overall organizational performance.

These measures or performance indicators may include quality, cost, time, inventory, delivery, health and safety, flexibility, innovation, sustainability among other categories (Gaik Chin and Zameri Mat Saman 2004; Sangwa and Sangwan 2018; Winroth et al. 2016; Ishaq Bhatti and Awan 2014; Behrouzi et al. 2011).

Slack et al. (2018) claim that production performance can be evaluated at different levels:

(a) Social Level: which uses the triple bottom line to assess the social, environmental and economic impact of the operation;
(b) Strategic Level: at which production performance can be analyzed in terms of how it affects the organization's ability to achieve its strategy; and
(c) Operational Level: which examines aspects of performance most directly at the operational level—quality, speed, reliability, flexibility and cost.

Recently, a comprehensive literature review of sustainability measures has indicated that the studies are divided into eight distinct areas. Regarding sustainability disclosure and performance, companies disclose from pure environmental data and

include information on pollution or greenhouse gas emissions to social information that primarily includes employees and community-related metrics (Mura et al. 2018).

On the other hand, the area classified as critical environmental accounting emphasizes that conventional financial accounting, the triple bottom line and the Global Reporting Initiative (GRI) are insufficient conditions for organizations that contribute to sustaining the ecology of the earth, as they can reinforce highest and usual levels of non-sustainability. Another important point identified by the authors is related to the area of sustainability metrics: most studies focus on the development of environmental and social indicators (Mura et al. 2018).

Still on sustainability metrics, studies based on Simons' control levers (1995) show that environmental indicators can be used as interactive and diagnostic controls, that is, to monitor and control performance, but also to trigger future conversations. Stimulate innovation, besides being a facilitator of proactive communication with external parties (Mura et al. 2018).

In terms of social value, social value measures are often considered distinct and unrelated to other performance measures, such as financial and operational. Only a few organizations have the "maturity" to integrate socially valuable information into strategic decision making, most preferring to collect and communicate this information to appeal to external stakeholders. In part, this is due to the traditional belief that the most important dimension of organizational performance is financial, which also means that managers often have little awareness of how to measure and manage social performance. In part, despite a growing appreciation of its relevance, social value is often treated as a "separate" dimension of performance, which requires expertise and dedicated practices and reporting flows (Beer and Micheli 2018).

However, when implementing and using a performance management system, companies face six sources of complexity: function, task, and types of procedural complexity associated with the social dimension and methodological, analytical, and technological types associated with the technical dimension (Okwir et al. 2018).

Finally, and based on the Slack et al. (2018) ratings and with some additions to the Bibliographic Portfolio articles, Fig. 1 shows performance measures at the three levels.

In Fig. 1, all terms with the expression "(O)" are original terms from the work of Slack et al. (2018). The other expressions follow the following caption:

- "[38]" represents the terms extracted from Article 38 of Sangwa and Sangwan (2018);
- "[36]" means terms taken from Article 36 of Winroth et al. (2016);
- "[27]" represents the terms extracted from Article 27 by Behrouzi et al. (2011);
- "[32]" represents the terms extracted from Article 32 by Ishaq Bhatti and Awan (2014);
- "[31]" represents the terms taken from Busso's Article 31; Miyake (2013);
- "[23]" represents the terms taken from Bakhtiar et al. (2009); and
- "[24]" represents the terms extracted from Article 24 by Muchiri et al. (2011).

All these performance measures or some dimensions, also called perspectives, can be grouped into an integrated evaluation system, expanding the information for

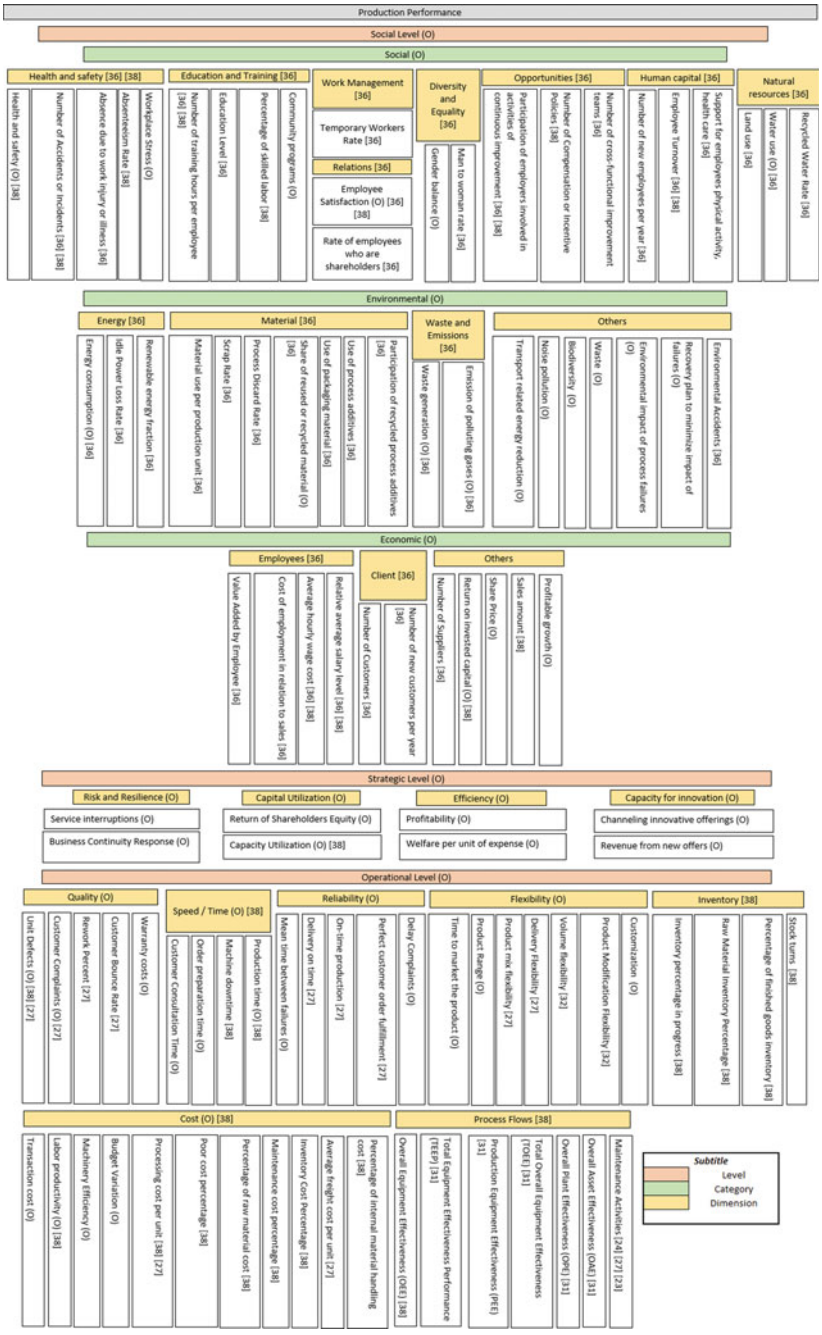


**Fig. 1** Social, strategic and operational performance measures. *Source* Research Data

decision making. The Balanced Scorecard (BSC) approach crosses the strategic and operational levels and includes financial performance measures (Slack et al. 2018). The creators of this approach considered four different perspectives for a complete assessment of an organization: financial, customer, internal business processes, and growth (Kaplan and Norton 2000). The BSC is also cited as the methodology of the performance management approach to the interorganizational model (Fenema and Keers 2018).

## 3 Methodological Procedures

This section aims to highlight the methodology used for the development of this research, being subdivided into: (i) methodological framework; (ii) procedures for selecting the Bibliographic Portfolio; (iii) procedures for bibliometric analysis; and (iv) procedures for content analysis.

### *3.1 Methodological Framework*

Regarding the nature of the objective, this research is descriptive because it seeks to describe the characteristics of the articles in the Bibliographic Portfolio with the establishment of relationships between the different levels of production performance evaluation and their categories and dimensions (Gil 2009). The article is still classified as theoretical, that is, it is dedicated to studying theories (Demo 1995) and the data collected in the articles downloaded from Databases are primary data (Richardson 1999).

This study used bibliographic research as a technical procedure and the intervention instrument used is called Knowledge Development Process - Construtivist (ProKnow-C) because it is an internationally recognized methodology and able to build knowledge in researchers on the themes associated with organizational performance assessment (Staedele et al. 2019). And while the ProKnow-C methodology, more specifically in the bibliometrics process, makes use of some statistical operations such as counting and frequency, most of this research focuses on interpretation techniques that seek to describe, decode and translate the understanding of evolution. And current scenario of production performance evaluation and not with the frequency of occurrence of the variables of a given phenomenon, thus characterizing a research with qualitative approach (Maanen 1979).

### 3.2 *Bibliographic Portfolio Selection Procedures*

According to the ProKnow-C methodology, the first step in the Bibliographic Portfolio selection process, defined as Raw Article Database Selection, is structured in Fig. 2.

It can be seen from Fig. 2 that this search process was reduced to only 2 Search Axes (Performance and Production Evaluation) and with specific keywords, joined by the Boolean operator "AND". Using these operators helps to delimit material selection according to the topic to be investigated (Dresch et al. 2019).

The choice of the small number of keywords and the elimination of the keyword adherence testing step is due to the fact that the origin of this research comes from the work of Taylor and Andrew (2009) who identified that the topic Performance Measurement is highlighted as representative in the field of operations management published in the International Journal of Operations and Production Management. Thus, to identify the state of the art on this topic, researchers agree to keep the same topic, without variations, as one of the keywords.

In the next step, Scopus and Web of Science were defined as the databases to search for articles. The choice of these databases among several other available databases is justified in terms of scope and multidisciplinarity. The Scopus database is considered the most comprehensive peer-reviewed literature database, and the Web of Science is a multidisciplinary database that indexes a variety of peer-reviewed journals across diverse fields of knowledge (Dresch et al. 2019). Following, the search itself occurs in the selected databases and the articles resulting from this search are forwarded to the article database filtering process.

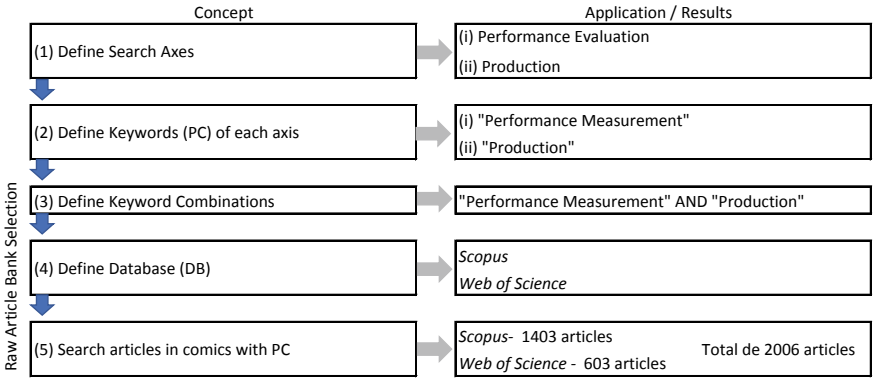


**Fig. 2** Selection of the raw articles database for the production performance assessment bibliographic portfolio. *Source* Research Data

### 3.3 Procedures for Bibliometric Analysis

Bibliometrics consists of statistical analyzes of bibliographic data (Miguel et al. 2018). In ProKnow-C methodology, bibliometric analysis can identify, for example: (i) the degree of relevance of journals; (ii) the scientific recognition of articles; (iii) the degree of relevance of the authors; (iv) the most commonly used keywords and (v) analyze the impact factor (JCR/SRJ) of bibliographic portfolio journals (Bortoluzzi et al. 2011).

### 3.4 Content Analysis Procedures

Content analysis consists of a set of techniques for systematic text analysis (Mayring 2003) and this method will be conducted by the steps suggested by Mayring (2003) and Seuring and Muller (2008), represented in Table 1.

Table 1 shows that the Material Selection matches the 39 articles that make up the Bibliographic Portfolio and that the Descriptive Analysis, suggested by Mayring (2003) and Seuring and Muller (2008), corresponds to Bibliometric Analysis, since the Analysis Descriptive also involves checking the number of publications, most prolific authors, and major journals (Taticchi et al. 2015).

Regarding the selection of categories to meet the objective of identifying which level of assessment (social, strategic, operational) is most addressed among scientific research, the codes used within the MAXQDA Software correspond to the 26 dimensions shown in Fig. 1. It should be mentioned at this point corresponding to the fact that some articles present only the performance measures, without categorization while other works highlight the performance measures already categorized. In the first case, it may happen that several measures are coded within the same dimension, which could distort the results. To do this, the Software's own ability to 'post entries per document only once' is used.

**Table 1** Content analysis steps

| Steps suggested by Mayring (2003) and Seuring and Muller (2008) | Application/occurrence |
|---|---|
| (i) Material selection | 39 articles in the bibliographic portfolio |
| (ii) Descriptive analysis | Same as bibliometric analysis |
| (iii) Category selection | In order to highlight the most addressed assessment levels, the categories (codes) used correspond to the 26 dimensions shown in Fig. 1 |
| (iv) Material evaluation | To highlight the most commonly used evaluation methodologies, categories will be created each time a new method is identified in the analysis process |

*Source* Research Data

Finally, for the last objective, which is to identify which appraisal approaches/techniques are the most used, we chose to insert the code of these techniques, each time it is mentioned in a work. The procedures for the selection of the Bibliographic Portfolio, for Bibliometric Analysis and Content Analysis occur between 08/07/2019 to 31/07/2019.

## 4 Results and Analysis

This chapter highlights the results found for (i) selection of the Bibliographic Portfolio, (ii) Bibliometric Analysis and (iii) Content Analysis.

### *4.1 Bibliographic Portfolio Selection*

From the search in the Scopus and Web of Science databases, 2006 returned raw articles, which were selected for the next stage of the ProKnow-C methodology, called Article Bank Filtering, as shown in Fig. 3.

According to Fig. 3, 436 articles were excluded, based on Filter 1, as they were in duplicate. Regarding Filter 2, which aims to find papers aligned with the purpose of this research, by reading the title, 897 articles did not present alignment and were also

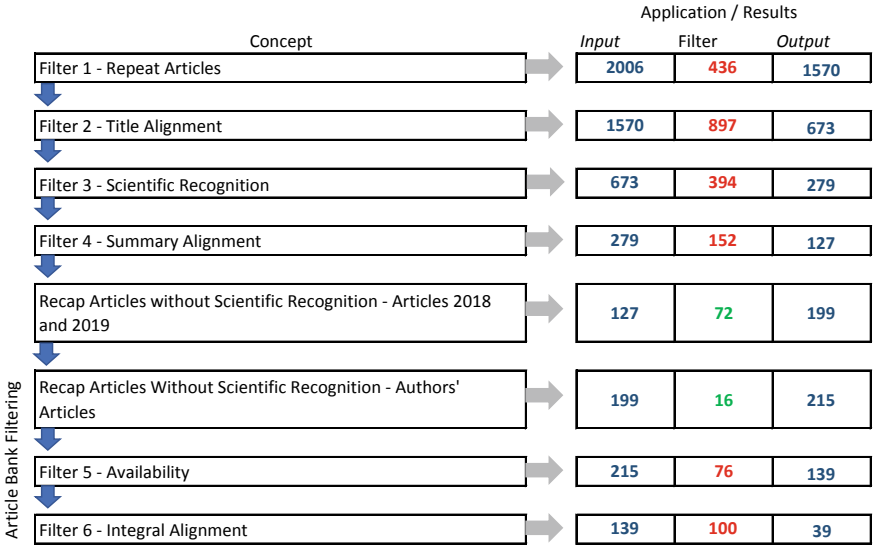


**Fig. 3** Article bank filtering for the production performance assessment bibliographic portfolio. *Source* Research Data

excluded. After these first two steps, there were 673 articles that were scientifically recognized, due to the citations that each work presents in Google Scholar. This enables the research to be carried out in the most representative works on the subject of production performance evaluation. As soon as the citations survey was done, the representativeness cut was defined and occurred in 10 citations, that is, all works with less than 10 citations were eliminated. Thus, in Filter 3, 394 articles representing 3.13% of citations were excluded and the 279 articles that passed the phase represent 96.87% of citations.

Reading the abstract, it was noticed that only 127 articles presented some kind of alignment with the objective of this research and the 152 without alignment were excluded. In the recap stages, 72 articles were added to the process because they were recent articles and 16 articles were also added because they were prepared by authors of the Authors Bank. This made the input data for Filter 5 total 215 articles. However, 76 articles were not available and 100 articles did not present alignment after the full reading of the paper. Thus, the Bibliographic Portfolio was composed of 39 articles.

## *4.2 Bibliometric Analysis*

The bibliometric analysis was performed based on the articles of the Bibliographic Portfolio as well as the References of the Bibliographic Portfolio and evidenced the degree of relevance of the journals, the scientific recognition of the articles and the degree of relevance of the authors. The results are presented in Fig. 4.

Analyzing Fig. 4, it can be seen that there was no congruence in the results, that is, the information extracted from the Bibliographic Portfolio and Bibliographic Portfolio References are different. The most relevant journal in the Bibliographic Portfolio is the International Journal of Production Economics while the International Journal of Operations and Production Management is the most relevant journal in the Bibliographic Portfolio References.

In the articles, Measuring supply chain performance was the most influential article in the Google Scholar Bibliographic Portfolio with 3081 citations and The Changing Basis of Performance Measurement was the featured article in the 5-citation Bibliographic Portfolio References. Both articles were published in the International Journal of Operations and Production Management. The last analysis showed that Stefano Tonchia and Robert Steven Kaplan are the most prolific authors of the Bibliographic Portfolio and References, respectively. Tonchia has been cited 4 times in the Bibliographic Portfolio and Kaplan has been cited 39 times in References. The negative highlight is that the articles relevant to the production performance appraisal theme identified earlier were not written by these authors.

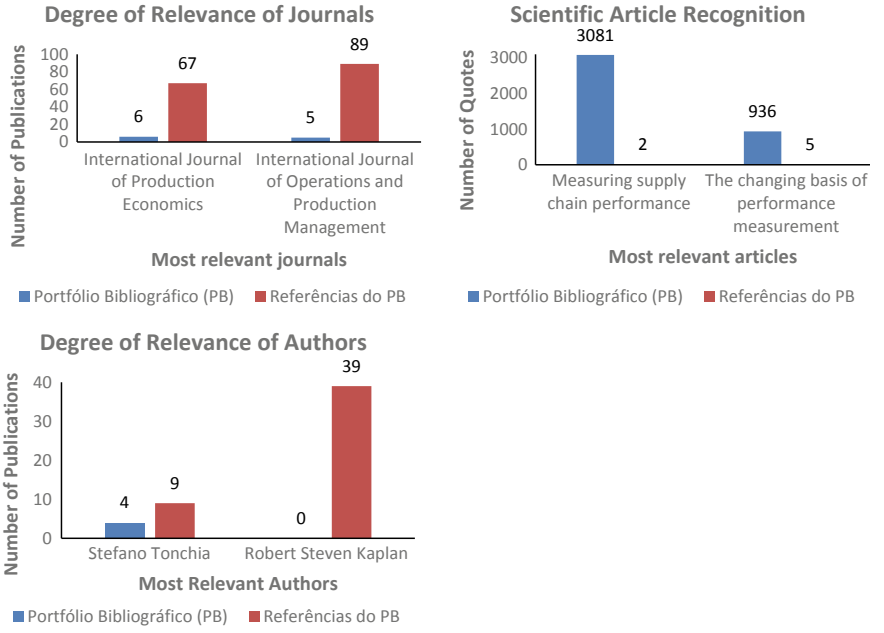


**Fig. 4** Bibliometric analysis panel for the degree of relevance of journals, scientific recognition of articles and degree of relevance of authors. *Source* Research Data

## *4.3 Content Analysis*

The results to identify which level of assessment (social, strategic, operational) is most addressed is shown in Table 2. The 26 codes were coded 132 times.

As shown in Table 2, the level of evaluation that most appears in the articles of the Bibliographic Portfolio is the Operational with 20 papers that presented 65 codings, followed by the Social Level with 59 codings and searched in 7 articles. Articles not shown in Table 2 were not coded for the assessment levels. In terms of time analysis, the first work to address Social Level performance measures is 2007 and in 2016 virtually all dimensions of that level were detailed, more specifically in Article 35. It is further noted that after 2010 the work that assessing social, environmental and economic impact (social-level categories) began to appear more frequently and converging with the results of the literature review on sustainability measurement by Mura et al. (2018).

Table 2 also shows that most works on production performance appraisal take an individualized approach, that is, they address more deeply only one of the levels: social, strategic or operational. Among the few studies that study performance measures at the three levels, highlight to article 29 by Tokos et al. (2012) who proposed a methodology for integrated performance assessment for breweries and article 32 by Bhatti et al. (2014) who explored key performance indicators in

**Table 2** Evaluation level for each bibliographic portfolio article.

| Article No. | Year of publication | Number of occurrences for each evaluation level | | | Prevalent level of assessment |
|---|---|---|---|---|---|
| | | Social | Strategic | Operational | |
| 1 | 1995 | 0 | 0 | 4 | Operational |
| 3 | 1996 | 0 | 0 | 5 | Operational |
| 4 | 1996 | 2 | 0 | 2 | – |
| 5 | 1996 | 0 | 0 | 2 | Operational |
| 7 | 1999 | 0 | 1 | 6 | Operational |
| 11 | 2001 | 0 | 0 | 4 | Operational |
| 13 | 2003 | 1 | 1 | 4 | Operational |
| 14 | 2004 | 0 | 1 | 4 | Operational |
| 17 | 2006 | 0 | 0 | 1 | Operational |
| 20 | 2007 | 7 | 0 | 0 | Social |
| 21 | 2008 | 0 | 0 | 1 | Operational |
| 22 | 2009 | 0 | 0 | 1 | Operational |
| 23 | 2009 | 0 | 1 | 3 | Operational |
| 24 | 2011 | 0 | 0 | 1 | Operational |
| 25 | 2011 | 1 | 1 | 2 | Operational |
| 26 | 2011 | 0 | 0 | 1 | Operational |
| 27 | 2012 | 2 | 0 | 0 | Social |
| 28 | 2012 | 6 | 0 | 0 | Social |
| 29 | 2012 | 2 | 1 | 5 | Operational |
| 30 | 2013 | 0 | 0 | 1 | Operational |
| 31 | 2014 | 4 | 0 | 5 | Operational |
| 32 | 2015 | 2 | 1 | 3 | Operational |
| 33 | 2015 | 0 | 0 | 4 | Operational |
| 34 | 2016 | 8 | 0 | 0 | Social |
| 35 | 2016 | 14 | 0 | 0 | Social |
| 37 | 2018 | 3 | 1 | 6 | Operational |
| 38 | 2018 | 5 | 0 | 0 | Social |
| 39 | 2019 | 2 | 0 | 0 | Social |
| Total | | 59 | 8 | 65 | Operational |

*Source* Research Data

Pakistan's manufacturing sector. This shows that companies have not yet reached the maturity level suggested in the studies by Beer and Micheli (2018).

In terms of dimensions: for the social level the most frequent dimensions are Energy, Waste and Emissions and Education and Training (7 occurrences) followed by the Health and Safety dimension (6 occurrences). The large occurrence of the

Waste and Emissions dimension is congruent with the findings by Mura et al. (2018). At the strategic level the most cited dimensions are Efficiency and Innovation Capacity. Finally, at the operational level, the Quality with 14 occurrences dimension is highlighted, followed by the Reliability with 12 occurrences dimension.

Regarding the division between practical and theoretical research, there is a predominance of studies with operational-level performance measures in practical research and a predominance of studies with social-level performance measures in theoretical research. However, while operational-level studies remain constant, both in practice and in theory, social-level studies are evolving, especially in the theoretical field.

The fact that scientific research is more focused at the operational level means that companies and academia as a whole are concerned with delivering potential for better services and products, in a way to deliver their services and products faster by creating New services and products, in a wider variety and with different volumes and delivery dates, and always aim for a low cost, even if the organization does not compete directly on price.

Regarding the most used methodologies in this production evaluation process, the following tools were highlighted: POA, IMAQE-Food, IPMS, QMPMS, IP2MS, BSC, PMQ and SMART. The most widely used methodology that matches the literature is the BSC.

## 5 Final Considerations

This study aimed to identify, through a systematic literature review, which level of assessment (social, strategic, operational) prevails among scientific research and which evaluation methodology is most used. With a bibliographic portfolio of 39 articles, we identified as relevant the journal International Journal of Production Economics; Measuring supply chain performance was the most influential article and Stefano Tonchia and Robert Steven Kaplan the most prolific authors.

The 26 dimensions used as a parameter for coding in the MAXQDA returned 132 occurrences, of which 59 are related to the Social Level and 65 occurrences are related to the Operational Level, which was evidenced in 20 studies, thus concluding that research on production performance evaluation address Operational Level performance measures. However, in terms of temporal analysis, there was a strong evolution of the Social Level, encompassing the term Environment and which in 2016 was addressed in almost all dimensions detailed in this research. In agreement with the literature, the BSC methodology is the most used.

The challenge of integrating social, environmental and financial impacts in the decision-making of day-to-day management is related to the various tensions between these goals, such as: decentralization, employee empowerment, cooperation, clear, measurable and short-term metrics in opposition socioenvironmental measures, surrounded by uncertainty and long-term, the dilemma of profit versus socioenvironmental performance caused by competitors' prices, scarcity of resources or

sustainable consumption, among others. For this challenge, a solution found in the study by Epstein et al. (2015), is that the simultaneous management of social, environmental and financial performance occurs when managers recognize the financial value of stakeholder reactions to social and environmental performance, creatively use technology and innovation to overcome "win–win" scenarios-lose" and develop organizational values that support reasoning and long-term decision-making, with an emphasis on cross-functional work across company sectors, to do the right thing and find compensation in another department.

The present study has as limitations: the databases defined in the article selection process and the reduced number of keywords. Suggestions for further research involve performance measures themselves, where other work may focus on highlighting the highest number of performance indicators at each level, or exploring more closely one level and extracting more information such as For example, the most widely used branches of activity as a basis for empirical research and even a deepening of the reasons why companies pay more attention to the operational and social level over the strategic level.

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# Rufina Beach and Sustainable Development: The Role of Women in Mucajaí, RR, Brazil

**Ana Sibelonia Saldanha Veras, Diogo Guedes Vidal, Maria Alzira Pimenta Dinis, and Nelson Azevedo Barros**

## 1 Introduction

Due to its immense forest, geomorphology, landscape, drainage of rivers and their tributaries, the volume of freshwater and the relevance of all in the life of the populations, the Amazon region has a significant importance for the environmental balance of the world (Divino and Mc Alleer 2009; Fechine 2008). In addition to environmental wealth, there is a cultural diversity such as rubber tappers, chestnut trees, farmers, ranchers, rural workers, who, living in a remote area, far from contemporary living standards and dominated by technology, seek to live a life within a specific reality (Rodrigues et al. 2015; Zanetti et al. 2018), arousing the interest of many to know this region. In this territory, Legal Amazon represents 60% of the land, which includes heterogeneous environments and various forms of land use of citizens who inhabit the states of Acre, Amazonas, Amapá, northern Mato Grosso, Pará, Tocantins, Rondonia, Roraima part of Maranhão.

Located in the Amazon, the state of Roraima has a territorial extension of 224,273.831 km$^2$ with 605.761 inhabitants (IBGE 2019), corresponding to a low population density of 2.7 inhabitants/km$^2$. This portion represents only 0.0026%

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of the Brazil total area, concentrating 0.29% of the national population. Due to its distance from the country's main economic and political centres, to the lack of public investments and the difficulties imposed by environmental conditions, much of this territory lacks basic infrastructures and internet connection, which undermine the possibility to develop professional tourism and to take advantage of abundant water resources (Souza et al. 2019).

The municipality of Mucajaí was created by Federal Law no. 7,009 on July 1, 1982. In its genesis are families of north-eastern emigrants that moved to region in 1951, initially called the Fernando Costa agricultural colony, and currently corresponding to a population of 14,792 people, that lives close to Mucajaí River (IBGE 2019). Among the natural resources of the region, water is widely used in tourism in the Northern Amazon, specifically in Mucajaí, RR, Brazil. There is a symbiotic relationship between the human being and the fluvial ecosystem, comprised by the streams, lakes and rivers. Being used for the sustenance and leisure of local populations, the commitment to environmental safeguarding lies not only in public managers, but also in citizens and visitors.

Recently widespread in Brazil, geotourism is therefore considered the cornerstone for the practice of sustainability (Beretić et al. 2019) through geological heritage giving rise to many springs of perennial waters, rivers and lakes. In addition, it values the local culture, integrating it into the tourist practices of the region and making local populations active in this process. The freshwater resource is good for the worthy citizen and promoter of sustainable local development.

With the establishment of the Sustainable Development Goals (SDGs) as global targets adopted during the 2015 United Nations Conference on Sustainable Development (United Nations General Assembly 2015; Vidal 2019), poverty eradication, SDG 1, and hunger, SDG 2, are aligned, aiming to improve health, SDG 3, and education, SDG 4, achieve gender equality, SDG 5, promoting inclusive and promote sustainable economic growth, SDG 8, making cities more sustainable, SDG 11, and combating and protecting oceans and forests, SDG 14. SDGs are key elements for a fairer, more equitable and sustainable society, more specifically for a more dignified and integrating secure environment, also addressing social responsibility.

SDGs are challenges for all citizens of the planet in their search for sustainable and resilient solutions in everyday life and institutions, playing a key role in the environmental sphere, given the growing ecological interdependence and strengthening the role of citizens facing inequalities. The environmental debate is indispensable in the Agenda 21, with the objective to promote collective actions in favour of the socioeconomic, political and environmental areas. It is extremely important for the Brazilian reality to adopt SDGs as references for the implementation of a development model with a strong focus on ecosystem conservation, so as to ensure the sustainable and legal use of finite resources (ONUBR 2018), creating oportunities of social responsibility and sustainability.

The World Tourism Organization (WTO) highlights sustainable tourism as a form of resource management in which the economic, social needs and physical characteristics of attractions can be met, while maintaining cultural integrity, essential

ecological processes, biological diversity and sustainable systems life support as climate (Butler 1999; Hall 2019; Higgins-Desbiolles 2017; UNWTO 2007).

The objective of this research is to describe the actions experienced by women in geotourism and the possibilities of geotourism practices, anchored in SDGs, in the region with low population density in Mucajaí, RR, Brazil.

## 2 Sustainable Geotourism Activity and Its Interfaces

Throughout history, tourism is not just an object of leisure exercise, but of scientific and social experience, and of citizens integration. Thus, it is possible to emphasize that geotourism allows a greater contact with the local ecosystem where it is possible to understand the importance of the environment and its conservation, as well as its dynamics. This connection is made by residents who create and recreate the local culture.

With emphasis on geological and geomorphological aspects, geotourism has emerged with significant emphasis since the 1990s due to the need to value geodiversity and consider indigenous populations as holders of local knowledge and contributing to the discovery of places. However, geotourism is not yet recognized as a segment in Brazil (Brandão 2019). This activity, defined as tourism practiced in natural areas, explores geology for understanding the Earth Sciences, using the landscape from the discerning of geosites, and must fundamentally include the citizens (Hose 1995).

In line with the SDGs, tourism must be able to meet the needs of the present without compromising the future generations. In this sense, sustainability is represented by the modern concept consisting of three pillars or dimensions: economic, environmental and social (Šušić and Dordević 2019). Given these basic principles, the socioeconomic benefits of tourism represent an important source of income, in addition of generating jobs (Dogra 2019; Halisçelik and Soytas 2019). Therefore, tourism is seen as ecologically sustainable and economically viable activity in the long run, as well as providing an equitable social ethics for local communities. The social dimension, as example, includes the women who, mastering specific activities, apply skills and reiterate the important status towards liberation and visibility of this gender. At this regard, it is important to refer to the skills of women in rural Amazon (Bühler and Souza 2011; Furtado 2019; Dogra 2019) who felt the need to take advantage of the abundant and finite resources that are available in the scope of tourism, increasing their participation to complement family income, assimilating tourism activities, and playing a relevant role in terms of social responsibility and overall environmental sustainability.

## 3 Women's Sorority and River Wisdom

The Amazon biome has gained attention and greater relevance due to its high cultural and biological richness, materialized in finite water resources, representing the largest and most preserved region of tropical vegetation (BNDES 2010). Many citizens survive on agriculture and complement their activities with tourism, with rivers being used as indispensable resources, limited by natural cycles. This region is characterized by a very peculiar climatic variability, with natural watercourses presenting a regular annual cycle of high-water levels, known as floods, and, very low-water levels in the dry season, also known as weather drought or hydrological drought (Almudi 2019).

In the context of touristic activities, a number of citizens' initiatives are driven by water cycles, also including the beaches for leisure, and this environmental dimension is in favour of experienced residents. In these Amazonian waters of great importance, surrounded by forests of various shades of green colours, biodiversity is vigorous and gigantic, interspersed with streams where curiosities and stories of fishermen are expressed with such realism that are believed to be true (Pojo et al. 2014). These initiatives of unity for the benefit and conservation of nature are triggered by women of north-eastern origin, demonstrating, through the preparation of regional fish-based dishes, handling and confection of fibre and seed crafts from the region, their skills and close connections with the natural water cycle (Simonetti 2015).

## 4 Materials and Methods

The adopted methodology sought to describe and value the interpretation of natural environments and the different social practices of the local Amazon community in Mucajaí, RR, Brazil, being the object of study the geotourism and the role of women in the conduction of tourist activities (Lohmann and Panosso Netto 2012), an opportunity to contribute to local sustainability in this region.

## 5 Study Area

Mucajaí is in the middle of the Northern Amazon, in the state of Roraima, Brazil. It is located at a distance of 51 km from Boa Vista (capital), having an altitude of 70 m above the sea level. Its access is made by highway BR-174 towards the south. The geographical dimension is about 12,351.341 $km^2$, housing non-Indian and indigenous populations in the Yanomami Indigenous Land in the portion of the immense Roraima-Flona National Forest; Arboreal savanna or thick field of thin physiognomy and Savannah graminosa. The climate of the region is, according to Köppen's classification (Geiger 1954), as rainy tropical, from "Ami" type (Barbosa

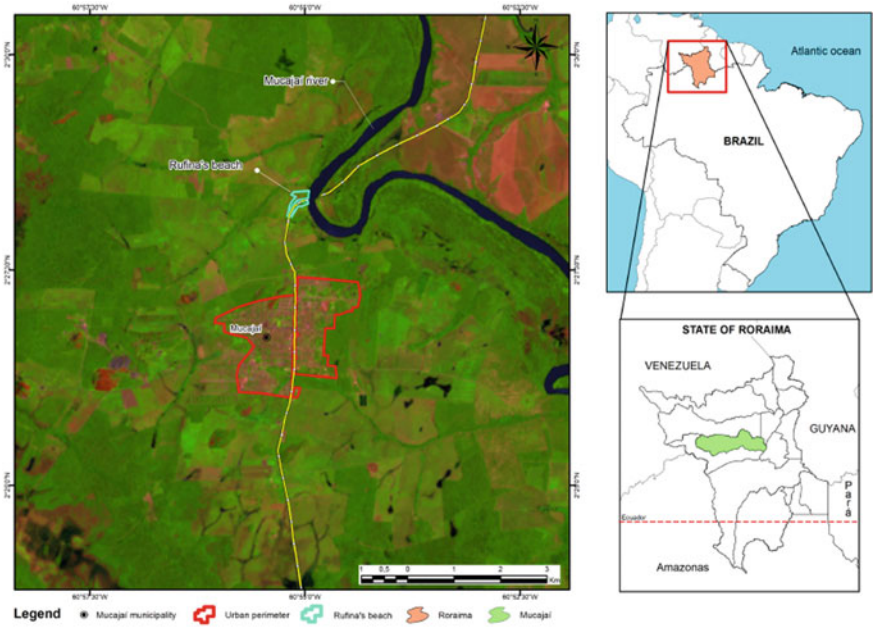


**Fig. 1** Location of Mucajaí, RR, Brazil. Mucajaí, RR, is highlighted in red. In blue, the beach of Rufina on Rio Mucajaí. Author: Victor Viriato Maia. Cartographic base of the state of Roraima of a scale of 1:100,000 provided by the Brazilian Institute of Geography and Statistics (IBGE)

1997), with temperature varying between 28 and 38 °C. The Centre/East region has water deficits around 3–5 months with reduced rainfall. As for the drainage of the municipality, the river basin is composed of the Rio Branco tributaries, with the Couto de Magalhães, Catrimani, Apiaú and Mucajaí rivers to the north (IBGE 2019). The geographical location of the survey area is shown in Fig. 1.

## 6 Fieldwork

Fieldwork, an essential component of geography, was chosen as the research methodology. Accordingly, the applied methods were based in informal interviews, direct observation, participation in the life of the group, collective discussions and self-analysis, as suggested by Groh (2018). Anchored in a qualitative approach, the visits to the region were accompanied by a historian and members of the Association of Rural Women Workers of the Municipality of Mucajaí, RR. The main objective was to know the reality of the activities developed by the women in this region of Mucajaí, RR, Brazil. The contact with the region occurred in part by land walk and in part by canoe, following the most used routes and tours. With the oral support of local women and capturing images of freshwater environments, the visits allowed

describing the reality and social and cultural practices of the region. In addition to this approach, this research has a strong ethnographic component, justified by the integration of the researcher in the community. Due to this methodological option, four types of field notes were taken in four different domains: job notes, namely some keywords or expressions written during the visit to the field area; field notes, which are complete and descriptive notes about the physical context and people involved, namely relating behaviour and types of communication; methodological notes, consisting in new ideas that have emerged during the visit and that will be applied in future visits; and, finally, journals and diaries, where the researcher records all the events, such as rituals, socialization and oral histories.

## 7 Results and Discussion

### *7.1 Rural Women Workers of Mucajaí, RR*

From the need to strengthen environmental causes, ecological preservation, support for educational services, movements for the protection of religious minorities, feminists, advocates of ethnic, cultural, academic causes, neighbourhood associations and community organizations, the Association of Rural Women Workers of the Municipality of Mucajaí, RR was created. Its main beneficiary is the local population, thus having a fundamental role in terms of social responsibility and sustainability. It is important to note that this Association makes use of the possibilities offered by law to guarantee the exercise of citizenship, consequently, contributing to the sustainable use of environmental resources and overall sustainability. In line with what the SDGs advocate, based on the principles of internalizing, disseminating and giving transparency to local agendas, the same Association provides opportunities for social groups interested in leisure activities, folkloric and carnival events, and artistic segments, aiming to broaden experiences at the local level, both in terms of professional activities and income. Currently in Mucajaí, RR, Brazil, there are three associations that together can carry out various activities to bring people from nearby municipalities. This is also due to women's advancements in strengthening positive experiences, spreading the importance of local agendas towards poverty eradication, a very important subject in this region, since there is a reduced dependence on aid from the municipality. It is about repositioning the place of women in this region, in areas where men were at the centre as the main element for exercising the activity of tourism.

## 8 The Contribution of Fish Gastronomy

Women work in food preparation using natural ingredients free of pesticides, mastering the typical regional cuisine, and this is an important point, especially in the preparation of native fish dishes marketed to visitors such as stew, marinade, fish fried fish, fish bait and roast fish *tambaqui* (*colossoma macropomum*), *matrinxã* (*brycon cephalus*), *piau* (*leporinis obtusidens cantares*). Therefore, fish enters the diet which is mostly served to visitors, followed by poultry, such as regional chicken.

## 9 The Importance of Boating

The boat rides or canoes last for one hour and are a time for contemplation of flora and fauna. In some points of the river, there are stops for the visitor to interact with locals and local culture, and the information passed to the visitors derive from the reading of nature developed by women, presenting the enigmatic and the exuberance of the scenarios. The care with the environment is highlighted, and it is also related with the accumulation of waste by visitors, or even by the residents, who are advised to transport generated waste, after the visit, for proper disposal. These tours are considered one of the greatest experiences in nature, where care occurs in favour of the preservation of water resources.

Freshwater beaches provide spaces for recreation, such as bathing, water sports and sustainable activities. The canoes made of wood do not impact the waters, an example of the care with nature.

All these activities contribute to instigate social responsibility in citizens, and that the same time, contribute to overall sustainability in this specific region.

## 10 Rufina Beach and Its History

The name Rufina originates from the story of a legend that occurred in the region with the disappearance of a woman that used to go to the river to fish:

> This beautiful woman, whose name was Maria Rufina decided on a beautiful sunny day, to go fishing with her two sons and her husband, but suddenly the family split to go looking for bigger fish and Maria Rufina was feeling tired and decided to take a nap in the sand, trying not to lose the fishing tied by the line of the hook in one of her legs and slept. Maria Rufina's idea was good, but it failed in one detail: she did not wake up and a very large fish dragged her into the depths of the river. When her children and husband returned, they did not find her, only finding a Lord of the World who owned a straw house near the river, who soon said: I do not know what happened, but I heard some shouts to that side and when I watched there was no one. And no one ever heard from Maria Rufina again despite the extense search.

To this day, the region is known as Rufina Beach and Rufina Lake. The legend says that the woman Maria Rufina, did not allow her family, children and husband,

to fish small fish, still very young. Instead, it directed them to return small fish to the water and to remove the hook to catch big fish (Silva 2007), a sustainable attitude related to the protection of the natural space, aiming at minimal impact in nature, and water biodiversity, in particular. The story of Maria Rufina feeds the imagination of visitors who are encouraged by residents to go to the beach in order to stay in touch with the story. It is a region rich in fish and typical white sands of moon gazing around bonfires and many stories of fishermen and legends, much appreciated in the Amazon, Mucajaí, RR, Brazil. It contributes to involve families in providing tourist services, as well as in the distribution of benefits to the residents in dealing with the visitors and having sustainable attitudes for the preservation of freshwater environments, and consequently a sustainable geotourism, contributing to reach the SDG goals (Fig. 2).


**Fig. 2** **a** The Mucajaí river in its largest bed and anchoring a sightseeing boat. **b** Mucajaí River panorama in its flood period providing Rufina Beach leisure environment and object of the Legend of Rufina. **c** Side of the ravine stopping boat for sightseeing

## 11 Sustainable Experiences Adopted in the Fresh Waters of Rufina Beach

Positive initiatives ensure environmental conservation, allowing a harmonious coexistence with the citizens. It is possible to highlight the use of rowing canoes, equipment made of wood from the region, the use of water and the beach used by small groups of people held on the night moon and the stars, during full moon nights with jokes and chants, thus reducing the impact on the environment, thus contributing to environmental sustainability. The waste produced by groups of people during the tours are brought by each visitor. Sensitivity attitudes occur with the handling of the flora, with no vegetable being cut down or burnt and not allowing to take anything from nature. The integration of deforestation and burn prevention actions are important. The absence of children and/or adolescents in tourist activities contribute to this care with the environment. The emphasis given to the use of the rest of the wood when falling naturally, as is the case of seeds and woods, and used in the construction of handicraft pieces, are all important aspects of these geotourism activities, and important social responsibility actions.

## 12 Final Considerations and Future Directions

Reflecting on the SDGs, with regard to specific SDGs 1, 2, 3, 4, 5, 8, 11 and 14, small actions and attitudes of citizens, aiming to preserve the environment can be observed in the Mucajaí, RR, Brazil region studied, although not yet fully implemented. Environmental issues, responsibility and commitment to the preservation of geotourism, are presented in this text as an alternative in favour of nature and environmental promotion.

This municipality has historically registered a high number of important activities made by females, symbolizing that women are supported and well accepted in executive work and, more recently, also in the tourism sector. These characteristics demonstrate the projection of women as full citizens in comparison with men in conducting tourist activities and dealing with nature in environmental conservation. Thus, with regard to the tourism services in Mucajaí, women also act in this sector with dedication and great responsibility in the face of nature and in terms of a relevant social role, intending to provide income to families.

Despite the obvious limitations regarding the women's role in society, the actions developed need to be improved to ensure the progress of all women living in the Amazon. Government is still the largest investor in capacity building and dissemination, exploiting the high potentials available in forests and wetlands that need to be preserved for humanity, and women may actively contribute to assist local authorities in a more equal society, playing an essential role in terms of social responsibility and sustainable development. A financial stimulus, with proper planning and technical

guidance for small businesses, will boost the entire geotourism production chain, thus contributing to the overall sustainable development.

In terms of future research, it is important to have in consideration that this activity is conducted by women that have a powerful connection with the environment, thus a more in deep research on the women's role in the leadership of entrepreneurship activities should be carried out. These activities are related with the destination of non-biodegradable waste, such as plastics generated by the activities and by the community's own residents, that currently happens in a fragmented and isolated way. Future research should also integrate major issues, addressing the environmental impacts of such activities, in order to develop sustainable strategies based in social responsibility, along with a sociographic study of these women and their understanding about sustainability in living environment. Being this the last decade to achieve the sustainable development goals, geotourism must be seen as a socially responsible way to balance wanderlust and preservation of fragile areas such as in Mucajaí, RR, Brazil.

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# The Role of Regional Administration on the Promotion of Social Responsibility Practices: A Case Study in the Amazon Region


**Maria do Perpétuo Socorro Lamego Oliveira, Evailton Arantes de Oliveira, and Ana Margarida Fonseca**

## 1 Introduction

In a society that is increasingly intolerant to unsustainable practices, companies adopt Social Responsibility (SR) to enhance their commitment and contribution regarding sustainability issues. The general public is highly aware of the need to change behaviours to promote environmental and social sustainability, and stakeholders are pressuring companies to integrate these concepts in their practices and management models.

The responsibility of corporations regarding their multiple stakeholders is supported by the Stakeholder Theory (Freeman 1984), defending that sustainable success depends on the satisfaction of stakeholders' needs and expectations. Business strategies that promote the creation of shared value for the organization and its stakeholders have proven to be relevant success factors (Porter and Kramer 2011; Strand et al. 2015).

The adoption of SR strategies leads to the conscious planning and execution of activities, decreases negative impacts and promotes positive interactions, in short-, medium-, and long-term scenarios. The implementation of SR programmes is becoming common practice in organizations at a global level, with several associated benefits: the efficient use of resources leads to cost reductions; competitive

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advantages are obtained through improved public image and reputation; pollution prevention and waste reduction have beneficial impacts both at the local and global scales; SR leads to organizational improvements, namely increased productivity, enhancement of innovation skills, and more efficient communication processes; the promotion of active changes in behaviours and practices has relevant impacts both at internal levels as well as throughout the value chain (Lozano 2015; Sukitsch et al. 2015; Baumgartner and Rauter 2017; Martinez-Conesa et al. 2017).

In 2015 the General Assembly of the United Nations defined 17 Sustainable Development Goals (SDGs) addressing social and environmental challenges currently faced by humanity. In the pathway to achieve the SDGs, deep transformations are necessary in all society levels and activity sectors, and this will require complementary actions by governments, civil society, academia, and business companies (Scheyvens et al. 2016; Leal Filho et al. 2017; Sachs et al. 2019).

To enhance a valid contribution of companies towards Sustainable Development, adequate guidance, regulations and surveillance from governments and public administration are widely important, as recognized in the literature review described in the following section of this paper. The questions that the present study aims to answer are:

- In the context of a developing country with a growing economy (Brazil), how effective are surveillance plans implemented by local administration bodies in the prevention of inadequate practices regarding Sustainable Development?
- In this context, how can local administration bodies effectively promote sustainability-oriented practices among professionals and companies?

As a contribution to answering these questions, the present paper describes a research study on the activities of a local administration body operating in the Brazilian Amazon region—the Regional Council of Engineering and Agronomy of Amazonas (CREA-AM), focusing on environmental surveillance and promotion of adequate sustainability practices. The analysis of administrative processes on detected environmental irregularities, in 2017 and 2018, enables the identification of the most frequent procedures/actions performed by engineering and technical professionals that cause damage to the environment. Through this analysis, improvement opportunities were identified, resulting in the proposal of new procedures regarding environmental inspection and surveillance in CREA-AM, to be implemented in 2021 and 2022.

The results of the present study are expected to contribute to raise awareness of companies and professionals operating in the Amazon region on the importance of adequately planning and executing their activities to reduce negative environmental impacts, and therefore contribute to the preservation of this internationally important region of the globe. It is also expected that the improvement opportunities identified, and the new procedures proposed, can be useful to other local administration bodies with responsibilities in environmental inspection and surveillance, thus contributing to a wider promotion of sustainability-oriented practices.

In the following section of this paper a literature review will be presented regarding the impacts of government policies on the promotion of Social Responsibility practices. Special attention will be given to the construction industry, which was found to be responsible for the main inadequate environmental practices under the scope of CREA-AM surveillance. A detailed description of CREA-AM, its responsibilities and scope of action, will be presented in the subsequent section, followed by the description of the methodology used and the analysis of the results obtained. The conclusions' section ends the paper.

## 2 Government Policies and the Promotion of Corporate Social Responsibility

Society increasingly expects the integration of corporate social responsibility in corporate governance, based on the premise that in all businesses it is company's responsibility to meet social and environmental expectations, since profit-focused corporate governance is leading to the destruction of the environment and the planet (Aluchna and Roszkowska-Menkes 2019). Local government actions are essential to create social and environmental responsibility in what concerns the achievement of low carbon targets, and local government leaders are successful in creating innovations in environmental policies (Ming et al. 2020). Local governments' policies regarding social and environmental responsibility must be aligned with local economic development (Yu and Huang 2020), therefore a careful assessment of the economic and environmental contexts of local governments must be done before implementing environmental sustainability policies.

The disorderly economic growth of developing countries leads to environmental degradation, and it is fundamental for governments to create incentives, new policies and rules in order to raise awareness on the importance of corporate social responsibility in macro and microeconomic growth environments. The dissemination of knowledge through lectures, seminars and courses, and the encouragement of innovation in new business models integrating corporate social responsibility and environmental responsibility, are key to the sustainable development of growing countries (Bradley et al. 2020). For example, the energy exploitation of coal in Colombia faces a series of social and economic pressures, at the national and international levels, to meet environmental and social goals. A study focusing energy transition and natural resources governance in this Colombian activity sector showed that discursive policies between government officials and coal companies had the greatest influence on political strategies (Strambo et al. 2020). According to this study, the discursive policies were important to make companies aware of their responsibilities to society and the planet, as their managerial focus cannot be solely on financial profits, regardless of the health of their employees and of the environmental impacts of the companies' activities (Strambo et al. 2020).

Governments and public administration can enhance sustainability-oriented behaviours in business companies through policies, regulations and guidance, either providing incentives or charging penalties. Several studies can be found in the literature focusing the relation between governmental policies and corporate social responsibility. According to Mahmoudi and Rasti-Barzoki (2018), in the Indian textile industry the most effective government approach to minimize negative environmental impacts is to impose tariffs. In what concerns construction industry, specific incentive policies, defined by the government, have proven to be effective in the enhancement of sustainable construction practices (Xia et al. 2018; Zhang et al. 2019). A research study conducted in medium and large manufacturing plants in Pakistan concluded that government oversight of the role of corporate social responsibility is essential for companies to achieve satisfactory levels of environmental performance (Abbas 2020). A survey of three energy companies in Denmark showed the need for companies that directly affect the environment to be involved in climate mitigation activities, responding positively to climate change challenges, and meeting government goals set by the Paris Agreement (Toft and Rudiger 2020). According to this study, it is up to government agencies to support compliance with these companies' environmental responsibility and corporate social responsibility actions, so that all environmental and social objectives are met (Toft and Rudiger 2020). Cao et al. (2020) describe the policy of laws and regulations implemented by the Chinese government regarding remanufacturing industries, and recognize its essential role on the supervision of corporate environmental and social responsibilities regarding the increasing industrial waste production. China's policy regarding this subject is having positive and beneficial effects, such as increasing the annual value of remanufacturing production (Cao et al. 2020). The same research study concludes that remanufacturing goals can only be achieved with public awareness and participation from everyone, business and citizens, but environmental actions aimed at recycling and reusing waste need government support, resources and supervision.

The construction sector has a paradoxical relation with social responsibility (Xia et al. 2018): positive social impacts are undeniable due to the effects of the built environment on the wellbeing of communities; but, on the other hand, construction activities are harmful to the environment due to the intensive consumption of energy and resources, and generation of large amounts of waste; also, construction industry generates a large amount of employment, contemplating both skilled and non-skilled workers, thus proving important means of survival to lower social classes; but, on the other hand, since construction activities are generally labour intensive, construction workers are highly exposed to accidents and negative occupational health impacts. Social and environmental responsibility in the construction sector needs governmental incentives and regulation regarding the use of clean energy, the pursuit of energy reduction goals, low carbon targets and environmental conservation (Wen et al. 2020).

New global trends in technological development, such as Industry 4.0, artificial intelligence and emerging markets, including exploration of outer space through space companies, show clearly that a global trend of interconnection between companies needs to go side by side with the development of policy innovations regarding

corporate social and environmental responsibility (Robinson and Mazzucato 2019), under penalty of serious irreparable ethical and environmental damage affecting society and the planet in a near future. These evolutions and revolutions are opening a window to the discussion of new corporate social and environmental responsibility policies that should be implemented as soon as possible. Governments should encourage these new corporate social and environmental responsibility policies and set limits to the development of technological developments when they overcome ethical and moral barriers that harm society and mankind.

## 3 The Regional Council of Engineering and Agronomy of Amazonas (CREA-AM)

CREA-AM is located in the city of Manaus, Amazonas, Brazil, in the center of the Amazon Rainforest, on the right bank of the Rio Negro.

The history of CREA-AM began in a growth phase of the city of Manaus, due to the expansion of technological sectors and the emergence of the Free Zone. This new economic moment in the Amazonian capital introduced several challenges, mainly urbanistic, and urban growth required Engineering and Architecture professionals. Supervising all these new technical works and activities was a difficult task, since Amazonas was under the jurisdiction of CREA from Pará (PA). At that time, the Amazon region had approximately 300 registered professionals, who had to travel to Pará to perform bureaucratic procedures such as registrations, annuities, visas and Technical Responsibility Annotations (ARTs). In order to claim regionalization of the system in a structured way, it was legally required to have organized professional bodies. Thus, CREA-AM was created with the support of the Engineering, Architecture and Agronomy entities in the Amazon region, with the aim to assure the qualification of technical professionals to the local labour market. Leading this process were the mechanical engineer Raimundo Lopes Filho, then president of the Association of Engineers and Architects of Amazonas (AEAA), the architect Severiano Mário Porto, who presided at the time the Regional Department of the Institute of Architects of Brazil (IAB) and the engineers Arly Coutinho and Valdyr Brito. According to Brazilian legal records (Ordinance n. 4,773), the responsible inspector was the agronomist José Liberato da Silva, assisted by the engineers Carlos Salustiano de Souza Coelho and Gilberto Ferrer de Carvalho. The implementation of new technology schools and the increase of the specialized workforce, together with the struggle of the professional categories involved, resulted in the creation of the Regional Council of Engineering, Architecture and Agronomy of Amazonas/Roraima (CREA-AM/RR) of the 20th Region, on the 30th August 1974, in accordance with CONFEA Resolution 223. The first president elected was mechanical engineer Raimundo Lopes Filho, and CREA-AM headquarters was officially opened in September 18th 1978.

During the following years, CREA-AM advanced, expanding its actuation areas, both in preventive supervision and professional development. In 2015, this administration body entered a new phase with the informatization of its operating system. Prior to this change, procedures and services were performed manually. With the implementation of the new system, CREA-AM services were made available through the Internet, and processes were informatized, providing greater control, agility, and convenience for professionals, companies or ordinary citizens, both in the capital and in interior regions.

A tax officer is appointed by the Regional Council to act as inspector, housed in the unit in charge of the supervision of CREA. This inspector acts according to the guidelines and specific determinations drawn up and decided by specialized chambers. Among the inspector's responsibilities is the assurance that the works and services related to Engineering, Architecture and Agronomy are being performed in accordance with the regulatory standards of professional practice. In the performance of his duties, the inspector must act rigorously and efficiently so that professional practices covered by CREA-AM occur with the participation of legally qualified professionals. CREA-AM's supervision has the prerogative of avoiding improper practices by technology professionals who work in the Amazon region.

According to the provisions of Brazilian Law n. 5,194 of 1966, it is the responsibility of CREA bodies to verify and supervise the professional practices regulated therein. To fulfil this function, CREA should designate collaborators with powers to draw up notices of violation of the legislator provisions, called tax agents. CREA-AM controls the attributions and functions of engineering and technology professionals through the Technical Responsibility Annotation—ART of each technical work/service performed by the engineering and technology professionals working in the Amazon Region, according to article 34 of Brazilian Laws n. 5,194/66 and n. 6,496 of December 7th, 1977. When an irregularity occurs in an ART, CREA-AM formalizes an administrative process to investigate failures and responsibilities, in order to protect society from improper engineering practices that may cause accidents or damage to those involved (Resolution n. 1,025 of October 30th, 2009). CREA-AM is also responsible to investigate public citizens' complaints regarding inadequate professional activities, and to curb unethical practices from professionals and companies, according to the CREA-AM Ethics Council Guidelines (Resolution n. 1,002 of November 26th, 2002, and Resolution n. 1,004 of June 27th, 2003).

When facing a notification from CREA-AM, professionals and companies may present clarifications and counterarguments in their defence. In the scope of a notification, technical professionals may be penalized by CREA-AM through warnings, fines, or the suspension/hindrance to practice. Companies may also be penalized with warnings, fines and suspension of the licence to perform technical activities and to participate in biddings with the Public and Private Sector.

To dully comply with its surveillance functions, CREA-AM establishes periodic inspection plans. Table 1 shows the CREA-AM Inspection Plan executed in 2017 and 2018, including the actions planned, responsible sectors, implementation period and expected results. The responsible sectors for implementing the CREA-AM Inspection

**Table 1** CREA-AM inspection plan (2017–2018)

| Item | Action to be addressed | Foreseen actions | Responsibilities | Period | Expected outcome |
|---|---|---|---|---|---|
| 1 | Internal inspection | • Official journal (contracts)<br>• ART analysis: verify the declared activities, aiming to detect the need for the registration of complementary activities, possible abusive attribution, or finalization error | SUAFI<br>CEEC | Continuous | Increase ART records |
| 2 | External surveillance use of GIS (geographic information system) | Mapping of sector and neighbourhood actions: mapping will be done through graphs of supervised addresses, and other relevant data for each action taken | ASGEO<br>SUAFI | Continuous | Basis for programming the next financial years |
| 3 | Online complaints | Verify situation on-site, and return communication to the author of the complaint | SUAFI | Continuous | Increase ART records |
| 4 | Detailed inspection of large-scale works | Visit all complementary phases of the work | SUAFI | Continuous | Increase ART records |
| 4.1 | Professionals' surveillance | Normative Decision No. 111/2017 (Critical Analysis of ART), Resolution n. 1090/2017, Paragraph 2 of Art. 5 "CREA shall initiate legal proceedings when facing evidence, by any means at its disposal, including news published in appropriate media, of public misconduct, scandal or defamatory crime" | SUAFI | Continuous | Increase ART records |
| 4.2 | Waste (generation) | Solid waste management plan | SUAFI | Continuous | Increase ART records |
| 4.3 | Prefabricated | Precast concrete (works/manufacturing companies) | SUAFI | Continuous | Increase ART records |
| 4.4 | Survey report/testing | Geotechnical surveys | SUAFI | Continuous | Increase ART records |
| 4.5 | Waste (final destination) | Solid waste treatment and final destination (companies) | SUAFI | Continuous | Increase ART records |

(continued)

**Table 1** (continued)

| Item | Action to be addressed | Foreseen actions | Responsibilities | Period | Expected outcome |
|---|---|---|---|---|---|
| 4.6 | Bids | Budget and basic project—Bids Technical Guideline n. 1/16 of the Brazilian Institute of Public Works Audit "Every element that integrates the basic project must be prepared by a qualified professional, and the registration of the ART is indispensable, identifying the author and author's signature" | SUAFI | Continuous | Increase ART records |
| 4.7 | Justice Forum | Common and criminal justice report | SUAFI | Continuous | Increase ART records |
| 5 | Condominiums | Visit 10 condominiums—maintenance | SUAFI | Continuous | Increase ART records |
| 6 | Companies | Companies specializing in foundations, structures, concrete and asphalt | SUAFI | Continuous | Increase ART records |
| 7 | Cities | Atalaia do Norte, Benjamin Constant, Tonantins, Tabatinga, cities at the Solimões River | SUAFI | Continuous | Increase ART records |

Plan were the Deputy Supervisory Superintendence (SUAFI), the Specialized Civil Engineering Chamber (CEEC) and the Geoprocessing Advisory (ASGEO).

## 4 Materials and Methods

This research was conducted at CREA-AM headquarters, in the city of Manaus, Amazonas, Brazil, through the consultation and analysis of public administrative processes of ART registrations, from January 2017 to December 2018. In 2017, there were 11 companies from the environmental area and 50 environmental professionals registered at CREA-AM. In 2018 the number of registered companies remained the same, but the number of registered professionals raised to 74. The research covered all the physical and digital administrative processes of ART registrations regarding environmental technology professionals and companies operating in the environmental area—202 in 2017 and 541 in 2018—and also the records of administrative notifications regarding inadequate practices—12 in 2017 and 17 in 2018.

In 2015, CREA's Computerized Administrative Processing System (SITAC) was implemented at CREA-AM, and professionals and companies now register their ARTs through the internet in a 100% electronic way. All documents were digitized

and made available for consultation, stored in SITAC database, and all administrative processes are now electronic. To assure transparency, technology professionals and companies have internet access to all the phases of the processes they are involved in.

Since physical paper administrative processes cannot leave CREA-AM, they had to be analysed at CREA-AM's own headquarters, in a suitable room made available for this study. The names of technology professionals and companies have been preserved and kept confidential. The methodology applied to study CREA-AM's administrative processes followed the subsequent steps:

1. All administrative processes in the environmental area were divided into lots I and II, respectively for 2017 and 2018.
2. For each lot the environmental activities involved were identified and catalogued.
3. For each catalogued environmental activity, the potential environmental impacts were studied.
4. For the administrative notifications regarding inadequate practices, the causes were analysed regarding its source and recurrence; it was also registered who was responsible for the failure: the company or the technology professional.

The data collected through the research of the physical and digital processes of CREA-AM were analysed to find the most frequently occurring environmental activities, their potential environmental impacts, and the most frequent inadequate practices identified, in the years 2017 and 2018.

## 5 Results and Discussion

The analysis of CREA-AM's administrative processes revealed that the main registered inadequate practices in the environmental area are the lack of registration in CREA-AM, the illegal exercise of activities, the lack of hired environmental technicians, and the exercise of activities in the environmental area without the respective ART (Fig. 1). The frequent lack of environmental technician reveals that companies are using unskilled workers for the performance of activities in the environmental area, with consequent risks to the environment that could cause serious damage to the Amazon Forest. In what concerns failures in adequate registration of companies in CREA-AM, Fig. 1 shows that the numbers increased a 100% from 2017 to 2018. This can be explained by the economic crisis that led many professionals to open waste collection companies without being technically and legally qualified to operate in this sector.

The analysis of the ARTs registered in CREA-AM in the environmental area, in 2017 and 2018, showed that the most frequent activities performed by environmental technical professionals include waste collection, waste transportation, waste disposal, waste treatment, environmental monitoring, environmental management and planning, remediation of degraded areas, environmental impact studies, environmental licensing and environmental impact assessment.

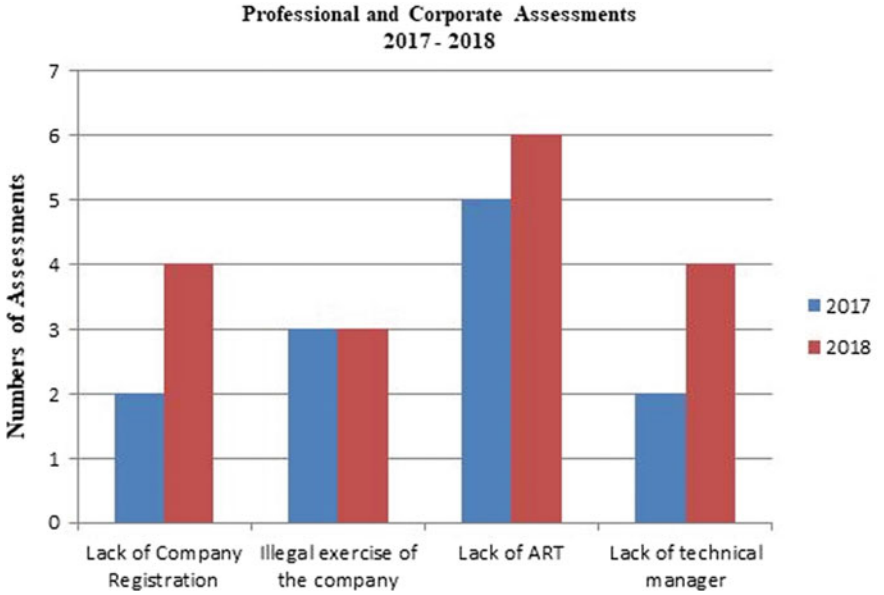


**Fig. 1** Assessments of irregular procedures registered in CREA-AM in the years 2017 and 2018

In 2017 the main records of activities performed by environmental professionals registered in CREA-AM were related with construction activities: 160 of the total 202 ARTs registered in CREA-AM (79%) were in the construction industry. Surprisingly in 2018 the number of registered ARTs in the environmental area focusing construction-related activities decreased to 44 in a total of 541 registered ARTs (8%). To identify possible causes of this sudden and relevant alteration, registered ARTs related with construction activities were further analysed. Table 2 shows the specific environmental activities reported in the ARTs associated with construction projects. These results show that the collection of Construction and Demolition Waste (CDW) is frequently referred both in 2017 and 2018, but the remediation of degraded areas shows a drastic reduction from 2017 to 2018, accompanied by a reduction of

**Table 2** ARTs registered at CREA-AM in 2017 and 2018, related with construction activities

| Activity | 2017 | 2018 |
|---|---|---|
| CDW collection | 9 | 12 |
| CDW transport | 5 | 1 |
| CDW destination | 10 | 1 |
| CDW treatment | 12 | 6 |
| Environmental monitoring | 16 | 19 |
| Remediation of degraded areas | 99 | 1 |
| Environmental impact studies | 9 | 4 |

activities related to the transportation, destination and treatment of CDW. This might be explained by the economic situation in Brazil in 2018, aggravated by change of government, which affected construction, leading to a reduction in investments in real estate projects in 2018.

The inadequate disposal of construction and demolition waste has relevant environmental impacts due to the toxicity of metals, paints, varnishes and oils frequently found in CDW. Therefore, special attention must be given to construction activities and this must be taken into consideration in the preparation of a proposal for the new Environmental Inspection and Surveillance Plan from CREA-AM.

The expected result of increasing the registration of ARTs with the CREA-AM Inspection Plan implemented in 2017 and 2018 was not verified in the construction industry, since registered ARTs decreased from 160 in 2017 to 44 in 2018—a 72.5% reduction. This demonstrates that the Inspection Plan was not fully implemented in this activity sector, so improvement suggestions are proposed for a new CREA-AM Environmental Inspection and Surveillance Plan. As presented above (Table 1), in the scope of the 2017–2018 Inspection Plan the actions to be performed internally in CREA-AM were the search for contracts published in the Official Gazette of the Brazilian Government and the analysis of Technical Responsibility Notes in order to find the need for ART registration of complementary activities, possible excessive attributions or finalization error. External actions involved the use of Geographic Information Systems (GIS), the investigation of online complaints, the detailed inspection of large-scale works, the inspection of residential condominiums in the city of Manaus (sampling 10 condominiums), the supervision of engineering companies (foundations, concrete and asphalt), and the supervision of works in the municipalities of the interior of the Amazon region, such as Atalaia do Norte, Benjamin Constant, Tonantins and Tabatinga, in the Alto Solimões gutter region of Amazon. Detailed oversight of large-scale works focused companies manufacturing prefabricated concrete and steel, companies that perform geotechnical survey reporting services, the solid waste management plan, the supervision of bids for the registration of ART regarding the preparation of budgets and the preparation of basic projects, and the inspection of ART records for the preparation of Technical Reports required by the Common Justice. Inspection reports would be biweekly. This former Inspection Plan had also financial purposes, aiming to increase ART registrations in CREA-AM, in 2017 and 2018, and therefore increase CREA's financial resources with ART registration fees.

The new proposal for the CREA-AM Environmental Inspection and Surveillance Plan suggests the intensification of surveillance in the area of CDW collection, transportation, disposal and treatment, to curb illegal companies from causing serious environmental impacts through improper CDW handling. CREA-AM's new Environmental Inspection and Surveillance Plan recommends the registration and tracking via GPS of the CDW collection boxes that are stored in construction sites and renovation works in general. Currently in Manaus there are many clandestine and illegal landfills that receive CDW without the slightest technical condition, causing environmental impacts that affect the Amazon Rainforest and the population of Manaus,

due to the toxicity of CDW containing paints, varnishes, oils, plaster, lead, etc., that can reach streams near these clandestine landfills.

Table 3 shows the proposed CREA-AM Environmental Inspection and Surveillance Plan, to be executed in the coming subsequent years, including the actions planned, responsible sectors, implementation period and expected results.

The proposed Environmental Inspection and Surveillance Plan aims to alert companies to the importance of Corporate Social and Environmental Responsibility, ensuring that company's management is not only tied to profits, but also to the respect for the environment. The proposed plan initially foresees a series of lectures and training courses directed both to professionals and companies, promoting awareness on the need to protect and preserve the Amazon heritage.

## 6 Conclusions

Results found in this case study demonstrate the vulnerability of the Inspection Plan implemented by the Brazilian regional administration body CREA-AM in the Amazon Region, in 2017 and 2018: the records of activities performed by environmental professionals in the construction sector suffered a 72% reduction, which suggests inadequate practices of companies regarding the collection, transportation, disposal and treatment of construction waste, and the remediation of degraded areas. Also, the illegal professional practices documented in administrative processes show that companies and technicians are acting without the necessary technical knowledge to mitigate the negative environmental impacts associated with the construction industry.

As a result of this research, improvement measures are suggested for CREA-AM to enhance the effective promotion of sustainability-oriented practices. A new Environmental Inspection and Surveillance Plan is suggested, which includes environmental education actions to promote the sustainability of waste management procedures in construction sites, focusing on good operational practices regarding the reuse and recycling of construction waste materials. This new inspection plan is proposed to the Civil Engineering Chamber of CREA-AM to come into force in the 2021–2022 biennium. It is expected to foster good practices among technology professionals and companies operating in the Amazon region, specifically reducing contamination by toxic waste from construction sites in the Amazon Rainforest, caused by inadequate disposal and illegal burning. Given that the territorial area covered by the activity of CREA-AM involves the Western Amazon, on Brazil's border with other Latin American countries, such as Peru, Bolivia and Venezuela, this research study is expected to lead to environmental improvements at an international scale.

As main conclusions of this case study, regional administration bodies have a relevant role in the surveillance and promotion of adequate operational practices in the context of Sustainable Development, particularly important in developing countries with a growing economy. In order to fully achieve the purpose of promoting sustainability-oriented practices among professionals and companies,

**Table 3** Proposed CREA-AM environmental inspection and surveillance plan (2021–2022)

| Item | Action to be addressed | Foreseen actions | Responsibilities | Period | Expected outcome |
|---|---|---|---|---|---|
| 1 | Internal inspection | • Consultation of corporate social goals through the Official Gazette<br>• ART analysis—verify the declared activities, aiming to detect the need for the registration of complementary activities, possible abusive attribution, or finalization error<br>• Research on the registration and legality of CDW collection, transportation, destination and treatment companies | SUAFI<br>CEEC | Continuous | Increase the legality and regularity of companies |
| 2 | External surveillance use of GIS (geographic information system) | • Mapping of actions in each sector/neighbourhood in the city of Manaus, through georeferenced address graphs of the inspected locations, and other relevant data for each action taken<br>• Mapping CDW drop boxes for real-time location tracking and destination tracking | ASGEO<br>SUAFI | Continuous | Basis for programming in the next financial years |
| 3 | Online complaints | Verify situation on-site, and return communication to the author of the complaint | SUAFI | Continuous | Increase ART records |
| 4 | Detailed inspection of large-scale works | Visit all the complementary phases of the work | SUAFI | Continuous | Increase ART records |

(continued)

**Table 3** (continued)

| Item | Action to be addressed | Foreseen actions | Responsibilities | Period | Expected outcome |
|---|---|---|---|---|---|
| 4.1 | Professional's surveillance | Normative Decision No. 111/2017 (Critical Analysis of ART), Resolution n. 1090/2017, Paragraph 2 of Art. 5 "CREA shall initiate legal proceedings when facing evidence, by any means at its disposal, including news published in appropriate media, of public misconduct, scandal or defamatory crime" | SUAFI | Continuous | Increase ART records |
| 4.2 | Waste (generation) | Surveillance at the headquarters of companies supplying CDW collection boxes | SUAFI | Continuous | Increase the legality and regularity of companies |
| 4.3 | Prefabricated | Precast concrete (works/manufacturing companies) | SUAFI | Continuous | Increase ART records |
| 4.4 | Survey report/testing | Geotechnical surveys | SUAFI | Continuous | Increase ART records |
| 4.5 | Waste (final destination) | • Surveillance of clandestine landfills<br>• Remediation of degraded areas | SUAFI | Continuous | Increase the legality and regularity of companies |
| 4.6 | Bids | Budget and Basic Project—Bids Technical Guideline n. 1/16 of the Brazilian Institute of Public Works Audit "Every element that integrates the basic project must be prepared by a qualified professional, and the registration of the ART is indispensable, identifying the author and author's signature" | SUAFI | Continuous | Increase ART records |

(continued)

**Table 3** (continued)

| Item | Action to be addressed | Foreseen actions | Responsibilities | Period | Expected outcome |
|---|---|---|---|---|---|
| 4.7 | Justice forum | Common and criminal justice report | SUAFI | Continuous | Increase ART records |
| 5 | Condominiums | Visit 10 condominiums in the city of Manaus | SUAFI | Continuous | Increase ART records |
| 6 | Companies | Companies specializing in foundations, structures, concrete and asphalt | SUAFI | Continuous | Increase ART records |
| 7 | Cities | Inspection of municipalities in the metropolitan region of Manaus and other municipalities in the interior of the Amazon | SUAFI | Continuous | Increase ART records |

regional administration bodies should complement their surveillance plans with activities that promote awareness and education regarding Sustainability and Social Responsibility.

In what concerns future research opportunities, attention should be given to the involvement of regional administration bodies in the promotion of practical instruments that enhance the adoption of sustainability-oriented practices. Specifically regarding construction waste management, CREA-AM is contributing to the operationalization of a mobile phone application that is expected to facilitate the reuse and recycling of waste by companies and ordinary citizens, thus opening space for the development of Circular Economy practices in Brazil.

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# "Beira Trilhos": The Implementation of the Right to Housing and the City by an Extension Project in Southern Brazil


**Marcos Antonio Leite Frandoloso and Eduardo Nischespois Scorsatto**

## 1 Introduction and Characterization of "Beira Trilhos" Territory

The scope of the present work comprises conceptualizing the right to the city by questioning the city itself, its rights and notions that are constantly restructuring and redefining themselves. The main challenge of the project developed by the University of Passo Fundo—UPF—is to understand such flows, from a new perspective, that states no one ever sees the city from the outside, or in a stagnant state of time. On the contrary, the process of analysing is by itself a movement that enters city space in its mobility and immobility, subjectivities and meanings (Frandoloso et al. 2019a; b). According to Harvey (2013), "knowing what kind of city we want is a question that cannot be dissociated from knowing what kind of social ties, relationships with nature, lifestyles, technologies and aesthetic values we want".

These assumptions are directly related to the Sustainable Development Goals (SDGs) to "end poverty and hunger worldwide; fight inequalities within and between countries; build peaceful, fair and inclusive societies; protect human rights, promote gender equality and women's empowerment as well as to ensure long-lasting protection of the planet and its natural resources by 2030". The United Nations takes into account the different levels of development, national and local capacities by creating

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"conditions for sustainable, inclusive and economically sustainable growth, shared prosperity and decent work for all" (UNIC Rio 2015, pp. 2–3).

The present project derives from the fact Brazil has received large public and private investments to develop rail passenger and cargo transportation infrastructures. As a result, such investment made the installation and expansion of this type of mobility possible. However, over time these investments have been redirected towards road transport. Nowadays, these areas and infrastructures are commonly occupied by the local community who is often not granted the right to housing, but people who see such territory as a possibility to access the right to the city (CDHPF 2005). These rights fit in an integrated way into the 17 different SDGs, and do not limited themselves by solely relating to reducing inequalities (SDG10) or sustainable cities and communities (SDG 11) according to Fig. 1.

In the state of Rio Grande do Sul, specifically in the city of Passo Fundo, such violation of fundamental human rights is no different from other places in the country. Since the removal of the railway section that crossed the urban centre four decades ago, there has been an extension of several occupation zones through approximately 15 km—Fig. 2. Even though there is variation based on different operational regions; there are households located in non-operational areas occupied by the population within the territory previously granted to railway operations (Frandoloso et al. 2019a; b).

Therefore, the Beira Trilhos, territory is understood as not only the occupying population, but also the granted and occupied territory along with the actual denial of rights, spatial segregation, social stigmatization and sub-citizenship (Scorsatto 2019). The Beira Trilhos extension project is the result of the mobilization and organization of several municipal entities and institutions, functioning as a Working Group (WG). It is established by the Municipal Government whose goal is to monitor


**Fig. 1** Sustainable Development Goals. *Source* UN (2015)

previous research developed in 2005, focusing on the occupations socioeconomic, urban and geographic data (CDHPF 2005; Kalil et al. 2007).

WG diagnosis from 2008 (GT Beira Trilhos 2008) showed 1086 families residing along the 15 km of Beira Trilhos. Such distribution crossed the urban area in an east–west direction, and it is estimated that currently 1500 families live in this territory, with a population of up to 4500 people. CDHPF (2016) also presents relevant information, when updating some of the data, in order to understand the characteristics and evolution of occupations along the railroad. For example, some of reasons for living on the edge of the trail, as shown in Fig. 3, is commonly related to lack of housing alternatives. More than half (51%) of the interviewees state they live on site because "they are unable to buy a lot to build a house in another location; 21% say they "bought" the right to live there; 15% say they live there to "avoid rent"; 7% claim "they have always lived there", and the remaining 6% have other reasons to live there (such as cheaper rent, proximity to family members and no other place to go).

Interviews conducted with administrative departments in Passo Fundo in regard to the intersection of Beira Trilhos with neighborhoods such Valinhos and Vera Cruz, represented on Fig. 4; explore the sources of understandings, misunderstandings, certainties and doubts about the territory's urban reality (Scorsatto 2019). Such visual representation demonstrates different levels of proximity and familiarity with the discussion below and it also points to central elements related to the experience


**Fig. 2** Beira Trilhos Territory in Passo Fundo. *Source* GT Beira Trilhos (2008)

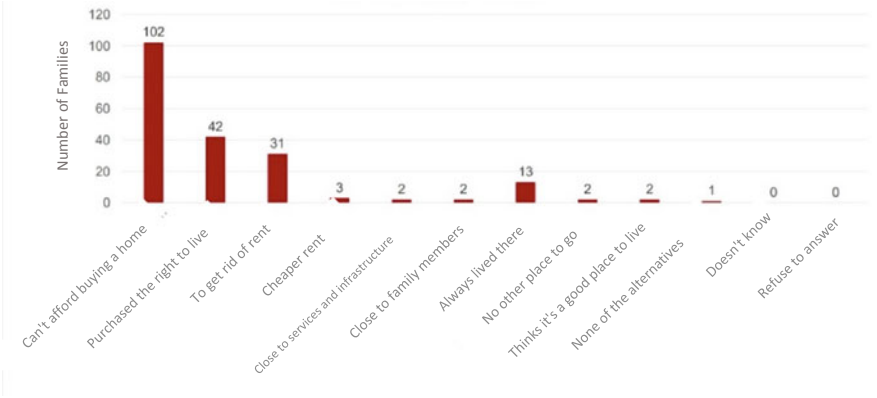


**Fig. 3** Beira Trilhos: reasons for occupation. *Source* Scorsatto (2019) based on CDHPF (2016)

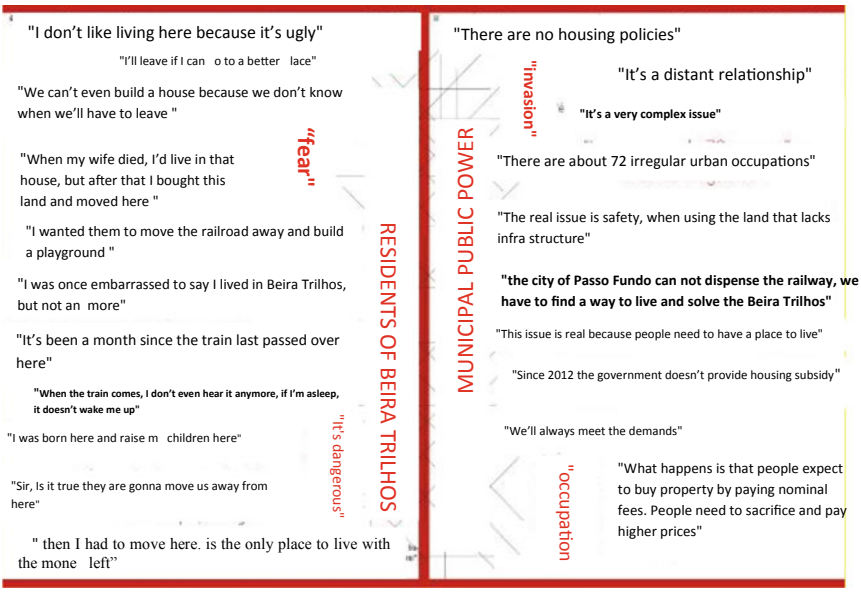


**Fig. 4** Reports from the local population. *Source* Scorsatto (2019)

present in that place. Such experience can be explored from within, that is, by those who live and have occupied the area, or those who look at and observe the occupation from the outside.

UPF's connections with the community, and thus its commitment to the SDGs, start with the premise of the indispensable "role of the university in promoting the right to the city, recognized as a collective right", which presupposes decent living conditions, recognition of citizenship, social coexistence with racial, ethnic

and gender diversities, essential for solidarity and urbanity (Dalmolin and Moretto 2014, 54). The dialogue with society has always been a key element in the decision-making processes of the university, from its role as a Community University—ICES (Brasil 2013), a private non-profit institution, in which normative basis includes the institutionalization of permanent programs extension and community action focused on the formation and development of students and the society progress (Frandoloso and Gasparetto Rebelatto 2019).

Based on the need to implement and systemically foster this type of contribution, as well as to trigger a process of consolidation and effective implementation; UPF announced, in April of 2014 its "Social Responsibility Policy—RSU" to the community. The institution defined guidelines, principles and goals of each thematic axes and later discussed them with the academic community and administrative structures (Provost and University of Passo Fundo's Foundation), mediated by Frandoloso et al. (2019a). As a result, the main axes of the RSU-based management model are: (a) organizational governance; (b) practices that promote human rights; (c) involvement and community development; (d) responsible practices to preserve and promote culture and the environment; (e) dignifying working practices; (f) Impartial marketing towards subjects that seek university education.

## 2 The Beira Trilhos Project: Methodology

The project is based on the idea that a university's community engagement should take a critical stance and serve as a transforming force within the community and the territory where the project emerges. According to Tommasino and Cano (2016), critical and active community engagement allows participants to communicate the actual and global purposes of a university, which are based on practices and social reality.

The main goal of the Beira Trilho Project (Carbonari and Vasconcellos 2016) is to continue the current, legal, urban and social processes, expand their perspectives and interfaces. It aims to promote the right to housing on the city for communities located in the territory called "Beira Trilhos". As an institutionalized project at University of Passo Fundo (UPF) since 2017, it abides by the University's Social Responsibility Policy—RSU (Dalmolin and Moretto 2014) as well as the Extension and Community Affairs' Policy (UPF 2017). These actions intend to improve the quality of life and respect social, cultural and aesthetic needs of the region and community.

The main goals of the project are the following:

- Recognize and strengthen the role of Beira Trilhos residents, by contributing to invigorate organizational, associative groups that are capable of solving social problems;
- Build a proposal for interdisciplinary action by involving several areas of knowledge, in order to link academic and community knowledge and co-produce new knowledge;

- Deepen action-oriented and community education methodologies, participant-action research and human rights education;
- Elaborate interactive and formative strategies among project participants, in order to build a space where everyone has the change to teach and learn;
- Produce strategies and practices to deepen community, teaching and research connectivity;
- Seek global solutions, but also promote specific or even exemplary initiatives with a global perspective;
- Engage with public authorities (Executive, Public Prosecutors and others), in order to reinforce the involvement and activism of Beira Trilhos residents;
- Complement student training whose project participation in is voluntarily or financially compensated; promote professional development, through a social, theoretical, practical and global experience, transform the institution-societal relationship by affirming the social character of higher education.

Thus, the goals to be achieved throughout the project's development process are:

- Seek communication with national and international movements/communities that face similar conditions of Beira Trilhos in Passo Fundo;
- Establish interdisciplinary and transdisciplinary partnerships with courses, projects and institutions that can contribute to the current project goals to integrate and monitor communities at Beira Trilhos in Passo Fundo;
- Incorporate local community members into the teams at all project stages;
- Offer courses and seminars on the issue of the right to housing, the right to the city, that can put together different audiences, in order to promote different views on the present issue.
- Institutionalize the survey, monitoring and evaluation of the occupation processes of the urban voids in the city of Passo Fundo, in order to contribute to the discussion about the social function of property as a research project;
- Discuss possibilities of joint action to improve immediate and specific community issues, through actions such as bottom up and/or hands on, as a way of creating, reinforcing ties and visualizing the group strengths;
- Monitor the reformulation of municipal legislation that encompasses the right to housing and the right to the city, as well as current civil actions in Passo Fundo and in nearby cities;
- Search to network with students and professionals within the areas of occupation, as a way to understand these territories as spaces of responsibility and professional performance from different areas;
- Build novel and flexible methodologies based on shared experiences, in order to register, systematize and promote them at events and seminars.

The project proposal is organized in three axes (Carbonari and Vasconcellos 2016). The first axis, Monitoring, gathers and articulates follow-up actions with residents and partnering institutions. It aims to include projects with public authorities, civil legal actions, revisions of the current PDDI—Integrated Development Master Plan, and other Municipal Plans that contribute to the creation of the City Council and to the

update on urban voids reports. These follow-up actions remain on the government's agenda and imply a lack of control over the project's duration. However, the current survey on urban voids will be institutionalized as research and produce results such as analyses and publications.

The second axis, Training, aims to strengthen the power of leaders and Beira Trilhos communities, in order to expand their role into the current process, additional student and associated social member training. Actions such as visits, meetings, courses and seminars on the right to the city will be developed.

The third axis, Global Project, aims to create a global vision and include various representatives, when facing the current situation of Beira Trilhos. Actions such as: exchange visits in order to learn about similar experiences that have led to solutions to the problem in Beira Trilhos, as well as working meetings in order to search for and map potential financing representatives. By being an axis of articulation with multiple representatives, it aims to build a definite solution to the issue, however, it may fail to hold total control of actions involved in such project.

The actions promoted within the community, clearly linked to the Training axis, should be flexible and supported by the community shared experiences. The methodological steps should be discussed and re-established jointly as an open and articulated workplan, including community members, students and teachers.

The proposed actions indicate an initial and integrated reflection for the resolution of specific issues, and it follows a similar trajectory to the one described in Chart 1.

## 3 Results and Discussion

Based on theoretical accounts (Lefebvre 1969; Santos 2012; Rolnik 2017; Maricatto 2015) the project's methodological and its foreseeable results, the primary focus, in 2019, included reviewing and understanding the physical territory where organizations and communities were located. It also included updating the data related to populations living in the same territory (Scorsatto et al. 2019).

Examining the territory involved interconnecting the current project with pedagogical activities and incorporating such themes into the development of a course completion project. Scorsatto (2019), one of the scholarship grantees involved in the Beira Trilhos group, developed an urban analysis and data resulting from the community demographic diagnoses. Scorsatto focused on the main route of occupations at the Vera Cruz and Valinhos neighbourhoods, its characteristic of greater population and seniority, as it was part of the original road railway—from the end of the nineteenth century.

In order to complement these analyses and diagnoses, Scorsatto developed an honour's thesis proposal for an urban project in the area. All guiding intervention proposal principles focuses on integrated urban planning, sustainable development, the bottom-up approach, the city as a meeting place, the human scale, expected housing and walking. In addition, the proposal was structured into axes guidelines that are: housing, mobility, security, work, ecology, leisure and social. For each

| | |
|---|---|
| • Approach the community and its environment in order to look for resources, possibilities and contributions. During this exploratory phase, the goal is to bring students, teachers and the community together, for a listening-diagnosis debate and raise important community issues which are parallel to the issue of housing and the city, such as the development of mental or thematic maps; |  |
| • Create spaces for discussion on specific themes involving collective aspirations, through workshops and recreational activities. Build a collective image of what is desired by evaluating what is a priority. Instruments such as a physical model of the area where the community is located could be used here; |  |
| • Compile initial surveys by using tables, graphs, drawings, in order to guide the integrated planning with the community, integrate them carefully with guidelines (what) and strategies (how) based on the set of raised demands. Establish possible actions and determine their possibilities and limitations, in order to define practical paths for such projects or actions; |  |
| • Participate and/or monitor the implementation of each project stage and/or actions planned by the community. Reflect on necessary adjustments on the advances obtained in view of existing expectations; |  |
| • Seek to establish community relations with groups, movements and similar experiences so that they can interact, exchange knowledge and strengthen the practical and political aspects involved in the occupation of urban land; |  |
| • Produce articles and reports on the project and its development. Share this formulation and initial presentation with the community. |  |

**Chart 1** Proposed actions and partial results. *Source* Authors

axis, problems and potentialities were diagnosed, guidelines, strategies and intervention proposals were built. The program requirement included allocating the soil of surrounding urban voids, rearranging operational residences into these urban voids, regulating land occupations in private areas and implementing a linear park. Geoprocessing equipment and information mapping using drones were used as complementary diagnostic tools—Fig. 5. This activity also integrates other academic subject courses and certainly emphasizes the inter and multidisciplinary nature of the Beira Trilhos Project.

When searching for alternatives to the current territory conditions, case studies were developed, in order build repertory on previous developed projects and practices (Casasola et al. 2019). In view of the current situation of the Beira Trilhos community, inquiries regarding possible solutions and alternatives to improve their conditions are fundamental. A suitable case study derives from the Manguinhos Complex in Rio de Janeiro, see Fig. 6. The project plans the socio-spatial integration of a territory divided by the walls of the train line, which breaks the complex in half (Broken City 2011).

The proposal was designed for the target intervention area. It's classified as a landscape project that transforms the environmental quality of the surroundings (spaces, vegetation, activities and constructions). Such linear space is intended to become

**Fig. 5** Images from the Beira Trilhos territory—Vera Cruz District. *Source* Authors

**Fig. 6** Manguinhos complex—Rio de Janeiro. *Source* Broken City 2011

a sector connector, promoting a public environment that acts as a social articulator (Broken City. Frandoloso et al. 2019a, b).

Activities were developed to study the "urban voids" in order to establish strategies for organizing the urban space. According to Jardim (2012, p. 38), idle areas, endowed with infrastructure, within the urban perimeter that lack constructions, hinder the full development of the city, as they are spread out and dispersed. These areas push communities into peripheral regions and lack to optimize the current urban infrastructure. They also create unnecessary costs, which could be better used to boost public resources in a more compact city, with well-distributed space and infrastructure.

According to the criteria established in previous stage of the project—2018, the areas inside the urban perimeter of Passo Fundo were identified to analyze the urban voids in the city, the free plots, the access to basic sanitation within an area of more than 5000 $m^2$. The survey (Jacobs 2016; Panhossatt et al. 2019; Frandoloso et al. 2019a, b), identified 124 urban voids larger than 5,000 square meters. In total there are more than 730 empty hectares, of which about 139 ha are buildable as represented in Fig. 7.

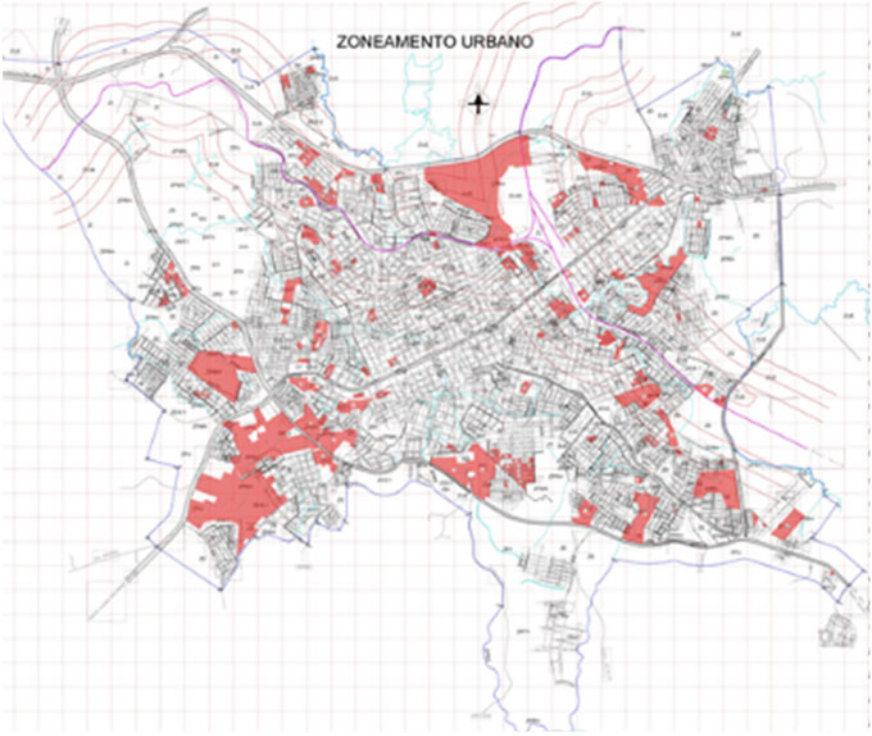


**Fig. 7** Map of urban voids in Passo Fundo. *Source* Jacobs (2016)


**Fig. 8** Debates about the right to the city. **a** Workshop on environmental impacts; **b** Faculty workshop. *Source* Authors (2019)

Mapping the region made it possible to identify potential areas for land and housing organization, albeit they are located in peripheral areas and away from the occupations along the railroad. The survey also indicates the existence of smaller and closer areas of the Beira Trilhos territory—as seen in Fig. 7. In future stages of the project these areas will be selected following other analysis criteria such as the property's situation, restrictions and urban indexes among others.

Within the previously described and proposed actions, spaces and moments to train new members are promoted. Workshops, proposal presentations are used in order to expand the current areas of knowledge involved in this project. Not only students and teachers involved in Architecture and Urbanism, but also professionals integrating areas such as Journalism and Advertising (developing activities to publicize activities through the TeleCidades Project), Psychology, Social Work, Civil Engineering, Environmental and Sanitary Engineering. It also involves other research projects and community engagement groups such as Viva! and EMAU—a student office, by promoting the debate over housing rights, the right to the city and their environmental impact. Those moments are represented by Fig. 8a, b.

The proposed goals and actions as seen on Chart 1, comprise recruiting the communities, organizations and institutions aligned with current project objectives. These institutions have been identified, represented and promoted by the Passo Fundo Human Rights Commission—CDHPF. Moreover, when dealing with a very wide and linear territory of 15 km within the urban area, some of its own identities and demands are also dispersed. As a result, project debates have called for a more concentrated and focused approach in more homogeneous areas, as it is the case of the western region, represented by Bairro Vera Cruz and Valinhos, as mentioned previously.

## 4 Conclusions

The Project Beira Trilhos has developed inter and multidisciplinary characteristics. It has enabled the construction of a space to exchange experiences and knowledge, which is a practice intrinsically related to the university's community engagement goal. This goal includes not only the internal academic community, but also the

external community and other civil organizations. Despite a current scenario of human rights violation and omission of responsibility; this project is committed to discussing and analyzing proposals of changes. Proposals that consider the reality of the usual neglected and abandoned population, the subjects and motivation of such activities, as well as the integration of the Sustainable Development Goals and the UPF's Social Responsibility Policy—RSU.

Previously developed activities consider the complexity of realities, social and cultural contexts for each of the occupations along the railroad. Understanding such physical and human territory included in the cases and situations the occupations are found is relevant. It allows one to obtain viable results for the improvement of these conditions, and, to see the region needs that are often left aside. These actions are extremely necessary to improve the conditions in which the Beira Trilhos population faces nowadays.

Analysis and diagnosis studies aim to obtain a foundation for future interventions in the area(s). Research, as the main type of methodology, is able to compare empirical studies with the current situation. Research also analyses the population-railway dynamics in order to implement effective alternatives and solutions to improve the quality of life in such environments, and to guarantee the right to housing and the city.

Developing the proposed activities also emphasizes the role of academics from distinct courses involved, in order to develop skills regarding the themes of the right to housing and the city. It comprises this territory of social, economic and environmental vulnerability, and also potential urban spaces. These activities also integrate the communities involved, who are agents of transformation in such context. Likewise, the academic results are related to the activities of the three pillars of Higher Education: community engagement, teaching and research.

As proposed by the RSU Policy, the initiative of the Beira Trilhos project contribute to the understand that university social responsibility means the university's ability to produce and disseminate practices based on a set of principles, general and specific values through four key processes: management, teaching, research and engagement. Finally, based on these considerations, UPF's social functions were discussed considering their roles into preparing citizens to transform their realities and contexts; focusing on the processes developed to promote reflection on what education means and above all, on Education for Sustainability.

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# The Social License to Operate as a Tool to Promote Sustainability and Social Responsibility in Mining Industry: Case Study of Parauapebas and Canaã dos Carajás (Pará, Brazil)


**Thiago Leite Cruz**

## 1 Introduction

Environmental impacts and fulfilment of legal requirements are no longer the solely concerns of great industrial companies (Black 2013). Currently, businesses must cope with matters of social responsibility, properly managing economic and social impacts, improving infrastructure and corresponding to people's expectations in their operations are located (Franks et al. 2014). This is due to the crescent empowerment of civil society, as different social actors gather together to press companies and governments to have social demands addressed (Conde 2017).

The concept of Social License to Operate (SLO) becomes ubiquitous in this context, especially in mining industry due to its multidimensional impacts. It is informally granted by local communities and other influential stakeholders, reflecting their social perceptions of an industrial project, its impacts and the relationship with the companies. It is unrelated to existing formal licenses, it is tacit and changes overtime, but some studies attempted to quantitatively measure it to support businesses' activities (Boutilier and Thomson 2018; Zhang et al. 2015).

Companies need to balance benefits and costs in local communities. The population may praise industries for generating income, jobs and local development; and yet, hold grievances due to environmental hazards, uneven distribution of benefits and non-participation in decision-making processes (Lujala et al. 2016). Hoelscher and Rustad (2019) highlight the SLO can be used both for social resignation and social empowerment. Boutilier and Thomson (2018) indicate that an absent or weak SLO

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indicates intense social dissatisfaction, manifested through semi-organized disruptive activities such as strikes, and riots that disrupt production and logistics, besides increasing social tensions (Hoelscher and Rustad 2019).

Several negative impacts and social conflicts are associated with mining industry in Brazil (Cruz et al. 2020), despite its huge importance in national economy (a share of 4.69% on Brazilian GDP in 2017). Located in the northern state of Pará, Carajás region, Parauapebas and Canaã dos Carajás are the two main Brazilian mining municipalities, home to the largest iron ore mine in the world (Duddu 2018). However, this region hosts frequent conflicts between mining companies and the local inhabitants, due to environmental impacts, human rights violations and land possession struggles. Mining activities and logistics are usually interrupted during such commotions (Santos and Michelotti 2017; Cruz and Congilio 2017).

Public opinion regarding mining in the region may have worsened significantly in 2019, due to a tailings dam breach in a Brazilian mining venture in Brumadinho—Minas Gerais. This disaster gravely damaged the environment and killed around 270 people (BBC 2020). Prno and Slocombe (2014) and Hoelscher and Rustad (2019) identified that current social perceptions are significantly influenced by negative experiences with mining in other locations or in the past.

Considering the huge importance of the Carajás region for Brazilian mining production, and the intensification of social conflicts between industry and local communities in the area, the present research aims at quantitatively and qualitatively assessing the SLO of mining industry in Parauapebas and Canaã dos Carajás, expanding previous works in the region. It assessed how the following factors interact and influence the SLO: procedural fairness, company-community communications, improvements in social infrastructure, economic benefits, economic and environmental impacts, trust in companies and governance.

This paper is divided into six sections. The second section reviews the literature on SLO and relates the license to social conflicts in northern Brazil. The methodology of data collection and assessment is explained in the third section, and the results are described and analyzed in the fourth section. Finally, the fifth section presents the concluding remarks.

## 2 Social License to Operate (SLO) and Social Conflicts in Brazil

### *2.1 Understanding the SLO*

Although the SLO is neither formal nor tangible and originated as a metaphorical concept, some works attempted to quantitatively measure the license and incorporate it into business strategies and government's reports (Black 2013; COAG Energy Council 2013; Faria et al. 2019). Boutilier and Thomson (2011) modelled the SLO

**Table 1** SLO levels which can be identified through the application of a questionnaire, assessed in a Likert scale Adapted from Boutilier and Thomson (2011)

| Levels and scores | Definition |
|---|---|
| Refusal (1.00–2.49 points) | No support or sympathy for the company. Costs are considered greater than benefits |
| Acceptance (2.5–3.99 points) | The company is merely tolerated and allowed to operate |
| Approval (4.0–4.49 points) | Stakeholders are pleased and satisfied with the company and the balance of costs and benefits |
| Identification (4.5–5.0 points) | Enthusiastic support to the company, which is seem as part of the community |

as a four-leveled scale (Table 1), in which it is essential to build trust and legitimacy in a transparent relationship with the stakeholders to reach higher levels.

Legitimacy refers to the perceptions of economic benefits and fulfilment of legal requirements, representing the most basic conditions to achieve **Acceptance**, whereas trust is crucial to strengthen the license (Boutilier and Thomson 2011). Zhang et al. (2015) quantitatively demonstrated that trust mediates the influence of environmental, social and economic costs, benefits and governance on the SLO.

In most developing countries, extractive industries are socially pressed to address issues that the government do not address properly due to low-governance. Their environmental legislation is usually weak, then environmental hazards are common (Boutilier and Thomson 2011). Understanding the characteristics and historical dynamics of the communities where operations take place is essential to properly apply adequate strategies (Cruz et al. 2020). A strong SLO enhances the resilience of local communities by promoting economic diversification, strengthening their socio-institutional environment and governance, and empowering them for self-management (Hoelscher and Rustad 2019; Cruz et al. 2020).

However, some companies develop SLO strategies that prioritize business risk management over community engagement, failing to stablish meaningful dialogues with society. Therefore, the problem is not the actual concept of SLO, but its misunderstanding and misuse. Demajorovic et al. (2019) analyzed the factors involved in the SLO of the Samarco's mining project in Brumadinho (Minas Gerais, Brazil), whose tailings dam broke in early 2019. The community trusted and supported the company, granting an SLO. But it was achieved by masking risk perceptions, through maintenance of good perceptions of corporate reputation, using the media and strategic alliances with few stakeholders. There was no social involvement in decision-making processes, and no transparency regarding the existing dam risks. Otherwise, social pressures could have pressed the company to mitigate risks and avoid the tragedy.

In 2016, Cruz et al. (2020) assessed the SLO of mining industry in Canaã dos Carajás (Pará, Brazil), focusing mainly on the urban population. In Boutilier and Thomson's (2018) scale, the SLO in the municipality was found to be Acceptance (3.62 in a Likerty Scale). This level indicates companies are allowed to operate, but serious crises could trigger conflicts (Boutilier and Thomson 2018).

Economic benefits and improvements in infrastructure led the community to recognize the legitimacy of the business, but its credibility was still weak—it lacked transparency and engagement with the community. Quantitative analyses demonstrated that procedural fairness, good company-community interactions and improvements in infrastructure favored trust and the SLO, whereas economic and environmental hazards harmed perceptions towards regional mining projects (Cruz et al. 2020).

The 190 interviewees lived mostly in urban areas. Furthermore, many respondents declared not to trust in the local government to hold mining companies accountable for environmental impacts, and to properly manage the mining taxation. Cruz et al. (2020) suggested future studies in the region should assess the influence of governance in the levels of SLO, and to include more respondents from rural areas in the sample.

## *2.2 Social Conflicts and Mining Industry in the State of Pará—Brazil*

In fact, rural communities are prominent in protests against mining industry, due to the uneven distribution of benefits and their vulnerability to negative impacts, because of their proximity to mines and dams. Mining companies prioritize the development of urban areas and paving roads where their employees live and work, despite the importance of agriculture and livestock for economic diversification (Hoelscher and Rustad 2019).

Historically, small farming settlements where predominant in the region of Carajás—Pará. But the discovery of abundant mineral and ore reserves in the 2000s changed the dynamics of the region, as mining companies expanded their operations and had to acquire lands from rural workers' properties.

Besides the expropriation process, mining production caused issues to rural workers who remained in the region, due to environmental hazards such as water pollution, dust emissions and damages to households and livestock due to explosions (Cabral et al. 2011). Negative impacts, grieavances and violent conflicts increased significantly. National reports indicate that over 8400 people were involved in conflicts related to land use and mining impacts in the state of Pará (CPT 2018).

Hoelscher and Rustad (2019) analyzed the historical mining exploration in other municipality in the state of Pará, Barcarena. When the company Vale controlled mining operations there, it followed the same procedures as Samarco in Brumadinho—Minas Gerais (Demajorovic et al. 2019). Vale secured its interests and minimized conflicts through a paternalist approach to SLO. It provided housing to its workers, constructed infrastructure and financially supported certain community leaders and social projects. Politics of resignation alienated the inhabitants, accustoming them to support the company to get benefits the state failed to provide (Benson and Kirsch 2010).

However, this approach had deleterious long-term effects: it increased inequalities and economic dependence on mining, and weakened civil society organization by reinforcing asymmetries in their relationship with the company. Vale's privatization increased social tensions, as social benefits and improvements were no longer promoted or supported by Vale. Frequent protests interrupted production and logistics due to social dissatisfaction (Hoelscher and Rustad 2019).

From 2011 on, the company Hydro took ownership of Vale and changed the previous CSR paradigms, incorporating human rights topics into business agenda. It sought to improve its relationship with local stakeholders, building legitimacy and deepening community engagement through long-term CSR strategies. However, Hydro faces resistance from local community, because they were used to short-term benefits provided by the paternalist approach of the past, whereas the negative environmental impacts and social conflicts remain in collective memory. Hoelscher and Rustad (2019) indicate that SLO strategies need to acknowledge the past experiences and create a common shared vision with the community.

The mining projects in the municipalities of Parauapebas and Canaã dos Carajás, in Pará state, are controlled by Vale (2012). Hoelscher and Rustad (2019) emphasized it is important to analyze the history and dynamics of the companies and properly understand the characteristics of the municipalities, to correct mistakes from the past and shape better futures.

## 3 Methodology

### *3.1 Location*

This study was conducted in the municipalities of Parauapebas and Canaã dos Carajás, located in the state of Pará, region of Carajás (Fig. 1). For some decades, both municipalities were small farming settlements in the municipality of Marabá. Mining exploration in the 1980s boosted migrations to the region, and Parauapebas was founded in 1988. Its mines explore copper, manganese, among others. Canaã dos Carajás was founded in 1994, and nowadays hosts the largest iron ore mine in the world (Cabral et al. 2011; Duddu 2018). The estimated population in Parauapebas is 208,273 inhabitants, and 37,085 in Canaã dos Carajás (IBGE).

The huge mining production in the municipalities is reflected in their tax collection. Parauapebas and Canaã dos Carajás are the greatest mining tax collectors in Brazil: US$244,701,241.25 and US$149,442,005.00 in 2019, respectively (ANM 2020). However, these municipalities are not well positioned in the FIRJAN Index. Created and monitored by the Federation of Industries of Rio de Janeiro, such an index evaluates yearly the standards of living in every single Brazilian municipality, assessing the following sectors: jobs and income, education and health. In 2016, Parauapebas, Canaã dos Carajás were in 1318th and 2503rd position on the Brazilian FIRJAN ranking, respectively (FIRJAN 2020).

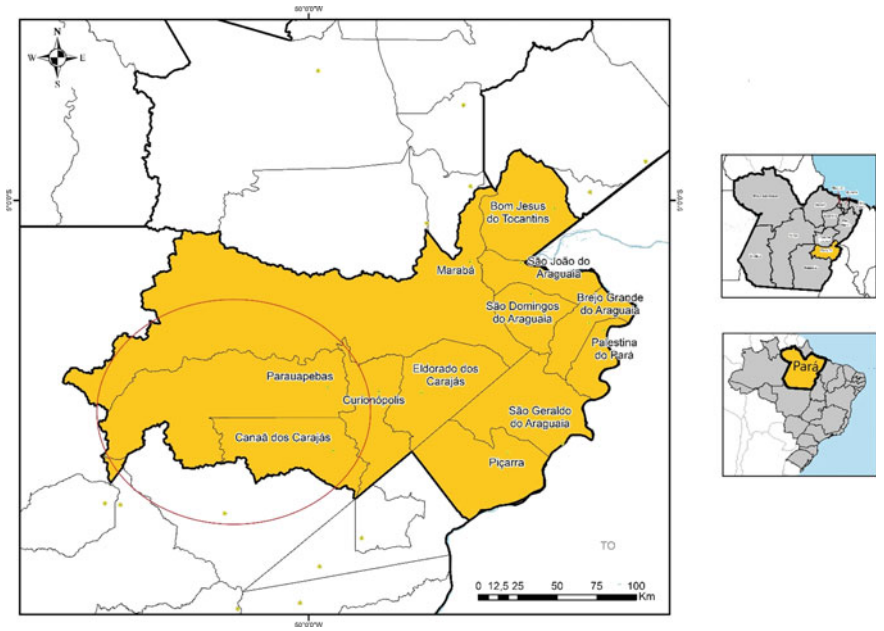


**Fig. 1** Location of Parauapebas and Canaã dos Carajás. *Source* The author (Adapted from: Fapespa (2017)

## *3.2 Assessing the Social License to Operate*

Questionnaire surveys were conducted with 400 anonymous participants: 200 in Canaã dos Carajás, and 200 in Parauapebas. Stratified sampling proportionally selected members from ten different social groups, to reflect local diversity: rural workers, students, teachers, politicians, journalists, public workers, commerce and service workers, religious leaders, industry workers, and NGOs/Trade Unions members. Rural workers were visited in two rural communities in Parauapebas (Palmares I and II), and three in Canaã dos Carajás (Serra do Rabo, Vila Bom Jesus and Vila Planalto), which are associated with frequent social conflicts and environmental impacts (Cabral et al. 2011).

The sample margin of error was approximately 10%. The sample size would have been smaller, but sub-samples were taken for small social groups to make sure all participated in the study. 67.5% (270) of the respondents were men, and 32.5% (130) were women. The average age and its standard deviation were 35.4 and 13.4, respectively. Age varied from 18 to 73 years. The average years of education and its standard deviation were 10.84 and 2.95, respectively. 19.8% of the participants complemented Elementary School, with 8 years of education; 55% finished High School, with 11 years; 23.2% completed a bachelor's degree, with 15 years. Only 2% completed more than 15 years of education.

Data collection took place in February 2020. The respondents were asked to rate some topics in a Likert scale (1 = strongly disagree; 5 = strongly agree). The mean average score of the first 12 (adapted from Boutilier and Thomson 2018) indicated the level of the SLO. The following topics (adapted from Zhang et al. 2015) assessed different factors that influence the tolerance and support to mining companies (Table 2).

The variables were averaged for each participant, for socials groups and, finally, for the entire sample. A Path Analysis (a complex Multiple Regression) was conducted to investigate the relationships between the variables and analyze how they affected the tolerance and support to companies, using the IBM SPSS 23 software (IBM Corp. 2015).

The Path Analysis tests hypotheses' coherence with the existing data. The following hypotheses were tested (Fig. 2):

(a) Good company-community communications and governance positively and directly influence trust in companies;
(b) Procedural fairness, economic benefits and improvements in infrastructure positively and directly influence trust, tolerance and support to companies;
(c) Economic impacts negatively and directly influence tolerance and support to companies;
(d) Environmental impacts directly and negatively influence trust, tolerance and support to companies;

The Path Analysis evaluates the goodness-of-fit of the hypothesised models to check whether the proposed relationships are adequate using chi-square test, Comparative Fit Index (CFI), Normed Fit Index (NFI), and Root Mean Square Error of Approximation (RMSEA). Satisfactory fits are indicated by nonsignificant chi-square test, CFI $\geq$ 0.95, NFI $\geq$ 0.95, and RMSEA $\leq$ 0.06 (Hu and Bentler 1999; Kenny and McCoach 2003; Moffat and Zhang 2014).

## 4 Results and Discussion

The current SLO level of mining industry in the municipalities of Parauapebas and Canaã dos Carajás is **Acceptance** (2.6 points; standard deviation: 1.01), a very low level just 0.1 point above the minimum acceptable (Fig. 3). Local stakeholders barely tolerate the mining companies and their activities, as trust and goodwill is low. Unplanned unfortunate events may cause social turmoil and subsequent blockages to roads and entrances to mines.

The current SLO levels are lower than the results found by Cruz et al. (2020) in 2016 (Acceptance level: 3.63 points; only in Canaã dos Carajás). Participants involved in NGOs/Trade Unions and industry workers still granted the highest SLO levels, as companies kept engaging with their institutions through sponsorships for projects that benefits their activities. Religious leaders and people involved in

**Table 2** Survey topics and SLO variables

| SLO variables | Survey topics |
|---|---|
| Level (Refusal = 1.0–2.49; acceptance = 2.5–3.99; approval = 4.0–4.49; identification = 4.5–5.0) | (1) We can benefit from a relationship with the mining companies |
| | (2) We are very pleased with our relationship with the companies |
| | (3) The presence of mining projects is a benefit to us |
| | (4) The companies listen to us |
| | (5) In the long term, mining will contribute to the well-being of the whole region |
| | (6) The companies treat everyone fairly |
| | (7) The companies respect our way of life |
| | (8) Our group (teachers, students, journalists …) and the companies have a similar vision for the future of the region |
| | (9) The companies give support to those who they negatively affect |
| | (10) The companies share decision-making with us |
| | (11) The companies are concerned with our interests |
| | (12) The companies openly share relevant information with us |
| Procedural fairness | 4; 7; 10; 11 |
| Company-community communications | (12) The companies openly share relevant information with us |
| | (13) Our contact with the companies is frequent |
| | (14) Our contact with the companies and their staff is pleasant |
| | (15) Our contact with the companies and their staff has positive outcomes |
| Trust in the companies | (9) The companies give support to those who they negatively affect |
| | (16) The companies keep the promises |
| | (17) The companies care about our safety |
| | (18) The mines are safe |
| | (19) We trust in the mining companies |
| Governance | (20) The local government adequately monitor and hold mining industry accountable |
| Improvements in social infrastructure | (21) Access to medical and health facilities has improved |

(continued)

**Table 2** (continued)

| SLO variables | Survey topics |
|---|---|
| | (22) Access to education has improved |
| | (23) Mining improved the quality of the urban infrastructure (e.g.: paving of streets and roads) |
| | (24) Sanitation has improved |
| Economic benefits | (25) Income opportunities and job creation improved in town |
| | (26) Companies give training and employment opportunities to local people |
| | (27) Mining generates local, regional and national economic benefits |
| Economic impacts | (28) Mining increased our cost of living |
| | (29) Mining increased housing speculation in town |
| | (30) Mining harms other industries |
| Environmental impacts | (31) Mining has negative impacts on water resources |
| | (32) Mining has negative impacts on forest resources and soil quality |
| | (33) Mining has negative impacts on air quality (dust; pollution) |
| | (34) Mining contributes to climate change |
| Tolerance and support to mining companies | (35) We tolerate the operations of the mining companies in the region |
| | (36) We enthusiastically support the mining companies |

commerce and services praised mining industry for generating jobs and income opportunities.

Nevertheless, journalists, students, teachers, politicians and public service workers were more critical of the mining companies' activities. The interviewees, especially in Canaã dos Carajás, resented the apparent segregation of the companies' workers. The school sponsored by the mining companies is exclusive to students whose parents work in mining, according to some respondents. An entire district was created to host exclusively mining workers' and their families, with good infrastructure, commerce and services.

Most respondents also declared the companies should engage in open and frequent dialogues with the actual community, not just few institutions or social leaders that did not represent the interests of all members. Some interviewees considered that occasional meetings with the community were rather monologues than dialogues, as the community was not heard at all.

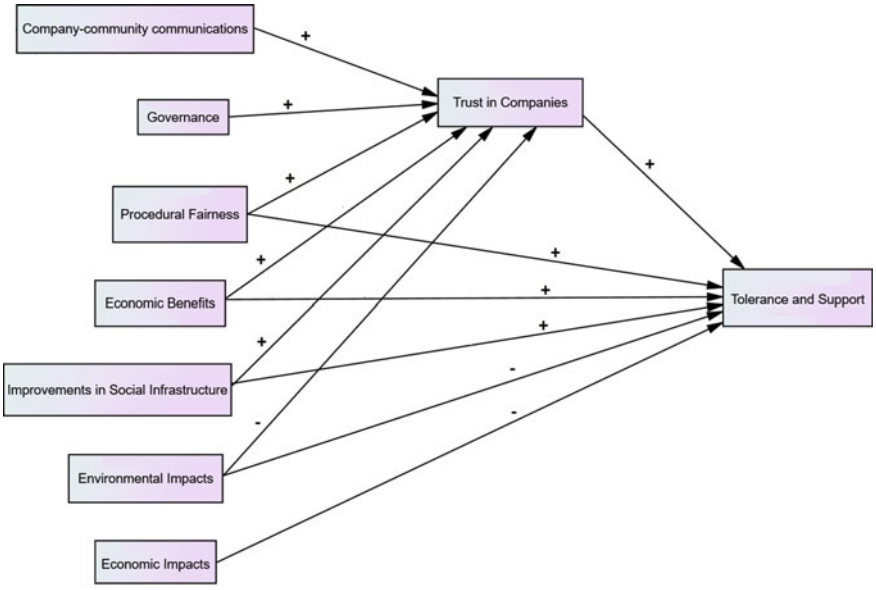


**Fig. 2** Hypothetical model tested by the path analysis method

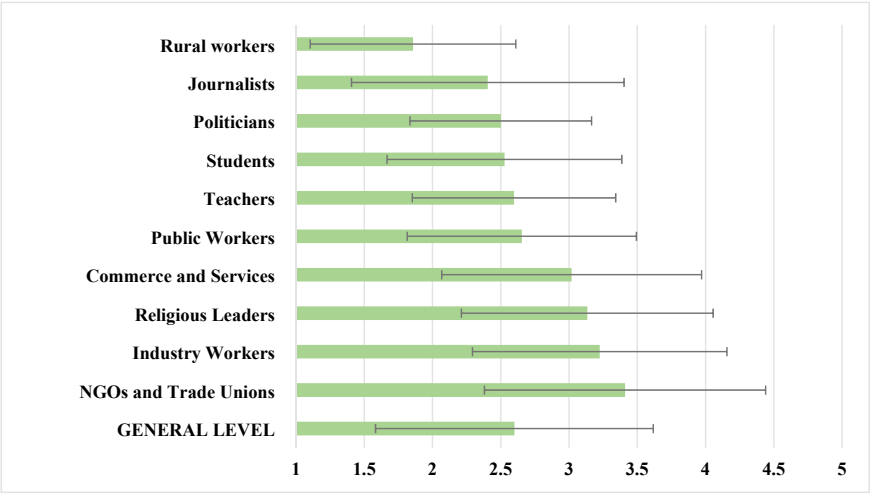


**Fig. 3** SLO levels and standard deviations (thin bars) in Parauapebas and Canaã dos Carajás (Pará, Brazil), for each social group

Poor communications and lack of engagement were common complaints, especially in rural communities. Most of them considered riots were their only tool to be heard and have their demands addressed. However, some rural protesters have been prosecuted for demanding better life and working conditions (Clésio 2020). Consequently, rural workers did not grant an SLO—its low level indicates grave dissatisfaction and reflects the low commitment of mining companies with that social group.

In February 2020, rural workers blocked roads to mines in the municipality of Canaã dos Carajás (Fig. 4). They claimed for indemnification due to expropriation from the Serra do Rabo community, where they lived and worked with agriculture and livestock for years. Nonetheless, the company needed to create an environmental preservation unity in 2017, to be allowed to expand mining exploration in the region. Therefore, the company created the unity in the territory where Serra do Rabo was located. Social dissatisfaction increased as there were no compensations and some community members were prosecuted for farming in their lands, declared by federal government to be a protected area (Lacerda 2020). The company disrespected local way-of-life and did not fulfil promises, harming its own legitimacy and credibility (Boutilier and Thomson 2018).

The Path Analysis confirmed the hypotheses (Fig. 5). The nonsignificant Chi-square ($\chi 2[2df] = 2340$; $p$-value $= 0.505$) indicated that the hypothesized covariance

**Fig. 4** Rural workers from Serra do Rabo and other communities protesting in Canaã dos Carajás (Pará, Brazil) in February 2020. *Source* The author (2020)

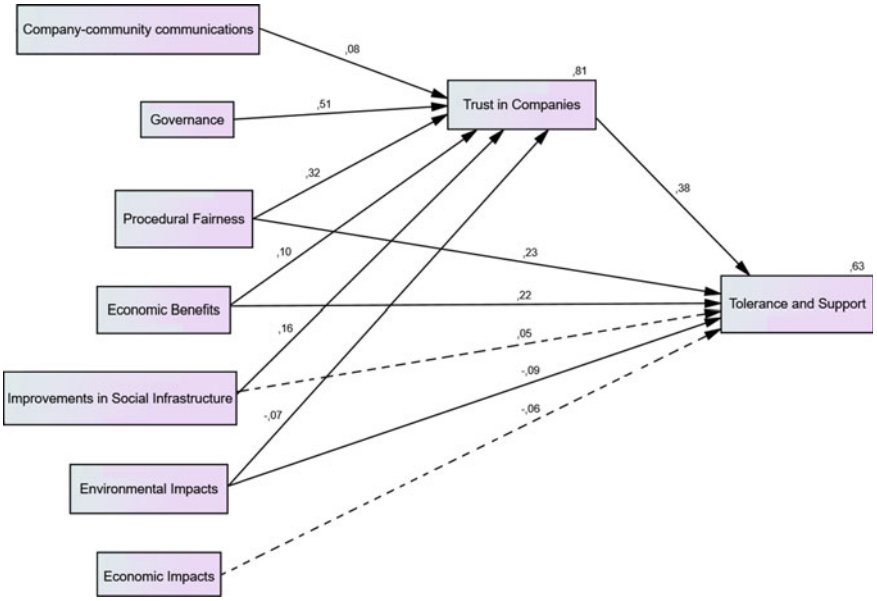


**Fig. 5** Path analysis indicating the relationships between the influencing factors of the SLO in Parauapebas and Canaã dos Carajás (Pará, Brazil). Block lines indicate statistically significant relationships, dashed lines indicate nonsignificant ones. The explained variance of trust, tolerance and support is indicated by the estimated coefficients above them

matrix did not differ from the actual one. The other parameters confirmed the good fit of the model to the data (CFI = 1.0; NFI = 0.999 and RMSEA = 0.000). The hypothesized model explained 81.0% of the variance in Trust and 63.0% in Tolerance and Support of mining companies, indicating a good index (Hu and Bentler 1999; Kenny and McCoach 2003; Moffat and Zhang 2014).

It was confirmed that procedural fairness, company-community communications, improvements in social infrastructure, economic benefits, governance, trust in companies and tolerance and support are positively correlated with each other. Economic and environmental impacts are positively correlated with each other and negatively with the other factors, including trust and tolerance and approval (Table 3).

The greatest positive effect on trust by governance ($\beta = 0.51$; $p$-value = 0.000) reveals the importance of government and legislation in holding mining companies accountable to environmental hazards. The more people trust the government to be responsible, the higher the trust in company. The importance of good perceptions on procedural fairness strongly related to higher trust ($\beta = 0.32$; $p$-value = 0.000) should encourage companies to be honest, transparent and correspond to people's expectations. Likewise, improvements in infrastructure ($\beta = 0.16$; $p$-value = 0.00) and economic benefits ($\beta = 0.10$; $p$-value = 0.00) were associated to higher trust as well.

**Table 3** Beta weights indicating the strength of the relationships between the variables

| Variables | | β (path analysis correlations) |
|---|---|---|
| Economic benefits | Procedural fairness | 0.431 |
| Procedural fairness | Improvements on social infrastructure | 0.583 |
| Improvements on social infrastructure | Economic impacts | 0.009 |
| Governance | Improvements on social infrastructure | 0.459 |
| Environmental impacts | Economic benefits | −0.266 |
| Environmental impacts | Procedural fairness | −0.460 |
| Environmental impacts | Governance | −0.548 |
| Procedural fairness | Economic impacts | −0.154 |
| Governance | Economic impacts | −0.240 |
| Company-community communications | Improvements on social infrastructure | 0.545 |
| Environmental impacts | Company-community communications | −0.467 |
| Company-community communications | Economic impacts | −0.167 |
| Company-community communications | Governance | 0.630 |
| Economic Benefits | Improvements on social infrastructure | 0.504 |
| Environmental impacts | Improvements on social infrastructure | −0.220 |
| Environmental impacts | Economic impacts | 0.421 |
| Procedural fairness | Company-community communications | 0.740 |
| Economic benefits | Governance | 0.374 |
| Procedural fairness | Governance | 0.663 |
| Economic benefits | Company-community communications | 0.413 |
| Economic benefits | Economic impacts | −0.028 |

Whereas the influence of improvements in social infrastructure on tolerance and support were not significant ($\beta = 0.05$; $p$-value $= 0.210$), procedural fairness ($\beta = 0.23$; $p$-value $= 0.00$) and economic benefits ($\beta = 0.2210$; $p$-value $= 0.00$) had almost the same influence on the variable. In fact, people tend to tolerate better mining activities when there are financial benefits such as jobs generation and more income opportunities.

Negative perceptions of economic impacts did not significantly influenced tolerance and support ($\beta = -006$; $p$-value $= 0.091$), whereas environmental impacts

negatively and significantly affect both trust ($\beta = -007$; $p$-value $= 0.009$) and tolerance and support ($\beta = -0.09$; $p$-value $= 0.0019$). Cruz et al. (2020) noticed higher negative influences of environmental impacts on both trust and acceptance and approval.

In the present study, most interviewees were already familiar with the new mining project, the largest one in the world. It is eco-friendly and less-pollutant, therefore people manifested less environmental worries. Nevertheless, environmental concerns still have stronger influences on tolerance and support than economic impacts, which some respondents attributed to government at local and national levels.

The Samarco's tragedy in 2019 may have influenced the low SLO levels in the Carajás region, as 75% of the respondents spontaneously commented about the disaster during the survey and manifested their fears. Trust in the adequate management of tailings dams and environmental impacts was found to be very weak among the interviewees. It confirms the relevance of cross-scale effects, events in other locations or in the past, which significantly influences the SLO locally (Prno and Slocombe 2014).

After Samarco's disaster, local politicians were invited to visit other mines and dams to check their safety. Demajorovic et al. (2019) consider such strategy as a means to use companies' public relations tools to enhance their trust and minimize potential risks (Meester and Behagel 2017).

Mining companies in Parauapebas and Canaã dos Carajás clearly adopt a paternalist approach to CSR, providing sporadic social benefits in the short-term and engaging with selected social leaders.

However, Hoelscher and Rustad (2019) demonstrated that mining companies' paternalist and philanthropic approach to CSR has deleterious effects in the long-term, as it exacerbates social conflicts and grievances, and perpetuates underdevelopment by increasing dependence on mining industry. Hoelscher and Rustad's (2019) depicted the history of mining development in Barcarena (Pará, Brazil), but the narrative is very similar to the historical development of mining industry in Parauapebas and Canaã dos Carajás, according to some interviewees' spontaneous comments:

> "Vale's engagement with local communities was patriarchal, reflecting paternalistic modes of company–community relations of the time. 43 Vale used a 'company town' model, developing planned facilities for workers and their families close to refineries at Villa dos Cubanos, leaving the rest of the municipality underdeveloped. Alongside the town with company-provisioned housing, roads, lighting, water and sanitation, informal communities sprung up to house those who arrived hoping to find work. Despite this inequality, Vale was generally viewed rather positively as they provided many services in the region in lieu of the local government. Reflective of Brazil's history of philanthropic approaches to CSR, Vale's paternalism was inherent in how the company cultivated goodwill – and soothed dissent – by intermittently supporting discretionary investments. Vale strategically used relatively small investments in social projects to engender support from communities to preserve their SLO and secure their operations. Close links were maintained with selected community leaders, and unions were financially supported by Vale to encourage a compliant workforce and minimise risks of worker strikes or walkouts.
>
> Over time Vale's approach exacerbated inequality, weakened civil society and created dependence on private industry for local development, with the company becoming the de facto patron of the community. This 'reinforc(ed) a cycle of dependency' between the local

> community and industry45 and despite 'criticisms of the industrial impacts, (citizens) found themselves entangled in an asymmetric relationship of power with the local ventures'. Focus group interviews with long-time community leaders reiterated that the town was largely beholden to the acts of Vale (…)" (Hoelscher and Rustad 2019; pp. 104–105).

History seems to be repeating itself in Parauapebas and Canaã dos Carajás. Such ineffective practices from the past must be identified, collectively discussed and properly managed. Then, new approaches to CSR and SLO can be successful and effectively benefit communities, companies and other stakeholders. Reaching higher SLO levels demands actively engaging and empowering the local communities, by generating long-term benefits and economic independence from mining industry. Even rural communities are increasingly growing more dependent on mining, as one rural worker spontaneously declared that mining is the only feasible economic activity in town, as agriculture becomes less profitable each day.

The responsibility of promoting economic diversification was also attributed to local government. One of the participants reported that mining companies provide more benefits in social and urban infrastructure than the local government. In fact, mistrust in government was a very common complaint during data collection. Some respondents trusted the companies paid the mandatory taxes and obeyed laws, but the government misused the mining taxation. It suggests that governance and trust in political institutions may play an important role in social perceptions of mining activities.

Hoelscher and Rustad (2019) emphasize the importance of industries and government to engage enthusiastically with all social groups and discuss important issues. Facing and managing social past and current grievances is essential to transform them, in order to properly design in tandem a shared vision of a common future. Nonetheless, delivering short-term benefits should not be the main strategy, but rather a complement to commit the population with new sustainability paradigms, empowering them to change their present and future.

## 5 Conclusion

This paper aimed at understanding what drives the SLO and what triggers social dissatisfaction towards mining companies in the state of Pará (Brazil), based on CSR literature and analytical tools. Historically, this license has been used as a tool for promoting social resignation and minimizing social opposition, but it can promote sustainability and social responsibility if well managed. SLO studies can give voice to marginalized social groups in local communities and identify their perceptions and feelings.

The SLO in Parauapebas and Canaã dos Carajás is low, on **Acceptance** level (2.6, likert scale). Stakeholders tolerate the companies and allow they operations, but satisfaction and goodwill are weak. Rural workers, for instance, do not grant an SLO. Poor social engagement, environmental hazards and lack of transparency were the main factors that harmed the SLO in both cities.

Filling a gap in Brazilian literature on the SLO, the role of governance was found to be relevant in this context. Trust in government and legislation to hold mining companies accountable for environmental hazards strengthens trust in the companies and strengthens the SLO. Procedural fairness, interactions between company and communities, economic benefits and improvements in social infrastructure strengthened the license, whereas environmental and economic negative impacts harm trust and tolerance and support to mining companies.

The population **wants** and **needs** to be heard, to feel relevant to the business rather than merely labor force, consumer market and resources provider. Future studies in the region should reach even more mining cities in the state of Pará, assessing the influence of other variables in the SLO, such as: gender, race, poverty etc., including unemployed people among the participants.

Understanding the social dynamics and properly managing the SLO could empower social movements to create alliances with the companies, to generate long-term benefits and increase economic independence from mining industry. Thus, this study may guide companies and local government to adopt more effective strategies to improve sustainability in mining industry, correcting past mistakes and shaping an improved future.

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# A Preliminary Investigation into the Environmental and Social Dimensions on the Sustainability Triple Bottom Line


**Franciele Lourenço and Osiris Canciglieri Júnior**

## 1 Introduction

In recent years, human beings have caused unprecedented changes in ecosystems in order to meet the most diverse demands of societies, and these changes have brought benefits and harms to nature's ability to serve. In consequence of productive resources are limited and human needs are unlimited, several studies have been performed out in search of balance, theoretically is caused and solved by Say's Law—ability to balance supply and demand, this when promoting the dialogue of the actors, then, something a little utopia. Vasconcellos (2009) mentions that Say's law is when "supply creates its own demand"—translated by increased production, transformed into income for workers and entrepreneurs, who would be spent on the purchase of other goods and services.

However, this cycle becomes vicious, since companies need productive resources to produce, people (human resources) have to work to get income and, consequently, there is an imbalance, because needs and resources are limited.

Thereby, organizations are also forced to break paradigms, because new vision of reality, of thoughts, perceptions and moral values, cultural and ethical values; which seem to obtain common intentions that are not interrelated, for example, in 2015 the secretary general of the United Nations—UN, Ban Ki-moon, said that, when talking about preserving the land, "we don't have plan B or planet B", we can' forget

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the very lack of interrelationship between companies, community and government, considering the individual interests of each one or of society as a whole.

It is known that the concept of sustainability, despite being questioned, worrisome and considered by many to be current, it's a concern that has persists since the 1970s, therefore, a long time that there is a need for an disruption, making it possible to understand sustainability challenges, as we need, according to Almeida (2007) understand that the disruption is in relationships, in the way of thinking, and not only in technology and, the lack of resources, business will not survive and that. We need to leave the comfort zone and; understand that ethical behaviors bring economic gains, and not losses. Realizing that it cannot alone for financial reasons only, but for the existence and survival of man.

Officially, the concept of sustainability originated World Commission on Environment and Development—WCED, the objective was to disseminate the concept and propose a global schedule for awareness of humanity, combat environmental problems and scarcity of natural resources. Given that the impacts are masked by substitution agreements or financial compensation, but, the resources are not totally refunded and do not guarantee the continuity of humanity.

This movement gain force, starting several events, such as: Stockholm (1972), WCED, Copenhagen (1980), the Brundtland report (1987), Rio (1992), the Kyoto Protocol, among others. The discussions were growing day after day and, the most importantly, the concerns are being configured and reconfigured, especially when talking about decision making. Organizations seek for sustainable alternatives in order to keep their strategic and competitive position.

Therefore, according to the Brundtland Report (1987), entitled "Our common future", by the United Nations World Commission on Environment and Development (1988), the development of sustainability was defined as the capacity to meet human needs without compromising the needs of future generations.

That's what organizations are trying to do, transforming and fighting for strategies that are prepared for the new business reality and that its shareholders build their actions for the benefit of a higher number of social actors. Understanding that there is still a lot to do, in particular, realizing that the environment is not something that only serves to explore and generate wealth. Regarding with the concept of sustainability, Layrargues (1997) says that he doesn't have to worry about the development or protection of the environment, but what type of development is to be implemented from this moment, because, after the creation of technologies clean—the new competitive advantage in the market—development and the environment it became complementary. For this reason, the triple bottom line was divided into the three dimensions: environmental, economic and social—considered the most common. Purvis et al. (2019) says that: Despite the relative scarcity of literature that study conceptually the 'sustainability' and the 'sustainable development', a concept of the 'three pillars', environmental, economic and social, has spread. That is generally get as a balance of trade-offs between goals equally desirable in these three descriptions, although uses modify.

Layrargues (1997) characterizes the dimensions as: environmental—as a production model compatible with the ecosystem, that is, produce/consume while keeping

the repair ability or resilience of the ecosystem. The economic—your objective aims to increase the efficiency of production and consumption with to expand savings in natural resources through technological innovation—eco-efficiency. And the last dimension is the social dimension—a sustainable society supposes that there is social justice and that all citizens have the minimum necessary for a dignified life.

But why is sustainability important to people?

Sustainability is commonly studied together to the concept of sustainable development (system of mass consumption and concerns about nature), both linked to self-destruction—resulting from economic growth.

After all, aims to satisfy primarily expectations in terms of productivity, encouraging the consumption of goods and services, and, the quality of life (resulting from economic development) decreases and we find ourselves in a food crisis, economic crisis, social, environmental and to maintain future generations, therefore, the ecological system wouldn't support the forces exerted by the market, considering the current use of productive resources. Regarding the use of resources, another important point is the product life cycle, with phases ranging from development (start/project), introduction to the market, product growth and maturity until its decline. But what does the product life cycle have to do with sustainability? Have you ever wondered to think about how things are produced? What productive resources will be used? What is your organizational structure? How will your planning, investments and your release on the market? Anyway, how will the product's life cycle, during and after the end of its useful life?

Every product (product or service) generates some negative impact on the environment, in any of the phases of its existence, from the extraction of resources, production, distribution, consumption and discard.

We are convinced that, today, the society is living in a complex crisis of values—judging by the inability of judgment and decision, in relation to lifestyle, which surprises every day with new "modus operandi", it would be then a **Crisis of values or values in crisis**?

Thus, sustainability doesn't have necessarily a logical concept, however, this (in) definition is attributed the meaning of "less polluting", "ecologically correct", "socially fair", that is, the need for human beings make use of natural resources consciously, given their scarcity of them. Although the concept of sustainability is defended from a political perspective, in general, the economic aspect receives more significance than the environmental and social aspects, the latter being often ignored. That explains the fact that decision-making values business opportunities (economic dimension) and uses environmental capital only in an exploratory way, which in turn "forces" organizations to be environmentally responsible (environmental dimension). Finally, unfortunately, the process of repairing nature takes place slowly, facing the impacts of human capital (social dimension), as well as lack of responsibility and commitment in the same.

In view of the crisis and transformation, due from the triple "threat", this study verified the equalization of the social and environmental dimensions in the Triple Bottom Line, once, in its initial stages, only the economic dimension has been evident. The methodology adopted was that of a qualitative approach, with a theoretical essay

being carried out in a database, with the purpose of searching for concepts and establishing a theoretical structure that supports the analysis.

## 2 Methodology

This section aimed to present the methodology used for the development of this investigation. The adopted methodology deals with an exploratory research, Gil (2009, p. 41) conceptualizes it as one that "has as main objective the improvement of ideas and the discovery of intuitions". Given the readings and the survey of specific concepts and data base. The procedure was that of bibliographic research, Gil (2009, p. 44) defines it as that which is "developed based on material already prepared, consisting primarily of books and scientific articles"—the research was developed based on the articles available at data base of the Coordination for the Improvement of Higher Education Personnel (CAPES) and analytical reading books. Bibliographic and documentary research used existing data. However, the difference between them consists in the fact that the first uses data that has already received analytical treatment, that is, it is based on material (scientific articles and books) already published (Gil 2010). The methodology adopted was that of a qualitative approach, with a theoretical essay being executed through a data base, with the purpose of searching for concepts and establishing a theoretical structure that supports the analysis. As for the qualitative approach, Gil (2009) defines it as being everything that is quantifiable, and that can translate opinions and scientific information.

Its sample and collection, primarily, used the CAPES data base, however, after filtering, the population totaled 54 articles. While the content analysis referred to qualitative research, whose sources used were primary, secondary and tertiary, as described in stages 1, 2 and 3. Based on the keywords, considered central themes of the article, stages and procedures were laid out detailed below:

Stage 1: the research was determined by major themes arranged through the five keywords: (I) Triple Bottom Line; (II) Product Life Cycle; (III) Sustainability; (IV) Environmental Dimension; (V) Social Dimension.

Stage 2: Final search in the data bases. This stage led to the final search in the data bases, using the keywords and the data bases defined—the data base used as a reference was that of CAPES journals, as previously mentioned.

Some filtering procedures were applied in the data base for the final research and extension of the subject, with regard to the phases of the Product Life Cycle: "Product Life Cycle" OR "Obtaining Raw Material" OR "Development" OR "Productive Process" OR "Introduction" OR "Distribution" OR "Growth" OR "Use" OR "Maturity" OR "Final Provision" OR "Decline" AND "Triple Bottom Line"—"OR" (or) and "AND" (e) are used in order to associate the keywords, resulting in a greater number of words searched. This resulted in bibliometric studies recently published, originally in the English language, between January 2015 and January 2020, totaling 40 articles.

**Table 1** Countries and year of publication of data collection—40 articles

| Publication countries | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|---|---|---|
| Germany | 1 | 2 | 1 | 0 | 1 | 0 | 05 |
| USA | 2 | 0 | 4 | 4 | 2 | 0 | 12 |
| Netherlands | 2 | 3 | 3 | 2 | 3 | 1 | 14 |
| Lithuania | 0 | 0 | 0 | 1 | 0 | 0 | 01 |
| UK | 2 | 0 | 2 | 1 | 2 | 0 | 07 |
| Switzerland | 0 | 0 | 0 | 0 | 1 | 0 | 01 |
| Total | 07 | 05 | 10 | 08 | 09 | 01 | 40 |

*Source* The authors (2020)

Stage 3: The 40 articles were tabulated and separated by the dimension addressed (environmental, social and economic—the three dimensions were inserted, so that there was a comparison between them and their importance for the essay), following the stages of the life cycle product and its relevance(s) to the Triple Bottom Line. From then on, we realized that of the 169 keywords contained in the referred articles, the ones that appear the most, in a broad sense are: Triple Bottom Line (33 words); Sustainable Development (17); Sustainability (10) and Corporate Social Responsibility (5). Relative to countries and year of publications, considering, according to Table 1, the Triple Bottom Line has: (i) that Brazil doesn't have recent publications on the referred topic. It is high time to think about the construction of an ecological imaginary, which aims to group not only the three dimensions, but also the social and environmental dimensions; (ii) considering that Brazil is considered the barn of the world, care should be taken even more than other countries with financial dependence on imports and also to keep strategic positioning and activities.

## 3 Environmental Dimension on the Triple Bottom Line

According to Gimenez et al. (2012) "Environmental sustainability is often related to reducing waste, reducing pollution, energy efficiency, reducing emissions, decreasing the consumption of danger materials/harmful / toxic materials, decreasing the frequency of environmental accidents, etc.". Therefore, any and all ways of conserving the environment, giving it a good use or solutions to its use, in order to ensure its use for the benefit of future generations will be considered in the interest of the environmental dimension. Chang and Cheng (2018) also add that the environmental dimension refers to the conditions that involve human life.

In view of this, the environmental dimension also relates to environmental capital, which can be compensated or mitigated through the needs of society or environmental legislation, so environmental concerns should be thought out in advance and strategically, so that the impacts of the actions are reduced in the short, medium and/or long time, through an efficient environmental management and that deals

with clean processes and technologies. For example, one of the ways for a company to promote environmental sustainability is by adopting environmental education in the workplace. Debates, lectures, community actions that can serve as an example of environmental awareness can be organized. That means publicizing its importance and its benefits. After all if society walks towards a common goal, the journey will become less arduous and, so, who knows, we may reach sustainable development.

Silvestre and Tirca (2019) explain that the environmental dimension is:

An issue frequently discussed in recent years, which prevents us as a society from following a trajectory of sustainable development, is related to the environmental challenges that the world is currently confront. These challenges include, for example, air and water pollution, exhaustion and waste management, exhaustion of the ozone layer and, as result, and perhaps the most important is climate changes.

There is a growing concern and discussion around the reinless use of scarce natural resources, economic growth/economic development and the welfare of future generations has also won considerable relevance in the spotlight of scientific research. Unfortunately, the majority of society still doesn't see the real situation of our natural resources, closing your eyes for the lack of management or the almost or complete exhaustion of resources in the face of environmental problems.

These, at the national level, are several, such as: burning, silting of rivers, deforestation, and pollution of all kinds. These are relatively easy issues to mitigate, good investments and inspections were enough, the insertion of reforestation programs, the protection of springs, the use of renewable energy, reduction of water waste, soil depletion, efficient environmental policies, among other actions that aim at intensifying preventive actions and programs, in pursuit of the economic, social and environmental development. But, the search for the awareness of the actors is also done through more consistent and updated regulations and legislation, mechanisms that aim at protection around the excessive use of resources. Furthermore, it is easy to see that the human being will use sustainable industrial processes, if required by the government or by the demands of society. Otherwise, the high costs of implementing sustainable modes of production will be put aside, and their old form of polluting and "cheaper" production will come to the fore.

As they popularly say, the processes will only be modified if it hurts in your pocket! Be it poor or rich—which brings us to an unequal concern for the environment. This is due to the fact that there are consumers who are increasingly concerned with environmental issues and organizations that expect immediate profits through the so-called "green image". It is clear that the use of resources is not proportional to the results in organizations' financial income. These are proposed actions and returns that need to be carried out expecting positive long-time results. However, it is important to promote the continuous commitment and improvement of corporate managements, so that they involve the set of actors, in order to enhance them, engage them, promoting training and knowledge.

What makes the interrelation between the natural and the social and economic environment relevant, after all the socio-environmental issue - aims at the connection between man and nature, work and capital. Man uses nature, with this, he ends up being enslaved by his work and the need for survival makes him privatize nature

in favor of capital. Leaving the economic dimension a little aside, the concept of socio-environmental isn't yet known, the socio-environmental issue is understood as a "set of manifestations of environmental destructiveness, resulting from the private appropriation of nature, mediated by human work" (SILVA 2010, p. 144).

It is said that while capitalism ensures the continuous production and reproduction of the "environmental issue", as well as the social issue, it strives to minimize its manifestations, managing its contradictions through compensatory programs, based on respectful speeches human rights, "cooperation between countries" and the defense of the environment. That is, from this first understanding, it is possible to verify that the environmental dimension is evaluated not only by the individualistic conception, but collectively, after all, the big question is to ensure conditions that make survival on our planet viable.

With a view to survival, it is worth saying that prudence when using natural resources and awareness of the importance and risks to the environment are key factors in maintaining humanity and, in addition, result in important studies. The establishment of rules and regulations are necessary for environmental protection, in order to ensure minimum conditions of survival and well-being both for the current generation and for future generations.

With regard to the product's life cycle, the environmental dimension is becoming more relevant due to the legal and social requirements imposed, the internal and external effects that are being created in current and future generations. Thus, the management of environmental costs is associated with the impacts of the activity, of the product itself, and throughout its life cycle, therefore, it must be (re) adaptation, so that there are improvements in the process as a whole.

## 4 Social Dimension on the Triple Bottom Line

Social sustainability means that corporations (and factories) offer equitable opportunities, encourage diversity, promote connection inside and outside the community, ensure quality of life and provide democratic processes and responsible governance structures (Elkington 1994 cited by Gimenez et al. 2012). Therefore, when it comes to responsible governance, we automatically point to the four basic principles of governance, which according to the Brazilian Institute of Corporate Governance (IBGC) are: (i) transparency; (ii) accountability; (iii) equity and justice and; (iv) conformity (corporate responsibility). Wouldn't these four principles be considered the fundamental for growth and development of large corporations?

Transparency—provides information imposed or not imposed on interested parties; accountability—fully assume the consequences of their acts and omissions; equity and justice—it is the fair and equal treatment among all interested parties, taking into account the rights, obligations, needs, interests and expectations and; corporate responsibility—ensures the economic and financial viability and the policies, procedures and actions of the organizations.

For example, organizations that grow and tend to make their shares available on the securities market, must apply these four principles in their daily lives, so that the actors involved become aware of their dynamics, making their company more reliable and valuing it before the market and its shareholders. So, social sustainability aims to reduce social inequalities—giving access to basic services, sharing information, expanding rights. Therefore, the social aspect is important to promote the human person. Chang and Cheng (2018) say that the social dimension refers to the scope of human activities or settlement.

That said, the social dimension refers to human capital (society or community) it can be compensated or mitigated through social responsibility, that is, social concerns should be thought out in advance and strategically, in the form of social inclusion/behaviors, integration between people, that is, in the engagement of stakeholders—which aims to establish, keep and improve relationships with a focus on mutual benefits, internal or external to the organization.

Thus, Carrieri et al. (2009) they say that: even if organizations are composed of different groups, in terms of experiences, habits, customs, values, etc., there cannot be homogeneity in the discourse that reveals these constructions within them. After all, everyone's objective should be that of common actions, aiming at the welfare, quality of life and survival of all. As for the product's life cycle, the social dimension is more relevant in the decision-making process, applying social needs—beliefs, values, expectations, ethics, etc.

## 5 Social and Environmental Dimensions Versus Triple Bottom Line

If the connection between man and the environment is so intimate, it is surprising that nature is seen as something separate from us.

Unfortunately, it is constantly noted that most people do not perceive themselves as part of the environment, because a series of abuses against nature has been happening. Barbieri quoted Curi say that "the way we define the environment reflects our type of interaction with it". Since the beginning, the man, installed himself in certain locations, in a nomadic way, fearlessly explored all natural resources and, when these had already ended, he left in search of new areas, without regenerating nature after its departure. And it happened for a long time, until they were established in the form of social organization.

The concept of ownership, new technologies, the beginning of inequalities and environmental degradation have also continued. As well as, the manipulation, transformation and the profound impacts and abuses to the environment. These abuses, Fritjof Capra already reported a long time ago that it was "an ecological cause and effect literacy", that is, the human being has been feeling the bitter taste of his actions, the problem is that most of the times the burden falls on the less wealthy of

purchasing power, however, man's tools and predatory action, regardless of income, doesn't lessen his guilt.

Scholars then proposed the rational exploration of nature, which caused managers uncomfortable due to ecological initiatives to reduce profitability, but they saw no other way than to adapt. Giving greater emphasis to Product Life Cycle Analysis (PLCA)—considered a comprehensive management mechanism—according to CURI "the great advantage of PLCA is to evaluate the environmental impacts at different levels, from the extraction of raw materials to their waste disposal". In this regard, it is known that the five phases are important and that they aren't easy to analyze, as they overlap as changes arise. We must not forget that the concept of management must be constantly reviewed, after all, everything is constantly changing, people, products/production processes, fashion/trends, organizations, resources used, etc.

Therefore, it is necessary to think of something that is at least viable, endurable, sustainable and equitable, it would be the great start to think about the Triple Bottom Line. Previously, organizations were obviously looking for profit, and were almost satisfied, however, this objective is no longer sufficient to remain active in the products and services market and new strategies are being devised almost daily. Consumers have become more demanding, technological innovations faster and suppliers and/or partners more engaged. So, it is reasonable that companies have to pay attention not only to economic aspects, but to environmental sustainability and the needs of society.

The combination of environmental, economic and social acts must ensure balance and a good relationship, referring to "corporate responsibility". Due to this fact, previous studies on the supply chain, in particular, the product life cycle focused on economic aspects, failed to address the social and environmental dimensions, as their market view didn't let them realize that the interests go beyond the economic aspect.

Because of this, the 1990s were marked by a several debates regarding sustainable development, which, according to Oliveira cited by Oliveira and Souza-Lima "is the concern of society with the future supply of products and services indispensable to the survival of humanity". In other words, it is concerned with strangling production, preserving the environment and managing it—which should raise environmental awareness. Therefore, innovations, expectations, stakeholder engagement and sustainable practices are part of the new purpose of organizations. And, the objective of the sustainability assessment is to ensure that products, processes, plans and activities contribute in an ideal way to sustainable development (Verheem and Tonk 2000 cited by Ahmad and Wong 2018). After all, when we talk about development, we mention the satisfaction of human needs and aspirations. With that, Purvis et al. (2019) says that:

> Parallel to the three pillars can be seen in Campbell's "planning triangle". Campbell produced a model of what he considered three major objectives or priorities of urban planning: social justice, economic growth and environmental protection (Campbell 1996 cited by Purvis et al. 2019) Campbell argues that these objectives introduce three fundamental conflicts, but at the center illusory of the three is 'sustainable development', the balance of these goals. Campbell recognizes the difficulty of finding that balance, emphasizes the need to

think holistically and move towards the shared language, and recommends collaboration between development planners and environmental planners. Campbell's discussion explicitly highlights the notion of conflict or competition between these objectives and the need for interdisciplinary approaches to elaborate them towards a more comprehensive and rigorous conceptual framework.

In the long time, the development of a region can be explained by the environmental, economic and social dimensions, however, as seen above, the concern is mainly focused on the economic aspect, while the allocation/availability of resources and social activation—capable of emancipating people in favor of quality of life is slowly changing. It is noticed that there are already debates about the instability of the axes of the triple bottom line, Freitas (2011, p. 49) says that "any and all developments that become homicidal or denier homeostasis, even if they pay high taxes, will be unsustainable". Each and every model cannot be exclusionary, therefore, ensure survival and connection between all, generating social justice, dismantling discrimination, hunger, poverty, inequality and giving the right to quality access to health, security and education—through actions positive, objectives will be more easily universalized.

With regard to the environment, it is important to have responsibility for environmental degradation, crime, longevity, eco-efficiency, without this, human life would be rendered unfeasible. Therefore, if companies do not adhere to this new economic-socio-environmental paradigm—Triple Bottom Line, mainly with greater emphasis on the social and environmental aspects, their future will be compromised.

## 6 Final Considerations

The analysis allowed to understand that the attempt to unite the dimensions is done in an unbalanced way and that they still have a relative scarcity of scientific research on the theme in Brazil. Therefore, the triple will never be sustained with just one or two pillars, as well, corporate sustainability will not be in harmony, without the balance between product, process and people. After all, the sustainable posture contradicts itself, thinking that the sacrifices to life will be replaced again, as well as the environment itself with a payment for environmental services, damage repair, circular economy, etc., because pollution and degradation remains and that may not be able to be restored to nature. It seems that time, space and the environment are not harmonizing. And, the speeches are focused only on discussions of broader topics, such as: Sustainable Development, Triple Bottom Line, Corporative Social Responsibility and Sustainability. Because most articles are concerned with:

- Sustainability indicators—determined through data that aim to improve or not, mainly focusing on processes;
- Sustainable purchases—take into account consumers who are interested in sustainable purchases and even compare products that are not so sustainable with those of current technology and of 'green image';

- Supplier development practices—promoting development in providers, but not necessarily, with a view to social development, but of an economic nature;
- Corporate responsibility—translated into responsibilities that should be dealt with in a balanced way, but which, nevertheless, aim at responsibilities with regard, in the majority, only to the technical productive process;
- Decision making and organizational sustainability—keeping the company's image, or making decisions that target production itself;
- Project management—that develop products that are "easy to sell" to the public that believes in environmental sustainability, however, the focus is only on the product and not on the concern with the social and environmental dimension, among others.

However, the immediate and extreme need for research on topics, such as socio-environmental education; social and environmental awareness, behavior, responsible management, eco-efficiency, social equity, social and environmental impacts, biodiversity, supply management, environmental education, ecological and/or nature conservation and which require the commitment of the State, companies and people at the same time, not many results were seen. This study found that there is no equalization of the social and environmental dimensions in the Triple Bottom Line, the dimensions are unbalanced and unfair, since, in its initial stages, only the economic dimension has been evident and, in the subsequent moments, the two still remain in unbalanced, after all, further improvements, education and the updating of government agencies (laws and regulations), companies (productive resources and production models) and people (awareness and knowledge of cause). The publications show that organizations adopt sustainable means only when it is required, for increasing market share or for having a misunderstand regarding the function of the triple - which necessarily values the balance of the three dimensions. Not least, because the majority claims that the adoption of sustainable methods is still very expensive and, since the majority doesn't yet have the resources automatically, they end up with the "old practices".

Understanding that there is a lack of dialogue and engagement between the actors, which ends up harming a greater percentage of people who think about future generations, but in a conscious and polite, polite with meaning of knowledge of the risks—resultant the negative impacts regarding not only the environment and the social, but also the economic, because, currently, it is only thought about financially, but have a money tomorrow may not necessarily mean a competitive advantage.

When this happens, the necessary balance of the triple is promoted, reducing poverty, inequality, the exhaustion of productive resources and having environmental management and education that generates welfare and quality of life for society, who knows, this will be very close to positive indicators and on the path of long-dreamed sustainable development. There are more studies and construction proposals are needed that give greater attention to the social and environmental dimension, due to the fact that the results of the keywords are more evident and the number of publications (despite being a small universe, considering that publications from the last 5 years were analyzed) do not consider the equality of the two dimensions,

let alone the three. Finally, it is also essential to consider the trade-off, mentioned by the authors Purvis et al. (2019) translated by the conflict of interests, which ends up once again deconstructing the objectives considered common among the three dimensions.

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# Information, Communication, Education and Training

# The Strategy of Social Responsibility at Universidad Pontificia Bolivariana Toward the Implementation of the Sustainable Development Goals


**Ana Elena Builes Vélez and Paula Andrea Zapata Ramírez**

## 1 Introduction

Universities have a great responsibility in promoting the necessary conditions for the challenges posed by sustainable development to be overcome. Despite their budget and administrative limitations, they have a strong and viable ecological argument, understanding that they can reflect on possible ways of changing consumption practices procuring the conservation of natural resources. In this context, some nations have already been developing programs and operating strategic actions to act toward mitigating the degradation of environmental, social, and economic resources and toward the achievement of the sustainable development goals (SDGs) by 2030. In this sense, universities, because of their substantive work in research and innovation, are called upon to find solutions to unsustainable practices and environmental problems to catalyze transformations responsibly. Consequently, and connecting with the Universidad Pontificia Bolivariana's (UPB) goals of stewardship and academic achievement both in and outside of the classroom, we have constructed a plan for making the university campus more sustainable. The UPB is an institution with 83 years of foundation and has five campuses in several cities of Colombia, with the main campus (headquarters) located in Medellin, capital of the Department of Antioquia, located in the northwest of the country. The headquarter campus has an area of approximately 20 ha and an average population, between fixed and itinerant, of about 20,000 people. This community interacts in a variety of spaces: 25 buildings, restaurants, sports areas, laboratories, cultural spaces, and gardens.

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## 2 Methods

This work illustrates several of the internal and external approaches the UPB has been carrying out in order to achieve its institutional Mission and the strategy to promote the SDGs in their daily activities. To do so, we compiled several institutional documents and reports that contain the methods and results obtained from different efforts and projects. In addition, we also documented how the UPB is integrating corporate social responsibility (CSR) and sustainability measurements in their Strategic Plan (2017–2025). Particularly, we outline the following strategies: (1) organizational culture based on CSR and sustainability, (2) UPB internal key actions, and (3) UPB external actions in support of the SDGs.

## 3 Results and Analysis

### 1. Organizational Culture based on CSR and Sustainability

The previous organizational culture was based on a traditional administrative manner that did not take into consideration any sustainability strategy. Hence, in order to achieve the transition from this traditional way of reporting management results to a more holistic expression, the sustainability report, which is a CSR and sustainability performance measurement that integrates sustainable methodologies for corporative reports and gathers the *Global Reporting Initiative* (GRI) standards, is used. It has been necessary to articulate the efforts of the different areas of the university in the main headquarters and in its different national campuses toward the process of sensitization, education, and application in the areas of governance, materiality analysis, characterization of interest groups, and impact management indicators. With this, the institution has begun to unify a common language and frame of reference, as well as a meeting space for critical reflection and proposals, always aiming to achieve the institutional Mission.

To achieve the challenge of changing the organizational culture, it was necessary to implement CSR in the core of the organization. Understanding CSR as "how businesses align their values and behavior with the expectations and needs of stakeholders—not just customers and investors, but also employees, suppliers, communities, regulators, special interest groups and society as a whole." (Fontaine 2013) The CSR requests the organization actions that allow the management of economic, social, and environmental impacts of its operation to reduce negative outcomes and maximize the benefits for the stakeholders, the community, and the society.

In organizational terms, sustainable development is the highest commitment of the administrative and teaching staff of the university (Gomez 2018); this implies that the institution continues to exist and that it achieves its Mission and the Strategic Plan. The institution has been aware of the commitment to leave the new generations a better world and the importance of educating those generations with the understanding of their commitment to living in a sustainably. In particular, the Strategic

Plan declared the importance of an integral model that considers the care of the renewable and non-renewable resources used daily by the institution, designed to protect and to strengthen the social capital of the university community. Hence, the UPB recognizes and appropriates the call of the GRI to consolidate a sustainable economy in which organizations are managed responsibly and comprehensively, and transparently communicate their management to different stakeholders.

Beyond the numbers and measurements, the challenge of the institution is to create a culture of sustainability with which all the organizational work is permeated, to make possible its great commitment to envision a better world for the present and future generations. In other words, for UPB, sustainability means good practices, leadership, transparency, and accountability. It is important to highlight that in January 2018, the World Economic Forum ratified the need to strengthen the commitment to sustainability in order to help its partners and members make a substantial contribution toward sustainable development and, in this sense, has offered a platform for public–private cooperation. Sustainability policies of organizations are more prone to succeed if all the different parties are involved. The participation of stakeholders, suppliers, and others to join shared efforts that generates collective outcomes, as opposed to individual actions, results in superior effects that are more comprehensive. However, before embarking on the path of sustainability within the institution, it is necessary to establish a measurable action plan, such as the Strategic Plan (2017–2025). This plan should have achievable and challenging goals since what is not measured is not improved. It is also necessary to establish indicators to monitor the implementation of the sustainability plan and achieve a balance that allows the organization to endure over time in an increasingly competitive international environment.

Through its 83 years of existence, the UPB has had as one of its guiding principles the positive impact on each of the dimensions of what is now called sustainability. In terms of its structure, the institution has designed a series of policies aimed at promoting the well-being of its stakeholders. Throughout several administrations, this policy was aligned with the initiatives that occupied the panorama of social responsibility: The Global Compact and the Millennium Development Goals. Certainly, and in accordance with the Sustainable Development Objectives, efforts, such as the setting up of an Environmental Committee during 2017 conformed by a interdisciplinary team, have been made. The committee is led by the Environmental Research Group at the UPB headquarters in collaboration with the Colombian National Center for Cleaner Production. They built the annual report where measurements of the environmental footprints and the use of waste disposal, among others, are addressed.

One of the most important achievements of the first Sustainability Report (2017a; b) was the establishment of the bases for the analysis of unsustainable practices and the identification and prioritization of interest groups that are part of the university. Interest groups are conceived as actors constituted by persons or entities that have direct or indirect influences in the activities and decisions correlated with the performance of the UPB organization. It has been configured as an essential element in strategic planning, as indicated in the GRI Standards (2016).

Finally, the university begins to achieve the articulation of the teams at the headquarters campus since it has been found that the methodological approaches and the tools used in the report are also transferable to the multi-campus units at the national level, favoring cooperation and networking. It is necessary to continue working to achieve a coherent and interconnected UPB multi-campus strategy in sustainability, as a response to the expectations of interest groups that are increasingly attentive and aware.

2. **UPB internal key actions**

- **UPB Micro-Network**

By 2050, 70% of the world's population is projected to live and work in cities, with buildings as major constituents. The energy consumption of buildings contributes to more than 70% of electricity use, with people spending more than 90% of their time in buildings. Future cities with innovative, optimized building designs and operations have the potential to play a pivotal role in reducing energy consumption, curbing greenhouse gas emissions, and maintaining stable electric-grid operations. The digital evolution presents a great opportunity to achieve the goal of the modernization of the conventional electrical system by transforming it into a smart grid. Smart-Grid environments are focused on creating and using information and communication technologies to support new and potentially more sustainable ways of producing, transmitting, distributing, and consuming electricity. They offer the possibility of greater monitoring and control throughout the power system and, therefore, a more effective, flexible, and lower-cost operation. The security conditions, diversity of end-use, instrumentation, and presence of the appropriate human resource make the UPB campus headquarters a perfect scenario to implement and appropriate in a controlled manner many of the technologies that characterize living labs. The strategy is named *the UPB Micro-Network program,* and its central operation is located at the heart of UPB infrastructures, where the power distribution network is located. The Micro-Network supports various systems, including laboratories, safety, water, food, transportation, and communication. For instance, from the control center, real-time monitoring activities are conducted to follow the performance of the photovoltaic solar generation systems, the weather station, the electric vehicles and cycling charging stations, and other functions vital to the university's community. We are also implementing a smart building technology by using information about occupant locations and activities in order to improve building efficiency at the UPB headquarter campus (Isaac-Millán et al. 2018).

- **Integral Waste Management Strategy**

Waste, as a management issue, has been evident for over four millennia. Waste management is characterized by all the activities and actions required to manage waste, from its inception to its final disposal, and intends to reduce adverse effects of waste on health, the environment, or aesthetics. This includes collection, transportation, treatment, and disposal of waste, together with monitoring jointly with a regulatory framework relative to waste management (Popescu et al. 2016) (Fig. 1).


**Fig. 1** UPB Micro-Network central operation. Sustainability Report UPB (2017a; b)

UPB already has planned and implemented many successful reusing, recycling, and composting programs across the headquarter campus. The waste diverted from landfills has increased annually. In particular, the university has implemented an integral waste management approach, following the indications of the GRI Standard 306-2/306-4 (GRI Standards 2016). For instance, results of the integral waste management between 2017 and 2018 are as follows: ordinary waste 32.75%, recyclable 18.59%, organic waste 32.70%, Respel waste 0.5%, and special waste 15.48% (Fig. 2).

As part of the integral waste management**,** the UPB headquarters is currently implementing a bio-digester strategy as an additional approach to manage the waste produced at the campus. To that end, the university has designed, built, and acquired prototypes of anaerobic digesters of diverse technology and at various scales. A bio-digester is a method of closing the food-waste loop. The process takes the undesired food waste and turns it into two separately valuable products. Pre- and post-consumer food wastes are collected to be chemically decomposed in an airtight chamber. As the waste breaks down, the biogas created can be harnessed to produce clean, versatile energy. Solid remnants after decomposition are nutrient-rich and used as compost, returning the food waste to the earth (Hambrick 2011). Currently, the UPB produces an average of 120 kg of restaurant waste (processed and unprocessed food) daily. Pruning residues (branches, dry leaves, and fruits, among others) are also added to the waste because of the large green area of the campus of almost 20 ha. So far, two bio-digester systems have been installed at the headquarter campus. The first is a testing prototype designed at the university. It can take 50 L of feedstock per day and produce 600 L of biogas and 4 kg of a biofertilizer that is afterward used on campus

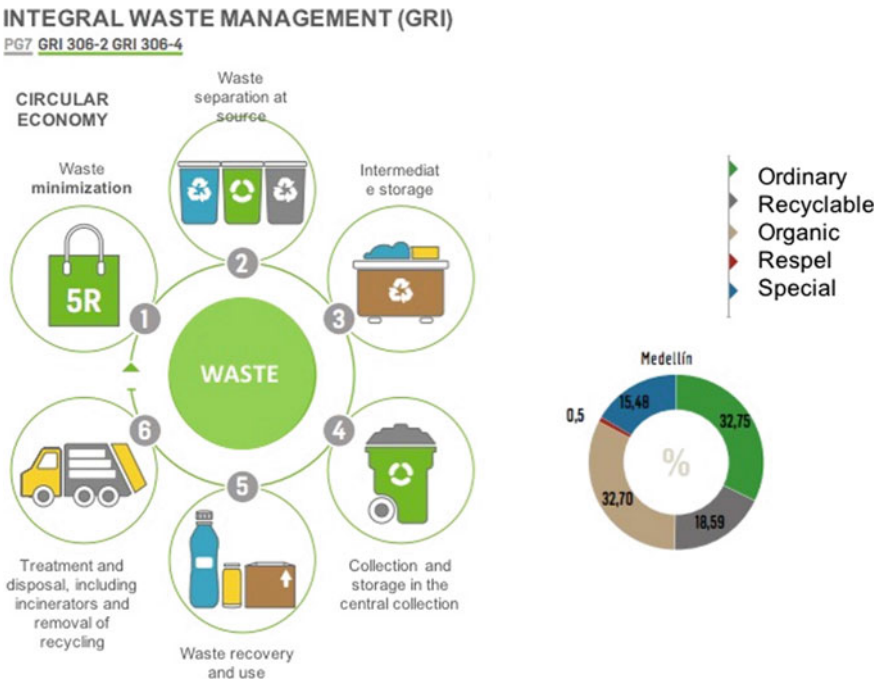


**Fig. 2** Integral Waste Management UPB Medellín. Sustainability Report UPB (2018)

to grow crops at the urban garden. In addition, a second low-cost bio-digester (650 L) system was purchased (Fig. 3). Both systems are planned to be used for the treatment of wastewater and the co-digestion of restaurant waste, to reduce the carbon footprint and improve the environmental aspects in water, soil, and air. The results of these tests will be used to escalate the treatment of waste at a larger scale.

Future efforts are focused to further increase recycling and composting on campus. Each building will conduct multiple waste audits to further understand the amount of waste produced and the types of waste products generated in the different parts of the university. All these actions will help the university to effectively and actively stimulate recycling practices on campus among students, the staff, and the faculty in general, through highlighting and encouraging the participation in waste reduction. Additional waste reduction initiatives and programs, such as the banning of single-use plastics and the reduction of paper consumption with the '*Zero Paper Document Management*' campaign, are being implemented and will be critical to help ensure that the UPB reaches the ambitious goals stated in the UPB Strategic Plan.

Furthermore, through the GRI 303-2 strategy (GRI Standards 2016), it was possible to review and measure the water consumption at the headquarters campus, which allowed the consolidation of an improved culture focused on the correct usage of water resources. It is important to recognize that the water consumed at the headquarters' campus is supplied by the public aqueduct and, therefore, the extraction of

**Fig. 3** Bio-digester UPB headquarters—Medellin. Picture provided by Oscar Vasco (2018)

this water is carried out by the company that provides the service. It is also important to note that during 2018, wastewater characterizations were performed at the headquarters' campus. Nonetheless, rainwater is also collected and used to supply the firefighting networks, the sanitary units of buildings 9, 10, 18, and 11, and the parking lot building. Thus, of the 100% of water consumed at the campus, 29% is supplied by rainwater (UPB 2018, p. 46). Figure 4 represents the water footprint at UPB Headquarters between 2017 and 2018. Indicators are measured by $m^3$/student.

In order to achieve the Carbon Neutral Certification, a carbon footprint calculation was carried out to meet this challenge. To do so, we used the methodological approach suggested by the Greenhouse Gas Protocol (GHG and GHG Protocol Standards 2015). In the measurement, four categories were taken into consideration: goods and services, leased assets, waste generation, and business travel (air and land). Figure 5 shows the direct and indirect emissions with their respective value equivalent to $CO_2$ (UPB 2018, p. 48).

- **UPB Smart House**

The Intelligent Micro-Network of the UPB and Materfad-Materials Center UPB, together with the Schools of Engineering, Architecture, and Design of the university, throughout an interdisciplinary project, conceived and designed the Habitat house (Fig. 6) as part of the strategy for the Smart Living Lab. During this project, UPB researchers designed a living house–laboratory with an area of 80 $m^2$. The project

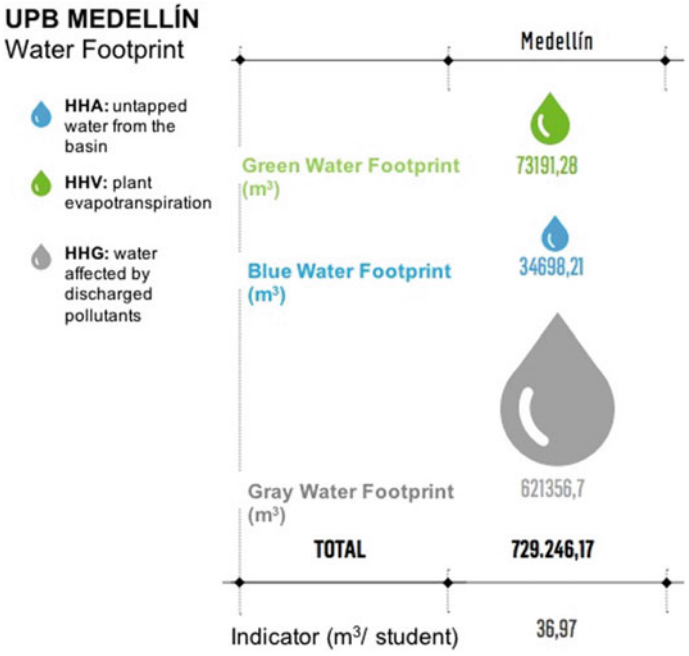


**Fig. 4** UPB Medellín Water Footprint between 2017 and 2018. Sustainability Report (2018)

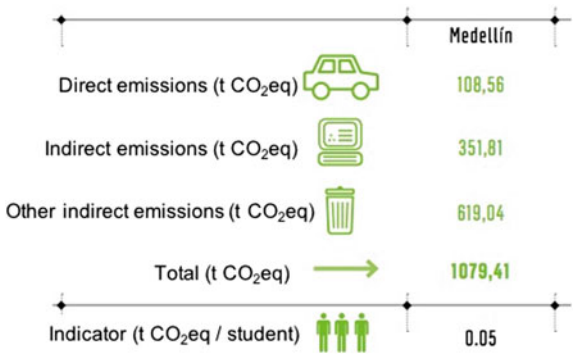


**Fig. 5** UPB Medellín Emissions 2018. UPB Sustainability Report (2018)

followed the three basic elements of smart living spaces: (1) smart technology, (2) smart materials, and (3) smart design. The house arose from a bioclimatic design, made with materials and construction processes that contribute to sustainability practices, and has adequate accessibility conditions for people with reduced mobility. The house has an integrated system for the generation of electricity from solar panels, homemade bio-digesters, and batteries, which can be connected or disconnected from the public service network at will. The space is domotized, that is, set up with intelligent control and automation of different elements (lighting, sound, temperature,


**Fig. 6** UPB Habitat House. UPB Sustainability Report (2018)

curtains, and security, among others). LED lamps allow access to the place at night. Additionally, urban micro-agriculture, such as home gardens with automated irrigation, green walls, crops built from recycled materials, and an aquaponic system, are also part of the smart house. The control center of the Intelligent Micro-Network of the UPB constituted the place where the system's performance is shown by means of graphical visualization systems. Finally, the project is very important for academic purposes since students also use the house as a space to practice and familiarize what they have acknowledged and to appropriate new technologies. The house constitutes a solution that looks forward to the possibility of bringing energy to remote areas of the country, reducing consumption, protecting the environment, and increasing energy efficiency.

All previous UPB strategies are of vital importance, in particular for Medellín and the university itself, since the city has been increasingly facing progressive environmental issues. The area in which the city and university are located, called Valle de Aburrá, shows a significant and incremental deterioration in air quality. The indicators of respirable particulate matter of 2.5 and 10 μm exceed the limits established by the environmental standards. According to the Medellín Ministry of Health, about 15% of non-violent deaths in the city are caused by respiratory diseases (Isaac-Millán et al. 2018).

Through the sustainability annual report, the information gathered in all of these internal strategies is being used to report to the UPB community fine-grained feedback about electricity, water usage, and waste management. The information is also being used for decision-making support, performance studies, protocol evaluations, development standards, security requirements tests, and automated functions, with

interoperability of new technological devices needed for the development of future smart- and micro-grid technologies at the headquarters campus, but also with the aspiration of replicating these practices and implementing them in other UPB campuses or, with a reasonably cost-efficient deployment, in remote areas of the country.

As a result of the combination of all these multiple strategies, the university was awarded the Carbon Neutral Certification (2018), provided by The Colombian Institute of Technical Standards and Certification, thus, becoming the first Latin–American university to receive said acknowledgment. This demonstrates the full commitment of the institution and recognizes the efforts made by the UPB to proactively manage sensitive issues in order to address the impact of climate change in an efficient fashion.

## 4 UPB External Actions in Support of the SDGs

The UPB is enhancing its research, transfer, innovation, and development activities in five strategic focuses: (1) health, (2) culture and humanization, (3) information technologies, (4) energy, and (5) water, food, and territory (Fig. 7). These focuses allow the institution to identify and systematize the relationship between internal capacities and the challenges posed in the global development agendas, which outline the social problems of today's world with relation to life, habitat, ecosystem resources, and future challenges. This strategy also conveys the UPB's capacities to evidence the challenges of greater impact, allowing the creation of scientific committees to provide analysis, advice, and consultation to the UPB's informational structures and to the community in general. In this sense, the UPB has decided to prioritize its strategic focuses, combining them with academic, scientific, and technological processes that allow it to generate a high social impact, according to the humanist identity, but at the same time, innovative in its pertinent impact.

One of the strategic focuses is *Water, Food, and Territory*, to convene human and institutional capacities toward the study, research, transfer, and innovation of resources and processes that are fundamental to the existence of life and the well-being of people and communities. Bearing in mind that these resources and processes are constitutive of the preservation and reproduction of life from a biological and social point of view, and access to them is mediated by culture and human needs,

**Fig. 7** Graphic representation of the Strategic Focuses of UPB. From left to right: (1) Culture and Humanization, (2) Water, Food and Territory, (3) Energy, (4) TICs and (5) Health. Reproduced from Sustainability Report UPB (2017a; b)

in addition to the fact that their interaction is a priority for human beings and their relations with the environment. As a result, this focus is established as an institutional bet that seeks to confront problems related to water, food, and territory, in the context of society's relations with nature. These problems go through the interpretation and design of proposals from interdisciplinary fields, considering that the UPB stands in a privileged position where it is possible to draw attention to what is happening in society. Sectors, groups, institutions, and society all look up to academia for scientific, technical, and comprehensive interpretations to think critically about alternatives in the face of specific manifestations. Concurrently, another strategic focus, energy, seeks for solutions that satisfy the rising high-energy demand in the coming years. This demand will be supported by the implementation of new energy sources, greater efficiency, balance in the distribution of energy resources, as well as new lifestyles, which allow the adjustment of the variety of costs and minimize the environmental impact generated by the population's growth. Both of these focuses recently joined efforts to promote collaborative work and the articulation of academic-administrative initiatives that enable co-creation between schools, faculties, and research groups (internal relationship of the academic-research communities). From this internal collaboration, a joint program was launched and entitled *Habitat and Sustainability*. The program aims to implement an interdisciplinary mobile laboratory that allows a dialog of knowledge between the communities' traditional knowledge and the systematic knowledge generated in academia. Jointly and collaboratively, the mobile laboratory seeks to build solutions to social problems related to a more sustainable habitat that can improve the livelihoods of different communities. After its configuration, the program built a map of capacities that contains the relationship with different stakeholders and the previous cooperation efforts made inside and outside of the university. Hereinafter, the program stated their lines of actions in order to ensure solid and strengthened proposals that were in line with the SDGs and with the Strategic Plan of the university. Particular attention was put on previous initiatives related to healthy living habits, environmental sanitation measurements, minimum conditions for living in a house and for obtaining and using energy, the minimum technical construction for the of housing stability, the adequate use of resources and sustainability, identification of available resources and their proper use, empowerment of their culture, territory, and capabilities and, finally, education with an intercultural approach, respecting and reflecting the knowledge of different communities.

The lines of actions of the program and its manifestos are as follows:

– Governance and Governance for Sustainability

The line understands the complexity of the interaction between stakeholders, society, the private sector, the state, and the academia for political processes of decision-making and formulation and implementation of public policies in a participative and collaborative manner in the search for sustainable, inclusive, and equitable development. Therefore, the line addresses questions of how, by whom, and for whom environmental decisions are made and about the access, use, appropriation, and

distribution of natural resources, thus contributing to changes in the way that society organizes itself to solve its dilemmas and create new opportunities.

– Ecosystem services and Infrastructure

The line will deal with issues related to the management and sustainable use of the ecosystem services, as well as issues related to the infrastructure, understood as the environment where a cycle of interaction and exchange of resources (matter, water, energy, communication, social, money, etc.) toward the development of society and common welfare in the built habitat takes place. While ecosystem services are understood as the benefits that nature brings to society, such as supply, regulation, support, and cultural value, the line can address problems and challenges related to materials, waste disposal, valuation of ecosystem services, responsible use of resources (energy, water, land, and air), availability of food, access to public space, recreation, and cultural expressions, among others, ensuring rapid and non-polluting mobility. The line will also address climate change issues such as resilience, adaptation, and mitigation.

– Housing and Social Interaction

The line on housing and social interaction tends toward a systemic vision, considering that no single aspect leads to a sustainable habitat. For this reason, the study of construction practices, materials, mobility, public space, and green space, among others, seen in their interrelation, are of interest. Empowering citizens to use different mobility solutions and to integrate them into the innovation process, motivating them to participate, putting the right tools in place to enable a bottom-up dialog, and translating ideas into sustainable commercial products or services, are also tackled in this line. This implies, among other factors, the needed education, and participation of citizens (including the users, government, and industry), around topics related to the projection of their environment, their interests, and the social and ecological implications of the construction of housing or infrastructure with certain characteristics.

## 5 Conclusion

The different strategies reported herein were important for the understanding of the current sustainable approaches on the headquarters campus and the obstacles that the university must overcome to become more sustainable and to fully fulfill the goals stated in the Strategic Plan. To do so, we are constantly in contact with other universities that have served as models for sustainability practices, attempting to learn how their various communities' initiatives succeeded in implementing similar strategies. Furthermore, the results show that it is important, and necessary, to create clear medium- and long-term strategies. Hence, the next efforts should focus on infrastructure improvement and the expansion of the technological capacity that could contribute new strategies to confront the increasing environmental challenges.

Sustainability needs to be thought of and acted upon as a harmonic compound of three great systems: the economic, the social, and the environmental. To solve today's most pressing development and sustainability challenges, the implemented UPB strategy has allowed the establishment of synergies between universities and research institutes and partnerships with the industry, government, and communities, in order to tackle several national development challenges. These synergies have enabled a more collaborative work, building trust among all the interested parties, and therefore, allowing the design of appropriate scalable solutions that could contribute to the achievement of the SDGs.

With the continuation of the strategy, the UPB has been linked to different national and international research networks on sustainability, to develop collaborative research and development proposals. One of the networks is *ROUTES Toward Sustainability* (2019), in which around 50 universities around the world are involved. This network has promoted an annual meeting to discuss the impacts of the multiple ecological, economic, and social footprints, as well as the development of research proposals for the Horizon 2030. Another important international partnership is *LeNS* (2019), the *International Network of Networked Learning on Sustainability* (2015–2018), an EU-supported project (ERASMUS+) involving 36 universities in Europe, Asia, Africa, South and Central America, with the target of promoting a new generation of designers (and design educators) capable of contributing effectively to the transition toward a more sustainable society for all. This network has worked on the development of educational strategies for the implementation of sustainability in the different programs of the university.

The final question that may arise after reading this paper is: can an integrated internal approach toward the implementation of the SDGs really make a substantive contribution to achieving sustainability inside the university that can impact the community? As Galpin, Whittington, and Bell explained, having an organizational infrastructure that promotes a culture of sustainability results in a positive employment and a more structured organizational level of sustainability and performance (2015). Nevertheless, to achieve the desired results from the university's sustainability efforts, leaders, in all levels, must continue to encourage a sustainability practice focused culture that permeates all levels of the university.

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# Pedagogical Sustainability Project Addressing Environmental Problems in Cabo Frio, RJ, Brazil

**Regina Célia Soares Pereira, Sandro Carlos Pereira, Maria Alzira Pimenta Dinis, and Luis Borges Gouveia**

## 1 Introduction

In recent decades, the municipality of Cabo Frio, RJ, Brazil has suffered frequent environmental impacts due to the disordered urbanisation process. Another factor that contributed to the anthropic effects was the temporary tourism, occurring unplanned, increasing the pollution of Araruama lagoon and decreasing the water supply, particularly in the most remote neighbourhoods of the tourist centres, besides significantly increasing solid waste (SW) in the city and on the beaches of the region (Romão 2018; Pereira et al. 2019).

According to surveys of basic sanitation from the Brazil Institute (BI 2018), the population of the municipality of Cabo Frio is 216,030 inhabitants. Data from the Brazil Institute show that of the total population, only 159,204 (73.70%) have access to clean water and 56,826 (26.30%) do not yet have this service. Regarding sewage collection, the Brazil Institute points out that only 129,055 (59.74%) of the population have this infrastructure, leaving 86,975 (40.26%) citizens out of these essential

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systems. In percentage, the numbers show that 73.70% of the total inhabitants of Cabo Frio municipality have access to safe drinking water. However, 26.30% of this population does not yet have access to this service. On the other hand, concerning the provision of sewage collection services, the scenario is worrisome and unequal, as availability applies only to 59.74% of the city's citizens, leaving 40.26% without access to the service.

It is noteworthy that the national basic sanitation guidelines in Brazil, Law 11.445 (Brazil 2007), deliberate on universal access to essential sanitation services to the population, which includes water supply, sanitary sewage, urban cleaning and water management, as well as a SW handled in a manner suitable for public health and environmental protection. This law is ratified by analysing the sixth Sustainable Development Goal (SDG), set by United Nations Educational, Scientific and Cultural Organization (UNESCO) (2015), which aims to ensure the availability and sustainable management of water and sanitation for all. However, and based on research from Brazil Institute it is possible to perceive that this context is quite contradictory about what is established by Law 11.445 (Brazil 2007) and its relation to the objectives of the SDGs.

This scenario justifies the need to develop strategies and pedagogical projects in the face of social and environmental problems and the marked local water crisis so that it glimpses the pedagogical praxis contributing to the formation of citizens active in the construction of a more sustainable society, also addressing social responsibility in schools. The school should be a space where reflections, discussions and practices of environmental education, concerning local social and ecological issues, are able to promote knowledge supporting sustainability actions (El Tugoz et al. 2017).

Conservation and correct management actions are alternatives to promote sustainable water use (Carli et al. 2013), to be addressed during school awareness pedagogical practices. In this sense, it becomes relevant to sensitise teachers and students to act in a conception of Critical Environmental Education about the local socio-environmental reality (Guimarães 2016). As highlighted by Otto and Pensini (2017), the development of work from an environmental perspective aims not only to impact an individual's internal representations in the world but also to awaken behaviours appropriate to the context in which citizens live.

In Brazil, Law 9.795/99 (Brazil 1999) defines that environmental education is an essential and permanent component of national culture, having as one of its principles the articulation of local, regional, national and global environmental issues. From this perspective, the fourth SDG states as one of its purposes that quality education provides students with the knowledge and skills needed to promote sustainable development and healthy lifestyles.

It should be emphasised that the city of Cabo Frio/RJ has two critical public institutions, both high school and technical, the Fluminense Federal Institute, campus Cabo Frio (FFI-CF) and the Ismar Gomes de Azevedo Education Institute (IGAEI). Both contain environmental guidelines. The pedagogical proposal presented in the Minimum Curriculum of the Teacher Training Course (SEEDUC 2013) aims to develop educational actions that go beyond the mere "do something for the Planet"

promoting themes focused on student education, so that students can identify anthropogenic activities that damage the ecosystem and take a critical stand against such facts. The Pedagogical Course Project (PPC 2019), prepared by the FFI-CF for Integrated High School Hosting Course (IHSHC), aims to enable students in the housing sector for social development and appreciation of local and regional cultural, historical and environmental characteristics. This is in line with the eighth SDG prepared by UNESCO (2015), which defines sustainable tourism as a possibility of generating employment, promoting local culture and products.

IGAEI also aims at its pedagogical proposal, structured through the Minimum Curriculum of the Teacher Training Course (SEEDUC 2013), the construction of innovative practices, contextualised according to the local and global environmental conditions, critically and consciously promoting conservation and the planet's natural ecosystems. In this logic, the pedagogical dynamics elaborated in a contextualised way to the students' reality are essential methodological tools, since they generate social interactions, vital aspects in obtaining meaningful and quality teaching (Oliveira et al. 2018).

This study aims to develop a sustainability project using pedagogical dynamics (PD), through Cycle of Living Activities (CLA) with problem situations, related to insufficient water supply in the city of Cabo Frio, RJ, involving the discipline of Fundamentals of Tourism and Hospitality (FTH) of the IHSHC.

## 2 Methodology

Data from this survey were collected during March 2019. This qualitative study uses tools of the exploratory methodology, seeking to work the problem to make it more transparent (Gil 2008). Therefore, action research was used as a methodological approach, aiming to solve common problems, in which participants and researchers are involved, to cooperate and contribute to the change of perception about their practices (Franco 2016). Problem situations were elaborated regarding the reality of the Monte Alegre neighbourhood, in the city of Cabo Frio, RJ, Brazil, which presents severe problems related to water supply.

The target audience for this research was 23 FFI-CF students enrolled in the first year of IHSHC, aged 15–16 years. The study was applied in line with the objectives of the FTH discipline to relate the pedagogical practices developed in each PD with the SDGs indicated by UNESCO (2015). It is important to highlight that these practices, also known as existing methodologies, were based on learning through projects that seek to address issues inherent in the students' context, making the learning process meaningful (Ferrarini et al. 2019).

The study was developed in three stages: organisation, subdivided into training and orientation; application of pedagogical practices through the CLA and, finally, the structured assessment of four questions, aimed at the FFI-CF students involved in the activities, so that they could give their opinion relating each PD.

**Table 1** Materials used in pedagogical dynamics

| PD | Materials |
|---|---|
| Mining activity construction | Polyvinyl Chloride (PVC) tubes, ropes of various sizes, buckets, water, coloured plastic balls, bicycle tire chambers, funnel and water hose |
| Aqueduct construction | Pieces of thin bamboo, twine, duct tape, and half-moon cut plastic tubes. To simulate water transport, coloured plastic balls were used |
| Chandelier construction | Plastic tubes, strings of various sizes, balls of different sizes |

*PD* Pedagogical dynamics

**Step 1: The Organization**

## *2.1 Training*

At this stage, six students enrolled in the 3rd year of IGAEI aged 18–19 years were trained at the institution where they study to act as monitors of FFI-CF 1st year students from IHSHC. They were instructed to make the materials used in each PD, presented in Table 1, and collaborated in the construction of problematic situations related to social and environmental problems at the local level. The activities carried out with the monitors were developed according to the educational guidelines, which point out the importance of developing pedagogical intervention projects that enable the integration of knowledge and experiences (SEEDUC 2013).

## *2.2 Orientation*

The orientation phase took place outside the FFI-CF, where the monitors made the three PD with the available objects that were handled by the FFI-CF students.

After assembling the material, the monitors met the FFI-CF students at an outside campus meeting point to explain how the practices would be developed. In the end, students were instructed on how to proceed with the execution of dynamics through four basic rules: i. Distribution of FFI-CF students into three teams, with eight and seven students, who received red, yellow and green coats to distinguish the groups; ii. Each team had to choose a leader who would have to collaborate with the group in conducting the activities; iii. The maximum time to solve the problem situations presented in each PD would be 20 min, using only the available materials and avoiding wasting resources as much as possible; iv. After the set time, a whistle would sound alerting teams to move to the next PD and perform the following task and thus close the CLA. Pedagogical activities that go beyond the limits of the classroom developed

playfully allow a greater understanding of the contents to be assimilated, promoting creativity and the pleasure of learning (Orsi and Ferreira 2019; Whitton 2018).

CLA can then be applied to teaching–learning activities with the intention that the students of the team mobilise in the search for solutions to a specific problem situation so that everyone is involved in achieving the proposed objectives (Alves et al. 2016). It is important to mention that problematic situations are didactic strategies that teachers can apply to collaborate in the construction of student knowledge, to solve problems, i.e., stories elaborated to contextualise the learning process (Almouloud 2016).

**Step 2: Application**
At this stage, the monitors responsible for each PD expected the teams to solve their respective problem situations, a task that each FFI-CF student group should perform to achieve the stated objectives. Also, they monitored the teams' performance to stimulate participation, correct eventual deviations and provoke reflections, bringing the practice closer to the theoretical dimension. Relating the problem situation to experimental activities makes the teaching–learning process enjoyable and develops the student's ability to reflect, discuss ideas, establish relationships with their context and make inferences (Oliveira et al. 2018).

## *2.3 Mining Activity Construction*

For the construction of the PD "Mining activity construction", the following problematic situation was presented: a mining industry has just been installed in the city of Cabo Frio, RJ, Brazil, in the Monte Alegre neighbourhood. The entrance of this company creates jobs for the region. However, the extraction of minerals requires the use of a larger volume of water. This scenario may compromise the already precarious supply of drinking water in the neighbourhood. The task of the teams was to plan the extraction of natural minerals, avoiding the waste of water. The goal to be achieved was to make students aware of the challenges of promoting sustainable growth to conserve natural resources and thus avoid wasting water due to the inadequate supply of this resource, which is one of the region's severe social and environmental problems. As known, environmental education must be based on a social practice related to reality, to transform it, understanding the values and the conception of local sustainability (Vieira 2016).

## *2.4 Aqueduct Construction*

For the "Aqueduct Construction" PD, the responsible monitors explained to the teams that the difficulty of water supply was intensified with the installation of the mining company, despite all efforts of the groups to minimise water waste. However, the

"Mar Azul Hostel", where this team is working, are also hosting workers involved in the mining activity, who are also receiving the impacts of water scarcity.

To solve the problem of insufficient water supply, it is necessary to build an aqueduct to transport treated water from one part of the city to another. As a task, the groups needed to set up an aqueduct with available materials to transport water from a nearby location to the hostel. The realisation of these activities aimed to stimulate teamwork to promote debate in the search for solutions to real problems of lack of drinking water supply.

As pointed out by Pontes (2014), the unavailability of water for ancient civilisations was a factor of geographical limitation, the overcoming of these factors is due to collective human action, in the sense of building monumental works in the water, as the aqueducts built by the Romans allowed the advancement of cities in initially inhospitable places. Similarly, in the city of Rio de Janeiro, RJ, Brazil, the construction of the Carioca Aqueduct, currently a tourist spot known as "Arcos da Lapa", served to channel and distribute the waters of the Rio Carioca, the main source of freshwater for the state population, being common to various points of the city (Jantália et al. 2017), thus highlighting the importance of the PD.

## *2.5 Chandelier Construction*

The scenario presented to the teams of this "Chandelier Construction" PD was related to the consequences generated by the high consumption of electricity resulting from the installation of the mining company. To minimise energy consumption and the constant light fall, the leading hotel in Cabo Frio, RJ decided to install a huge chandelier. This preventive measure would avoid displeasing the guests, businessmen who were in town promoting events, congresses and fairs, due to the activity of the mining company, which in turn would bring progress and employment to the region.

As a result, teams had to devise a way to safely transport the parts that were stored in a particular location and install the elements that make up the chandelier. The activities developed in this PD aimed to encourage students about the challenges of finding new solutions to old infrastructure problems, as well as encouraging teamwork and the importance of each member's attitude in achieving the result to stimulate the meaning of leadership and collaboration. Increasing interaction between team members will make them increasingly prepared to meet the proposed challenges (Bollela et al. 2014).

**Step 3: Assessment**

The third stage of the work aimed to assess the perceptions of students of the first year of FFI-CF in the FTH discipline, about the activities developed in PD, through the CLA. At the time, a video showing the performance of these students during the application of dynamics was shown. The use of the video tool as a pedagogical resource promotes student attention, besides being a motivational factor (Vogel et al. 2016), which, in this case, allowed to verify their performance in activities.

Students answered a questionnaire with four questions related to their perceptions of applied dynamics, such as (1) "Which PD did you find most interesting?"; (2) "In your opinion, what activities contributed to relate the FHT discipline with the environmental issues?"; (3) "Did the team activities facilitate the achievement of the proposed objectives?"; (4) "In your opinion, did problem situations help to develop activities?".

## 3 Results and Discussion

Table 2 shows the number of students' answers concerning question 1. "Which PD did you find most interesting?" It is possible to observe that Chandelier Construction was the PD that aroused most interest (47.82%), followed by the Mining Activity Construction (34.78%) and the least interesting PD was Aqueduct Construction (17.40%).

In the question 2: "In your opinion, what activities contributed to relate the FTH discipline to the environmental issues?". Students reported that: "Chandelier construction helps to reflect on the importance of saving energy"; "Mining and aqueduct construction activities collaborated to reflect on the water problem"; "We need to save energy"; "For the construction of the chandelier, we had to be patient." "The construction of the aqueduct and mining company is directly related to the environment versus economy and the lives of residents."

Student responses thus highlight the importance of sustainable tourism development to reduce negative impacts and maximise positive ones through practices such as energy saving, recycling, waste reduction and better local livelihoods (PPC 2019; Mihalic 2016).

In the question 3: "Did the team activities facilitate the achievement of the proposed objectives?". Students responded: "Yes. Teamwork makes things easier"; "Most activities only worked because they were done in teams"; "Doing it this way was not just one person who thought, but several people, to solve each step quickly"; "As a team, everything was easier and faster because everyone helped to come up with ideas"; "We developed team communication and were able to work more easily"; "We could only do the activities because the work was done in teams." As observed,

**Table 2** Students' answers to the first question

| PD | Frequency | Percentage (%) |
|---|---|---|
| Chandelier construction | 11 | 47.82 |
| Mining activity construction | 08 | 34.78 |
| Aqueduct construction | 04 | 17.40 |

*PD* Pedagogical dynamics

student reports indicate that the practice of teamwork enables dialogue, cooperation and positive social interactions, which promotes a safe environment relating future academic and professional challenges (Young et al. 2016; Bollela et al. 2014).

Concerning question 4: "In your opinion, did problematic situations help to develop activities?". Students responded: "Yes, we have learned in practice how to deal with problems"; "We gained more experience and learned to solve problems more easily"; "Through problem situations, we can understand what should be done." "We got a sense of how to solve such a problem if it occurred in real life."

Analysing the students' answers, it is clear that the application of these activities allowed the development of the learning process and the interaction between the participants. The experience of environmental issues contextualised through problematic situations stimulates the student in the search for team solutions that offer significant new learning (Almouloud 2016).

## 4 Conclusions

The results of this study demonstrate the relevance of working the Sustainability and Environmental Education duality, in the school universe, within the local reality context. Sustainability and awareness can be achieved by the practice of sustainable tourism, as by the exercise of citizenship where students can effectively participate in social, cultural, political and economic processes related to the conservation and protection of the environment.

The results also show that this work of awareness of the students to the environmental problems of Cabo Frio, RJ, Brazil stimulated greater interest, reflection and discussion about the local socio-environmental questions, contributing to potentiate the individual profile characteristics, expected of a future hosting professional for sustainable tourism, and also addressing the social responsibility component involved in the tourism activity.

From the perspective of a future contribution, it is expected that this multidisciplinary project will be included in the curricular, pedagogical programs of the FFI-CF, whose mission and value is the promotion of sustainability addressed in the context of technological education related to elementary and higher education.

Areas to be explored concern other PD and problem situations involving other subjects in different educational contexts, e.g., working on Environmental Education beyond the school space in protecting the historical and natural heritage of Cabo Frio, RJ, Brazil.

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# Assessment Tools and Performance Indicators for HEI Environmental and Sustainable Development Education


**Andressa Schlickmann, Edson Pinheiro de Lima, and Sandro César Bortoluzzi**

## 1 Introduction

Underlying the inspiring objective of the United Nations Decade of Education for Sustainable Development (2005–2014) to promote education as the basis for a more sustainable human society is the recognition that the world cannot achieve sustainability without a broad education on sustainability (Koehn and Uitto 2014). This importance, confirmed at Rio + 20, which established a second United Nations Decade of Education for Sustainable Development (2015–2024) and positioned education, and particularly universities, as a key factor in achieving sustainable development (Trencher et al. 2016).

While the letters and policy statements on sustainability in higher education contain important guidelines for education, none of them offer concrete operational-level prescriptions for what higher education must do exactly to make the most of sustainable development (Roorda 2000). Thus, the implementation of sustainability in higher education has brought sustainability assessment to the research agenda of education for sustainable development and science of sustainability (Disterheft et al. 2016).

Sustainability indicators and assessment tools have been highlighted as priorities for the sector. Universities need to understand if they are effectively contributing to

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sustainability (Larran Jorge et al. 2016). And while the educational dimension is the cornerstone of the university system, most assessment tools cannot adequately assess that specific dimension. Studies have shown that despite its importance within the university system, the educational dimension is the least addressed (Amaral et al. 2015).

Concomitant with the findings of Amaral et al. (2015), one of Shriberg's (2002) criticisms of revised interinstitutional assessment tools is the inclusion of sustainability education as a central part of curricula. More work is needed to substantiate the hitherto underrepresented fields of a university's involvement in sustainability, namely education and research (Yarime and Tanaka 2012; Fischer et al. 2015; Waheed et al. 2011a, b).

Amaral et al. (2015), Ferreira et al. (2010) and Henri and Journeault (2010) argue that sustainability management in a university would be facilitated if the procedure used to implement sustainability was aligned with the tool used to evaluate its performance. However, the diversity of academic perspectives created a variety of insights and made it difficult to build a theoretical foundation in the field of performance measurement and management (Bititci et al. 2018).

Santos et al. (2006) state that "the production of knowledge begins with the search for information about what was previously produced". Taking this premise as a starting point for establishing a common theoretical basis for researchers regarding environmental education assessment in the context of HEIs, this study focuses on (1) identifying the main sustainability assessment tools in higher education, based on in a Bibliographic Portfolio (PB) composed of 58 articles, selected through the Knowledge Development Process—Construtivist (ProKnow-C) intervention instrument and (2) to elaborate a framework of indicators for the aspect of environmental education.

The justification of the work includes scientific and practical aspects. Scientifically, this research will identify the status quo about what the academy has produced in terms of assessment tools and indicators for the dimension of environmental education in HEIs. The highlights and lack of knowledge found can guide the advance of the field towards a common theoretical base for researchers. In practical terms, the built framework can be used as an audit tool in Brazilian HEIs.

There is a lack of research on the evaluation of sustainable development for HEI in South America (Urquiza Gomez et al. 2015) and with application in Brazil, only the study by Da Silva Junior et al. (2018) proposes a set of indicators for a new academic category composed of four subcategories—institutional, university management, financial and social and environmental responsibility. Therefore, the unprecedentedness of this research involves the development of the indicator framework, focused exclusively on environmental education, based on the most recognized assessment tools in the literature and for disregarding the presence of specialists, for assigning weights to the indicators.

## 2 Theoretical Referential

Performance measurement can be conceptualized as an empirical and formal process aimed at obtaining and expressing descriptive information about the ownership of an object (eg process, activity or people) and consists of three main stages: information acquisition, analysis and representation (Micheli and Mari 2014).

A performance measurement system can also be defined as the set of metrics used to quantify the efficiency and effectiveness of actions. A performance measurement system is a multidimensional system, covering internal and external, delayed and forward-looking financial and non-financial measures in order to impact the environment in which it operates (Stormi et al. 2019).

By mapping the evolution of sustainability measurement research, highlighting current and emerging trends, Mura et al. (2018) realized that the main theoretical approaches to sustainability metric studies involved the Stakeholder Theory, Legitimacy Theory, and the Simons Control Levers Framework. Another theory mentioned in the literature encompasses the Social Learning Theory (Brunstein et al. 2015).

In the field of regulatory frameworks, statements, charters and laws are intended to inculcate environmental, social, economic and educational sustainability in colleges and universities. Key statements in higher education to support sustainable development include the Stockholm Declaration of 1972, the Talloires Declaration of 1990, Law 9795 of 1999 applicable to Brazil, the United Nations Decade for Sustainable Development 2005 and the UN Higher Education Sustainability Initiative at Rio + 20, 2012 (Alghamdi et al. 2017).

Figure 1 shows the context in which the main statements were inserted and how social forces, needs and a series of long-term environmental factors (lower level) and the evolution of the concept of sustainable development over four decades (higher level) combine to affect the extent and nature by which sustainable development has been integrated into higher education.

Nevertheless, some definitions are required. The concept of sustainability has to do with the existence of the ecological conditions necessary to sustain human life at a specified level of well-being through future generations and sustainable development is a complex concept, made up of economic, social and environmental pillars that need to be addressed. harmonized to acquire a holistic approach (Da Silva Junior et al. 2018). The present study assumes that sustainable development is the means to achieve sustainability, which is the ultimate long-term goal.

Regarding the terms environmental education and education for sustainable development: McKeown and Hopkins (2003) state that environmental education has evolved from a narrow focus on environmental issues to a broader concept involving social and economic issues. Thus, the terms are similar, complementary, and as the authors suggest that locally appropriate collaborative actions in environmental education and sustainable development education are more useful than a discussion of the terminology that should be adopted for this paper, these terms will be approached as synonyms.

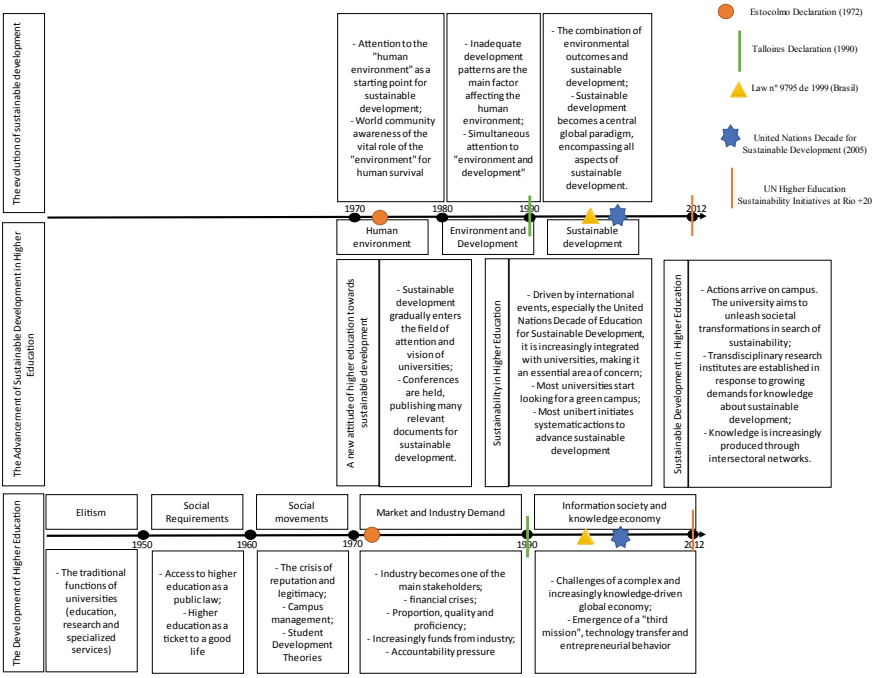


**Fig. 1** Regulatory Frameworks for the insertion of sustainable development in HEI, analyzed in the context of social influences and the evolution of sustainable development. *Source* Adapted from Trencher et al. (2016)

Moreover, the activities with which universities can contribute to a broader societal transition towards sustainability are generally grouped into four core functions: education, research, operations and community involvement (Fischer et al. 2015).

Activities related to education in sustainable development should include reviewing learning outcomes, reformulating the curriculum and introducing concepts of sustainable development as a subject in the curriculum of all higher education institution subjects and courses, as well as workshops, sustainable development conferences and seminars. This integration can be done vertically (sustainability integrated through specific sustainability-related courses) or horizontally (sustainability integrated into different regular curriculum courses) (Aleixo et al. 2018).

In Brazil, the concern with assessing the sustainability of higher education derived from the debates on environmental education, which culminated in Law 9795 of 1999. According to this law, it is not enough that the program has a course dedicated to environmental education. This topic needs to be addressed in teacher and student training, either as cross-sectional content or as skills and competencies that will also be developed in extracurricular activities (Brunstein et al. 2015).

The characteristics of the main activities in the HEIs in search of sustainability led to the emergence of two research groups in the literature: studies that address

the implementation of sustainability directly through curricular issues, ie, based on activities related to education and studies, which present more specific questions with organizational focus (Drahein et al. 2019). This study focuses on curricular issues.

The sustainability of HEIs implies the adoption of measurable and manageable objectives. Sustainability assessment tools can play a strategic role not only in developing a holistic and systemic approach to sustainability, but also as a vital enabler for the shift towards sustainability (Aleixo et al. 2018).

These tools vary in scope and purpose. Some focus on environmental aspects and eco-efficiency; other tools focus on social aspects and community outreach; while others consider including sustainability in curriculum and research. Figure 2 presents a list of the main tools for sustainability assessment in HEI and additional information on each of them.

Analyzing the information reported in Fig. 2, it is clear that there is no standard, both in terms of criteria and in relation to the number of indicators. The description, in turn, allowed Tappeser (2014) to classify evaluation tools according to their different monitoring objectives: (1) external audits and certification mechanisms; (2) self-assessment processes for organizational development and learning; (3) overall performance rating for benchmarking purposes; and (iv) integrative sustainability assessment to combat excessive competition for indicators and alleviate reputational concerns of participating institutions.

| Abbreviation | Tool | Year | Description | Criteria | Nº Indicators | Source |
|---|---|---|---|---|---|---|
| STARS | *Sustainability Tracking, Assessment & Rating System* | 2014 | STARS is the latest tool for assessing the sustainable development of higher education institutions in the US and Canada. It is based on a self-report framework to assess relative progress towards sustainability. | Curriculum; search; campus involvement; public engagement; air and climate; construction; meal services; energy; floor; purchase; transport; waste; Water; coordination, planning and governance; diversity and accessibility; health, welfare and work; and investment and innovation. | 74 | Lozano; Young (2013) |
| AISHE | *Assessment Instrument For Sustainability in Higher Education* | 2009 | The main objectives of this tool are to provide a framework that audits sustainability internally and externally; measure achievement in implementing sustainability on campus; and create a mechanism through which motivations and experiences can be exchanged between higher education institutions. | Operation; education; search; society and identity. | 30 | Alghamdi et al. (2017) |
| GASU | *Graphical Assessment of Sustainability in Universities* | 2006 | The GASU model was developed based on the GRI. The GASU framework has modified the GRI by adding another dimension, the educational one, applicable to colleges and universities. | Social; environmental; economic and educational. | 59 | Alghamdi et al. (2017) |
| GRI | *Global Reporting Initiative* | 1997 | The GRI model was developed to assess sustainability in companies. It has three dimensions of sustainability: social, environmental and economic. | Social; Environmental and economic. | 36 | Alghamdi et al. (2017) |
| CSAF | *Campus Sustainability Assessment Framework* | 2009 | CSAF is an academically developed standardized audit tool designed specifically for campuses. Canadians in response to a demand for change agents at Canadian universities to have a common to further develop the movement in HEIs in Canada. | Water; materials; air; energy; Earth; health and wellness; community; knowledge; governance; economy and wealth. | 169 | Lozano; Young (2013) |
| SAQ | *Self-Awarness Questions* | 2001 | SAQ is widely a qualitative teaching tool that encourages discussion and further evaluation. SAQ was prepared by the Association of University Leaders for a Sustainable Future. | Curriculum; research and scholarship; operations; teacher and staff development and rewards; extension and service; student opportunities; administration, mission and planning. | 35 | Lozano; Young (2013) |
| STAUNCH | *Sustainability Tool for Assessing Universities' Curricula Holistically* | 2007 | The goal is to evaluate university curricula beyond the current emphasis on anecdotal evidence and non-comparable ad hoc analysis. | Economic; environment; social and transverse | 36 | Watson et al. (2013) |
| Green Metric | *UI's GreenMetric University Sustainability Ranking* | 2014 | The main purpose of this structure (or ranking) is to be open to any higher education institution. to participate; be accessible to all universities in the developed and developing worlds; contribute to the knowledge set about sustainability in the education and greening of campuses; and promote social change led by the university in relation to sustainability goals. | Configuration and infrastructure; energy and changes climate change; waste; Water; transport; and education. | 33 | Alghamdi et al. (2017) |
| USAT | *Unit-Based Sustainability Assessment Tool* | 2009 | The main objective of developing this structure is not just a guide to educating and assisting universities in sustainability but also be a flexible tool used at departmental, faculty and unit level. | Community teaching, research and services; operations and management; student involvement; policy and written statement. | 75 | Alghamdi et al. (2017) |

**Fig. 2** Main tools for sustainability assessment in HEI. *Source* Research Data

## 3 Research Design

The study is descriptive because it focuses on finding facts and establishing the nature of something as it exists and can be used to find new characteristics, meanings and/or relationships in existing data. Approaches the qualitative method, from the search for understanding meanings, opinions and behaviors to reach hypotheses and theories (Hakansson 2013). This bibliographic research, which works from the contributions of the authors of the analytical studies contained in the texts (Severino 2007) used, as an instrument of intervention, the ProKnow-C methodology for BP selection.

Once a research question is formulated and the objective is established, a research instrument is chosen that provides the necessary answers for qualitative research; the process called ProKnow-C makes it possible to provide the necessary answers (Ensslin et al. 2017).

PB selection takes place in two phases and was carried out in October 2019: (1) selection of the raw article bank and (2) article bank filtering. In selecting the raw article database, you must: define the keywords; define the database; search the articles in the databases and test the adherence of the keywords. The filters applied to the raw article database that make up the filtering phase are: for redundancy; as for the alignment of the title; as for scientific recognition; regarding abstract alignment and full article alignment and availability. However, between the last two filters, there is a recap of recent articles and articles developed by authors of the author's database (Marcis et al. 2019).

The analysis of the PB and the construction of the indicator framework for the aspect of environmental education in the HEIs was based on the methodology proposed.

in Fig. 3.

The articles of the PB correspond to the input data. Following, there is the analysis of the evaluation tools used in the articles of BP. In this phase, the assessment tools mentioned and/or applied in each article of the PB are identified. Subsequently, assessment tools are classified into: recognized tools and unrecognized tools. The classification criterion adopted was the number of times the tool appeared among the BP works (cited or applied): with 3 or more mentions the tool is recognized and with 2 or less mentions, the tool was characterized as unrecognized by the literature.

The next step is to select the main evaluation tools taking as a parameter to cut 4 mentions. The indicators of the main assessment tools were related and formed the framework of indicators for the aspect of environmental education in HEIs. The analysis of the BP ends with the classification of the articles, according to the structure proposed in Fig. 4.

Figure 4 proposes the classification of articles as theoretical or practical. Theoretical articles include those who review and/or compare assessment tools and those who worked to develop and present a new assessment tool. Practical work can be subdivided into those using recognized tools, those using unrecognized tools, and those using sustainability reports to assess the sustainability level of HEIs. Finally, the application of both recognized and unrecognized tools also allows us to verify

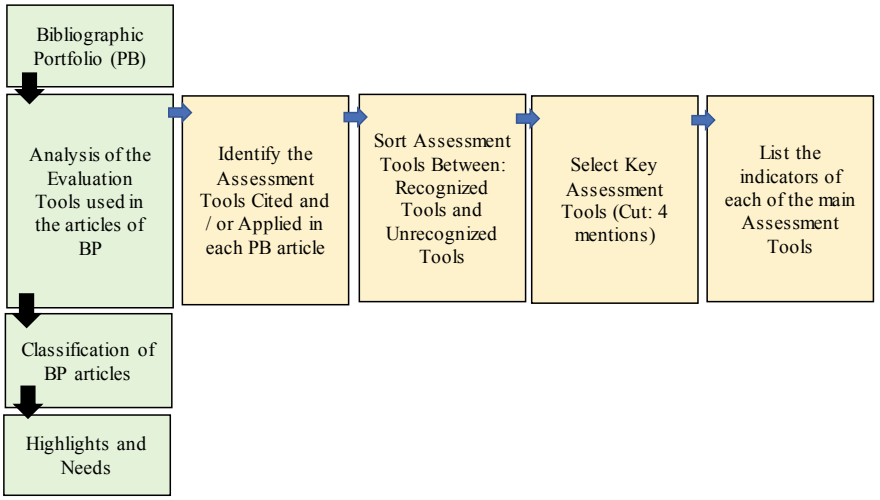


**Fig. 3** Procedures for BP analysis and construction of the indicator framework for the aspect of environmental education in HEIs. *Source* Research Data

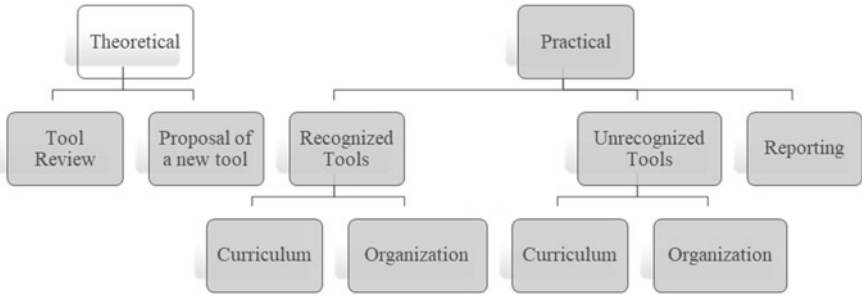


**Fig. 4** Suggestion for the classification of BP articles on evaluation tools in HEI. *Source* Research Data

whether the assessment itself occurred with a focus on curriculum or organizational aspects.

## 4 Results and Analysis

The selection phase of the raw article bank is represented in Fig. 5.

The keywords are subdivided into 3 research axes: Organizational Performance Evaluation, Environmental Education and IES/Public Sector. The selected databases were: Scopus, Web of Science and Science Direct, justified in terms of scope and

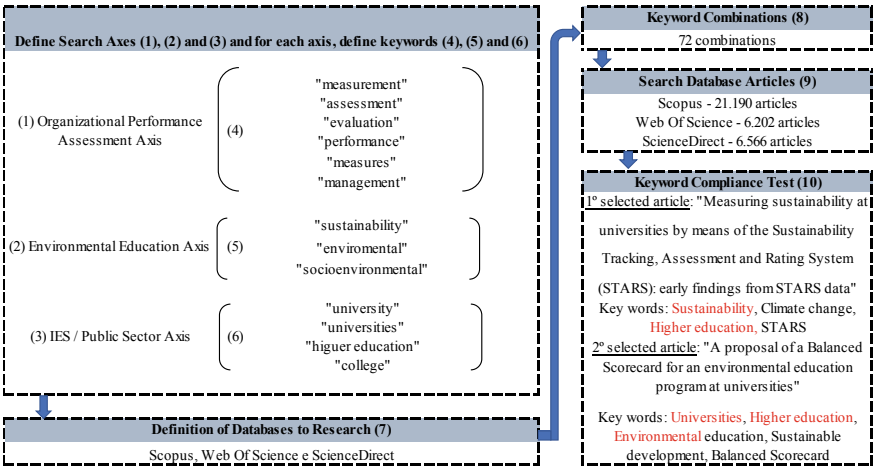


**Fig. 5** Results for the Selection phase of the Raw Article Bank on environmental education performance evaluation in HEIs. *Source* Research Data

multidisciplinarity (Dresch et al. 2019) and the adherence test showed convergence with the keywords defined at the beginning of the study search. Figure 6 presents the results for the article database filtering phase.

All 58 articles that make up the PB on environmental education performance evaluation in HEIs, after analysis, presented the following information:

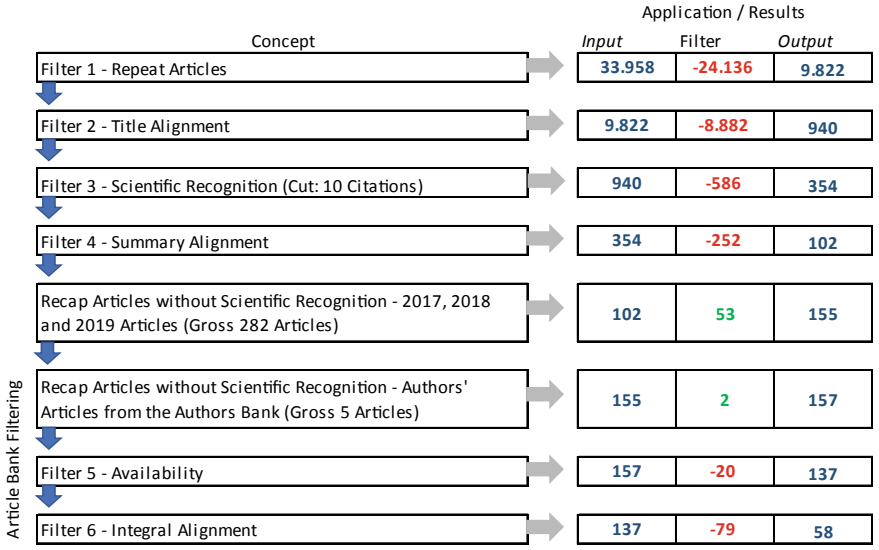


**Fig. 6** Results for the filtering phase of the Environmental Education Performance Assessment Article Bank in HEI. *Source* Research Data

- The reputable tools are: STARS, AISHE, GASU, GRI, CSAF, SAQ, STAUNCH, Green Metric, USAT, AUA, CSRC, ISCN, ISO 14001 and Green Plan;
- The main tools, ie those that have been mentioned 4 or more times are: STARS, AISHE, GASU, GRI, CSAF, SAQ, STAUNCH, Green Metric and USAT;
- The most mentioned tool is STARS, followed by AISHE.

Following and based on Fig. 4, the articles of the BP were classified and the result of this classification is shown in Fig. 7.

Eight articles from the PB were devoted to reviewing and/or comparing the assessment tools. Shriberg (2002) and Lozano (2006) reviewed 11 assessment tools; Von Hauff and Nguyen (2014) analyzed 4 sustainability assessment systems; Fischer et al. (2015) and Alghamdi et al. (2017), made a comparative analysis of 12 assessment tools and Kamal and Asmuss (2013) identified that STARS is the most effective tool for assessing and tracking sustainability in all areas of HEI.

However, it is perceived that the subjectivity as the representativeness of each activity within the tools is a flaw among the works of this group. For Kamal and Asmuss (2013) the SAQ tool has 11% of its indicators focused on the education activity. But, Berzosa et al. (2017) state that this percentage corresponds to 40% of the indicators.

Other theoretical works were devoted to propose a new evaluation tool. Kamal and Asmuss (2013) provides three main purposes for sustainability program evaluation. Waheed et al. (2011a, b) developed the Sustainability Index Model (D-SiM) that Waheed et al. (2011a, b) adapted for uD-SiM.

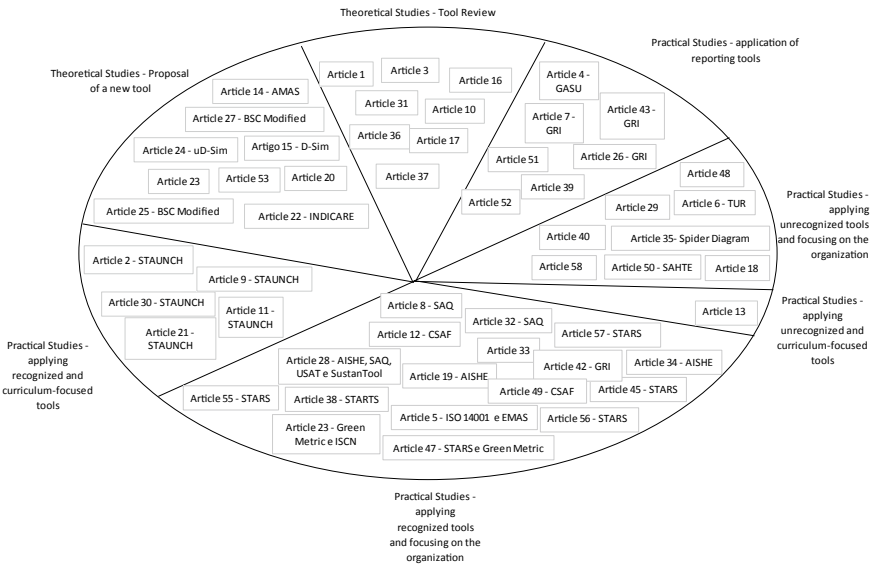


**Fig. 7** Result of the Classification of the articles that compose the PB on environmental education performance evaluation in HEIs. *Source* Research Data

Gomez et al. (2014) presented an Adaptable Model for Assessing Sustainability in HEI. Lin et al. (2016) provided details of how sustainability issues can be integrated into a modified Balanced Scorecard model for industrial-academic cooperation. From Andrade Guerra et al. (2018) developed a Balanced Scorecard strategic map for implementing and monitoring environmental education programs at universities.

Disterheft et al. (2016) developed INDICARE. Sonetti et al. (2016) propose a new approach that encompasses clusters of homogeneous campus typologies for university comparisons and classifications. Da Silva Junior et al. (2018) discuss a set of sustainability indicators applied to Brazilian HEIs.

In the group of practical studies with application of recognized tools and focusing on the curriculum, highlight the only tool mentioned in the works: STAUNCH. Lozano and Young (2013) verified the influence of student numbers and course credits and Glover et al. (2011), identified that the main focus of the courses is on the cross-sectional aspect and the lowest focus occurs on economic aspects. Lozano (2010) concluded that while some schools may be innovative in a specific dimension, they do not necessarily fall into the innovative category when the overall contribution of sustainable development is considered. In the work of Watson et al. (2013) STAUNCH results showed that the main focus was on the environmental dimension.

In the group of practical works, with application of recognized tools and focusing on the organization, we have: most of the HEIs in Canada are involved in sustainable development work, especially in the curricular area (Beringer et al. 2008). The CSAF tool has been classified as constructive for post-secondary sustainability education (Beringer 2006). In the work of Berzosa et al. (2017) the most important dimension came from environmental sustainability, followed by education, giving less importance to economic indicators.

Results in Saudi Arabia reveal that projects related to sustainability are not prioritized in universities and sustainable financial management practices are not significant (Alshuwaikhat et al. 2016). Lidstone et al. (2015) found greater emphasis on facility domains and less on research and education. In the United States, the degree of impairment of the entire HEI sample was rated high considering all dimensions of the HEI institutional environment; too high for the academic dimension and high for the operational and administrative dimension (Casarejos et al. 2017). Semeraro's study and Boyd (2017) demonstrated that the area with the highest scoring in the STARS database was planning, administration and engagement.

The only practical work with application of unrecognized and curriculum-focused tools was developed by Dlouhá et al. (2013), who analyzed models of Regional Sustainability Initiatives and Regional Centers of Expertise to identify general principles of efficiency and built a system for their evaluation based on indicators.

Regarding practical studies with application of unrecognized tools and focusing on the organization: the similarity between these studies is in the methodology. All papers review the literature on particular assessment tools, the indicators of these tools are related, and the final selection of indicators involves the participation of experts or stakeholders. The differences involve the region of application of the study. While the work of Larran Jorge et al. (2016) was applied in Spain, the de Aleixo

et al. (2018) occurred in Portuguese HEIs and Drahein et al. (2019) developed the SAHTE model in the context of Brazilian HEIs.

Finally, there are the practical studies that used sustainability reports as a data source for the application of GRI or GASU tools. Lozano (2011) results show that HEIs tend to focus on economic and environmental dimensions. The findings of Fonseca et al. (2011) suggest that sustainability assessments emphasize ecoefficiency. However, Bice and Coates (2016) found that specific social concerns of higher education, such as student involvement, local contributions, facilitation of the intellectual climate and enrichment of cultural and community life are not captured by GRI.

Search Results for Sassen and Azizi (2018a, b) showed a clear focus on the environmental dimension and very poor coverage of the social dimension. In the United States, the results show that all 23 reports analyzed included information on the environmental and university dimensions, information on the social dimension was included in only 17 reports, and the economic dimension was covered by only 11 reports.

The University of California has a stronger performance in the environmental and educational dimensions, while the social and governance dimensions are lagging behind (Sepasi et al. 2018). A positive point among research on performance evaluation tools for HEIs involves the contributions that the papers suggest and are accepted by other researchers. GRI, one of the most complete tools for assessing and relating sustainability in companies, has been modified to include the educational dimension and to meet the needs of HEIs. The indication of Glover et al. (2011) to consider the influence of the number of course credits or the number of students enrolled in the courses was the subject of a new version, STAUNCH 2010.

The indicators for the aspect of environmental education, extracted from the main assessment tools, are listed in Fig. 8.

According to the structure proposed in Fig. 8, the main assessment tools add up to 124 indicators for the aspect of environmental education. The major contribution in terms of indicators was from the AISHE tool. The CSAF tool indicators were not listed in the framework because the tool framework was not available for access.

## 5 Conclusion

This research aims to identify the main sustainability assessment tools in higher education and to develop a framework of indicators for the aspect of environmental education. With a descriptive character, qualitative approach and making use of bibliographic research, the research used ProKnow-C as an intervention instrument for BP selection.

The 58 articles that make up the PB emphasized the STARS and AISHE tools. The main tools identified were: STARS, AISHE, GASU, GRI, CSAF, SAQ, STAUNCH, Green Metric and USAT. All tools except CSAF were consulted and indicators for the aspect of environmental education were collected to build the framework. The articles were further classified, with the purpose of verifying among the theoretical studies,

| Nº | Indicator |
|---|---|
| 1 | Academic Courses |
| 2 | Learning Outcomes |
| 3 | Graduate program |
| 4 | Graduate program |
| 5 | Immersive Experience |
| 6 | Sustainability Literacy Assessment |
| 7 | Course Development Incentives |
| 8 | Campus as a living laboratory |
| 9 | The graduate profile contains some clearly identifiable aspects of sustainable development. |
| 10 | Sustainable development is explicitly mentioned in the postgraduate profile |
| 11 | Within its own disciplinary context, the postgraduate profile contains all or most of the relevant aspects of Sustainable Development. |
| 12 | Through its education, the organization clearly contributes to sustainable development at the level of adaptations and improvements. |
| 13 | Sustainable development in the graduate profile is explicitly based on the organization's vision for sustainable development |
| 14 | There are systematic assessments and adjustments of postgraduate profile |
| 15 | The postgraduate profile explicitly requires multidisciplinary skills |
| 16 | Through its education, the organization clearly contributes to the sustainable development of the level of sustainable innovation. |
| 17 | The professional field is actively involved in the determination, assessment and improvement of sustainable elements in the postgraduate profile. |
| 18 | Profile explicitly requires interdisciplinary skills |
| 19 | Through its education, the organization clearly contributes to the sustainable development of the level of systemic change. |
| 20 | Society is actively involved in determining, evaluating and improving sustainable elements in the postgraduate profile |
| 21 | The postgraduate profile explicitly requires transdisciplinary skills |
| 22 | Compared to comparable institutions, the organization plays a leading role in determining postgraduate profile |
| 23 | In some parts of the curriculum, methodologies are used to stimulate some aspects of learning action and reflexivity. |
| 24 | In many parts of the curriculum, methodologies are used to stimulate many aspects of action learning and reflective learning. |
| 25 | The methodologies were selected in such a way that innovation is stimulated |
| 26 | The entire curriculum is designed in such a way that all aspects of action learning, reflective learning and innovation are intensively practiced through a variety of methodologies. |
| 27 | Professional field representatives contribute significantly to the practice of action learning, reflective learning and innovation |
| 28 | Society representatives contribute significantly to the practice of action learning, reflective learning and innovation |
| 29 | Basic concepts of sustainable development are studied at the beginning of the curriculum. |
| 30 | A well-conceived introduction to sustainable development is studied, including relationships with the discipline itself. |
| 31 | This introduction explicitly aims to raise awareness of students' sustainable development |
| 32 | The introduction is explicitly based on the graduate profile. |
| 33 | The introduction to sustainable development is used as a foundation throughout the curriculum. |
| 34 | Professional Representatives Contribute Significantly to the introductory Study of Sustainable Development |
| 35 | Society representatives contribute significantly to the introductory study of sustainable development |
| 36 | Some aspects of sustainable development that have a direct bearing on the discipline itself are studied as part of the curriculum. |
| 37 | Many aspects of sustainable development that have a direct bearing on the discipline itself are studied, spread throughout the curriculum in a carefully designed manner. |
| 38 | Sustainable curriculum development is explicitly based on postgraduate profile |
| 39 | All aspects of Sustainable Development, which has a direct relationship with the discipline itself, are systematically studied. |
| 40 | Representatives from the professional field contribute significantly to the disciplinary study of sustainable development. |
| 41 | Society representatives contribute significantly to the disciplinary study of sustainable development |
| 42 | In some parts of the curriculum, connectivity and complexity are explicit goals and are realized in the learning process. |
| 43 | In many parts of the curriculum, connectivity and complexity are explicit goals and are realized in the learning process. |
| 44 | The relationship of this connectivity and complexity to sustainable development is made explicit. |
| 45 | The level of connectivity and complexity systematically increases throughout the curriculum in a carefully planned manner. |
| 46 | The resulting level of complexity and connectivity is sufficient according to the professional field. |
| 47 | Practical work has been designed in such a way that connectivity and complexity are intensively practiced in an interdisciplinary context. |
| 48 | Practical work has been designed in such a way that connectivity and complexity are intensively practiced in a transdisciplinary context. |
| 49 | Every year in a varundergraduate projects and undergraduate reports, sustainable aspects and development are present |
| 50 | Specific demands are formulated for all undergraduate projects and reports, explicitly related to sustainable development. |
| 51 | These requirements are verified as part of each student's grading project assessment. |
| 52 | A systematic analysis has been made of the demands, based on sustainable development, for undergraduate projects. |
| 53 | These requirements are a part of the examination regulations, such that a student cannot graduate until all these requirements are met. |
| 54 | The analysis is evaluated on a regular basis. |
| 55 | In this analysis, the professional field is actively involved |
| 56 | In this analysis, representatives of society are actively involved |
| 57 | Number and percentage (in total) of courses related to sustainability concepts |
| 58 | Number of students enrolled in sustainability-related courses |
| 59 | Number of courses with some content on sustainable development spas |
| 60 | Specific Course to Educate Educators on Sustainable Development |
| 61 | Management procedures for monitoring incorporation of sustainable development themes into curricula |
| 62 | List of course titles and sustainable development topics |
| 63 | Course structure, objectives and duration |
| 64 | Management structure and incorporation follow-up procedures, continuous improvement methods |
| 65 | Administrative Support (with detailed plan and budget) |
| 66 | Number and percentage of departments and colleges, including sustainability courses and curricula |
| 67 | Indicate the extent to which your institution offers courses that address sustainability topics |
| 68 | Which courses do you consider essential that are not being taught? |
| 69 | Indicate the extent to which sustainability is a focus incorporated into traditional disciplines such as science education, mathematics, literature, history, the arts, etc.? |
| 70 | Are undergraduate students required to take a course on environmental or sustainability issues? |
| 71 | The shift to sustainability requires critical thinking about the institution's role in its social and ecological systems. Circle which of the following (through individual, group, or departmental efforts) you try to teach your students. |
| 72 | GNP / Productivity / Profitability |
| 73 | Resource use / depletion (materials, energy, water) |
| 74 | Finances |
| 75 | Production / consumption patterns |
| 76 | Development Economics |
| 77 | Markets / Trade / Trade |
| 78 | Accountability |
| 79 | Politics / Administration |
| 80 | Products & Services: Transportation, Eco-Products & Services, Life Cycle Assessment (LCA) |
| 81 | Pollution / Accumulation of Toxic Waste / Effluents |
| 82 | Biodiversity |
| 83 | Resource efficiency / eco-efficiency / cleaner production |
| 84 | Climate change: Global warming / Emissions / Acid rain / Ozone depletion |
| 85 | Resource use: depletion and conservation of materials, energy, water |
| 86 | Desertification, deforestation, land use: erosion, land depletion |
| 87 | Alternatives: Energy, Technologies |
| 88 | Demography / Population |
| 89 | Employment / Unemployment |
| 90 | Poverty |
| 91 | Bribery / Corruption |
| 92 | Equity / Justice |
| 93 | Cheers |
| 94 | Politics |
| 95 | Education and Training |
| 96 | Diversity and Social Cohesion |
| 97 | Culture and Religion |
| 98 | Work / Human Rights |
| 99 | Peace and Security |
| 100 | Work / life balance |
| 101 | People as part of nature / Limits to growth |
| 102 | Systems thinking / application |
| 103 | Responsibility |
| 104 | Governance |
| 105 | Holistic Thinking |
| 106 | Long Term Thinking |
| 107 | Communication / Reporting |
| 108 | Sustainable Development Statement |
| 109 | Disciplinarity |
| 110 | Ethics / Philosophy |
| 111 | Transparency |
| 112 | The proportion of sustainability courses in relation to the total of courses. |
| 113 | The proportion of funding for sustainability research to |
| 114 | full funding for research. |
| 115 | Sustainability Publications |
| 116 | Sustainability Events |
| 117 | Sustainability student organizations |
| 118 | Sustainability site |
| 119 | As the department offers courses that involve sustainability concerns |
| 120 | The level of integration of sustainability topics in the above courses |
| 121 | The degree to which local sustainability issues and challenges are part of the department's teaching program |
| 122 | The degree to which global sustainability issues and challenges form part of the department's teaching program |
| 123 | To what extent does the department enroll students in courses that involve sustainability concerns? |
| 124 | The level of collaboration between colleges in teaching sustainability programs. |

**Fig. 8** Framework of indicators for environmental education performance evaluation in HEIs. *Source* Research Data

those that aimed to review and/or compare the assessment tools in higher education and those that proposed a new assessment tool. Among the practical studies, we identified the works that applied recognized and unrecognized tools. Finally, we identified the works that used sustainability reports as a source of data for sustainability assessment in HEIs.

The completed framework encompassed a total of 124 indicators. AISHE was the tool that contributed the most in terms of indicators, which characterizes this assessment tool with a strong focus on the educational dimension, together with STAUNCH: the only related tool among curriculum-focused articles in the curriculum. Among the practical studies, with application of recognized tools and focusing on the organization, the highlight is the STARS tool. The GRI and GASU tools appear to be the most suitable when the sustainability assessment is linked to the assessment of sustainability reports made available by HEIs.

Although Veleva and Ellenbecker (2001) state that it is not possible to have a set of sustainability indicators applicable to any company or organization, since companies vary greatly in their business activities, the indicator framework for the education aspect. Environmental assessment can serve as a parameter for an initial audit, which should then consider stakeholders so that measurement is conceptualized as a dialectical process between two or more actors (Mura et al. 2018).

Furthermore, it is possible to observe the importance of building a knowledge that can help managers to expand their understanding of current circumstances in relation to their values and preferences and to know the implications that involve decision making (Semler et al. 2015).

After identifying the production status quo in terms of assessment tools and indicators for the dimension of environmental education in HEIs, it is suggested to check whether the framework indicators are related to Stakeholder Theory, Legitimacy Theory, Lever Structure. Control Systems and Learning Theory.

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# University-Society Integration Through Action Research Projects


**Fabio Teodoro Tolfo Ribas and Janaina Macke**

## 1 Introduction

Social innovation can be understood as a product or service to address unmet or unmet needs involving leaders and social actors through networking. It can occur to solve a social problem and consequently achieve an improvement in the quality of life or impact on longevity. It is also understood as a complex process of introducing new products, processes, or programs that profoundly change the scenario or context in which it is inserted.

Studies on social innovation have focused on the perspective of transforming interpersonal relationships or achieving common goals (Mumford 2002; Westall 2007), other studies focus on solving social problems or needs (Nicholls and Dees 2015; Phills, Deiglmeier and Miller 2008), in addition to quality of life or longevity (Pol and Ville 2009), others in new social practices and new working relationships (Cajaiba-Santana 2014; Westall 2007) and in the transformation of essential routines, beliefs and resource flows (Westley and Antadze 2010).

Universities should play their role in local, regional and sustainable development by improving the living standards of local populations (Martinez et al. 2006; Leal Filho 2020), contributing to the promotion of research and development to find more effective approaches and means for solving local problems, regional and even national. Future-focused higher education emphasizes the role of innovation and the use of information and communication technologies, thereby integrating universities

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and society so that academics are able to create innovations that are integrated with business and society (Gaol et al. 2018; Leal Filho 2020).

The peaceful university is the term used when there is the integration of the university in society and society in the university (Norgard and Bengtsen 2016), that is, a university that invites and promotes openness, dialogue, mutual integration, care and joint responsibility, among the different stakeholders. Thus, this article explores the social problems of the local community through this academic citizenship, becoming a place that becomes a space for the public. The University becomes a means for the social, a means of exchange, both as a place to look for the solution or as a transformative agent.

This article aims to identify the key factors that impact the success and continuity of social practices or actions, which involve entrepreneurship or social innovation. Through action research, four social actions or practices were implemented that involved entrepreneurship.

## *1.1 Social Innovation*

Social innovation can be understood as a product or service, from the point of view as a product it serves to solve unmet or unmet needs, whereas, from the point of view as a service, it becomes a new way to engage stakeholders or actors to address needs. (Caroli et al. 2018).

Social innovation leads to social change and promotes the empowerment of actors to deal with social challenges. Although the term social innovation is used in many and overlapping forms in different areas, there is a common idea that social innovation occurs to solve a social problem and thereby achieve an improvement in the quality of life, such as the availability of clean water, owning an affordable home, or aiming for a graduate degree or longevity (Pol and Ville 2009). While social innovation is related to solving a social problem, it is understood as a complex process of introducing new products, processes, or programs that profoundly change basic routines, resource flows or authority, or beliefs (Westley and Antadze 2010).

The term social innovation has also changed over the years. In its first academic uses, it was used to refer to the creation of new patterns of human interaction, new social structures or new relationships (Table 1). Recently, the concept deals with innovations designed to solve a social or environmental problem or to address a specific flaw or social need of the context in which it is inserted (Nicholls and Dees 2015).

The concept of social innovation carries at its core the transformation of the scenario or context in which it occurs. From this perspective of change, social innovation is divided into three types: incremental, institutional, or disruptive. Incremental social innovation deals with goods and services; institutional social innovation reshapes social and economic structures to generate new social values, and finally, disruptive social innovation aims for systems change through political action (Nicholls and Dees 2015). Thus, social innovation can transform the context through

**Table 1** Social innovation definitions

| Authors | Definition | Means to transform reality | Social aim |
|---|---|---|---|
| Mumford (2002, p. 1) | "The term social innovation, as used here, refers to the generation and implementation of new ideas about how people should organize interpersonal activities, or social interactions, to meet one or more common goals" | New ideas | Interpersonal relationships or common goals |
| Westall (2007, p. 6) | "(…) focused on social goals, new products of new qualities of products, new methods of organization and/or production (often involving different partners and resources), new production factors such as atypical employment and involvement in governance, mixing voluntary and paid employment, as well as new market relations such as the changing welfare mix, or new legal forms" | Products, services, organization methods, and labor relations | Welfare and new forms of working relationships |
| Phills et al. (2008, p. 36) | "A novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individuals" | New and useful solution | Social need |

(continued)

**Table 1** (continued)

| Authors | Definition | Means to transform reality | Social aim |
|---|---|---|---|
| Pol and Ville (2009, p. 881) | "An innovation is termed a social innovation if the implied new idea has the potential to improve either the quality or the quantity of life" | New ideas | Quality of life or longevity |
| Westley and Antadze (2010, p. 2) | "Social innovation is a complex process of introducing new products, processes, or programs that profoundly change the basic routines, resource and authority flow, or beliefs of the social system in which the innovation occurs. Such successful social innovations have durability and broad impact" | New products, processes or programs | Routines, beliefs, resource flows |
| Cajaiba-Santana (2014, p. 3) | "(…) the process of social innovation creation as new ideas manifested in social actions leading to social change and proposing new alternatives and new social practices for social groups" | New ideas and social actions | New alternatives and new social practices |
| Nicholls and Dees (2015, p. 1) | "Social innovation refers to the processes and outcomes that develop a novel approach to addressing a social problem or need" | Processes | Social needs |

*Source* Drawn by authors based on literature review (2019)

a product, service, governmental action or process, changing the scenario gradually over time (Christensen et al. 2006; Mckeown 2008). These different focuses vary by sector, i.e., the incremental type focuses on products and services, the institutional kind, focuses the market, and in the disruptive typology the focus, is politics through social movements such as fair trade (Nicholls and Dees 2015).

In addition to this typology, social innovation can be understood through factors considered during the process, such as (1) leaders who encourage and reward successful innovations, (2) funding to support innovation, (3) incubation processes that feed innovation (4) promoting interactions between organizational, sectoral or disciplinary boundaries, (5) empowering actors, users and stakeholders to drive innovation, and (6) opening markets and governance processes for stakeholder groups, users and private companies (Mulgan 2006; Biggs et al. 2010). Social innovation also includes the reengagement of citizens in vulnerable situations: one way to reintegrate people in this context is by creating social actions or practices through entrepreneurship or social innovation (Westley and Antadze 2010).

In social innovation, stakeholders can build social capital ties through the dimensions of social capital: (1) structural, (2) relational and; (3) cognitive. In the structural dimension, tie configurations, network density and degree of the hierarchy are analyzed. In the relational dimension, trust, norms of reciprocity, and bonds of friendship are identified. Finally, the cognitive dimension contemplates shared codes and language (Nahapiet and Ghoshal 1998).

## *1.2 University-Society Integration*

The university's primary mission is "actively integrating teaching, research and extension activities in order to provide professionals with knowledge and skills that contribute to social development of their community" (Martinez et al. 2006, p. 1). The integration of the university with society for social development is based on interdependencies related to stakeholder problems (Vargo and Lusch 2014; Martinez et al. 2006; Vargo et al. 2008).

Universities should play their role in local and regional development where they operate, as their role focuses on training professionals, but also on expanding the boundaries of their contribution to the daily lives of communities and the region, such as improving the living standards of populations (Martinez et al. 2006). The contribution of universities lies in promoting research and development and sharing of scientific and cultural knowledge, as well as contributing to finding more effective approaches and means for solving local, regional, and even national problems.

A prerequisite for the integration of the university in society and society in the university is called a peaceful university, i.e., a university that invites and promotes openness, dialogue, democracy, mutual integration, care, and joint responsibility (Norgard and Bengtsen 2016). Ideally, universities should open its doors to the

society, for resources from academic knowledge, because higher education institutions usually adopt a posture that does not contemplate society, generating a disconnection between society and university (Solberg and Hansen 2015). Academic citizenship implies the formation of a place that becomes a space for the public, in the sense that the university is a means for the social—for society to seek through it the solution to social issues or problems, not just the university offering to solve or define the challenges of society (Norgard and Bengtsen 2016).

## 2 Method

In qualitative research, researchers seek to understand the meaning that individuals build (Merriam and Tisdell 2015), is used to explore social phenomena through the experiences of individuals or groups, through interaction between social actors (Gibbs 2018). Therefore, the qualitative approach becomes adequate to study the general objective of the present study as an approach that interacts and explores the context and the social actors, while interacting with the researchers.

The study strategy, action research, comprises empirically based social research carried out through a close connection between reflection, action, and the resolution of a collective problem (Cornwall and Jewkes 1995). In action research, researchers and project participants engage in a cooperative or participatory manner, playing an active role in solving the diagnosed problem (Thiollent 2011) and implementing collective and planned action (Gerassi et al. 2017).

The solutions or practical improvements of the diagnosed problems about real life (Mckay and Marshall 2001) make the researcher active and deliberate, in the context of his research as a critical participant in the process. Therefore, the approach and the research strategy are aligned with the purpose of the present study, which is to promote social innovation for sustainable development.

Action research is structured in four phases: exploratory, action development, action, and evaluation. In the exploratory phase, there was a meeting with the community leadership to carry out an internal diagnosis in order to raise the social problems of each context. In the development phase of the actions, the researchers, together with the participants, raised the problem situation and defined possible solutions. In the action phase, the interventions occurred through the practice and intervention of the actions discussed and selected. Finally, in the evaluation phase, actions were evaluated, seeking to identify the key factors that led to success (Gerassi et al. 2017; Apgar et al. 2017; Thiollent 2011).

The social practices implemented were: (1) a time bank proposal for a vulnerable community; (2) a free meal project once a week for low-income and unemployed people; (3) an entrepreneurship workshop for unemployed individuals; and (4) a children's painting workshop of a municipality Social Welfare Foundation. All these projects were carried out by a team of professors from a Higher Education Institution (HEI) in the city of Caxias do Sul, south Brazil. The four projects took place

between August and November 2019, starting with the idea exploration phase until the evaluation phase.

Data were collected through field diaries and recordings made in individual and collective interviews. To analyze the collected data the content analysis was used, through the text inference on the object of study, or social context studied, objectively and systematically, reconstructing the meaning of the text through categories and codifications, thus measuring a clear and reliable result (Bauer and Gaskell 2017; Bardin 2011).

## 3 Results Analysis and Discussion

### *3.1 Free Meals Social Project*

The Good Samaritan Project serves free weekly evening shift meals. The project was developed in a community in a situation of economic and social vulnerability, and its main focus is to involve children and adolescents. The meal is prepared with donated food, and also executed and served by volunteers, i.e., there is no financial investment in the workforce or food, but only with hygiene materials, gas, among others, in addition to having physical infrastructure funded by the local church. Social innovation occurs to solve a social problem so that the users achieve an improvement in their quality of life (Pol and Ville 2009).

Another key factor highlighted was networking, one of the most impactful for this project. Networking is a crucial element for social innovation because it provides stakeholder engagement in the search for solutions to needs (Caroli et al. 2018).

The presence of the educational institution serves as an incubation period (Mulgan 2006; Biggs et al. 2010), in which the educational institution monitors the steps and suggests future improvements. Through this intervention, the value was created because the interventions were collaborative, and there were mutual exchanges (Vargo et al. 2008). The main results of the intervention in the Bom Samaritan project are show in Table 2.

Social innovations that succeed are associated with a focused social problem, aligned with planning that involves coordination, goal-oriented, and legitimate actions taken by social agents for social change (Howaldt and Schwarz 2010; Hellström 2004; Nightingale 1998).

### *3.2 TimeBank Project*

In contact with the leader of a vulnerable neighborhood named Monte Carmelo, a workshop was held with six community residents. The results of the workshop found

**Table 2** Social innovation elements in Good Samaritan Project

| | Drivers for social innovation | Structural dimension (social ties configuration) | Relational dimension (social norms, trust) | Cognitive dimension (codes and narratives) |
|---|---|---|---|---|
| Good Samaritan Project (free meals) | Leadership, and networking | In the relationship between teachers and students, there were vertical ties of power and authority. Decisions are centered on the teacher, who in turn checked with the project leader for their appreciation and subsequent authorization. Between the teacher and the leader were horizontal ties, both at the head of their teams. The assisted only accessed the volunteers and had no close ties with the teacher and students | Norms and rules predominate in the relationship between teachers and students. Among volunteers, even if there were norms, trust predominates, as they may stop contributing at any time to the project. Among the assisted there is a bond of social identity. Between teachers and volunteers, there was a bond of trust, gradually as the project was developed | Between teacher and students, codes and languages are specific and common only among them, as well as between volunteers and assistants. Leaders were responsible for translating shared communication for their groups, i.e., the teacher for students, and the leader for volunteers and assistants |

*Source* Drawn by authors (2019)

that the social problems of the community are diverse and that one action would be to implement a time bank.

In this project, a central element was the leadership of a community resident, with legitimacy to ensure proper communication of the project, as well as the persuasion of users to join the cause. The TimeBank project can count on the participatory spirit of the community, fueled by trust in the project and its creators, evidence of the relational dimension of social capital, with trust as the driving force. The commitment of residents is essential to the project's development, functioning as a glue that keeps users believing in the success of the action.

The researchers also found that the cognitive dimension (Nahapiet and Ghoshal 1998) of social capital occurred differently among researchers, volunteers and assisted people, that is, there is a gap between their realities and contexts, and thus

**Table 3** Social innovation elements in the TimeBank project

| | Drivers for social innovation | Structural dimension (social ties configuration) | Relational dimension (social norms, trust) | Cognitive dimension (codes and narratives) |
|---|---|---|---|---|
| TimeBank project | Leadership, networking, and, alignment of needs | Volunteers, assistants, and students access leaders and teachers through vertical ties. Between teacher and leader, there are horizontal ties. Decision making is centered on the teacher who passes the deference of the leader who knows the needs of the assisted | Among teachers, students, and volunteers, the rules predominated. Among volunteers with the assisted, the bonds were reliable, gradually gained and by previous interaction. The credibility of the educational institution lends confidence to the project | Between teacher and students, codes and languages are specific and common only among them, as well as between volunteers and assistants. The community leader has taken responsibility for engaging and building trust, as well as dealing with project-related expectations. There are codes and language that permeate the boundaries between groups that begin to create a common language for all |

*Source* Drawn by authors (2019)

there are language codes, narratives, and dialogue that are proper to each group. Table 3 shows the drivers of social innovation present in this project.

The partnership with the educational institution is fundamental to perpetuate the TimeBank project. The impact of intermittent donations from partners can transform the context through the innovative process for the project, changing the scenario gradually over time (Christensen et al. 2006; Mckeown 2008), in which case the educational institution intermittently donates its support and knowledge to bring innovation in processes and new ideas to meet the demands.

## *3.3 Entrepreneurship Workshop Project*

Through a teacher initiative and financial support from a regional credit union, a project for entrepreneurship workshops that encourage entrepreneurial skills of people in economic and social vulnerability has been implemented. Social innovation addresses the reengagement of citizens in vulnerable situations, and one way to

reintegrate people in this context is by creating social actions or practices through entrepreneurship or social innovation (Westley and Antadze 2010).

Regarding the results already achieved by the project, some critical factors for the success of the project were found, such as leadership, networking, financing, alignment of needs and commitment. The networking of this case took place through the project coordinators and the group leader, as they already formed a network of other previous actions, and this facilitated the continuity of the partnership because of trust (Table 4).

Crowdfunding was one of the main drivers, given the cost of maintaining the project. The alignment factor of the participants' needs was present in this action since everyone was seeking qualification due to unemployment. Social projects can play an important role in fighting unemployment and promoting job growth, especially for people at high risk of exclusion from the labor market (Defourny and Nyssens 2007).

The results indicate that projects carried out within higher education institutions (HEI) take advantage of innovative knowledge and approaches, acting as a motor and agent of systematic social change (Kim and Leu 2011).

### *3.4 Painting and Art for Kids Project*

Through an initiative of a fine artist and an HEI teacher and crowdfunding funding, a painting project for socially vulnerable children was created. At the first meeting, the issue and purpose of the project were discussed, as well as the definition of the target audience—children who were taken out of their homes for lawsuits because of family abuse.

As for the project's results, some key factors such as leadership, networking, commitment, and funding have already been noted. As for the leadership of this case, the artist along with the teacher of the educational institution, coordinated the survey of financial and material resources, mobilizing their networking. Leadership, coordination, and other factors can all be combined in directing action (Westley et al. 2009).

Networking served as a key factor for building interpersonal relationships, as well as facilitating action through the knowledge of the coordinators. Commitment as a key factor served as the basis for keeping the actors active in the central objective, being visible in the behavior of the project leaders, as well as the social institution of childcare. Table 5 shows the drivers of social innovation in the Painting and Arts for Kids project.

**Table 4** Social innovation elements in Entrepreneurship Workshop Project

| | Drivers for social innovation | Structural dimension (social ties configuration) | Relational dimension (social norms, trust) | Cognitive dimension (codes and narratives) |
|---|---|---|---|---|
| Entrepreneurship Workshop Project | Leadership, networking, and financial resources | Volunteers, students, and assistants access teachers and leaders through vertical bonds of authority. The authority lies with the supervising teacher, who offers the opportunity to the people assisted and coordinates the team of instructors and volunteers. Leaders access teachers through the vertical hierarchy. Decisions are made and centered on the supervising teacher. Volunteer teachers have the exclusive role of running the workshop. The community assisted communicate vertically with the volunteers and teachers | Norms and rules prevailed among teachers and volunteers, as well as those assisted. This was borrowed by the structure of the educational institution as the project focused on training for the labor market. Trust was a bond found among the assisted with their respective leaders | Among teachers, students, volunteers, and assistants, codes, and languages are common. The language shared between the different groups happens because the main goal of the project is to share knowledge since it is a training project |

*Source* Drawn by authors (2019)

## *3.5 Final Remarks*

The results indicate that the factors leadership, commitment, networking, and financial resources are present in all actions and become fundamental for further project continuity. However, the alignment of needs was present in two projects—TimeBank and social entrepreneurship—in which users needed to see themselves in action as individuals who are meeting some need.

**Table 5** Social innovation elements in Painting and Art for Kids Project

| | Drivers for social innovation | Structural dimension (social ties configuration) | Relational dimension (social norms, trust) | Cognitive dimension (codes and narratives) |
|---|---|---|---|---|
| Painting and Art for Kids Project | Networking, and financial resources | Between the teacher and the volunteer with the coordinating role, there were horizontal ties of authority and power. Horizontal ties also predominated between the teacher, instructor, and entity leaders | The relationship of trust prevailed in all instances, as the project involved teacher, volunteer, and leader, all with coordination and management roles | Common codes and languages occurred in all instances, as the project involved teacher, volunteer, and leader. The role of leading and managing influenced the emergence of code and shared narratives among all. The horizontal hierarchical level facilitated the communication between all |

*Source* Drawn by authors (2019)

In the two projects that the needs alignment factor was not identified—free meals and art and painting workshop-, there are no predominant traits that justify their exclusion since the first they have the characteristic to meet the basic needs of survival and education.

The identification of the leading factor in all projects highlights the need for one or more people to lead and lead volunteers and users along the paths necessary for the success of the actions, or their continuity, as well as interfering with the behavior of those involved. The leader plays a key role and becomes the guiding and connecting thread between stakeholders.

The commitment factor is the bond that the individual assumes with the cause or project and makes her/him remain in action, either helping or being a user. Whatever affective, instrumental, or normative, commitment is the reason for the individual to be more assiduous and actively participative in the project. In all projects, commitment to action was essential to strengthen the individual's presence in the activities.

The networking factor serves as a means of communication and finding solutions through partners. In all projects, the presence of this factor caused barriers that arose during the execution of activities to be resolved or mitigated. During the seminars, stakeholder networking was triggered to seek options and means to drive the chosen

action. Networking permeates the project from start to finish, be it in decision making as well as choosing partners.

The financial resources factor fluctuates in each project according to the priority it is understood in each one, that is, in the entrepreneurship project it is fundamental because it impacts the purchase of the main material resources, but in other projects, it is necessary, but not a priority as it can be solved by crowdfunding.

Access to finance is a key factor in ensuring the continued growth of social projects as well as social enterprises, and one of the main challenges facing them, as well as HEI initiatives, is the lack of adequate funding. External funding from foundations, private companies, and governments is mostly short-term grants, but a project or social enterprise to continue needs medium to long-term financing.

Concerning social capital evaluation, the predominant structural dimension is formed vertical relations, where there was contact with the assisted, and in only one project that did not have contact with the supported, the ties were predominantly horizontal. The relational dimension, on the other hand, predominates bonds of trust between volunteers, social identity among the assisted, and power and norms between teachers and students. The results show that where there are vertical bonds, norms predominate, and where there are horizontal bonds, trust or social identity prevails.

The third cognitive dimension of social capital was evidenced through common codes and languages, in empowerment projects, and in those that dominated horizontal power ties. Those with predominant vertical ties externalized specific codes and languages. Pieces of evidence of the leader's role as a translator of a particular communication to make it common to groups were also observed, i.e., the leader permeates the boundaries between groups and understands the specific codes of other teams.

Future research can be suggested as the identification of the types of commitment that impact the volunteers' behavior on entrepreneurship or social innovation projects. It is also suggested to replicate the present study strategy to corroborate the findings in other projects or contexts, encouraging studies related to social innovation through university-society integration.

This study shows that the contribution of the educational institution, to the community where the projects are inserted, concerns the promotion of research and development, as well as the sharing of scientific knowledge to solve local and regional problems, which happened in the four projects. It was also found that there was social value generation in all projects by applying the skills of those involved for the benefit of a community or group of people to understand the best solution to the need of the moment, whose idea was co-created in the projects.

The results show that the project or social entrepreneurship needs leadership and commitment from those involved to have a better chance of success. Networking impacts on the agility to solve problems and needs to structure and conduct the project, as well as, to solve minor adjustments during the execution. Financial resources, on the other hand, influence the continuity of the project, aligned with the leadership and commitment. The alignment of needs impacts the behavior of users, as identification with the action, as well as their permanence at all stages.

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# Knowledge Management as a Critical Factor of an organization's Sustainability


**Talita Frozza, Edson Pinheiro de Lima, and Sergio E. Gouvea da Costa**

## 1 Introduction

Sustainability-related organizational changes are not simple, and sustainability has even been debated, along with innovation, as one of the major challenges affecting the role of universities in the global educational context (Veiga Ávila et al. 2019). It turns out that universities seeking a more sustainable path, either at an early stage or a more advanced level, face several internal and external barriers (Brandli et al. 2015), and addressing these barriers systematically becomes important. so that the initiatives work effectively and continuously, as well as not losing the interest of the people involved (Clarke and Kouri 2009).

To be able to execute a sustainability initiative, companies generally need to have a certain knowledge base. Especially if new (sustainability) challenges arise, companies need to develop new knowledge. If existing requirements are only stricter, existing knowledge can be used and refined to meet those requirements (Schrettle et al. 2014). The use of KM in the context of sustainability has been increasingly important over the years. Despite this importance, it is observed that this area is still little explored and there are many possibilities for academic research (Martins et al. 2019).

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That said, the purpose of this paper is to identify how KM influences organizational sustainability with a focus on higher education institutions, considering the intermediate through organizational processes, in which resources are applied to obtain the products/services of organizations. A secondary objective is the proposition of a framework that lists the elements addressed.

In addition to this introductory section, this article is structured with sections that address the theoretical framework needed to achieve the objective, a section that addresses the methodological aspects used in the preparation of this study, and sections that present the results achieved. Finally, the last section presents the concluding remarks, some research suggestions, and the contributions of this study.

## 2 Organizational Process

Organizations, as entities where numerous complex phenomena occur, can be understood and viewed in various ways (Silva 2002). And one possible way is to understand and visualize the organization through a process approach, which can be defined as collections of tasks and activities that together—and only together—turn inputs into products. The process approach emphasizes the links between activities, showing that seemingly unrelated tasks are often part of a single, continuous sequence (Garvin 1998).

Organizational processes can be classified into three categories: (1) work processes; (2) behavioral processes; and (3) change processes. Work processes focus on accomplishing tasks and have the premise that organizations do their work through interconnected chains of activity that span departments and functional groups, and that together turn inputs into products. These chains can be grouped into operational processes and administrative processes (Garvin 1998).

Behavioral processes, in turn, are the sequences of steps used to accomplish the cognitive and interpersonal aspects of work, reflect the characteristic ways in which an organization acts and interact, and profoundly affect work processes in their form, substance, and character. They are classified into three categories, both of which involve collecting, moving and interpreting information, as well as forms of interpersonal interaction: decision-making processes, communication, and organizational learning. Finally, change processes are explicitly dynamic and intertemporal and describe how individuals, groups, and organizations adapt, develop, and grow. They have three components: a set of initial conditions, a functional endpoint, and an emerging process of change, and can be classified into two types: autonomous and induced (Garvin 1998).

## 3 Knowledge Management

Formal knowledge is regarded as both fundamental and economic personal resources, and can today be regarded as the only significant resource, since traditional factors of production (natural resources, labor, and capital) can be obtained easily, provided knowledge. Thus, knowledge acquires a sense of utility, as a means to obtain social and economic results (Drucker 2002; Malavski et al. 2010).

Making personal knowledge available to others is the main activity of knowledge creation (Nonaka 2007), the emergence of which derives from the individual and passes through four modes of conversion, forming a spiral that describes how tacit and explicit knowledge is amplified. terms of quality and quantity, as well as from individual to group, and finally, at the organizational level (Nonaka 2007; Nonaka and Takeuchi 2008).

This spiral is formed by the modes of socialization, externalization, combination, and internalization. Socialization consists in the conversion of tacit to tacit knowledge through direct experience between individuals (Nonaka and Takeuchi 2008). It is a process of sharing tacit knowledge through sharing experiences, which is the key to understanding the way others think and feel (Nonaka et al. 1998).

The externalization process, in turn, consists of articulating tacit knowledge to the explicit (Nonaka et al. 2000) and from the individual to the group, that is, translating tacit knowledge into forms that can be understood by others. usually through metaphors, analogies, dialogue, and reflection (Nonaka et al. 1998; Nonaka and Takeuchi 2008).

The combination process occurs with the systematization and application of explicit knowledge and information, from group to organization, involving the conversion of explicit knowledge into more complex sets of this type of knowledge. Finally, the process of internalization is based on the incorporation of explicit knowledge into tacit knowledge from the organization to the individual through the activities of doing, training and exercising (Nonaka et al. 1998; Nonaka and Takeuchi 2008).

KM can also be understood as a set of processes aimed at identifying, acquiring, developing, sharing and distributing, using and retaining knowledge.

The identification of knowledge takes into account the fact that knowledge, whether internal or external, is not automatically visible. With this, organizations need to know where to find the knowledge they need, inside or outside the company. The acquisition, in turn, stems from the fact that companies often cannot develop the know-how they need on their own, so they can gain knowledge from outside sources such as experts, partners, customers, and others.

Knowledge development refers to the development of new skills, new products, better ideas, and more efficient processes, including all consciously directed management efforts to acquire or build competencies. Sharing and distribution are considered vital factors for transforming isolated information into something that every organization can use, and for it to occur, it is a condition that knowledge already exists, coming from internal or external sources.

In the process of utilizing knowledge, the organization shall ensure that knowledge is applied to its benefit, and this end shall take steps to ensure that skills and assets are fully utilized. The process of knowledge retention, in turn, consists of selecting, storing and regularly updating knowledge, to protect the company against its loss (Probst et al. 2002).

## 4 Organizational Sustainability

Considered to be a megatrend, over the past 10 years, it has constantly influenced companies' ability to create value for customers, shareholders and other stakeholders (Lubin and Esty 2010), sustainability has been discussed in numerous surveys around the world. which led to the dissemination of various conceptual interpretations, which vary according to the purpose of each research (Martins et al. 2019).

There is, however, a widely adopted concept, developed by the World Commission on Environment and Development, through the "Our Common Future" Report, which states that sustainable development is one that "meets the needs of the present without compromising the ability" of future generations to meet their own needs (Brundtland et al. 1987, p. 41). Later, in 1992, at the United Nations Conference on Environment and Development, the "environmental, social and economic" tripod to characterize sustainable development was accepted and formalized (Louette 2009).

When analyzing sustainable development with organizations, it can be conceptualized based on the sustainability tripod, that is, as the search for a balance between what is socially desirable, economically viable and environmentally sustainable (Silva and Quelhas 2006). Another concept goes further by stating that organizational sustainability concerns the inclusion in the management of organizations of the responsibility to insert concerns related to sustainable development into strategic decisions (Van Marrewijk 2003).

Based on the sustainability tripod, as originally proposed by Elkington (1998), it is possible to capture "the essence of sustainability by measuring the impact of an organization's activities on the world […] including both its profitability and shareholder values and its social, human and environmental capital" (Savitz and Weber 2006, p. 8).

Regarding the insertion of sustainability in organizations, which have come under numerous pressures, whether through legislation, governments, clients or activists (Nidumolu et al. 2009), a sustainable strategy must address the interests of all stakeholders: investors, employees, clients, governments and society at large, as well as improving environmental, social and governance (ESG) performance.

In this regard, there are proposed frameworks for sustainable strategy creation and value creation that consider factors such as: strategically focusing on the most "material" ESG issues—those that have the greatest impact on the company's ability to create shareholder value and produce major innovations in products, processes, and business models that prioritize these concerns (Eccles et al. 2013), doing old things in new ways, doing new things in new ways, transforming the core business,

and creating and differentiating a new business model (imperative of sustainability) (Lubin and Esty 2010).

Thus, sustainability has become a generating point for organizational and technological innovations that generate financial returns; which reduces costs as companies end up reducing the use of inputs; and that generates additional revenue from better products or new business. The quest for sustainability is beginning to change the competitive landscape, and the key to progress, especially in times of crisis, is innovation (Nidumolu et al. 2009).

## 5 Universities

Universities, similar to what has been happening to for-profit organizations, have come under intense pressure from society at large (Barlett and Chase 2013) because for legislators, society, the labor market, and others, a transformation is needed. higher education to ensure that more students graduate with the skills and abilities needed to meet 21st-century challenges (Brandli et al. 2015).

Together with the pressures suffered, universities have been undergoing organizational changes in recent years that seek to make them more competitive and even moving towards a concept of "entrepreneurial university", in which interaction with other institutions and economic agents is paramount (Secundo et al. 2016; Brusca et al. 2018). This interaction between university and other agents of society was also worked through the approach of the so-called "Sábato Triangle", in which universities, in their role of scientific-technological infrastructure, participate together with governments and productive structures, the insertion of science and technology in the development of societies (Figueiredo 1993).

Still concerning the organizational changes that universities have been going through, some strongly addressed questions concern sustainability, where sustainable values are becoming fundamental (Brusca et al. 2018), which can be understood given the great responsibility that universities have a role in transforming societies in particular by contributing to a more sustainable humanity (Barth and Rieckmann 2012), playing an important role in sustainable development from two perspectives: promoting education for sustainable development and introducing active policies to achieve this objective (Brusca et al. 2018), adopting concepts and practices in different domains such as education and curricula, research, facility/campus operations, organization of management/institutional structure, among others (Veiga Ávila et al. 2019).

## 6 Research Design

To reach the objective of the study it is necessary to carry out a literature review, because, fundamentally, the advancement of knowledge must be built based on previous work. The review must be valid, reliable and repeatable (Paré et al. 2015).

Thus, to meet these criteria, this study made use of the Fast-Systematic Literature Review (FastSLR) systematic review method that seeks, among others, to reduce errors in reviews and the process execution time. It supports the diagnosis, validation, and evaluation of the research content, and consists of three steps that consist of: Step 1—definition of criteria and research activities and search of articles; step 2—refinement process of the articles found in the previous step, using reference manager, sample calculation and reading of the articles, partially and fully; and step 3—characterized by the use of MC3R software to obtain bibliometric reports and matrices. Thus, following the guidelines proposed for the method, the steps performed in this research are presented (Kluska et al. 2018).

Based on the proposed guidelines for the method, the steps performed in this research are presented below. Regarding the first step of the method, the search criteria were defined as presented in Table 1.

Considering the not so large number of works, the sample calculation technique and the analysis cycle to reduce the sample size were not used. Thus, the second step was to import the dataset into the "Mendeley" reference manager and perform the analysis of the keywords, summary, and title. This step resulted in a set of 05 articles.

The third step of the method was not performed, given that to achieve the research objective, its realization would generate information that would not add to the final result.

The set of articles obtained by applying the method was analyzed and the information considered for the development of this study. However, because it is a low number of articles, the information was not enough, and it was necessary to perform

**Table 1** FastSLR criteria

| Search criteria | |
|---|---|
| Data base | Scopus |
| Type of documents | Not limited |
| Years | Not limited |
| Serach terms | "knowledge management"/ "sustain$^{ab*}$"/ "universit$^{*}$" |
| Operators | AND |
| *Database search* | |
| "knowledge management" AND "sustainb*" AND "universit*" | |
| *Results* | |
| Full portfolio | 278 |
| Final portfolio | 5 |

*Source* Prepared by the authors

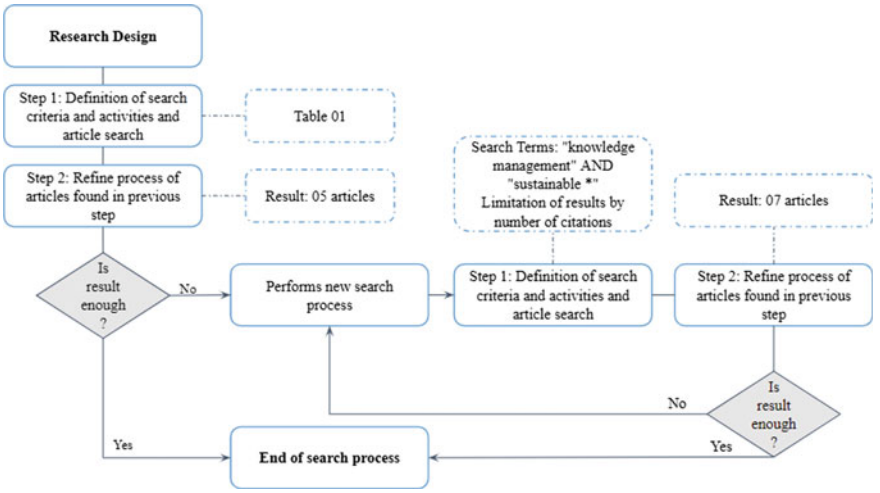


**Fig. 1** Search method flowchart. *Source* Prepared by the authors

an expanded search. Thus, the method was applied again, with other criteria, which made the search process composed of two phases, as shown in Fig. 1.

The criteria of the second phase of the research differ from the first in the search terms, which do not consider the "university" context, and the limitation of the results by the number of citations, having been considered the 100 documents with the largest number of citations, from which is a portfolio of 07 articles, through which was seeking to identify how KM has been applied to promote the sustainability of organizations, without considering a specific context.

Thus, the portfolios obtained with the two phases of the method application were analyzed as follows: the portfolio obtained with the first phase was analyzed to identify the applications of KM in sustainability, both from the perspective of conversion modes, and by process approach, and the second portfolio was analyzed in conjunction with the first one to analyze, through the process approach, without considering a specific context, which processes relate/influence which dimensions of sustainability, as outlined in the following sections.

## 7 Results and Discussions

Sustainable development concerns the insertion of sustainable development concerns into the management of organizations and involves issues such as producing major innovations in products, processes, and business models that prioritize environmental, economic, social, and governance concerns; transform the core business and create new business models; generating opportunities such as reducing input use, which consequently reduces costs, and generating additional revenues from better

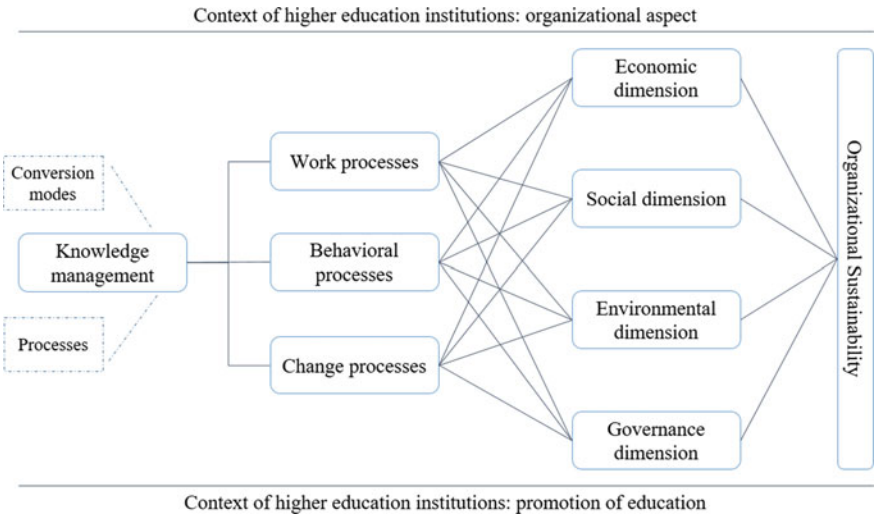


**Fig. 2** Theoretical and conceptual framework. *Source* Prepared by the authors

products or new businesses (Eccles et al. 2013; Lubin and Esty 2010; Van Marrewijk 2003; Nidumolu et al. 2009).

Organizational sustainability, in this sense, can be understood as the result of an organization's processes in society, with impacts on human, environmental and financial capital (Savitz and Weber 2006). These processes, which according to the process approach can be defined as collections of tasks and activities that together—and only together—turn inputs into products, can be strongly influenced by KM.

Considering this information, a representative framework was elaborated—Fig. 2, to visually represent how KM, through its performance in organizational processes, impacts the different dimensions of sustainability, to obtain the organization's sustainability as a final result.

To support the proposed framework considering the literature on the topics addressed, the following sections present applications and studies of the use of KM in search of sustainable results, considering initially the context of universities, and later, without considering any specific context.

## 8 Knowledge Management and Sustainability in the University Context

Universities are places to create and access scientific and technological knowledge. However, knowledge is rarely successfully applied to operational activities, so much so that among the barriers to sustainable development within organizations is the lack of KM, especially for issues such as connecting science, technology, innovation, and

sustainability, improving the conditions for management, make decisions and create incentives and control mechanisms (Veiga Ávila et al. 2019). However, it is possible to find in the literature some studies that seek to apply or investigate how KM can be used to facilitate sustainable development within organizations, with a special focus on higher education institutions.

One of these studies, prepared by Pascu (2015), shows that universities, at first, need to be efficient and effective in managing their knowledge assets. This is because they are knowledge-intensive organizations whose purpose is to "train" human resources and "transfer" them to the market. The author argues about using a knowledge management system that is used to create, gather, organize and disseminate knowledge, as well as provide a competitive advantage. It states that the capture, sharing, and use of internal knowledge are fundamental to the university's ability to implement an integrated sustainable management system.

Regarding the implementation of this system, Pascu (2015) states that different structures and levels must speak the same language and be synchronized. For this, it is necessary, besides the development, the documentation of the processes related to the system.

Another study found by Thomson et al. (2010), the authors have as their object of study the sustainability assessment within a university campus construction project. In identifying project sustainability issues, the KM was initially used through the knowledge exchange of the individuals who participated in the project, so that the sustainability criteria needed for the project were identified and defined and then formalized these criteria in a report. One of the individuals involved with the project was a sustainability consultant hired to assist with the project.

In addition to the implicit criteria obtained from the project individuals, several documents shared by those involved, such as environmental regulations, the master plan, and the university's sustainability strategy, were also used to prepare the criteria report.

In the remaining stages of the project, meetings were held for the definition of criteria and decision making, and the provision of knowledge by the sustainability consultant, as well as the use of tacit knowledge obtained by the project board with project experience previous university studies. At the end of the process, some documents were prepared by the teams involved in the project, such as reports, which were intended to communicate stakeholders effectively.

The third study found focuses on greening campus operations. The authors, Tan et al. (2012) state that KM is generally considered as a necessary basis for innovation in sustainability, and to contextualize their research proposal they present that KM has already been studied, together with information systems, as a means of promoting creation and capture of sustainability knowledge.

However, they expose that collective learning and the advancement of sustainability issues are still hampered by the inability to identify, capture, manage and reuse knowledge in construction domains, however, claim that KM has the potential to assist sustainability performance in building within universities, becoming a powerful tool to support building projects on sustainability issues.

A fourth study, Nupap (2017) seeks to create a KM system for use by a research group within a university department. The intent with the creation of this KM system was to enhance knowledge sharing and learning for sustainable development. Thus, with the system, it was possible to increase the sharing of tacit knowledge among group members and turn this tacit knowledge into explicit knowledge by storing it in a repository.

Of these studies, however, there are few applications in which the authors seek to categorize KM in some way. Thus, while presenting the respective definitions of KM considered by them and which activities are part of this management, to facilitate the analysis and understanding of the contribution of KM to sustainability, two Cause and Effect Diagrams were constructed. The first diagram, Fig. 3, seeks to synthesize the applications found in the studies through the perspective of knowledge conversion modes.

The second diagram aims to synthesize applications based on the GC process approach. Thus, from the existing processes, no applications of two were found: knowledge development and knowledge utilization, as expressed in Fig. 4.

Although studies provide insights and information relevant to a possible framework underpinning, the study of the impact of KM on sustainability in the context of universities is scarce, and studies that do not consider this specific context may become important sources of sustainability-oriented practices. that can be related/adapted to the studied context.

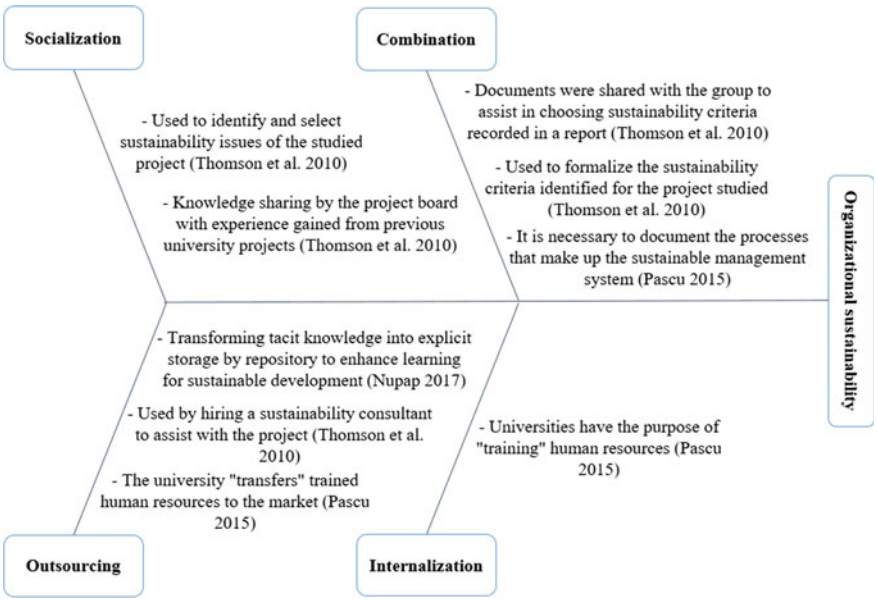


**Fig. 3** Diagram—Knowledge conversion mode. *Source* Prepared by the authors

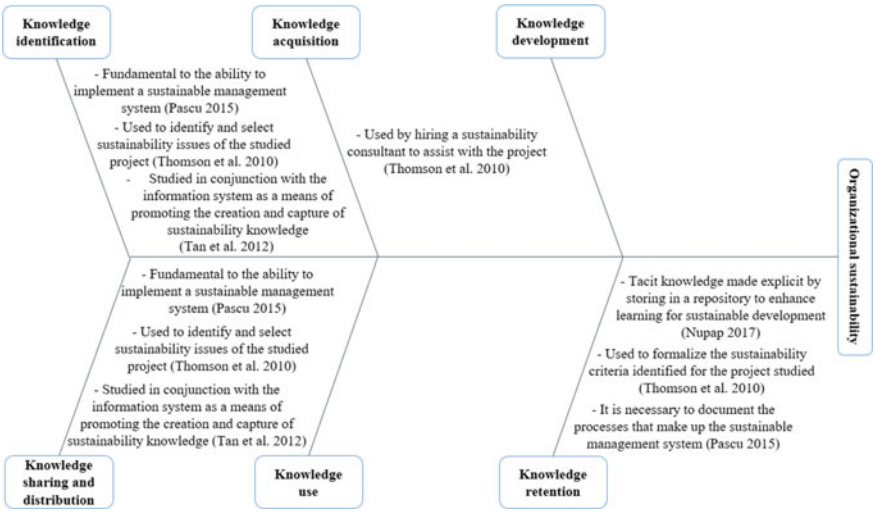


**Fig. 4** Diagram—KM processes.n *Source* Prepared by the authors

## 9 Knowledge Management and Sustainability in the Organizational Context

KM has the potential to influence many organizational aspects. It can, for example, promote continuous improvement, facilitate innovation in business processes and products, engage people as active participants at the heart of the knowledge creation process, and enhance stakeholder relationship management (Robinson et al. 2006). Several of the aspects impacted by KM, such as product and process innovation, can be found in sustainable organizational development initiatives.

The influence of KM, especially if considered under the process approach (identification, acquisition, development, sharing and distribution, use and retention of knowledge) can be identified in the sustainability initiatives of organizations from various sectors, which also enables identify in which of the different dimensions the GC has generated changes. However, not all relationships between KM processes and sustainability dimensions have been studied or tested.

Table 2 seeks to present which relationships have already been studied (relationships considered direct), which relationships have been studied, but do not express which process or dimension they apply to, which were determined by arguments found in the literature. (indirect relationships), and unknown relationships, which have not yet been studied or are not known.

In this sense, regarding the relationships considered direct, the first relationship studied involves the acquisition process, which concerns the need for organizations to acquire knowledge from external sources when they are unable to produce it, and the environmental dimension of sustainability. The argument that determines this relationship is that the highest relational dimension of green innovation development

**Table 2** Relationship matrix—KM processes and sustainability dimensions

| Dimensions of sustainability/ KM Process | Economic dimension | Environmental dimension | Social dimension | Governance dimension |
|---|---|---|---|---|
| Identification | Unknown | Unknown | Ayuso et al. (2011) | Ayuso et al. (2011), Pascu (2015) and Thomson et al. (2010) |
| Acquisition | Unknown | De Marchi and Grandinetti (2013) | Unknown | Thomson et al. (2010) |
| Development | Schrettle et al. (2014) | Unknown | Unknown | Unknown |
| Sharing and distribution | Unknown | Fazey et al. (2013) | Gloet (2006)<br>Ayuso et al. (2011) | Ayuso et al. (2011), Pascu (2015) and Thomson et al. (2010) |
| Use | Schrettle et al. (2014) | Fazey et al. (2013) | Ayuso et al. (2011) | Butler (2011)<br>Robinson et al. (2006)<br>Ayuso et al. (2011) |
| Retention | Unknown | Unknown | Unknown | Schrettle et al. (2014)<br>Pascu (2015)<br>Thomson et al. (2010) |

*Source* Prepared by the authors

is verified by using external knowledge to develop innovations internally, that is, by using external sources of information to a greater extent or by acquiring R&D from outside companies (De Marchi and Grandinetti 2013).

Another direct relationship found also involves the environmental dimension, but with the process of knowledge sharing, which is vital for transforming isolated information into something that every organization can use, justified by the argument that the effectiveness of environmental management depends greatly on how knowledge it is exchanged, with whom it is exchanged and how it is used (Fazey et al. 2013). This process is also directly related to the social dimension, given that the more intense the exchange of knowledge and information, the greater the chances of developing effective management and leadership resources to support sustainability (Gloet 2006). For this relationship, there is also the argument that KM and organizational learning are considered essential organizational competencies to meet the challenges of corporate social responsibility (Ayuso et al. 2011).

The process of using knowledge is the only one that has relationships identified with the four dimensions of sustainability. Direct relationships, in turn, involve the environmental and governance dimensions. With the environmental dimension, its relationship can be considered strong considering that the effectiveness of environmental management depends greatly on how knowledge is exchanged, with whom it is exchanged and how it is used (Fazey et al. 2013).

With the governance, dimension is found the largest number of relationships of the utilization process, which can be considered straightforward as applying explicit and

tacit knowledge to convert sources of legislation (regulatory), standards of compliance (normative) and cultural- cognitive approaches from various global environments in explicit knowledge contained in structured legal and compliance data (Butler 2011).

Finally, the process of knowledge retention, which consists of selecting, storing and regularly updating knowledge to protect the company against its loss, has a known relationship only with the governance dimension, which can also be considered. directly, by the argument that corporate decisions are influenced by previous decisions and the stock of acquired competencies (Schrettle et al. 2014).

The other relationships not mentioned, such as the relationship between the process of identification with the economic dimension, or between the process of development with the environmental dimension are not known, that is, from the literature, no arguments were found that these relationships exist, or they have not been studied yet. Relationships that are considered the indirect need for further investigation to make them relationships considered strong—tested or studied.

## 10 Conclusion

This study aimed to identify how KM influences organizational sustainability in the context of higher education institutions. To this end, the premise was the action of KM in organizational processes, which are responsible for transforming inputs/resources into products/services of the organization, and which produce the results of the organization, whether sustainable or not. This interrelationship between KM, organizational processes and sustainability were presented through a framework, which considered sustainability through four dimensions: economic, environmental, social and governance.

Thus, based on studies available in the literature, it was possible to relate KM, worked under the process approach—identification, acquisition, development, sharing and distribution, use and retention of knowledge with the sustainability dimensions, which allows us to conclude that although there are several shreds of evidence of influence and use of KM for organizational sustainability purposes, few relationships have been studied, especially in the context of higher education institutions.

As shown in Table 2, the dimension that has received the most applications from KM is the environmental dimension, which has been worked together with the processes of acquisition, sharing and distribution and use of knowledge. The relationships established between this dimension and these processes are considered straightforward once they have been studied.

In general, however, the dimension that has been mostly related to KM is the governance dimension, which has no relationship identified only with the process of knowledge development. However, most of the identified relationships were considered indirect, that is, relationships that have some evidence from the literature, but that needs to be better studied to confirm the consistency of this relationship.

In direct relations KM has been useful as a tool to acquire external knowledge and enable the development of innovations internally; to enable the sharing of knowledge among members of the organization, which impacts on the effectiveness of environmental management, as well as the development of effective resources for management and leadership, focused on the sustainable development of the organization; to facilitate the conversion of sources of legislation, compliance standards and cultural influences into legal and compliance data that can be effectively used by the organization; as well as providing the knowledge base to support future decisions.

In relationships considered indirect, KM has been seen as necessary to develop knowledge about consumer preferences and other requirements to address sustainability challenges, and to apply company knowledge to products and processes themselves. Overall, it is identified as a central factor in creating an organizational environment that supports creativity and promotes innovation, as well as essential to addressing the challenges of corporate social responsibility. It has also been seen as a tool for improving corporate governance, facilitating continuous improvement and increasing stakeholder value (Robinson et al. 2006; Schrettle et al. 2014; Ayuso et al. 2011).

Considering the above, although some applications and influences of KM on sustainability have been identified, the possibilities for future research are wide, especially considering the breadth of the themes and the attention that sustainability, in particular, has been receiving in recent years. Thus, based on the considerations generated from the research, it is suggested as a possibility for future research to study the relationships of other KM processes with the dimensions of sustainability; identify why KM has been applied most often in the governance and environmental dimension; and direct research that addresses the issues in the context of higher education institutions.

Finally, considering all of the above, it is understood as the main contribution of this research the identification of how KM has been used to assist organizations in the direction of sustainable development. From this contribution come secondary contributions, such as the generation of greater integration between the two main themes—KM and Sustainability, which until now have been strongly worked in parallel, but which can generate positive results if worked together and strengthening from the field of study of KM.

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# New Perspectives on the Concept of Sustainable Development: A Contribution by Brazilian Master's Students in Governance and Sustainability

**Ana Cristina Wollmann Zornig Jayme, Barbara S. Przybylowicz Beuter, Larissa Panko, and Norman de Paula Arruda Filho**

## 1 Introduction

The United Nations has a relevant role in promoting events and discussions on sustainable development since 1940, although scientists addressed the theme long before that, there are still many questions and a wide variety of definitions about the terms sustainability and sustainable development, which makes them subject to questioning and the target of discussions. (Lindsey 2011; Stepanyan et al. 2013; Feil and Schreiber 2017).

In order to contribute to such discussions, while deepening studies on the theme, this research presents new perspectives about the concept of sustainable development based on students' reflections from the Professional Master's Program in Governance and Sustainability of ISAE Business School.

By raising academic and institutional conceptualities on the subject, the evolution of understanding sustainable development over time was evaluated; thus, it is intended to shed light on the consolidation of a timeless concept and without borders of any nature within the scope of literature. Reinforcing the need to structure solid theoretical bases that translate to a focus on enabling their implementation in practice.

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The institution was one of only two representatives in Brazil to be part of the task force that defined the UN Principles for Responsible Management Education (PRME) in 2006. The initiative aims to make educational institutions include into their management processes and curriculum the promotion of the vision of development based on social justice, economic viability and environmental preservation.

As signatory of the UN PRME, ISAE (*Instituto Superior de Administração e Economia*) created a specific methodology for one of the disciplines of the Professional Master's Program which invite students to reflect and reconceptualize the expression 'sustainable development'. Therefore, this research aims to analyze the perspectives created by the studies compared to the historical context. It is a qualitative study of bibliographic research, using subjective interpretation (Feil and Schreiber 2017) to understand what is new and what remains at the essence of these definitions. The study was conducted in 2019 and analyzed the productions of master's students from 2013 to 2019.

## 2 Sustainability and Sustainable Development: Conceptual Implications

Literature presents multiple interpretations of sustainability and sustainable development (Stepanyan et al. 2013; Lindsey 2011). For Mazlooni and Hassan (2008) there are still many disputes about the scope of the concept and its multiple interpretations. Mori and Christodoulou (2012) advocates that interpretation of this term as inconsistent and with a high degree of ambiguity, which causes a deep misunderstanding of the problems related to poverty, environmental degradation and the role of economic growth (Slimane 2012).

According to Feil and Schreiber (2017), sustainability gained space and visibility due to discussions on the relationships between human and environment, especially by correlating the themes of global ecology and economic development.

The first records that refer to the idea of sustainability can be found in the period from 1713 to 1987 in various publications and discussions, however, without a consistent conceptualization of its meaning (Feil and Schreiber 2017). The centenary between 1760 and 1860 was marked as a period of recognition of trade-offs inherent between generating wealth and social justice. Following the late 19th and early twentieth centuries, natural scientists and ecologists who supported a discussion between anthropocentric conservationists versus biocentric preservatives gain to prominence in history.

Sequentially, at the 1970s more institutionalized movement focused on the environmental issue. An institutional perspective is the conception of a particular subject reflects the action and influence of large groups/institutions, "… whose performance influenced and influences the way society conceives the issue…" (Siena et al. 2012, p. 64).

At this point, Carson's (2002) iconic Silent Spring sought to draw attention to environmental awareness and impacts on the planet by human behavior. The same year dates back to the creation of the Environmental Protection Agency—EPA in the United States in 1970; followed by the first major meeting of heads of state organized by the United Nations to discuss the environmental issue. With the participation of 113 countries, the UN Conference on Human Environment took place in Stockholm, Sweden and was responsible for the launch of the report "The Limits to Growth", which drew international attention to issues related to environmental degradation and pollution, not limited to political borders. According to Meadows et al. (1972) when imposing limits on growth, the report advocates a "global system that is sustainable".

A few years later, economist Georgescu-Roegen (2012) became known by the so-called ecological economy (or bioeconomy), criticizing the neoclassical, mechanistic economy and warning that if we maintained the standards of production and consumption of the time, we would reach an irreversible pattern. With this, became the alert that society must have ecological stability, besides being socioeconomically sustainable, capable of meeting the basic conditions of humanity (Goldsmith 1972; Meadows and Randers 2012).

At this point, on his first records, Sachs (1978) advocates the concept of "Ecodevelopment" as a development that aims to harmonize social and economic objectives with an ecologically correct management, in a spirit of solidarity with future generations (Sachs 1978). As an advisor to the United Nations Environment Program (UNEP), Sachs (1978) minimizes the notion of "trade-offs" between environmental management and economic growth and defends "a different, environmentally prudent, sustainable and socially responsible growth." Yet, the term sustainability would be popularized only from the 1980s (Pisani 2006), with increased global attention to climate issues.

Sachs's perspective (2000) was in line with the UN World Commission's Our Common Future Report on Environment and Development which attested "SD as the development that meets current needs without compromising the ability of future generations to meet their own needs" (Tolba and Biswas 2013).

In the same year, Elkington and Burke (1987) introduces the notions of social and environmental responsibility to the corporate business. Elkington (2012) follows the same line of Sachs (2009) and defends the plurality of the concept of Sustainability which he calls the Triple Bottom Line, as described by the authors:

> Starting from the concept of 'bottom line', popularly used in the business world and that refers to the economic performance of the company, the author adds the environmental and social aspects to the evaluation of the results of organizations, since society depends on the economy and the economy depends on the environment. (Sugahara and Rodrigues 2019, p. 38)

The sustainability model created by Elkington and Burke (1987) was universally approved during the 2nd United Nations Conference on Environment and Development, which became known worldwide as Rio Eco 92 (Stockler and Hanashiro 2019; Novaes 1992). Years later, Sachs (2000) would present different criteria for sustainability, defined as social, cultural, ecological, environmental, territorial, economic,

national and international policy, registered in the work The Path to Sustainable Development (Sachs 2000).

With this brief account this survey aims to highlight that it is possible to find in literature different perspectives that add up creating a theoretical set about sustainability and sustainable development. For Purvis et al. (2019) this variety of conceptualization of terms brings together, in short, a critique of the economic status quo based on the incessant pursuit for economic growth, short-term agriculture, industrialism and lack of consideration to the fragility of complex ecosystems.

In other studies, authors such as Dovers and Handmer (1992) advocate sustainability as the ability of a natural or mixed human system to resist or adapt to endogenous or exogenous changes indefinitely. Bolis et al. (2014) complement this link considering possible positive reflexes in the economy and society. Jabareen (2008) resumes the idea of the economic and socio-environmental tripod by advocating that sustainable development has the capacity to solve the ecological crisis without affecting economic relations; since it aims to solve the paradox between environmental (sustainability) and economic (development) biases.

Another line of thought gains prominence with the placements of Grober (2007), who punctuates the cultural factor of sustainability, defending it as a way of thinking and acting. This connection of the idea of sustainability with behavioral bias is also cited by authors who interpret sustainability as a result of sustainable development, feasible only from a long-term strategy that aims the improvement of society's quality of life. (Hove 2004; Dovers and Handmer 1992; Feil and Schreiber 2017).

In more critical approaches, Boff (2014) and Feil and Schreiber (2017) sees with skepticism the corporate use of the term Triple Bottom Line and condemns the decontextualized use of the term sustainability, stating that it has become "a fad, without its content being clarified or critically defined". Boff (2014) also points out that "sustainable development" is proposed either as an ideal to be achieved or as a qualification of a production process or a product, made allegedly within sustainability criteria, which, in most cases, does not correspond to the truth. (Boff 2014).

It is possible to realize that even after more than thirty years after the definition of the Brundtland Report, the concept of sustainable development still attracts significant criticism (Yolles and Fink 2014) which stimulates the study of society's understanding of this theme in view of its social relevance.

Over the years, increasing attention has been paid to the ethical, environmental and social dimensions of business, usually under the title of corporate social responsibility (Kolk 2016). Since 2002, the World Bank has developed a CSR practice to support governments in developing countries on roles and instruments to be adopted to encourage CSR, because they recognize that companies are part of society and have the potential to make a positive contribution to its goals and aspirations.

While many organizations subscribe to the triple P and sustainable development, it is debatable to what extent this is just a pretense for more positive public relations or indeed a strategy being held (Kolk and Van Tulder 2010). However, CSR activities are becoming increasingly strategic in the sense that they affect the company's core business and its growth, profitability and survival (Kolk and Pinkse 2008; Verbeke

2009), with CSR as a potential source of competitive advantage (Porter and Kramer 2006).

There are many different views on what social responsibility implies (Kolk 2016). Votaw (1973) describes it as the idea of legal responsibility for some and socially responsible behavior in an ethical sense for others. According to Alvarado-Herrera et al. (2017), there are at least two ideas about CSR shared at the academy. The first is the assumption that the company has responsibilities beyond profit maximization (Carroll 1999; Davis 1960). The second idea is linked to the first and maintains that the company is not only responsible to its owners, but also with other stakeholders (Frederick 1960; Jones 1980; Marrewijk 2003).

The term sustainable development, in the business sphere, is generally in line with the one advocated by Elkington (2012), demanding the organization's attention to develop CSR strategies and actions that are more tangible and easier to be evaluated and perceived by consumers (Alvarado-Herrera et al. 2017). From this perspective, Alvarado-Herrera et al. (2017) adopts the concept of CSR as "the commitment of a company to maximize long-term economic, social and environmental well-being through practices, policies and commercial resources" (Du et al. 2011). This definition is defended because it allows the identification of CSR dimensions to the sustainable development model and its sustainability-centered rationality translates into managerial and operational objectives (Kakabadse and Rozuel 2006). In summary, The CSR is a multidimensional reflective construct whose three dimensions—economic development, social equity and environmental protection—correspond to the dimensions of sustainable development (Marrewijk 2003).

Prugo and Assadourian (2003) advocate the concept of sustainable development as flexible and open to interpretations. In this context, discussing new perspectives on sustainable development aims to enable a comparison between the definitions that have hitherto existed, already presented and those proposed by the academics, with a view to identifying what are its new nuances and dimensions, and what remains unchanged and can be understood as nuclear and intangible to the conceptualization already presented.

The exercise of creating definitions is a process of dialogical constructions, matching, in the sphere of the literacy system, with the Knowledge Theory readings, which became known as Paulo Freire's Method (Feitosa 1999) and which consists of two principles:

1. the politicity of the educational act: in synthesis, conceptualized as an axiom according to which there is no neutral education (Feitosa 1999);
2. the dialogicity of the educational act: according to which, the educator-educating-object tripod of knowledge is inseparable and dialogue with each other (Feitosa 1999). In this sense, according to Feitosa (1999), "Learning is an act of knowledge of concrete reality, that is, of the real situation experienced by the student and one that only makes sense if it results from a critical approximation of this reality" (italics in the original) (Feitosa 1999, p. 50).

Exactly with regard to the essence of this second principle is that Paulo Freire Method relates to the exercise of a sustainable development reconceptualization developed by ISAE's Master's classes and presented in the sequence.

## 3 New Perspectives

### *3.1 Institutional Context*

*Instituto Superior de Administração e Economia* (ISAE) is characterized as a higher education institution in the non-profit model, based in Curitiba in southern Brazil, which offers the Professional Master's degree in Governance and Sustainability, unprecedented in the Country, since 2013.

The school has built a reputation for promoting responsible executive education after becoming a signatory to the United Nations Global Compact in 2004, and subsequently participating in the task force that outlined the Principles for Responsible Management Education (PRME) from the UN.

Currently, ISAE is among the most active PRME group of schools known as Champions Group and is part of the Board of Directors committee of the Global PRME, being that person the President of the institution. This position of relevance requires the implementation of practices that promote education for sustainability within the academic curriculum of Higher Education Institutes (HEI) and, consequently of the 2030 Agenda for Sustainable Development.

According to Morin (2014), promoting education for sustainability implies the adoption of pedagogical practices for a transformative education based on the human condition, on the development of understanding, sensibility and ethics, cultural diversity, plurality of individuals, and that it enables the construction of a knowledge of a transdisciplinary nature, involving individual-society-nature relationships.

The same term can also be found as one of the goals of the 2030 Agenda for Sustainable Development, in the UN, and it is composed of the 17 Sustainable Development Goals (SDGs). The 2030 Agenda, launched in 2015, addresses a series of 17 goals and 169 aims that focus on solving a wide range of challenges encompassing 5 main points: people, planet, prosperity, peace and partnerships (Parkes 2017).

The 4th objective stipulates the duty of nations to "Ensure inclusive, equitable and quality education, and to promote lifelong learning opportunities for all and everyone." Among its goals, sustainability education is understood as the need to:

> … ensure that all students acquire the necessary knowledge and skills to promote sustainable development, including, among others, through sustainable development education and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship, valuing cultural diversity and the contribution of culture to sustainable development. (https://nacoesunidas.org/pos2015/ods4/)

Schools that commit to the Principles for Responsible Management Education (PRME) start to adopt the 2030 Agenda as one of their goals and, therefore, the

promotion of quality education and education for sustainability becomes a priority commitment.

In the case of the institution here studied, the discipline of Sustainability in Organizations is designed based on the principles of the Global Compact and PRME and aims to promote business sustainability in the internal and external environments and Agenda 2030 activities that seek the commitment of those involved (Arruda Filho 2017). As a professional master's degree course, the applied methodology aims to associate a conceptual theoretical basis with market practices in the training of students, valuing the previous knowledge to the activities developed in the classroom, addressing the themes treated in the light of academic, corporate and governmental perspectives.

The exercise of sustainable development reconceptualization is part of the activities developed in the Sustainability in Organizations discipline in the Professional Master's in Governance and Sustainability since the very first class, starting in 2013. The activity begins from the studies of the classical concepts, previously mentioned in the theoretical survey part of this research. Subsequently, students are divided into groups and invited to reconceptualize the expression, promoting a discussion and exploring the perception of each individual.

The exercise cultivates collaborative construction, group work and mutual respect when demanding a more refined analysis of the theme from different perspectives. Similarly, it encourages participants to position themselves by exposing their individual point of view, agreeing or disagreeing with others and providing an environment of evolution. The conceptions elaborated by the groups are then transformed into a single definition, which should also be judged and approved by all students in the class, exercising collaboration. Thus, by seeking consensus from dissent, the activity alludes to the current corporate reality, in which leaders from various nations meet periodically to discuss the future of the planet (Arruda Filho 2017). The activity is developed since the first class as presented in Chart 2.

After defining the concept of each class, a final version is sent to the UN as a way of demonstrate society's understanding about sustainable development. This action was a suggestion of Jorge Chediek, Director of the United Nations Office for South-South Cooperation, who was at the school at the time and participated of the activity of the first class, also signing the final document. Chediek suggested that the document be mailed to UN Secretary General Ban Kin Moon, and this happens to all following classes.

Given the conceptions created by students and from a subjective interpretation, this research seeks to discuss what is new and what remains at the essence of definitions about the expression 'sustainable development'.

## 4 Results and Discussion

Discussing sustainable development has its relevance based on the various interpretations that the theme accepts and that are still a source of discussion in academia

| Year | Class | Definition |
|---|---|---|
| 2013 | I | SD is to be and to grow in order to transform our living. |
| 2014 | II | SD is the balance in relationships for the valorization of life. |
| 2015 | III | SD is the balanced transformation of the planet, people and prosperity with peace. |
| 2016 | IV | SD is the progressive transformation of the human being to ensure better life on the planet. |
| 2017 | V | SD is a transformative alliance that promotes practices in a balanced way for the sake of life. |
| 2018 | VI | SD is a collective commitment that transcends territorial particularities and promotes the regeneration of the consciousness of unity between the human being and the ecosystem. |
| 2019 | VII | SD is the promotion of a collective and solidary consciousness for the balance among the environmental, economic and social dimensions for the benefit of the well-being of all life forms. |

**Fig. 1** Perspectives on the expression 'sustainable development'

and society in general. By bringing this practice to a structured action in the classroom, the institution in question creates an environment of collaborative construction and makes tangible the practical applicability proposed in the methodology of the Professional Master's. Likewise, it seeks to foster the critical reflection of the term sustainability, a need that responds to Boof's (2014) critical placements.

In this perspective, it should be noted that the teacher's role, in a process of such a nature, will be to conduct and encourage the relevant debates, distancing him/herself from the idea of echoing content that is "ready" and previously established, while avoiding being under the insignia of 'holder of knowledge'. Which converges with the structuring of teaching led by Freire (1963), in which he considers that we have surpassed the ideal of the teacher being the discussion coordinator, as well as the student being solely the participant of the group and the class through dialogue, that is, every participating person, student or teacher, is equally relevant in the process. The author states that, by challenging groups with existential situations, the programs lead students to the most "critical positions" (Freire 1963, p. 09).

Hence, knowing the vocabulary universe of students, their knowledge translated through their orality, starting from their cultural baggage full of lived knowledge that manifests itself through their stories, their 'tales' and, through constant dialogue, in a genuine partnership with the student, reinterpreting them, recreating them (Feitosa 1999, p. 47) is a task that raises the degree of maturity of those involved.

The Paulo Freire method is based on this process of appropriation of content, so that students become protagonists of their knowledge and generate content that reflects their reality. The connection with the practice mentioned takes place to the extent that the results of the debate and the exchange of ideas between academics are constituted, into which should be included the explicitness of their own individual understandings on the subject examined, notably with regard to their previous experiences in their most diverse spheres: family, social, educational and economic.

Indeed, only after this dialogical construction, lastly, is that the concept of each class is architected in its collectivity; respecting and maintaining, as far as possible, the essential core of the individual definition of each one of those involved in the process.

In the concepts presented by ISAE students, we observe the effort to rediscover the true meaning of the term in a given temporal space, after exposure to a process of knowledge and debates, moving away from the fad of the term. The words related to transforming and balancing are the most recurring. The use of—transform, transformation and transformative—suggests concern about the need to change the attitude that needs to occur from the point of view of the individual, as in his/her various forms of collective. On the other hand, the employment of—balance, balanced—seems to signal a concern with the prospect of harmony and stability.

The occurrence of words linked to transform is present in the years 2013, 2015, 2016, 2017. The following classes (2018 and 2019) make no mention of transformation as an inherent element of sustainable development; but mention the figures of collective commitment and conscience. It seems possible to assume that over time the concern about sustainability would be going beyond the barriers of transforming, revolutionizing, and assuming the need for a conscious commitment between the parties involved and incorporated into the daily life of their actions.

There may be a correlation with the fact that the goals and results of the Paris Conference have not been met, denoting the importance of strengthening commitment to what has been agreed. This correlation is evidenced in the most recent definitions (2017, 2018 and 2019) that state that SD is: a transformative alliance; a collective commitment and; the promotion of a collective and solidarity conscience. These statements seem to recognize the importance of collectivity: to the extent that the concern for sustainability becomes rooted in one or more individuals and in one or more groups, it is conceived that the next step is that these individuals and groups strive to raise awareness of other individuals/groups, so as to effectively build a collective consciousness.

In September 2015, United Nations member countries approved the document "Transforming Our World: The 2030 Agenda for Sustainable Development" based on five axes of action: Peace, People, Planet, Prosperity and Partnerships (Parkes 2017). This fact may have been the motivation of the class of 2015 to refer its definition to the five Ps of sustainable development, thus suggesting a direct relationship with Agenda 2030.

The words related to balance, and the expression consciousness of unity that also gives the notion of balance are present in 71% of the definitions—2014, 2015, 2017, 2018, 2019. The recognition of the importance of harmony dialogues with the defense of Sachs (2009) regarding the concept of sustainability, and is reinforced as the planet (ecosystem) and human beings' relationships are also in focus in the years 2014, 2015, 2016 and 2018.

The highlight to the term "life" present in the years 2013, 2014, 2016, 2017 and 2019 would be justified to the extent that the minimum for development to be considered sustainable would be the very maintenance of life on the planet.

Each definition proposed by the master's students seeks to highlight one aspect: the individual behavioral issue was focused on in 2013 and 2016, the balance in relationships was highlighted in 2014 and 2015 while the commitment of the collectivity prevailed in 2017, 2018 and 2019. The fact is that all these definitions find connection with various concepts tackled in literature.

The idea of sustainability with behavioral bias is cited by authors who interpret sustainability as a result of sustainable development, feasible only from a long-term strategy that aims to improve the quality of life of society (Hove 2004; Dovers and Handmer 1992; Feil and Schreiber 2017). Georgescu-Roegen (2012) argues that "Resource depletion and waste dumping at some point will affect the possibility of subsequent generations having equal or greater quality of life" (Cechin and Veiga 2010, p. 446); consequently, in order for sustainable development to be possible, a change of mindset is effectively necessary, which, from the author's perspective, is beyond the reduction and modification of consumption habits only, it presupposes economic 'ungrowth'. The 'ungrowth' in this approach can be correlated as the desired balance in relationships.

Sachs's approach (1978) on a development aimed at harmonizing social and economic objectives with ecologically correct management, in a spirit of solidarity with future generations refers to the balance and commitment of collectivity advocated by the students. Same way as Meadows et al. (1972) argues that modern growth-based economy is unsustainable on a finite planet and also reinforce the idea of the importance of balance.

It is also important to highlight the correspondence of the concepts proposed by the master's students with the CSR, based on the argumentation of Marrewijk (2003) that establishes the relationship between the three dimensions of the CSR—economic development, social equity and environmental protection—with the dimensions of sustainable development.

Regardless of the specificities of each of the concepts presented, as pedagogical exercise or as a contribution of academia and institutions, and even the temporality in which they occurred, a point that seems to be the link: it is the concern to bring up the sense of urgency that the theme demands.

## 5 Final Considerations

This study aimed to present new perspectives on the concept of sustainable development based on reflections from students of the master's degree in Governance and Sustainability at ISAE Business School, after an intense process of exposure and debate on the topic.

From the comparison of the final product of each class with the evolutionary process of the main conceptualizations and historical implications in terms of sustainability and sustainable development, there was a great influence of the authors of the

1970s and 1980s. However, such influence was not an impediment in the appreciation of some aspects seen as of greater relevance by the groups—individual behavior, balance of relations and commitment of the collectivity.

This reinforces that, although the theme 'sustainable development' is widely discussed, the expression still does not have a fully sedimented concept, both in academic and institutional bias. It also demonstrates that it is a changing understanding and in constant construction, simultaneously with the evolution and ripening of society in relation to its role towards sustainability, as a whole.

Future studies can expand the research sample, mapping an overview of the perception of students from PRME signatory schools, comparing with non-signatory schools, on the expression and implications of sustainable development. Another contribution would be the development of a research on the actions developed by the students in their institutional environment after the activity of reflection and reconceptualization of the expression sustainable development, in order to understand how this exercise can influence their daily practice.

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# Social Entrepreneurship and Innovation Social: A Systematic Review Publications in the Last Ten Years


**Norma Brambilla, Sandra Aparecida dos Santos, and Edson Pinheiro de Lima**

## 1 Introduction

The approach to issues important to the welfare of society and economic development are challenging the orientation of actions to scholars and researchers in the approach to the research conducted involving social innovation and social entrepreneurship aims to better understand the context and realize the prospects of so many evolution of concepts such as interaction with other areas of study and practical application.

In this context the problem investigated in addressing concerns identified as the literature has presented the results of research in this field. And the purpose of the study wasconduct a literature mapping on the number of scientific articles published in the last ten years in the areas of social entrepreneurship in conjunction with social innovation.

Social innovation is a response given by Actors initiative seeking to meet a particular need, create solutions, take advantage of opportunities in order to make actions, social and cultural relations (Tardif and Harrison 2005).

It is true that there is a close relationship between innovation and entrepreneurship. Innovation is the characteristic tool of entrepreneurs, that is, the means by which they exploit change as an opportunity for a new business or service. Thus, entrepreneurs

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need to search for the sources of innovation, change and its evidence pointing the opportunity (Drucker 2010).

Social entrepreneurship in Brazil emerged in the late 1990s, due to rising social questioning, the reduction of public investment in the social field, the growth of third sector organizations and the participation of companies in the investment and social action (Oliveira 2004).

Market requirements, both commercial, as labor, are growing, but few are the conditions that allow the inclusion of a large part of humanity, which, historically, is excluded from access to social goods and services necessary for their survival (Oliveira 2004).

Social businesses are intended to produce goods or provide services that solve or reduce social problems and/or environmental. Do not depend on donations or public funds for financial viability, because, like exercise economic activities, are self-sustaining (Andreazza 2018).

Innovation is at the same time, characteristic and instrument of social entrepreneur. Therefore, the theme of social innovation takes relevance when working with social entrepreneurship.

In different countries, the social economy takes different typologies and studies on the topic may cover other aspects beyond that will be addressed here. Despite the social economy constitute a not a recent phenomenon and increasingly recognized and significant, both from a practical point of view as an object of theoretical studies, it is still rarely addressed in Brazil (Andión and Servant 2006).

The process of globalization and the growing direct relationship between social and environmental brought new claims. Both the States and civil society have come to realize that, before such a panorama, need, in the face of growing difficulties, position yourself beyond the economic efficiency and working through institutions and other mechanisms of solidarity towards social inclusion, development social and social cohesion (Caeiro 2008).

Following the work, the concepts of social entrepreneurship and social innovation, the description of the procedures for data collection, the result of research on the topic and an analysis regarding the information that has been identified.

## 2 Theoretical Foundations

Innovation is defined by Drucker (2002, p. 25) as "a tool used by entrepreneurs to exploit change as an opportunity for a different business or a different service."

In Brazil the Law of Innovation Law n. 10.973/2004 provides for incentives for innovation and scientific and technological research in the production environment, as, article 2, section IV: "IV—Innovation: introduction of novelty or improvement in the productive or social environment that results in new products, processes or services" (Brazil 2004).

The definition according to the Oslo Manual (2006, p. 55) which is a technical production of the Organization for Economic Cooperation and Development

(OECD), presents innovation as the "implementation of a product (good or service) new or significantly improved, or a process, or a new marketing method, or a new organizational method in business practices, workplace organization or external relations".

The point is that technological innovations have acquired an indisputable relevance to economic development. Certainly they have always existed, however, is only the meeting of science with production during the Industrial Revolution, the production of technological innovations can be made through a specific and formal activity. The moment that scientific activity ceased to be contemplative to become active is the one where the source of practical industry solutions did not serve to solve the growing range of problems; to add practical solutions came in increasing numbers, scientific solutions. The evolution of capitalism has led to very relationship between science and production to higher levels of formalization, organization, finally, to systematize (Zawiślak 1994).

For researchers Tardif and Harrison (2005) social innovation is a response given by Actors initiative seeking to meet a particular need, create solutions, take advantage of opportunities in order to make actions, social and cultural relations. The above authors ensure that happens one mix between identities, norms and individual values resulting in a collective learning.

Silva (2012) identified in the literature, studies on social innovation and its spread, which led to realize that there is no agreement on the definition of the term. However, the author pointed out that the concept has been pluralized in several countries, notably the United States, Canada, Europe and even in Brazil. In the United States, there are universities, such as Stanford, Harvard and Brown, who formed study groups to research the topic. In Canada, one of the main groups of social innovation studies, the Center de Recherche Sur Les Innovations Sociales (CRISES). In Europe, INSEAD, University of Cambridge, and projects such as EMUDE and ISESS, who conduct research and actions of social character. In Brazil, there is the work done by the Institute of Social Technology (ITS).

The original concept of entrepreneur is important and pretty old. Supports its roots in classical economic doctrine originated in the seventeenth and eighteenth centuries and is the basis of studies of the late nineteenth century and early twentieth century. For this theory, entrepreneurship is the activity of the entrepreneur. The entrepreneur is typically an economic agent. (Schumpeter 1995, p. 619). "The term had changes over time" (Dornelas 2005, p. 14). The entrepreneur organizes resources—money, property, land, people—to get the best material result (Marins 2010).

Undertake means changing reality to it offer positive values to the community. Means furthermore engender ways to generate and distribute material and immaterial wealth through ideas, knowledge, theories, arts, philosophy. Undertake means to "believe in the ability to change the world; indignation at social inequities. Undertake is especially a future building process" (Dolabella 2003, p. 30).

Entrepreneurship involves subjects and methods in order to adapt an idea into a suitable opportunity for trading, in which the entrepreneur is the guy who envisions a commercial operation targeting an interest, therefore, be responsible for calculated risks. Thus, entrepreneurship has become critical to the development of the economy,

stimulating increased production so that the social changes leading to greater capacity and resources to organizations (Degen 2009).

It is true that there is a close relationship between innovation and entrepreneurship. Innovation is the characteristic tool of entrepreneurs, that is, the means by which they exploit change as an opportunity for a new business or service. Thus, entrepreneurs need to search for the sources of innovation, change and its evidence pointing the opportunity (Drucker 2010).

Entrepreneurship can be divided into two components: i. The first relates to the generation of new businesses or setting up a business; ii. The second aspect relates to the expansion of a business or existing business. In both stands out corporate behavior aimed at seeking and exploring new opportunities, creating economic and social value for the community or customers (Dolabella 2003).

Social entrepreneurship has emerged in recent decades as a way to identify and generate possibly transformative changes in society. A combination of government intervention and pure entrepreneurial business:

> The social enterprise is able to treat problems whose scope is too narrow to instigate the legislative or to attract private capital activism. The success of these projects depends on both an adoption social goals as strict financial constraints. Typically, the goal is to benefit a specific group of people, transforming their lives permanently changing a prevailing socioeconomic balance that operates to the detriment of their interests (Martin and Osberg 2015, p. 2).

The study Greg Dees, on the concept of social entrepreneurship, was written only in 1998 and revised by the author in 2001 and despite the result to describe the differences between the classic entrepreneur and social entrepreneur, did not capture the look of cultural movement that was emerging transformer (EB 2001). "The language of the transformative movement is new, although their practice is not, "there have always been social entrepreneurs, even if they were not so designated" (Dees 2001, p. 2).

## 3 Procedimentos Methodological

The adopted methodological procedure is divided into three groups of activities: consulting the literature, development and empirical evidence. The query to the literature involved the collection and selection of literature related to the theme "Social Entrepreneurship Generator Social Innovation". Already occurred in developing the analysis of the content, with the aim of "nalisar factors that must be present in the social enterprise for this to be considered social innovation generator".

The literature review provides an introductory perspective on the development of a research project and resumes the accumulated scientific knowledge on the subject. It also enables the researcher to become even more familiar with the subject searched, allowing you to create new constructs (Afonso et al. 2012). Similarly, The literature relating to the study further and continuous dialogue with the literature, filling gaps and extending earlier studies (Creswell 2010).

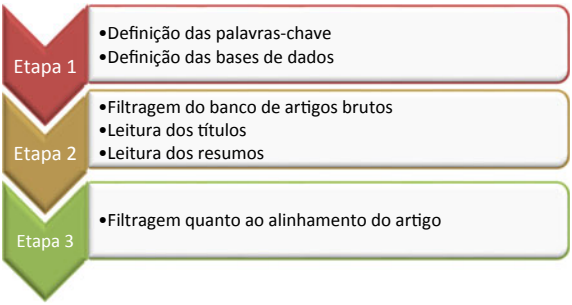


**Fig. 1** Stages of construction of the research development. *Source* adapted from Ensslin (2010)

Figure 1 provides an overview of the construction of the steps used during the study for the development of the collection of the information necessary to analyze the information.

The literature review was carried out in three phases suggested ProKnow-C methodology.

> The bibliographic references selection methodology ProKnow-C, defined LabMCDA consists of a sequential series of procedures that start from the definition of the search engine of papers to be used, followed by a series of pre-established procedures, by reaching the stage of filtering and selection of relevant literature on the subject portfolio (Afonso et al. 2012, p. 5).

For the definition of keywords broke an overview of research. Factors that must be present in the social enterprise with social innovation.

The consultation consisted of literature searches in the Scopus database. This database was chosen because it is the most recognized in the scientific community, in the studied subjects.

The results presented below serve both so you can make the collection of articles, as well as to see if the chosen keywords are appropriate for the topic in question, that is, it allows the search of the main articles of the area (Table 1).

a new search only focusing on social entrepreneurship was held in order to better filter the results and come to publications involving simultaneously the two areas of social entrepreneurship and social innovation.

As the results listed in Table 2, was also carried out a search filter with the keywords matching the themes: "social entrepreneurship and social innovation" that result in 178 articles. The following was done reading all the titles and abstracts of these articles.

**Table 1** Combination of entrepreneurship and innovation

| Keywords | Results |
|---|---|
| Entrepreneurship | 38,327 |
| Entrepreneurship and social entrepreneurship and | 25,194 |
| Entrepreneurship and social entrepreneurship and innovation and social and | 16,708 |

*Source* author (2019)

**Table 2** Combination of social entrepreneurship and social innovation

| Keywords | Results |
|---|---|
| Social and entrepreneurship | 9575 |
| Social and entrepreneurship and social innovation and | 5916 |
| Social entrepreneurship and and and and and social innovation) | 178 |

*Source* author (2019)

Scopus database was chosen as the source for this research is the most basic summaries and references to the scientific literature, reviewed by pairs, allowing a multidisciplinary approach and integrated relevant sources of systematic literature review. The reading summaries is recommended to start a systematic literature search of wide coverage and methodologically correct (Freire 2010).

a filter bank raw articles and reading the titles and abstracts of all articles found was carried out at the end of each search. For management of the articles, as well as control of duplicate articles, we used the Mendeley software, to organize the bibliographical sources found, share those files online with other researchers and automatically manage the citations and references in the Word application. For the creation of graphs, Excel application used.

For bibliometric analysis of the portfolio of selected items for the development of the theoretical framework was used the method of Ensslin et al. (2010), consisting of three steps: bibliometric analysis of the selected articles, bibliometric analysis of the references of the selected articles, the classification of items as relevant in the sample.

## 4 Analysis of Results

For data analysis, we used the distribution of publications per year, areas, and types of periodic publications, the most relevant and its synthesis and analysis of research related to social entrepreneurship.

Figure 2 shows the distribution of articles per year. It can be seen that the first publications the issue of respect are dated 1993 and, from 2011, there was a significant increase in the number of publications with 11 publications and 2018 was the year in which more was published on the subject, obtaining 28 dated articles. And in November 2019, when this search was conducted, it was made 19 publications.

With a focus in recent years, one can notice that from 2009 was widening the publications on the subject of social entrepreneurship and social innovation, with a demand generated by the results of research and contribution to the subject.

As can be seen in Fig. 3, the author shows that more publications in this search is Ratten 4 articles and Horwitch, Mullooth, Nijkamp, Wagner appear in second place with two publications.

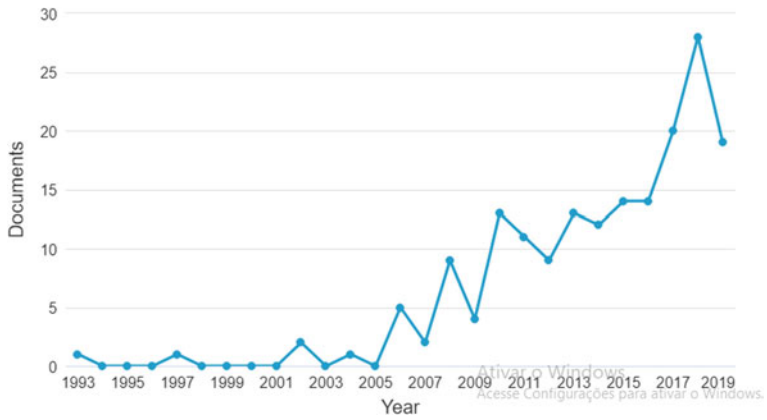


**Fig. 2** Number of publications per year. *Source* Author (2019)

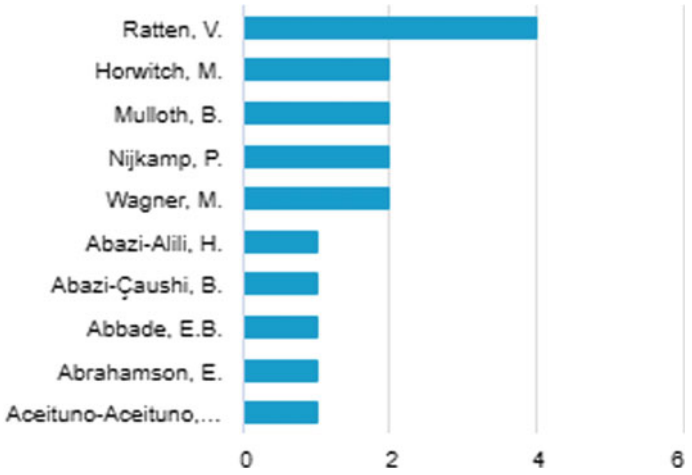


**Fig. 3** Authors with more publications. *Source* author (2019)

The importance of identifying the authors and the areas they are working on social entrepreneurship and innovation are strategic to observe the results of the theme approaches to search form to assess the impacts on society.

Next, in the publications are presented by areas. As can be seen in Fig. 4, the business area stands out with a number 95 (30.5%) publications. Next comes the social sciences area, with 58 (18.6%) research,economy, finance and econometric 37 (11.9%) research, and the area of computer science 3 (10.3%) research.

Analyzing the vehicles in which they were published these surveys, there is the following result: Espacios (3) International Journal (3) Of Entrepreneurship And Small Business (3), Journal Of Technology Transfer (3), Iop Conference Series

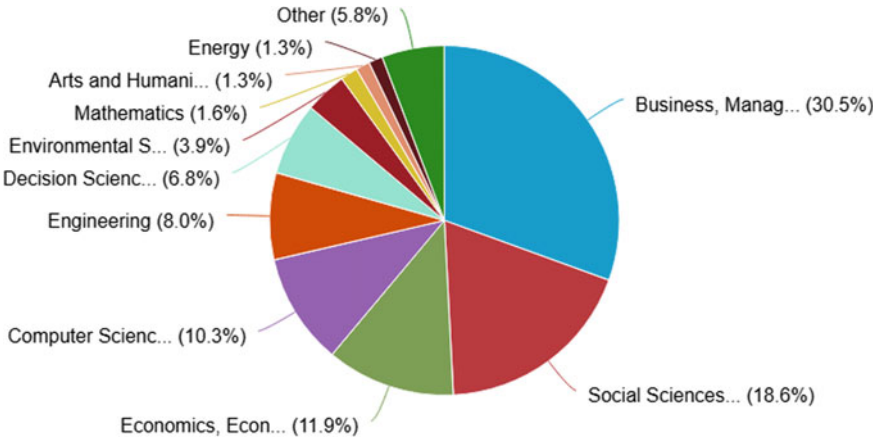


**Fig. 4** Publications by areas database. *Source* author (2019)

Materials Science And Engineering (2) Journal Of Cleaner Production (2) Journal Of Entrepreneurship And Public Policy (2) with the smallest number among others.

While viewing Table 3, it can be seen that the types of publications are varied, and the journal articles are the majority, with 105 publications, then the Papers presented at conferences, with 38.

Although we attempted to identify the various types of documents generated by the results of research in social entrepreneurship and social innovation, the analyzes are founded on the articles, being very relevant documents on the topic that has good reliability to present concisely and on time be suitable results and peer-reviewed.

As Fig. 5, the country that has publications are the United States (36), followed by United Kingdom (17), China (13) Brazil (11), France (11), Australia (10), Italy (8) and Spain (8).

**Table 3** Types of publications

| Type of publication | Amount |
|---|---|
| Article | 105 |
| Conference paper | 38 |
| Review | 10 |
| Review conference | 06 |
| Book chapter | 13 |
| Book | 05 |
| Total | 177 |
| Undefined | 01 |

*Source* author (2019)

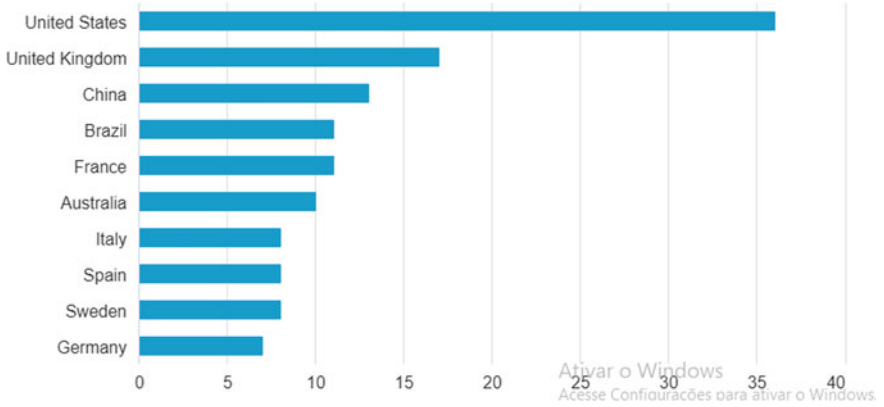


**Fig. 5** Publications by countries. *Source* author (2019)

According to Fig. 6, the universities that publish more on the subject are: University of São Paulo (USP) 4 publications followed by La Trobe University (3), Aalborg University (3) and Leuphana Universität Lüneburg (3)

For analysis purposes, we selected 23 items for better understanding of the theoretical approaches that involve the theme social entrepreneurship together with social innovation. The approaches to the content of these texts will be carried out further study (Table 4).

The study of deepening in relation to the content of the 23 texts selected by the full reading of the titles and abstracts enable a broadening of understanding regarding how to approach to the subject and the methodologies used, but with this initial analysis was possible to understand that social entrepreneurship and social innovation has been working on increasing over the past decade, the areas that are deepening in

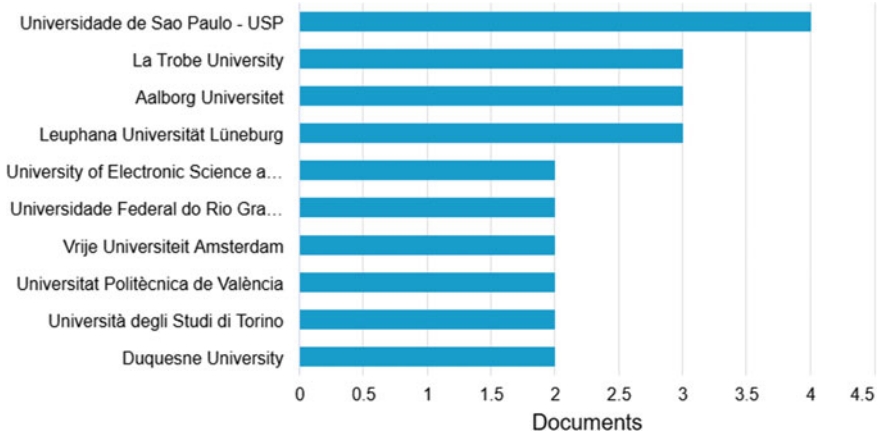


**Fig. 6** Publications by universities. *Source* author (2019)

**Table 4** Articles of bibliographic portfolio Scopus

| Title | Author | Year and source |
|---|---|---|
| Dual-goal management in social enterprises: evidence from China | Yin, J., Chen, H. | Management Decision 2019 |
| Institutional Entrepreneurs and Social Innovation in Danish Senior Care | Jensen, P. H., Fersch, B. | Administration and Society 2019 |
| An aging well collaboration: opportunity or wicked problem | Hazelton, L. M., Gillin, L. M., Kerr, F., Kitson, A., Lindsay, N. | Journal of Business Strategy 2019 |
| Is social entrepreneurship the panacea for sustainable development enterprise? | Javed, A., Yasir M., Majid, A. | Pakistan Journal of Commerce and Social Science 2019 |
| Understanding Social Entrepreneurship Based on Self-Evaluations of Organizational Leaders-Insights from an International Survey | Erpf, P., Ripper, M. J., Castignetti, M. | Journal of Social Entrepreneurship 2019 |
| Psychological capital of MIS development teams, system effectiveness, and social innovation: A systematic literature review | Tang, Y., Shao, Y.-F. | Frontiers in Psychology 2019 |
| An examination of financing practices of social entrepreneurs in Nigeria: A study of selected non-governmental Organizations | Ademola, A. H., Olajide, O. P., Ayodele, A. Y., Olusola, A. J. | Journal Academy of Entrepreneurship 2019 |
| Social innovation and sustainable tourism lab: an explorative model | Spila Castro, J., Torres, R., Lorenzo, C., Santa, A. | Higher Education, Skills and Work-based Learning 2018 |
| Strategies and Best Practices in Social Innovation: An Institutional Perspective (Book) | Peris-Ortiz, M., Gomez J. A., Marquez, P. | Strategies and Best Practices in Social Innovation: An Institutional Perspective 2018 |
| SHEstainability: How the relationship networks influence idea generation in opportunity recognition process by female social entrepreneurs | Spiegler, A. B., Halberstadt, J. | International Journal of Entrepreneurial Venturing |
| NGOs perception of social entrepreneurship in Kazakhstan | Otarbayeva, B. | Proceedings of the European Conference on Innovation and Entrepreneurship, ECIE2018 |

(continued)

**Table 4** (continued)

| Title | Author | Year and source |
|---|---|---|
| Collective learning environments in social innovation and entrepreneurship context | Blackbird, A., Oliveira, L. | Iberian Conference on Information Systems and Technologies, CISTI 2017 |
| Global Social Entrepreneurship Competitions: Incubators for Innovations in Global Health? | Huster, K., Petrillo, C, O'Malley, G. (…), Rush, J., Wasserheit J. | Journal of Management Education 41 (2) - 2017 |
| Social innovation model for business performance and innovation | Salim Saji, B., Ellingstad P. | International Journal of Productivity and Performance Management 2016 |
| Encouragement social factors of entrepreneurial activities in Europe | Abazi-Alili, H., Ramadani, V., Ratten, V., Abazi-Çaushi B., Rexhepi G. | International Journal of Foresight and Innovation Policy - 2016 |
| Including innovation and the role of partnerships: The case of Semi di Libertà | Mapelli F., Arena, M., Strano, P. | Organizing for Sustainable Effectiveness - 2016 |
| Social entrepreneurship - innovative solutions' provider to the challenges of an aging population: The case of Romanian retirees | Dragusin, M., Welsh, D., Grosu, R. M., Fulvio, A. E., Zgura, I. D. | Economic Amfiteatru 2015 |
| Entrepreneurship and its impact on innovation and development: A multivariate analysis with socioeconomic indicators | Ge'zer I., Cardoso, S. P. | Journal Globalization, Competitiveness and Governability - 2015 |
| Social innovation, social entrepreneurship and development (Book Chapter) | Széll, G. | Challenge Social Innovation: Potentials for Business, Social Entrepreneurship, Welfare and Civil Society 2012 |
| Prone to progress: Using personality to identify supporters of social innovative entrepreneurship | Wood, S. | Journal of Public Policy and Marketing 2012 |
| Sustainable entrepreneurship and innovation sustainability: Categories and interactions | Schaltegger S., Wagner, M. | Business Strategy and the Environment 2011 |
| The role of social networks and internet-based virtual environments in social entrepreneurship: A conceptual model | Datta, A., Jessup, L. | 15th Americas Conference on Information Systems 2009 |

(continued)

**Table 4** (continued)

| Title | Author | Year and source |
|---|---|---|
| Creating social entrepreneurship in local government | Irani, Z., Elliman, T. | European Journal of Information Systems 2008 |

*Source* author (2019)

research business area that stands out with a number 95 (30.5%) publications, and then immediately appears the social sciences area, with 58 (18.6%) research. Thus it can be seen that the Social entrepreneurship is a proposal to identify social demands and generate changes with the potential to transform society and contribute to the development.

## 5 Conclusion

For the research were being used various expressions of the first search with broader terms in the area of entrepreneurship, social entrepreneurship, social innovation and innovation alone or in combinations, to meet the study's purposes it was checking the publications that addressed both issues simultaneously social entrepreneurship and social innovation, It was carried out a search with the keywords: "social entrepreneurship and social innovation" that resulted in 178 articles. Soon after there was the reading of all the titles and abstracts of these articles to select those with specific focus on the relationship between the two terms in the same context.

It was picked as a source of research Scopus database to be the largest base of abstracts and references from the scientific literature, reviewed by peers, allowing a multidisciplinary and integrated vision of relevant sources for a systematic literature search. After carrying out the reading of the titles, abstracts and keywords were then selected23 articles and read in its entirety to better understanding of the theoretical approaches that involve the theme social entrepreneurship together with social innovation. The approaches to the content of these texts will be carried out further study. This study verificaspublications per year per areas, periodicals and types of publications that include in the same context, social entrepreneurship and social innovation, the main results are compiled and shown in Table 5.

With the study were identified by the search for publications on the subject of social entrepreneurship and social innovation that an initial approach to the subject appear in 1993, but the last ten years, from 2009 the volume of publications will expand, showing a greater interest in research and analysis on this issue and what the society also awakens to the interest of social problems and seeking solutions for the benefit of the community. Stressing that social innovation is a response of actors who perceive certain needs and proposes solutions in order, according to Tardif and Herrisson (2005), to transform the social and cultural relations, generating a positive

**Table 5** Summary of search results

| Analyzed items | Results |
|---|---|
| Publications made over the ten years of observation | From 2009 it was widening the publications on the subject of social entrepreneurship and social innovation. In 2018 was the year in which more was published on the subject, resulting in 28 articles |
| Authors with more publications | The author shows that more publications in this search is Ratten 4 articles and Horwitch, Mullooth, Nijkamp, Wagner appear in second place with two publications |
| Publications by areas | The business area stands out with a number 95 (30.5%) publications. Next comes the social sciences area, with 58 (18.6%) research, economy, finance and econometric 37 (11.9%) research, and the area of computer science 3 (10.3%) research |
| Types of publications | Articles in journals are the majority, with 105 publications, then the Papers presented at conferences, with 38 |
| Publications by countries | The country that presents publications are the United States (36), followed by United Kingdom (17), China (13) Brazil (11), France (11), Australia (10), Italy (8) and Spain (8) |
| Publications by universities | Universities that publish more on the subject are: University of São Paulo (USP) 4 publications followed by La Trobe University (3), Aalborg University (3) and Leuphana Universität Lüneburg (3) |

*Source* author (2019)

effect in the aspect of social and economic development, as collective values and learning.

How to identify the areas that are working the issue with greater emphasis was realized that the business area held 95 (30.5%) publications, and second comes the social sciences area, with 58 (18.6%) surveys, followed by economy, finance and econometric 37 (11.9%) researches. It is noticed that the sectors that concentrate the study are those involving the economic and social development and therefore have significant impacts on the community. Linking social innovation with entrepreneurship can be noted that it points to"Believe in the ability to change the world; indignation at social inequities. Undertake is especially a future building process" (Dolabella 2003, p. 30).

The theme approach demonstrates the need to advance research and increase the understanding of the social context has required many demands of researchers, managers and public agent and it is important to observe the recommendations that the conditions are scarce to enable the inclusion of a large part of humanity, which,

historically, is excluded from access to social goods and services necessary for their survival (Oliveira 2004).

Promote the expansion of social business makes it possible to generate goods or services that contribute to the solution of social and/or environmental problems. Managers and entrepreneurs can go beyond public donations or resources to carry out social innovation actions can propose solutions by businesses that have financial viability, have social and economic activities with products and services that are self-sustaining and promoting the welfare of the community.

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# Environmental Education in School as a Contributor for Social Responsibility Towards the Sustainability of the Historical and Natural Heritage of Cabo Frio, RJ, Brazil

**Regina Célia Soares Pereira, Ivaní Nadir Carlotto, Maria Alzira Pimenta Dinis, and Luis Borges Gouveia**

## 1 Introduction

The consequences of anthropogenic impacts on the environment are well known. Pollution of water sources, atmosphere, soil, scarcity of natural resources and social and environmental exclusion are some of the severe problems that affect life on the planet (Masterson et al. 2019; Souza and Santos 2016).In this context, the city of Cabo Frio, located in the State of Rio de Janeiro, Brazil, stands out for presenting tourism as one of the pillars of the economy due to the diversity of historical and environmental heritage, which needs recognition, belonging to the country's identity. They are related to reminiscence, which maintains a link with the cultural identities

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of the receiving communities (Camilo and Bahl 2017). In light of this, the current challenge for cities with historical and environmental value is to develop tourism ableto promote sustainability, with the objective of maintaining a balance between the demands of the economic and social axis (Reis 2009). Thus, a systemic management composed by social responsibility and sustainability is necessary (Mello and Mello 2018).

A possible way lies in the promotion of a critical environmental education that provides sustainable tourism for the knowledge, dissemination and preservation of the historical and natural heritage. To this end, students need to actively participate in the process of diagnosing real environmental problems in search of solutions (Da Cruz et al. 2018).

Environmental education actions must be in line with the National Tourism Policy (NTP) Law 11,771, which decides on the need to promote the practice of sustainable tourism in natural areas, encouraging the adoption of less impactful and compatible educational methods with the conservation of the environment and the preservation of cultural identity, social values of traditional communities and populations (Brazil 2008).

In this scenario and using pedagogical resources as an interactive lecture, students are allowed to know theoretically the origin of the historical and natural heritage of the city of Cabo Frio and, at the same time, to identify the impacts suffered by them. Also, the technical visit enables the connection between theory and practice, which is reinforced through mobile devices, such as the application of educational games, like *Kahoot*. These actions are essential methodological tools that complement each other to know the historical and environmental spaces, reflect on the local reality and apply the knowledge in a practical way. In addition to having fun and challenging characteristics, they allow the individual to leave the comfort zone and enable learning that can be used in real situations (Pessini et al. 2018).

Parra (2018) highlights that interactive lectures contribute to promote interaction between students, stimulate interest and cognitive involvement in situations and content presented in class context. The themes developed in the lecture were intended to know, value and learn, in order to preserve the socio-environmental heritage of Cabo Frio, RJ, Brazil. The real experiences and practices during the technical visits place this learning strategy as an important teaching and awareness tool for students, so that they can act on the environment in order to contribute to the development of the sustainability of these environments rich in biodiversity, but fragile (Silva et al. 2019).

The use of games through mobile devices can become an ally for the development of meaningful learning for students, as they belong to young people's daily lives, thus contributing to consolidate knowledge (Pereira et al. 2020).

The objective of this study is to sensitize students, through sustainable pedagogical actions, about the importance of socio-environmental preservation of the historical and natural heritage of the City of Cabo Frio, RJ, Brazil. The target audience consisted of 33 students enrolled in the 1st year of FFI-CF. Thus, a brief exposition on the cultural and natural historical heritage of the city of Cabo Frio, RJ, Brazil is needed.

### *1.1 The Historical Heritage of Cabo Frio, RJ, Brazil*

Cultural heritage consists of monuments, groups of buildings or sites that have exceptional and universal historical, aesthetic, archaeological, scientific, ethnological or anthropological value (UNESCO 1972).

The Organic Law of the Municipality of Cabo Frio (OLMCF 2018) in its article 174, it guarantees the right to quality of life, the protection of the environment and natural resources and the integrity of the city's ecological, cultural and architectural heritage, promoting the awareness of the population and the adequacy of education in order to disseminate the principles and objectives of environmental protection.

In this sense, Brum (2015), Junior (2016) and Barbosa (2019), researchers who worked in the municipality, highlight in their studies some of the various historical heritage of the city of Cabo Frio, RJ, Brazil, for example, São Matheus Fort, built in the seventeenth century in 1617, with reused material for the defence of the city; Charitas, built in 1939/40, known as the "Wheel House" or "Wheel of the Exposed", which accommodated abandoned children and was later used for other purposes, such as library, forum and school; Itajuru Fountain, the only source of water supply until the mid-nineteenth century, of great value to the colonisers for the amount of vessels; the church of São Bento, built by the slaves in 1701, scene of manifestations of African culture and artisanal fishermen; and the Convent of Nossa Senhora dos Anjos, constituted as a monastery of the priests of the Franciscan Order.

### *1.2 The Natural Heritage of Cabo Frio, RJ, Brazil*

According to UNESCO (1972), the World Natural Heritage corresponds to physical, biological and geological formations, habitats of endangered animal and plant species, and areas with exceptional and universal scientific, conservation or aesthetic value. The same document reportsthat the degradation or disappearance of an artistic and natural good results in the irreversible impoverishment of the heritage of all peoples of the world.

The city of Cabo Frio also has an extensive natural heritage, such as Morro da Guia, with panoramic views of the town, intensely researched by archaeologists who preserve the memory of indigenous ancestors, through the so-called "grooved stones"; the Black Dunes, recognised as "Sambaqui do Forte", has become one of the leading archaeological remains dating from prehistoric periods (Brum 2015; Junior 2016).

Another essential natural heritage is Araruama Lagoon, which stands out for being the largest hypersaline lagoon in the world, however, due to the demographic increase, its margins are under high anthropic pressure (Almeida et al. 2018; Bertucci et al. 2016). Natural heritage acquires social dimensions throughout the historical process, and its frequent use must be carried out with conscience and responsibility (Pelegrini and Funari 2017).

### *1.3 Pedagogical Actions and the Objectives of Sustainable Development*

Pedagogical practices are developed through the interface between the theoretical paradigm and praxis, to critically analyse pedagogical reproduction about the conservatism of actions that guide social and environmental issues (Gingrich 2019). In this study, the pedagogical actions implemented aim at sustainability awareness, based on the Sustainable Development Goals (SDGs) proposed by the UNESCO Plan of Action (UNESCO 2015) for the implementation of the 2030 Agenda. The universal adoption of the 2030 Agenda for Sustainable Development and the 17 SDGs is a strong signal of global interest integrating economic, social and environmental elements in the development aspirations of countries around the world. An ambitious result of this integrated perspective is a substantial improvement in the areas addressed, safeguarding the natural and economic systems that depend on them (Moallemi et al. 2019). Nations need globally coordinated, nationally and internationally integrated multisectoral planning and analysis to support goal setting that prioritises sustainability-oriented interventions efficiently and effectively across all social contexts, economic and socio-environmental models (Gao and Bryan 2017).

As highlighted by the SDGs for the construction of the 2030 Agenda, it is necessary to implement policies that encourage sustainable tourism, job creation and promotion of local culture. It must also protect and safeguard the world's cultural and natural heritage. SDGs 8.9 and 11.4 focus, respectively, sustainable tourism contributing to job creation and promoting local culture, by strengthening the means to protect the world's cultural and natural heritage.

Of crucial importance is also the observation on educational interventions highlighted in SDG 4, to ensure inclusive, equitable and quality education and the promotion of lifelong learning opportunities for all (UNESCO 2015). In accordance to SDG 4, Article 205 of the Brazilian Federal Constitution establishes that education is a right of all and the duty of the State and the family, promoted and encouraged with the collaboration of society, with a view to the full development of the person, their preparation for the exercise of citizenship and its qualification for work (Brazil 1988).

In view of these considerations, it becomes necessary that such pedagogical practices be developed in a conception of education that promotes the development of quality education to achieve sustainability among the social, economic and environmental in Brazil.

### *1.4 The Fluminense Federal Institute—Cabo Frio Campus*

The city of Cabo Frio has the FFI-CF, whose mission is the qualification of professionals in different levels and modalities of education, with emphasis on local, regional and national socio-economic development, allowing the creation of technical and technological solutions for sustainable assist development and social inclusion.

In addition, the institution's social responsibility aims to contribute to an economic and social development in the defence of the environment, memory and cultural heritage (PDI 2018–2022). For that, it becomes relevant that the knowledge is developed within pedagogical strategies that integrate theory and practice, to be guided by the connection between sustainability and social responsibility.

The institution aims to establish agreements with human bodies and movements focused on Social Technologies, Environmental Conservation and Cultural Heritage, in addition to training professionals capable of understanding the social, economic and environmental impacts related to the housing sector (PPC 2019). Accordingly, the discipline of CH aims to develop in the student the ability to broaden critical awareness about historical and natural heritage, material and intangible and their preservation over time (PPC 2019).

## 2 Methodology

Qualitative research, exploratory-descriptive methodology, with an ethnographic approach, whose objective is to reflect on the teaching-learning process related to environmental issues, analysing it in a broader sociocultural context, promoting a relationship between theory and the praxis (Oliveira 2008), was used.

Initially, in the preparation phase of this study, a bibliographic survey was conducted on the themes of historical and natural heritage, sustainable tourism, pedagogical practices and SDGs and, later, they were related to the CH discipline. The execution phase was carried out in three stages, used as an educational resource an interactive lecture, developed in the classroom, to stimulate students to theoretically know the different historical and natural spaces of the city and at the same time provoking interaction and reflection with other students on the topics covered.

In the second stage, a technical visit was made, which allowed contact with the practical experience of the contents learned in the classroom (Monezi 2005). This activity was developed with maritime resources, promoted by FFI-CF in partnership with the Cabo Frio City Hall's Tourism Office (CFCHTO), in view of the "Paths of History" project. Thus, the students had the opportunity to have a guided class, highlighting the history of some of the city's sights. The idea of this activity was to stimulate in students the knowledge and skills necessary to promote sustainable development through education, encouraging a culture of peace, global citizenship and appreciation of cultural diversity (UNESCO 2015).

In the third stage, the learning was verified, with the students answering ten questions related to the tourist points presented in the interactive lecture and experienced in the nautical course. At this stage, the *Kahoot* app was used as a teaching resource. *Kahoot* is a free, friendly, online platform with an instant feedback system that allows teachers to create a fun environment that involves competitively healthy games (Kuo and Chuang 2018). Digital games used as pedagogical tools develop skills such as problem solving, critical thinking and enable greater interest and concentration on

the part of students (Dellos 2015). Gamification applied in education provides challenging, pleasurable and engaging classes motivating students to achieve the established goals (Martins and Gouveia 2019), making teaching creative, as the pedagogical contents are worked through a different methodology, in combination with means of technology information, such as the *Kahoot* app (Cheng 2018). Also according to UNESCO guidelines (2014), the use of playful methods, such as educational games on mobile devices, develop cooperative, affective and motivational relationships, allowing a greater understanding of the content. The use of a pedagogical practice through digital technologies enhances new ways of looking and interacting with the world and the environment (Pereira et al. 2020).

## 3 Analysis of Results

The game was realised with the participation of 33 students. However, the final sample totalled $n = 15$ students, due to the difficulty of internet access presented during the study. Despite the technological limitations imposed, the students worked in partnership, making their devices available to other participants so that everyone could participate in the activity. Table 1 presents the ten questions that were applied through the *Kahoot* app.

Through the application of the ten questions, it was intended to highlight the relationship between the preservation of the CH and the natural city of Cabo Frio, RJ, Brazil, worked with the students after the exposure of the contents developed through the interactive lecture and the nautical technical visit. At this stage, students' involvement and motivation were perceived, mainly due to the characteristics of the activity, developed with a standard response time of 20 s/question. According

**Table 1** Description of the questions of the instrument used in the *Kahoot* app

| Question number (Q) | Question content |
|---|---|
| Q1 | What characterises the Sambaquis? |
| Q2 | Where can we find the Sambaquis in Cabo Frio? |
| Q3 | Was the city of Cabo Frio inhabited by Indians of the tribe? |
| Q4 | Where in Cabo Frio is it possible to find Sulcadas stones? |
| Q5 | What is the place created for the rejected children, known as "Wheels of the Exposed"? |
| Q6 | Was it created in 1696 to be a Franciscan monastery? |
| Q7 | An essential source of water created since the first indigenous tribes of Cabo Frio? |
| Q8 | What was used in ancient times to transport water from one point to another? |
| Q9 | Was it used to illuminate old houses and lodgings? |
| Q10 | The church of São Bento in Cabo Frio was built by whom? |

**Table 2** Relationship between the correct answers using the *Kahoot* app and the number of successful students

| Number of correct questions *versus* number of students | |
|---|---|
| Correct questions *n* (%) | Students *n* (%) |
| 10 (100) | 3/15 (20) |
| 9 (90) | 5/15 (33) |
| 8 (80) | 3/15 (20) |
| 7 (70) | 3/15 (20) |
| 6 (60) | 1/15 (7) |

to Santinello et al. (2018), the relationship between media-education enables new reflections and different opportunities in the teaching-learning process.

Table 2 presents the relationship between the number of correct answers and the questions developed in the *Kahoot* app, referring to the CH, as well as the number of students who succeeded.

Analysing Table 2, from the 15 students accessing the *Kahoot* app, three students answered all ten questions correctly and one student correctly answered 6 questions, the minimum number of correct questions answered. Only the questions that were answered correctly were counted as "right", respecting the expected time period of 20 s/question.

Given the results achieved with the *Kahoot* app, the teacher is then able to review with the students the difficulties encountered, making it possible to make the assessment a moment of constructive feedback, positively building the teaching-learning process, as highlighted by Vilela (2017).

## 4 Conclusions

This study revealed the importance of developing pedagogical work in educational context, through sustainable practices related to social responsibility, employed by FFI-CF in the defence of the environment, and of the cultural heritage of the region of Cabo Frio. This contributes to sensitize the students to become more aware of the preservation of the historical and natural heritage of the city Cabo Frio, RJ, Brazil, in addition to leading students to critical reflections on the relevance of sustainable tourism for the city, since theses students belong to a hosting course and should thus be able to contribute to minimize anthropogenic impacts in the environment.

It was found that the teaching strategies in the form of interactive lectures and technical visits stimulated and aroused interest, involvement and excitement among the students, thus promoting the preservation of the historical and natural heritage of the city of Cabo Frio.

The application of the quiz by means of the *Kahoot* app made it possible to assess the students' learning in relation to the concepts developed, integrating media-education. The results showed that 11 (73%) students correctly answered to or above

8 questions, 3 (20%) students answered 7 questions and 1 student (7%) answered 6 questions. It should be noted that students who did not have access to the internet also participated together with their colleagues in answering the questions, which were not accounted by the application, thus revealing and highlighting the interest of everyone involved in the process. This alertsto the need for better and more democratic access to technological resources in the educational process, also addressing social responsibility within the school context.

This study found that the combination of pedagogical practices developed through an interactive lecture, technical visit by nautical route and the application of a quiz in the *Kahoot* application enabled students to have accessto a playful, practical and reflective learning, directed to the local socio-environmental reality.

As a future work, it is suggested to carry out studies in environmental education with sustainable pedagogical practices that may involve other IHSHC. Subjects or other school contexts related to socio-environmental problems in the city of Cabo Frio, such as basic sanitation, a major issue.

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# Environmental Bioethics, Sustainable Development and Social Responsibility in Higher Education

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## 1 Introduction: Bioethical Principles and Higher Education Institutions

Higher education institutions (HEIs) are essential for developing the implementation of health promotion (HP) programs for professors and staff. Because they have different ethos and cultures, they act as optimisers of the conceptual aspects and interdisciplinary values of HP, such as equality, social justice, inclusion, equity, sustainable development and social responsibility (Dooris 2006; Dooris et al. 2017). Bioethics emerges as an essential intervention tool when considering the ethical challenges present in the daily life of HEIs and the health actions practised in these institutions. Through this perspective of permanent attention and protection, bioethics promotes and reinforces planned and integral health actions and not just isolated activities or programs (Carlotto and Dinis 2019a). By framing the bioethical principles of autonomy, beneficence, non-maleficence and justice in HEIs, bioethics promotes a global reflection on the concept of health, providing a socio-phenomenological perspective and addressing the issue of social responsibility (SR)

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necessary to understand, plan and implement holistic actions in the universities (Carlotto and Dinis 2018c).

Environmental bioethics, in turn, emerges as one of the first arms of bioethical studies, evidenced by Potter in 1971 in his work "Bioethics: A Bridge to the Future" (Potter 1971). In this study, Potter sought to address eco-focused bioethics by raising issues that have implications for human health and the ecosystem, and which cannot or should not be addressed in isolation (Fiore 2016). Given this paradox, the hypothesis to be verified refers to the interface between bioethical principles with HP and sustainable development (SD) and SR, justifying the implementation of health action programs in HEI, from the ecosalutogenic point of view advocated by bioethics. environmental. Thus, Potter's "Bridge to the Future" (1971) was conceived with the genuine intent to reconnect humanity and scientific knowledge with the outside world and life as an integrated whole (Semplici 2015).

The analogy of bioethics with HP in its different areas, specifically in HEIs, reaffirms the understanding that to articulate health, HP and bioethics, it is necessary to reflect on human quality of life, preservation of ecology and biodiversity, finitude of natural resources, ecosystem balance, concern for sustainability, inclusion, equity, justice, dignity, among others (Carlotto and Dinis 2017, 2018a; Dooris 2009; Real de Asúa and Herreros 2016; Sanz 2016).

Siqueira-Batista et al. (2015) argue that bioethics should be considered the ethics of science that combines humility, responsibility and competence with an interdisciplinary and cross-cultural approach and allows the true meaning of humanity to prevail. In assisting and implementing health practices, bioethics creates bridges between being and acting, between the institutional and public policy universe, allowing an interface between rights and duties, in which the scope of SR prevails as the guiding principle of a society transdisciplinary ethics (Zoboli 2010).

According to Siqueira-Batista et al. (2015), ethical problems arise from factors such as lack of articulation between intersectoral public policies, poor accessibility to health services and programs, or social and economic heterogeneities. These authors also point out that bioethical challenges are evident when tensions are established between technical-scientific and practical knowledge, hindering a reflexive analysis of the question presented, in all dimensions in which it manifests itself. Thus, it is possible to conceive that bioethical discussions involving scarce health resources rarely lead to a critical analysis of current economic structures and policies, hampering HP practices as these reductionist debates become self-limiting and do not contribute to the reflective practice that characterizes bioethics (Carlotto and Dinis 2019b).

In order to achieve a broader reflection, it can be inferred that bioethics has two epistemological streams: an approach with more ecological aspects, as recommended by Potter (1971), and another stream of more clinical aspects, as evidenced by Hellegers and Ramsey (1973). Thus, it is possible to identify two basic research paradigms involving the bioethical discipline: a paradigm of hermeneutic and critical importance that investigates the interpretation of the cultural assumptions of the use of biotechnologies and the other, more casuistic paradigm, that seeks concrete resolutions for the dilemmas. Both are epistemologically complementary and need each

other (Junges 2006). Other more specific paradigms that could be cited, e.g., are the models of North America, Latin America, or Europe (virtue bioethics, interventionist, care bioethics, etc.).

## 2 Environmental Bioethics

By publishing his first book, Potter (1971) recognised the interrelationship between human life and nature as evidence-based information. Thus, it knew that humans are situated in a natural environment and sought to reflect on this connection involving not only health but health as part of a holistic whole in the world.

In 1988, Potter published his second and last book, entitled "Global Bioethics: Building on the Leopold Legacy" (Potter 1988). In this work, he reflects on the return of Global Bioethics to earthly origins as a way of re-living the relation with nature and ecology harmoniously and regretting the fact that bioethics was forgotten as a proposal to combine human values with ecological facts. Potter established the initial milestone in the study of environmental bioethics, as it established a connection between medicine and ecological and environmental conservation, opening doors for the study of SD and SR (Carlotto and Dinis 2018c; Richie 2014).

For Daniel Callahan, a respected Hastings Center bioethicist in the USA (Callahan 2015), the paradoxes surrounding the issues of life and death, pain and suffering, law and the power to control one's life, including responsibility for oneself and others. Health and well-being are among the oldest issues of humanity. He suggests that bioethics is not only an intersection of ethics and life sciences, but also an academic discipline, as well as a vehicle for policymaking in medicine, biology, and environmental research, as well as providing a multicultural perspective (Gluchman 2015).

Strictly speaking, bioethics is a new discipline that originated in the search for answers to new scientific and technological challenges. In a broader sense, it can be described as an area that dialogues with law, politics, literary, cultural, and historical studies, as well as with media, philosophy, religion, and literature. The main task of bioethics is to formulate a question that requires a solution at any level, whether in clinical practice or at a political or legal level (Callahan 2015; Gluchman 2015).

Environmental impact on health, SD and SR point to ethical issues about environmental management and its relationship to health and HP actions. A concern with the management of terrestrial ecosystems leads to a reevaluation of health practices to provide a balance between social and environmental responsibilities, taking into account guiding aspects of both medical ethics and environmental ethics. Thus, the bioethical argument for valuing and reinforcing the issues involving SD and RS stems from ethical commitments common to both medical ethics and environmental ethics.

The concept involving environmental bioethics is based on the condition that it reflects human health as dependent on the health of the ecosystem in which humans live. This holistic concept enables individuals to develop a sense of SR by connecting with others and the natural environment (Jameton and Pierce 2001).

## 3 Sustainable Development, Social Responsibility and Environmental Bioethics

The definition of SD involves a set of evidence that suggests limits to the exploration of the natural environment. This perspective holds that the impact of human actions on the biosphere must remain within some identifiable limits to prevent sudden changes and the consequent loss or scarcity of valuable vital resources that support human health.

Environmental degradation can lead to a drastic reduction in the number of resources available, whether through depletion of natural resources or harmful climate events such as droughts, tornadoes, heat waves, floods, etc. Today, humanity faces many environmental issues—climate change, loss of biodiversity, depletion of natural resources, etc. Such factors pose severe threats to the health, well-being and stability of societies.

SR and environmental bioethics are concepts and tools compatible with ecological reality and SD since they do not conflict with ideas of a political or governmental nature since their actions involve the understanding of the existence of a holistic and multicultural environmental context (Fragnière 2016).

Therefore, bioethics acts as discipline and practice. The broad definition of bioethics includes the health sciences as well as the natural sciences and the social and human sciences. It is imperative to consider an approach that values these sciences so as not to risk not understanding all dimensions of current bioethical issues. And in this scenario, the concept of environmental bioethics fits as the first guide of this approach.

Finally, a concept that should be remembered, and as it appears along with the environmental issue, of SD and SR, is the concept of globalization. All of these approaches include aspects that involve global justice, not only in socio-economic or political terms, but considering human relations, information sharing and mutual help (Stanton-Jean 2015).

## 4 Methodology

This research had a cross-sectional design with a quantitative and qualitative approach and was exploratory and descriptive in nature (Prodanov 2013). The population was composed of professors from 9 Universities in the Brazilian state of Rio Grande do Sul (RS). They were selected sample random, non-probabilistic sampling out of convenience (*openepi* = 95%CI (%), $n$ =1400 professors). Data was collected between March and July 2017. The study was approved by the Research Ethics Committee of the Clinical Hospital of Porto Alegre (HCPA), by the Ethics Committee of Fernando Pessoa University (UFP) in Porto, Portugal, and CAAE Registry 550666168.0000.5327, Plataforma Brasil.

For data collection, an online survey was built and hosted on the Survio© platform and then sent to the participants via e-mail. Leaders of each university had been contacted previously to present the study objective and obtain approval for the survey. All of the respondents were informed about the need for their approval the Informed Consent Form (ICF) that accompanied the protocol.

The statistical analysis of the results was performed with the aid of the *R* statistical software environment (*R* Development Core Team), version 3.3.1 (2015), as well as through the cross-checking of survey data and the conceptual frameworks of the Health Promoting Universities (HPU)/World Health Organization (WHO). Qualitative and dissertation data were treated using content analysis as per Bardin (2009). The data were collected through the application of 1400 questionnaires, each of which contained 35 questions. Each question had five possible answers on a Likert scale to which the following values were attributed: 1 point—I don't know about this; 2 points—I know a little bit about this; 3 points—I know a moderate amount about this; 4 points—I know a lot about this; and 5 points—I am fully aware of this or know everything about it. The instrument was an adaptation of the WHO protocol/HPU Toolkit of the University of Central Lancashire in Lancaster, UK, the use of which was expressly authorized by its creator, Professor Mark T. Dooris.

The Toolkit Self Review Tool is a questionnaire structured around five topics that reflect the key areas a university must address as it works toward its goal of becoming a Healthy University. The Toolkit Self Review Tool used in this research adapted to the Brazilian reality with formal authorization of its author. The five areas covered by the study are: (i) Leadership and Governance: This section of the tool focuses on the university's corporate commitment to working toward becoming a Healthy University. (ii) Provision of services: This section of the tool identifies the level of on-site and off-site provision of services to support the health and wellness needs of staff and students. (iii) Facilities and Environment: This section of the tool supports the university in reviewing the facilities it provides and the environment it creates to support the health and well-being of staff and students and the community at large. (iv) Communication, Information and Marketing: This section of the tool analyzes the processes involved in communicating information and health and wellness messages to employees and students and how the university markets health and wellness in its promotional materials. (v) Academic, Personal, Social, and Professional Development: This section of the tool is about how the university uses the opportunities presented by curricula, research, knowledge transfer, and professional development to improve health and wellness and respond to the needs of its employees and students. Table 1 presents the description of the issues addressed in the instrument adapted to the Brazilian reality Toolkit Self-Review Tool, addressed to the professors.

This research tool is valuable as it values environmental interactions with health in HEIs. Environmental bioethics, SD and SR emerge as research variables of extreme importance for institutions from the bioethical and HP point of view.

The Toolkit Self Review Tool includes a research tool that enables universities to analyze and reflect on their perception of health, sustainable development, and well-being in their core business and organizational culture. The significance level of

**Table 1** Discrimination of the questions of the adapted inquiry to the Brazilian reality, Toolkit Self Review Tool

| Questions (Q) | Discrimination of the questions |
|---|---|
| Q1 | There are plans and strategies in the University that enable the health, well-being of professors, students and the academic community to be addressed |
| Q2 | The University discloses in its strategic planning actions regarding the health and well-being of individuals in the Institution |
| Q3 | The University has data collection tools capable of measuring levels of employee satisfaction with regard to health, wellness and emotional and physical support |
| Q4 | The University has a system that makes it possible to evaluate the impact of health and wellness initiatives in the academic community |
| Q5 | The University works in partnership with health promotion organizations and other relevant bodies in this area |
| Q6 | The University takes a broader and holistic approach to addressing specific health issues (for example., mental well-being, physical activity, environmental health, health promotion campaigns, smoking, addiction, etc.) |
| Q7 | The University has a sector and/or some human resource dedicated to supporting and developing health and wellness actions at work |
| Q8 | There is a specific sector in which professors can inform their health and well-being priorities at the university |
| Q9 | The University has strategic links and partnerships with external entities (for example: health, sports, physical activity, social assistance) that can support health and well-being in the academic environment |
| Q10 | The University has programs that include the academic community in its health and wellness actions |
| Q11 | The University has appropriate health services that recognize the diverse needs of its professors, students and staff |
| Q12 | Professors and students are consulted about what health services they need |
| Q13 | There are activities that provide professors with knowledge, understanding and access to health and wellness support activities |
| Q14 | The University has clear policies and procedures regarding the perception, identification and referrals of health problems that most affect its teaching staff |
| Q15 | The teaching staff is enlightened about key contacts involving internal and external health support services as well as for emergency situations |
| Q16 | The University provides health information and future planning in this area for the academic community |
| Q17 | The University offers access to wellness and health support services for its entire staff |
| Q18 | The built environment and social spaces of the University are conducive to the promotion of physical, mental and social well-being (for example access to natural light, good ventilation, thermal conditioning, adequate furniture, equipment, environmental comfort) |

(continued)

**Table 1** (continued)

| Questions (Q) | Discrimination of the questions |
|---|---|
| Q19 | The facilities and environments used by professors, students and the academic community for leisure, sports and physical activity at the University contribute to the promotion of the health of its users |
| Q20 | The University has some kind of consultation mechanism with the departments regarding the use and development of its green space, as well as the built and social environments |
| Q21 | The assessment of the impact that built and natural environments have on health and well-being is included in the University's sustainable development strategy |
| Q22 | The University has an ethical sustainable food policy system, contributing to the overall improvement and well-being of professors, students and staff |
| Q23 | Professors and students are regularly consulted on quality, prices, varieties and food and beverage offerings throughout the university |
| Q24 | The University encourages faculty to practice physical activity, leisure and social facilities (family support services, community, rehabilitation, volunteers, etc.) |
| Q25 | The University works to improve physical, leisure and social facilities to ensure that they are accessible and inclusive to professors and students |
| Q26 | There are communication strategies at the University that more broadly address the promotion of health and wellness for professors, students and staff |
| Q27 | The University makes use of digital technology/new media to provide health and wellness through messages and information for professors, students and staff (for example, Twitter, Intranet, Facebook and text messaging—SMS, WhatsApp, Viber) |
| Q28 | The University seeks to reinforce that health and wellness disseminated through messages and information campaigns are drawn from sources based on reliable evidence |
| Q29 | The university works generated in the Institution are used as a source of information about health and well-being, the academic community and the community outside the Institution |
| Q30 | The University actively shares, in the academic environment, its practices regarding the health and well-being of its staff |
| Q31 | The University discloses to the academic community the benefits of positive health and well-being in marketing and promotional materials (e.g. recreational, social and leisure opportunities, support services, supportive work) |
| Q32 | There are opportunities in the academic curriculum that address health, well-being, and sustainable development that are targeted at professors and students |
| Q33 | The University has a strategic vision that incorporates health, well-being and sustainable development in its curricular bases |
| Q34 | The University provides the adequate dissemination of learning related to health research, in its disciplines, departments and academic services, as a way of valuing the knowledge generated internally |

(continued)

**Table 1** (continued)

| Questions (Q) | Discrimination of the questions |
|---|---|
| Q35 | The University has strategies of incentives for scientific research and dissemination of results that are related to health and health promotion for the professors of its staff |

1% was adopted, rejecting hypotheses whose descriptive value (*p*-value) was lower than 0.001; Varimax® rotation with factorial load retention > 0.40 was used; the analysis of Factors and Analysis of Principal Components (APC) with a value that is higher than 1.0 was applied to identify groups or groupings of variables, and thus to understand the structure of a set of variables and to show the relations between them, reducing the data set to a more manageable size while retaining as much of the original information as possible. Cronbach's alpha (acceptable *index* > 0.60) ensured the internal consistency of the instrument used.

## 5 Results

The general profile of the sample points to the following data: 14% of the professors ($n = 199$) were admitted to the universities surveyed in the early 2000s, 87% of which ($n = 1219$) were linked to private universities. Among the sample population, 76% ($n = 1070$) were female, and 53.7% ($n = 752$) were between the ages of 46 and 55. When asked about their fields of expertise, 67% of respondents ($n = 943$) reported health sciences, followed by engineering at 10% ($n = 42$) and humanities at 7% ($n = 109$). The level of schooling varied only slightly: 75% ($n = 1046$) had doctoral degrees while 19% ($n = 266$) had master's degrees. In addition, 60.3% ($n = 845$) had 15 to 20 years of teaching experience, and the weekly workload was 40 h for 26.2% of respondents ($n = 368$), 20 h for 16.1% of respondents ($n = 226$), and 30 h for 13.5% of respondents ($n = 189$). Of the 1400 professors surveyed, 79.5% have a working relationship with only one educational institution ($n = 1113$). Table 2 shows the sociodemographic characteristics of the professors included in the study.

Statistical analysis used was Factorial Analysis (FA) with Principal Component Retention (PCR) and Varimax® rotation, whose retention of factorial loads was higher than 0.40, and MCR with eigenvalues higher than 1. The Kaiser-Meyer-Olkin (KMO) and Bartlett produced positive values of 0.88 and test value ($p$) of less than 0.001 and Cronbach's alpha ($\alpha$) with an index of 0.80.

FA produced six principal components (PC), i.e., PC1 to PC6, which were titrated and were interpreted using Qualitative Content Analysis (QCA), according to Bardin (2009), using the qualitative analysis software MAXQDA® (2018), making it possible to categorize the relevant information by analyzing expressions and more recurring vocabularies. From this stage, the interfaces between the professor's perception evidenced by the responses attributed to the instrument on HP in the universities, and the use of the conceptual reference of the bioethics explored.

**Table 2** Socio-demographic characteristics of the professors

| Socio-demographic characteristics of the professors | | |
|---|---|---|
| Characteristics | Respondents | |
| | *n* | % |
| *Age* | | |
| 26–30 years | 106 | 8 |
| 31–35 years | 143 | 10 |
| 36–45 years | 215 | 15 |
| 46–55 years | 752 | 54 |
| +55 years | 184 | 13 |
| *Marital status* | | |
| Married/companion | 1080 | 77 |
| Separated/divorced | 159 | 11.8 |
| Single children | 156 | 11 |
| Widowed | 3 | 0.2 |
| *Level of education/schooling* | | |
| Ph.D. | 1046 | 75 |
| Specialist | 35 | 2 |
| Master's degree | 266 | 19 |
| Postdoctoral degree | 50 | 3 |
| Other training | 3 | 1 |
| *Gender* | | |
| Male | 330 | 24 |
| Female | 1070 | 76 |

## 6 Discussion

Using the concepts involving environmental bioethics, SD and SR as a starting point, health and HP are considered, in this scenario, as a multidimensional resource (physical, mental, emotional, spiritual, social). The objective for the establishing an ecological and salutogenic paradigm is not just about identifying needs, behavioural changes and disease prevention, but also about promoting and strengthening positive assets and resources for health, well-being and prosperity (Dooris et al. 2017). Environmental bioethics and PH value and reflect on the interactions of individuals with social environments and, in this approach, ecological models are presented as a possibility of developing health actions holistically, integrating concepts of DS, SR and salutogenesis, stimulating positive aspects related to bioethics, well-being and quality of life (Dooris et al. 2017; Carlotto and Dinis 2018c).

The main objective of promoting these concepts in higher education (HE) is to combine these paradigms with the autonomy of individuals, derived from health actions: to investigate and visualize the gaps in which environmental bioethics and HP

can, through transdisciplinarity, strengthen relationships and produce health, well-being and quality of life in HEIs, relevant indicators in public health. The university environment is a complex social system in its entirety, with several pulsating inter-relationships between parts and the whole. This system is extremely dynamic, with its elements affected by constantly moving feedback loops.

When applied to health in HEIs, this theory illustrates that healthy structures (e.g., strategic plan adoption and managerial commitment) are a prerequisite for healthy processes (e.g., effective communication and efficient management are prerequisites for health outcomes and therefore health determinants (Dooris et al. 2017; Carlotto and Dinis 2018b).

The results of this study indicate that, in addition to the principles of HP generally identified in the literature (Tsouros et al. 1998), such as accessibility, equity, transdisciplinarity, and holism, other principles were identified. Concepts such as solidarity, public trust, autonomy, resilience, individual and community well-being, global health, shared commitment and environmental sustainability were evoked, whose principles are aligned with environmental bioethics and SR, impacting on general health, the well-being individual and collective, and in the social justice of HEIs. Universities act as research and learning sites for SD and SR, stimulating HP activities. On the other hand, the diffusion of ecosalutogenic models in health is presented as a transdisciplinary and principled alternative that seeks to reflect on the qualified health processes in HE. From this perspective, the transdisciplinarity proposed by environmental bioethics becomes a tool for the recognition of shared goals, the need to consider plural knowledge and the reflection of practices. The principles of bioethics and ecological models are integrated in order to aim at building a more humanized and socially responsible HP model (Carlotto and Dinis 2019a).

Stimulating healthy work and learning environments leads to educational processes SD and knowledge exchange, as well as increased health and well-being, reinforcing the commitment to HP in HEIs. Thus, bioethics acts as a useful intervention tool, and reflects on how it is possible to contribute to stimulate appropriate and inclusive health actions in the academic environment, viewing health as an integral part of the culture, structure and processes of HEIs (Carlotto and Dinis 2017).

## 7 Conclusions

HEIs have a vital role to play. Universities act as research and learning sites for SD, stimulating HP's activities. In this proposal, environmental bioethics, as an analytical and principle-based activity, seeks to reflect on the impact of environments on HP in HE, contributing to the construction of qualified health action processes, with the essential conceptual and transdisciplinary clarity that characterises the processes bioethical.

Using the methodology proposed in this research is this possible to verify the importance of the ecosystemic and salutogenic approach in the planning of health

actions in HEIs. The results showed, through the analyzes carried out by the quantitative and qualitative methodologies, the need to assign meaning, coherence and legitimacy to the HEI in fields still unexplored, such as SD and SR. This evidence supports the admission of a cross-sectional model of HP's actions, compatible with the principles of environmental bioethics. The ecosalutogenic approach identified is a promising means of stimulating and promoting environments that support health, well-being and behavioural change and which, due to the bioethical principles evidenced, have proved to be an essential intervention tool in the systematisation of HP's actions. In this scenario, bioethics acts as an integrating, transdisciplinary and moderating element. The positive (holistic) health model stands out as a concrete alternative that contributes to the planning and development of HP's programs and actions in HEIs, through a sustainable and socially responsible approach, promoting aspects related to ethics, well-being and quality of life, and positively reinforcing the health-environment binomial. As future challenges and opportunities for future researches, it is possible to highlight the need to disseminate research on bioethics and the broad scientific knowledge of this discipline through multidisciplinary research; development of institutional strategic planning in HEIs involving bioethics in its multiple curricular and transdisciplinary domains; the implementation of scientific research in evidence-based bioethics; the strengthening of HP, SD and SR in HEIs, considering their transdisciplinary locus and extensive to several areas of knowledge.

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# An Ecological Vision with Social Responsibility in the Sustainable Environment: Promoting Ecological and Environmental Awareness in Centro Universitário Municipal de Franca-Uni-FACEF (Sao Paulo)


**Melissa F. Cavalcanti-Bandos and Alberto Paucar-Caceres**

## 1 Introduction

This project emerged as the result of postdoctoral research at Manchester Metropolitan University (MMU) in the UK, where one of the authors spend two months working in the area of systemic approaches to environmental public policies linked to ways to achieve the United Nations (UN) Sustainable Development Goals (SDGs). MMU has undertaken a number of initiatives to gain sustainability and green credentials that have placed as the second greenest Higher Education Institution (HEI) in the UK. Exposure to these initiatives prompted us to develop actions and sustainable practices at a Brazilian university, where one of the authors acts as administrative dean, putting into practice some of the experiences learned and witnessed in the UK University. The author organised a series of meetings with various university stakeholders such as marketing, procurement, infrastructure, work safety representatives; also included as well as municipality officials.

This project was called VERSAS ('Visão Ecológica com Responsabilidade Social em Ambiente Sustentável')—Ecological Vision with Social Responsibility in the Sustainable Environment—and was conceived to tackle problems on four areas: (1) Disposal and proper collection of solid waste; (2) Relevance of the University content programmes in relation to the municipal and institutional environmental real needs;

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(3) Dissemination of sustainable actions to the internal and external community; and (4) Working towards sustainable procurement.

The main objective of the paper is to report on the way sustainability' project elements and the MMU Sustainable model helped to design VERSAS Project. We discuss the process of design and implementation of a project to promote sustainable development and ecological awareness amongst the Centro Universitário Municipal de Franca (Uni-FACEF), situated in Franca, Sao Paulo, Brazil. The importance of this paper resides in the fact that we worked on a real-world case of sustainability practices to be implemented in Brazil, from a UK experience. The paper also contributes to the debate as to how to align sustainable development practices in HEI along with the UN SDGs.

The paper poses the following Research Questions—RQs:

RQ1 How can the Centro Universitário Municipal de Franca Sustainability strategy can be aligned with some of the UN SDGs?

RQ2 How can the VERSAS Project be used to implement the Centro Universitário Municipal de Franca sustainability strategy?

RQ3 How can the Centro Universitário Municipal de Franca adapt and adopt HEIs sustainability models from European universities, in particular from the UK universities into its overall sustainability strategy and reach the community stakeholders involved in Sustainable Development (SD)?

We attempt to answer the first RQ by discussing the relevant SDGs and the strategic efforts of Centro Universitário Municipal de Franca to align and mirror this SD. The main part of the paper describes VERSAS Project as a platform in which the university can implement its sustainability strategy. The third research question assumes that it is possible to adapt the experiences from European HEIs in bringing SD into their sustainability strategy agenda. As indicated above, one of the authors spent two months in the UK and it is her witnessing the work developed by MMU that has fed the implementation of the VERSAS Project.

The rest of the paper is organised as follows: after this introduction, we briefly review two strands of the literature related to the topic we aim to address. In Sect. 3, we discuss sustainability in Higher Education Institutions: the experience of Manchester Metropolitan University. In Sect. 4, the methodological steps to implement the VERSAS Project is discussed in detail. In Sect. 5, we present the initial findings of our efforts to align the VERSAS Project with both the SDGs and the UK models on SD. Finally, in Sect. 6, we offer some conclusions, recommendations as to how to progress with this project, and, at the same time, to propose further researches.

## 2 Literature Review

For the purpose of the paper and in an attempt to answer RQ1, it was decided to divide the literature review into two literature strands. First, we discuss the United Nations Sustainable Development Goals because of the relevance, they have been

dominated the debate about sustainability over the last years. Second, we outline the related themes of Higher Education and Sustainable Development; this helped us to set the context and also because the paper focuses a project on developed in a university, so it is important to know the significant relationship between the themes Sustainable Development and Higher Education.

## *2.1 UN Sustainable Development Goals*

In 2015, 193 United Nations members had the opportunity to adopt the new sustainable development agenda—The 2030 Agenda for Sustainable Development—and reach a global agreement, which determines the global course of action to end poverty, promote prosperity and well-being for all, protect the environment, and address climate change. The United Nations (UN) has worked with governments, society and other partners and the actions were taken at this time resulted in the 17 Sustainable Development Goals (SDGs) and 169 targets (United Nations, Brazil 2019).

Thus was a historic opportunity to bring the countries together and the global population to decide ways to improve lives everywhere. This agenda was discussed at the UN General Assembly, during the Sustainable Development Summit, and reflects challenges linked with the result of "Rio + 20—the UN Conference on Sustainable Development", held in 2012 in Rio de Janeiro (Brazil) (United Nations, Brazil 2019).

Briefly, the 17 SDGs are: (1) No Poverty; (2) Zero Hunger; (3) Good Health and Well-being; (4) Quality Education; (5) Gender Equality; (6) Clean Water and Sanitation; (7) Affordable and Clean Energy; (8) Decent Work and Economic Growth; (9) Industry, Innovation, and Infrastructure; (10) Reduced Inequality; (11) Sustainable Cities and Communities; (12) Responsible Consumption and Production; (13) Climate Action; (14) Life Below Water; (15) Life on Land; (16) Peace and Justice Strong Institutions; and (17) Partnerships for the Goals.

As indicated in the introduction, this paper presents the VERSAS Project which emerged as the result of postdoctoral research at MMU, where one of the authors studies systemic approaches to environmental public policies linked to ways to achieve the UN SDGs. The Public Policy—*The Municipality Green Blue Programme*—is related to 12 SDGs: Zero Hunger (2), Good Health and Well-being (3), Quality Education (4), Clean Water and Sanitation (6), Affordable and Clean Energy (7), Sustainable Cities and Communities (11), Responsible Consumption and Production (12), Climate Action (13), Life Below Water (14), Life on Land (15), Peace and Justice Strong Institutions (16) and Partnerships to achieve the Goal (17).

During the first stage, the VERSAS Project is related to two SDGs: *Goal 12: Responsible Consumption and Production* and *Goal 15: Life on Land*. Thus, next, we will describe how we can relate to the local university project these SDGs.

The 12th Goal establishes *sustainable consumption and production which is about promoting resource and energy efficiency, sustainable infrastructure, and providing*

*access to basic services, green and decent jobs and a better quality of life for all. Its implementation helps to achieve overall development plans, reduce future economic, environmental and social costs, strengthen economic competitiveness and reduce poverty* (SDG, 12 2019). Additionally, this SDG states that the goal: *includes educating consumers on sustainable consumption and lifestyles, providing them with adequate information through standards and labels and engaging in sustainable public procurement, among others* (SDG, 12 2019). By reading the tenor of this goal, we believe that the VERSAS Project is addressing these issues.

Furthermore, there are three important targets related to this university project: (…) target 12.5—*by 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse*; (…) and target 12.7—*promote public procurement practices that are sustainable, in accordance with national policies and priorities*; 12.8—*by 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature*.

Goal 15 of the UN established that it is important that human beings have to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably managed forests, combat desertification, halt and reverse land degradation and halt biodiversity loss. *Forests cover 30.7% of the Earth's surface and, in addition to providing food security and shelter, they are key to combating climate change, protecting biodiversity and the homes of indigenous populations. By protecting forests, we will also be able to strengthen natural resource management and increase land productivity*. (SDG, 15 2019). The VERSAS Project will work in activities connected with the community, which explain the importance of reverse land degradation, also revealing during the "Green Week" how people can protect, restore and promote the sustainable use of terrestrial ecosystems.

## *2.2 Higher Education and Sustainable Development (SD)*

To start talking about sustainable development we should start from a basic premise: there is only one planet with human life, 'The Planet Earth'. When thinking about its sustainability, we are thinking about human longevity on the planet. This fact affects all of us who live here. Therefore, it is a fundamental subject to be researched and exhaustively discussed.

Consequently, by taking care of the planet, planning actions with a low impact on the environment, thinking about saving scarce resources, properly disposing of waste generated by the human being itself, among other actions that have become mandatory in the current twenty-first century.

In this context, Vargas et al (2019) highlighted the outstanding role of the United Nations, together with various national and local actors, in recognizing SD, and emphasized the importance of universities' role or Higher Education Institutions' (HEI) role in influencing and contributing to SD. This field at universities is rapidly emerging (Leal Filho et al. 1996; Leal Filho 2012; Leal Filho et al. 2018). About

this, Lozano (2011) explained that in the eighties, few universities considered sustainability relevant in their activities, but nowadays there is a different scenario because thousands of universities contemplate sustainability in their activities.

For this paper's purpose, it is important to indicate that 'development' in the SD context must holistically contemplate society and the environment (WCED 1987). In addition, the university has a relevant role, in considering the SD in an integrative approach (Leal Filho et al. 2018). Universities should develop a systemic approach addressing SD issues, playing through research, education and community engagement as leadership in the development of the intervention decisive to the survival of the planet and of humanity (Shiel et al. 2016; Trencher et al. 2014).

In this regard, universities in Brazil are also developing actions in their research, teaching, and outreach activities, institutionalizing the social and environmental issues in their planning and management processes (Malheiros 2019). Furthermore, Velazquez et al. (2006) had already described that integrating sustainability into a university system presents many challenges (in education, research, operations, and outreach) and the universities made substantial efforts to enhance their understanding of the environmental dimensions of their operations (Carpenter and Meehan 2002).

Leal Filho et al. (2018) in their research, indicates that although some progress has been made, sustainable development agendas in Brazilian universities are still underdeveloped. "*In Brazil, SD in universities has been underdeveloped, although in recent years, many more universities have become engaged, with most universities having at least one initiative*" (Leal Filho et al. 2018, p. 95)

Amaral et al. (2015) explain that universities are a type of organization that needs to think in three dimensions of sustainability: economic, environmental and social, plus the five dimensions of their organizational activity: education, research, operations, community outreach, and reporting. Lozano et al. (2013) in the same way clarify that universities could contribute by integrating into all areas of their activity (estate management, teaching, and learning, research and outreach activities).

In this context, the expression "campus greening" has appeared. About this Leal Filho et al. (2018) said that "campus greening" has become mainstream. They continue to explain that around the world, there are innovative universities examples of initiatives related to green building design, recycling and reusing, energy-efficient lighting, water-conserving fittings, and public transportation.

But for SD to actually be applied, Too and Bajracharya (2015) explain that it is a complex and challenging task changing attitudes and behaviours, and it takes more than just information dissemination to influence and change attitudes. Faculty, students and staff need to involve in real problem-understanding exercise and ensure your university becomes an essential force in guiding wider community efforts to promote the sustainability of society (Trencher et al. 2014).

Policies are not a precondition for SD university engagement, however, they are important because they can promote new solutions in the existing gaps, making the universities more efficient and reducing their activities footprints (Leal Filho et al. 2018). Lozano (2013) suggested that the policy needs to consider some elements

as curricula, research, campus operations, community outreach, university collaboration, assessment and reporting, trans-disciplinarily, incorporating SD into the institutional framework, into daily experience and educating educators.

For Vargas et al. (2019) policy frameworks, which exist at international, national and institutional levels, are important instruments to implement SD. They mentioned that for an effective SD implementation, a vertical policy support integration is fundamental in the process. In their research, the results suggested that the policy frameworks should include policy issues: collaboration, partnership, education, outreach, teaching and learning, staff development, curriculum review, research, campus operations, and SD policy implementation.

## 3 Sustainability in Higher Education Institutions: The Experience of Manchester Metropolitan University

Manchester Metropolitan University (MMU) is a United Kingdom university, with more than 37.000 of students (Vargas and Heyes 2016), divided into six faculties: Arts and Humanities; Business and Law; Education; Health, Psychology and Social Care; and Science and Engineering, twelve research centres and a range of departments, schools and professional support services. Former Manchester Polytechnic became Manchester University in 1992. MMU's mission is "We are a great, modern university, in a great global city, here to make an impact on Manchester, our nation and beyond, with a driving ambition to discover and disseminate knowledge, and make higher education accessible and beneficial to all those with the passion and ability to succeed" (MMU 2019a).

MMU has undertaken a number of initiatives to gain sustainability and green credentials that have placed it as the second greenest HEI institution in the UK. The university has institutional priorities in Education for Sustainable Development (ESD), including the University's Strategy for Learning, Teaching, and Assessment, the Environmental Sustainability Strategy, professional development workshops (Matthews and Vargas 2018). About the Strategy for Learning and Teaching, MMU has CELT (Centre for Excellence in Learning and Teaching), which offers a number of workshops, and accredited units, and gives support for staff linked with the ESD university agenda (Matthews and Vargas 2018).

At MMU we can find LiFE—(Living in Future Ecologies), it is a cross-faculty collaborative research group, which investigates themes for sustainable development in the city context (Cocchiarella et al. 2018). In addition, there is a 'Waste to Resource Innovation Network' (MMU 2019b) lead by a Science and Engineering Programme which works through MMU Cross Faculty Network and Steering committee (Reid 2018). The cross-faculty research network works with 'policy implementation and use of waste management', 'provide educational interventions to improve municipal recycling rates, best practice across five European countries providing education to

improve recycling', 'developing circular economy business models', '3D printing—educational hub and integration of recycled plastic', and many others. The Waste to Resource Innovation Network offers expertise in science and technology behind the circular economy, as well as in business modelling and consumer behaviour insight. Waste to Resource Innovation Network's work encompasses the social, behavioural, cultural, ethical, environmental, economic, legal and regulatory know-how to support a successful transition to the ambition of a truly circular economy.

From the literature reviewed, we can conclude that, in general, the universities have an important role in influencing and contributing to Sustainability Development via the teaching of the subject but also by applying SD principles in their own operations. It is imperative, however, they should take a systemic view in which universities, its community, society, and the environment should be seen holistically, and in an integrative approach (curricula, research, campus operations, community outreach, university collaboration, assessment, and reporting, transdisciplinary). In addition, a salient theme of the literature review was that there was a challenging task changing attitudes and behaviours, but the literature review suggested the integration of faculty, students and staff to promote the sustainability of society. In addition, another fundamental point is vertical policy support integration.

## 4 The Methodological Approach to Implement the VERSAS Project at Uni-FACEF

In this section, we discuss the steps leading to the design and implementation of the 'VERSAS Project'. First, we introduce the environmental context, describing the HEI—Uni-FACEF. Then, important considerations about the sustainability actions of the HEI are outlined, which provides the foundation for its development. This is described as the 'Background of VERSAS'. The last part of this section discusses the VERSAS Project in some detail.

### *4.1 The University*

Uni-FACEF, Centro Universitário Municipal de Franca, is a public (municipal) higher education institution founded in 1951, located in the city of Franca,[1] in the state of Sao Paulo, Brazil. The university has about three thousand students and fourteen undergraduate courses as in Accounting Sciences, Business Administration, Civil Engineering, Communication Studies, Information System, Languages and Literatures, Mathematics, Medicine, Production Engineering, Psychology, Nursing, Software Engineering, Computer Sciences, and Economics. There is some specialization,

[1] Franca is located 400 km away from Sao Paulo. The city is known as the Brazilian male footwear capital, as it is the larger producer in all Latin America and a relevant agribusiness sector.

for example, Accounting, finances, auditing, and tax planning; Human Resources Management; Sports Business Management; Management and Development of Web-Based Systems; Public Health; Business Management; Communications and Social Media; Literature, and a Master's Degree Program in Regional Development.

The university aims to promote ethical behaviour and solidarity, with the mission of educating active and responsible professionals. The university has received a high evaluation from the Ministry of Education, there are qualified professors who have a Master's Degree or Doctoral degrees in their areas of teaching and research. The students from Uni-FACEF have a high level of employability.

The university is divided into three buildings: unit 1, where we can find the administrative space, the secretariat, and the engineering courses; unit 2, where we can find the social sciences courses, the postgraduates courses, and the dean's office; and unit 3, a building specifically constructed for the health courses.

At Uni-FACEF we can find a distinctive infrastructure with computer labs, multimedia equipment, Wi-Fi and sound system in all classrooms and many laboratories to train course-specific practices, such as a "3D Digital Desk", a Laboratory of Professional Practice, a Morph-functional Laboratory to assist medical classes and a new state-of-the-art "Communication Set" for training future advertisers in Communication Studies. The students can find in the university an updated library with more than 28,400 titles and 63,000 copies in the Uni-FACEF Digital Library, Pearson Digital, and Elsevier Evolution Collections.

The university encourages the student's scientific research by several internal and public grants. There are many cooperation agreements with foreign universities, encouraging international exchange for undergraduate and post-graduate students. All students are encouraged to participate in social projects.

## *4.2 Background of VERSAS*

One of the social projects conducted at Uni-FACEF culminates in sustainability actions presented to the community in a specific week, called Green Week. Therefore, since 2011, the university started to institutionally encourage the concern of teachers, students and the community with the environment, especially with the green environment. This action began in an embryonic way with a project called "Green Week".

"Green Week" occurs every September, near the Brazilian Arbor Day (Brazil tree day). So, at this time, all the academic communities should communicate to everyone the importance of taking care of the environment. At the end of the week, the organizers should insert the actions done, the people involved, the results obtained in a website to receive a seal of "Social Responsible Institution". Together with the "Green Week", the other social projects conducted at Uni-FACEF are also inserted in this specific website to reinforce the HEI´s Social Responsible performance.

The first "Green Week" focused on the following actions: a) a "Green Trail" was set up in the university's hall, which was a workshop aimed at raising the awareness

of environmental green problems and the need for nature preservation; b) also during the week, seedlings and seeds from the City´s Forest Garden were donated to the community in the university hall; c) besides, university encouraged the tree planting by the students, professors, and the university staff. To set up the "Green Trail", the university invited the group 'Trail of Life' to help with a sensory experience inside the university lobby. Thus, everyone passing through it, with their eyes blindfolded, had the opportunity to understand the importance of taking care of the environment.

Next, the "2nd. Green Week", in 2012, prioritized workshops within the university, tree planting, and lectures focused on water saving and the use of medicinal plants. These actions brought people from the community into the university with the objective of working on environmental sustainability, with the slogan "With small gestures, we move the world".

On the "3rd Green Week" (2013), Uni-FACEF donated seedlings vouchers to the entire academic community to collaborate with the expansion of sidewalk arborization in the city. In addition, students received guidance on planting trees on their sidewalks. In the following year, the "4th Green Week" (2014) focused its efforts on actions around Material Recycling Workshops encouraging reuse and the conscious use of materials. The furniture, the result of the workshops, became a living environment for students and remained in the central hall of unit 2 until 2019, when they were donated, as the university had to readjust the layout in view of the growing number of students.

It is important to say with the first three-years of project, the actions were related to the 15th SDG—*Life on Land*, and in "4th Green Week", we started working with the 12th SDG—*Responsible Consumption and Production.*

The "5th Green Week" (2015) with the theme "Sustainability: New Views", the university encouraged discussions of environmental sustainability among HEI´s students and community members, through the several issues developed around the theme, in social projects that take place at the university.

From the "6th. Green Week" (2016), the theme care and preservation with the environment were linked with the Social Responsibility prioritizing care with the individuals' health. Therefore, at this time Uni-FACEF started to join "Green Week" with the "Social Responsibility Week". Many actions were promoted in the central square of the city. Among the actions were: measurement of people's blood pressure, distribution of seedlings, awareness about proper disposal of garbage, donation of litter-bags for use in cars, storytelling about the need for environmental preservation for children, donation of books, among other actions, all the undergraduate courses were involved especially: Medicine, Civil Engineering, Production Engineering, Languages, Psychology, and Mathematics.

After this, between 2017 and 2019, the university continued encouraging "Green Week" actions (7th, 8th, and 9th.) and linked them with the 2nd, 3rd, and 4th. "Social Responsibility Week". Students' involvement in actions and activities took place annually during this period, but the university needs to do more in SD.

### *4.3 VERSAS Project*

The VERSAS Project began to be institutionally discussed after the return of the administrative dean from a post-doctoral at MMU, in England, where she developed research focused on a public policy of the state of Sao Paulo—*The Municipality Green Blue Programme* that should be followed by the municipality.

So, when collecting practical information about the project at the City Hall, she came across the necessary guidelines to be followed by the municipality and the important and necessary help from the university. It is important to mention that we are describing a municipal university, so its role is more relevant in supporting public awareness of environmental sustainability in the city.

Because she was working on the subject during her stay in England, she observed researched material and tried to understand some of the actions of the UK University that could be implemented in the Brazilian University. Thus, on her return, she met with a group of employees responsible for many areas in the institution asking for their support in these actions, which at this time the municipality officials were also involved in.

Initially, it was provisionally named, "Uni-FACEF Sustainability Project", and she asked for support from the University Marketing Department in the search for a name that better defines all actions. They suggested VERSAS—"Ecological Vision with Social Responsibility in the Sustainable Environment", in Portuguese—'Visão Ecológica com Responsabilidade Social em Ambiente Sustentável'. The Marketing suggested this name based on https://www.dicionarioinformal.com.br/versas/. They developed the project logo and all visual communication of the project.

The group of employees who are part of the Internal Accident Prevention Commission (CIPA) was integrated into the project, and they are led by the institution's labour engineer and helped a lot with some of the actions.

The VERSAS Project initially, was conceived to tackle problems on four areas: (1) Disposal and proper collection of solid waste; (2) Relevance of the University content programs in relation to the municipal and institutional environmental real needs; (3) Dissemination of sustainable actions to the internal and external community; and (4) Working towards Sustainable procurement.

## 5 Results: The First Stage of VERSAS Project

This is a work-in-progress project, where we have the initial findings. So far, the project has been well received amongst the university community and external stakeholders. Next, we will describe what is being planned and worked on within the four initial areas, as well as the experiences and lessons learned from the UK universities, that is MMU which to some extent has inspired the VERSAS Project.

## *5.1 Disposal and Proper Collection of Solid Waste*

(a) ***The following priorities were defined***:

- Refit all HEI´s bins, including different colours. We decided to use only two colours because the municipality receives waste in two forms: recyclable waste (mainly paper, plastic bottles, and cans) and non-recyclable waste. The recyclable and the non-recyclable garbage are collected by the municipality on different days and to organized this process in the university we decided to identify them in different colours bags, to be better organized.
- There will be two forms of disposal: recyclable waste (blue bags) and non-recyclable waste (black bags). We renewed the tender to contract a company to clean the buildings and organize the garbage in this way.
- Guidance and awareness of cleaners about the importance of proper disposal. As it is an outsourced company, it was necessary to include in the bidding process this need. It was suggested to create a flowchart with the garbage disposal process to train the cleaning company.
- The involvement of the Internal Accident Prevention Commission (CIPA) to advise employees on proper disposal, among other actions. The Municipality Secretariat of the Environment was willing to help with whatever is needed in this area.
- After purchasing trash bins, visual adjustment and cleaning instructions were done, and we contact the recycle collection for the removal of the waste.
- In HEI´s administrative environment, a place was left to discard non-confidential papers.
- Purchase a paper shredder for confidential documents. Thus, they can be shredded correctly and taken to recycling.
- Organize with the University Marketing Department to articulate the best way to create Uni-FACEF new disposal culture, involving students and teachers. We will make a didactic visual identity to facilitate the disposal.

(b) ***Before the VERSAS***:

The university had four-color bins in some common spaces, but inside the room, there was only one kind of bin. The coloured bins did not guarantee that the waste was necessarily separated and would be correctly allocated to the municipal recycling cooperative, because sometimes it was confusing, and the cleaning staff was not trained for such separation. The garbage bags when they were removed from the trash cans, were in the same colour (all black), so it was confusing to separate.

(c) ***Lessons learned from MMU adapted into VERSAS project***

Inside that university, on every floor, there are very illustrative, self-explanatory bins on how to dispose of garbage. There areas special bins for used paper.

## 5.2 The Relevance of the University Content Programs in Relation to the Municipal and Institutional Environmental Real Needs

(a) ***The priorities were***:

- The necessity to conduct a survey with all undergraduate courses, gather the teaching plans, know who teaches the content of 'Environment' and/or 'Sustainability', and/or 'Ethics' and integrates the professors and the subjects with VERSAS Project and the real Municipal needs.
- Organize a meeting with department heads, inserting the municipal and institutional needs in the teaching plans, where all courses will necessarily be working with the local proposal to bring a practical global consequence.
- See the feasibility of inserting the institutional orientation of the Municipal Environment in the class.
- Study the possibility of an eventual "technical visit" to the Municipal Recycling Cooperative aiming to increase awareness in loco.
- Verify specific demands of undergraduate courses and align concrete institutional and municipal proposals and involve the students facing the changes that will be implemented.

(b) ***Before VERSAS***:

The undergraduate courses worked with 'Environment' and/or 'Sustainability', and/or 'Ethics', but not in this way. There was no alignment between courses to exchange experiences. The changes are going to happen in 2020.

(c) ***Lessons learned from MMU adapted into VERSAS project***:

The MMU has a cross-faculty Network with collaborative research groups.

## 5.3 Dissemination of Sustainable Actions to the Internal and External Community

(a) ***Priorities***:

Continue working with "Green Week" together with the "Social Responsible Week", but now aligned with VERSAS. Work on this issue of internal awareness and the cultural change through the student's projects involved in the causes. Students making students aware, because they speak the same language. In addition, bring content to be shared with the community, but linked with university priorities in Education for Sustainable Development (ESD), and create a University Strategy SD.

An excellent project was developed by the 'Communication Studies' students linked to awareness about the use of the elevator (accessibility and social responsibility). The communication created was awarded a prize at an important regional event. This project will be implemented in 2020.

(b) ***Before VERSAS***:

All the history about the "Green Week" and the "Social Responsible Week" was written in the topic 'Background VERSAS'.

(c) ***Lessons learned from MMU adapted into VERSAS project***:

At MMU there are university priorities in Education for Sustainable Development (ESD) with a University Strategy SD.

### *5.4 Working Towards Sustainable Procurement*

(a) ***Priorities***:

The sustainable purchases were prioritized from that date. As a public institution, the law requires bidding for purchases over a certain amount. The first actions were:

- It was decided that the changes regarding solid waste needed the purchase of bins and hiring a cleaning company with the proposed adjustments.
- It was decided that all lamps purchased from that date for the three units will be LED.
- It was decided to change the water consumption in disposable plastic bottles that were available to all teachers and staff to 'sustainable bottles' with the project logo, distributed to all teachers and staff.

(b) ***Before VERSAS***:

Purchased lamps with reactors, purchased 4.000 plastic bottles (500 ml) per month, approximately 40.000 per year (because we have two holiday months), and untrained cleaning staff not suitable for all garbage separation.

(c) ***Lessons learned from MMU adapted into VERSAS project***:

In the cross-faculty research network they research the circular economy.

## 6 Conclusions, Recommendations and Further Research

This is a work-in-progress project, with initial findings. As well as it was clarified in the literature reviewed that a vertical policy integration is decisive to support the

implementation of SD, it is important to link the SDGs with Environmental Public Policy emerged from *The Municipality Green Blue Programme* in the city of Franca, with the Policy and SD Strategy of the HEI.

Experiencing how SD practices have been implemented at MMU has been valuable. The useful lesson has been adjusted into the process of VERSAS Project implementation. Our main conclusion is that if we continue to adopt this experience and adapt them to the Brazilian context, the VERSAS Project will help Uni-FACEF to shape its SD strategy by consolidating the following actions:

(a) integrative approaches and development of holistic approaches;
(b) vertical integration giving a coherence between policy frameworks at supranational, national, regional and local levels;
(c) teaching, and learning, research and outreach activities;
(d) incorporate SD into the institutional framework, because the policy needs to consider curricula, research, campus operations, community outreach, university collaboration, assessment, and reporting, transdisciplinary;
(e) major involvement of students and teachers in projects that will impact cultural change, with specific strategies for the changes to being incorporated.

Finally, and from our experience at MMU, we believe that Uni-FACEF needs to create an SD agenda, developed with university priorities in ESD, also implement a circular economy and create cross-faculty network research.

During the next stage, we expect the implementation of a sustainable culture that adheres to the principles of a circular economy (procurement and awareness from the purchase of consumer items in the university to its final disposal). We also expect to consolidate practical actions on the ecological disposal of solid waste in the city. At the educational level, we expect to continue fostering among students discussions and actions about their local performance as a change agent, with the view of achieving the SDGs. Thus, the intention is to act locally to meet world premises, teaching, and learning, research and doing outreach activities in SD.

As future lines of research, we envisage investigating ways of creating economic and social indicators to measure the gain of the educational institution to change to a sustainable culture; and try to compare SD practices between institutions with the same size and nature in Brazil.

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# A Theoretical Framework Between Corporate Social Responsibility and Ergonomics for Sustainable Development


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## 1 Introduction

Social Responsibility in the organizational context assumes the nomenclature of Corporate Social Responsibility, being a dynamic discipline because it is constantly developing, providing a link between organization and society, often represented by the community of which the organization is part. It has strategy aimed at solid values and a more humane long-term approach, through dialogue, formation of business relations and with the State, and relations in various spheres of society, offering the organization commercial benefits and contributions to the welfare of society (Holme and Watts 2000).

Similarly, ergonomics acts in the relationship between the worker and its work within a socio-technical context (internal, external and personal). In its broader approach, macroergonomics are evidenced interactions between the social and organizational context in order to improve the existing work system and create new systems, optimizing the relations between human, organization, technology, environment and people (Guimarães 1999).

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Thus, there is a gap in which CSR and ergonomics (in its macroergomic approach) together can fill, considering the workers of key parts organizations for the contribution of organizational Sustainable Development. This, this study aims to propose a theoretical framework demonstrating the intersections between CSR and ergonomics and its validation in the context of health.

## 2 Background

### *2.1 Corporate Social Responsibility*

Social Responsibility (SR) is a consequence of a public stance towards society's resources, whether economic or human, being used for social purposes that transbordem interests of an organization or individuals. In the organizational context, it assumes the name Corporate Social Responsibility (CSR) (Carroll 2015).

Its objective is to contribute to Sustainable Development (with economic, environmental and social objectives). Thus, in an organization, Social Responsibility has the function of aligning its objectives with the needs and expectations of society and the environment in which it is inserted (Brazilian Association of Technical Standards 2012).

To meet the organization's objective to contribute to Sustainable Development, seven principles of Social Responsibility are considered, which are accountability (accountability for its impacts on society, the economy and the environment), transparency, ethical behavior, respect for the interests of stakeholders, respect for the rule of law, respect for international standards of behaviour and respect for human rights (Inmetro 2010).

In addition to compliance with the principles of Social Responsibility, ISO 26000 Standard 2010 guides the use of seven central themes composed of issues that help establish organizational priorities with regard to the subject. These are the themes: (i) organizational governance, (ii) human rights, (iii) working practices, (iv) environment, (v) loyal practices of operation, (vi) issues related to the consumer and, (vii) involvement and development of the community:

(i) *Organizational governance*: it is variable according to issues such as business size, type of organization, the number of people who will make governance, the context in which the organization is inserted (environmental, economic, social, political and cultural);
(ii) *Human rights*: for human rights to be guaranteed within an organization, this must be attentive to issues such as human rights risk situations; legal complicity (act or omission with substantial effect on the commission of an illegal act) and non-legal act should be avoided; prohibition of discrimination and, participation and inclusion of vulnerable groups; civil and political rights; economic, social and cultural rights; fundamental rights at work;

(iii) *Working practices*: encompasses actions related to work such as employment and employment relationships; working conditions and social protection; social dialogue; safety and health at work; human development and training in the workplace;
(iv) *Environment*: there are issues to be considered on the theme of the environment, such as pollution prevention (air emissions, water discharges, waste management, use and disposal of toxic and hazardous chemicals, other identifiable forms); sustainable use of resources (energy efficiency, conservation, use and access to water, efficiency in the use of materials, minimizing the requirement of resources by a product); mitigation and adaptation to climate change; environmental protection; environmental protection; environmental protection biodiversity and restoration of natural habtats (biodiversity enhancement and protection, valorization, protection and restoration of ecosystem services, sustainable use of soil and natural resources, stimulating environmentally friendly urban and rural development);
(v) *Loyal practices of operation* (anti-corruption): responsible political involvement; fair competition; promotion of social responsibility in the value chain; respect for the right of property;
(vi) *Consumer issues*: these are issues such as loyal marketing, factual and non-biased information and fair contractual practices; protection of consumer safety and health; sustainable consumption; the tendiment and support of the consumer and solution of complaints and controversies; prouting and privacy of consumer data, access to essential services, education and awareness;
(vii) *Community involvement and development*: communitysupport and access to information andcommunication technologies; promotion and preservation of community education and culture; job creation and training of community-owned professionals; support for technological development and access to information and communication technologies; wealth and income generation in the community; assistance in promoting and maintaining health; investment of organizational resources to improve social aspects (Inmetro 2010).

The Norm NBR 16001:2012 does not determine the organization's obligation to follow all issues of each theme, but rather determines that "the organization must periodically evaluate and document the relevance and significance of issues related to each of the themes of social responsibility" (Brazilian Association of Technical Standards 2012).

## *2.2 Ergonomics*

Ergonomics is the discipline that has the objective of understanding human interactions and other elements that make up the system of work in organizations, increasing human well-being and overall system performance (International Ergonomics Association 2020).

It can also be understood as human-system interface technology, being divided into two levels. The micro level includes human-machine interface or hardware ergonomics, human-environment interface or environmental ergonomics, cognitive ergonomics or software ergonomics. The macro level consists of human-organization-machine interface or macroergonomics.

Macroergonomics, defined by Hendrick, works in order to integrate the organization-human-machine systems, considers the human factor within the organization and external factors that influence its work, encompassing socio-technical characteristics of the organization, considering characteristics of the work system, the external system and the personal system and also macroergonomics (Hendrick 1995).

The macroergonomic approach makes use of participatory ergonomics, providing with the involvement of employees to improve productivity, increased satisfaction, improvement in safety at work and in the company, causing reduction of errors and accidents (Iida 2005).

There are several methods of applying macroergonomics, one of which is the Macroergonomic Analysis of Work (MAW). MAW can be used as a way of surveying problem situations, problem analysis, ergonomic diagnosis, definition of problems to be prioritized and proposing solutions that are then validated and implemented. The success of the application of MAW is linked to the participation of the worker in the decision-making processes of design, development and implementation of improvements, because it increases feelings of responsibility, motivation and satisfaction in relation to work (Guimarães 1999).

Throughout the application of the method, the separation of the ergonomic demands of workers by personal factors, external factors and internal factors that are separated in the constructs Environment, Biomechanical, Work Organization, Risk and Enterprise (EBCORE) (Guimarães 1999).

The Environment construct refers to temperature, ventilation, air quality, noise and lighting of the working environment. The Biomechanical construct refers to characteristics related to the job. The Cognitive construct refers to the items as physical effort, mental effort, monotonous work, limited work, creative work, dynamic work, work, complex work, repetitive work, grueling work, work involves responsibility, job appreciation, autonomy at work, stressful work, psychological pressure by superiorsands, feels job safety, likes work and workload. The Work Organization construct refers to the characteristics of design and organization of the work performed. The Risk construct refers to all occupational-related risks, and may be accidents, physical, chemical, biological and ergonomic. Finally, the Enterprise construct lists items related to the organization of the company, such as departments, benefits, salaries, among others (Guimarães 1999).

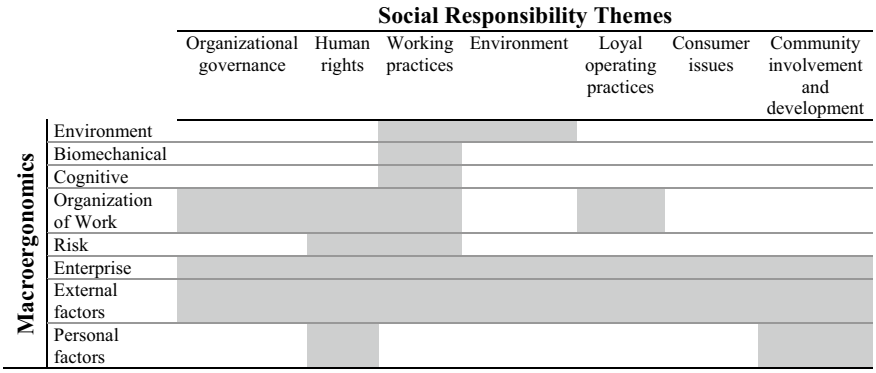


**Fig. 1** Model of representation between relations between macroergonomics and social responsibility. *Source* The authors

## 3 Methodology

The present study was based on concepts related to Social Responsibility and ergonomics for the construction of a theoretical model that presents the intersections of these two disciplines. The conceptual model is constructed in matrix format, in which in the columns are the themes of Social Responsibility (organizational governance, human rights, work practices, environment, loyal operation practices, consumer issues, community involvement and development) and in the lines are the characteristics of internal macroergonomics (EBCORE), external and personal. The intersections between these two disciplinas are marked in gray as shown in Fig. 1 in the next section.

For the validation of the theoretical scheme, this was applied in a case study presented in Sasaki and Leite (2018). In the relationships between the SR disciplines and macroergonomics, the symbol ✓ was marked.

The next section presents the theoretical framework built and its application in the case study in order to have aspects validated for Sustainable Development.

## 4 Results and Analysis

### *4.1 Theoretical Framework*

Social Responsibility considers issues relating to the environment, society and the economy in which an organization is influenced and influenced. In these issues it is clear that workers in an organization are fundamental for the principles of RS to be met and that the relevant themes are considered. Similarly, macroergonomics acts in order to understand the relationship of the worker with the socio-technical system of

which it is part. Then Fig. 1 presents the construção of a theoretical scheme that relates the themes of Social Responsibility with the characteristics of macroergonomy and the EBCORE constructs, in which existing relationships are marked.

The questions defined by Norm NBR 16001:2012 were considered for the existence of the intersection between the themes of SR and the characteristics of macroergonomy. The subject was related to each theme, which questions will be observed for each characteristic of macroergonomy.

For the theme "organizational governance" the working organization was related to the Organization of Work construct the issue of people who will make governance, for the construct Enterprise the context construct in which the company is inserted and, for external factors also the context in which the company is inserted.

The theme "human rights" can be related to the construct of the Organization of Work on the issue fundamental rights at work, with the construction Risk on the issue situations of risk to human rights, the construct Enterprise in the issue of legal and non-legal complicity should be addressed, with external factors in the issue economic, social and cultural rights and, with personal factors in the issue prohibiting discrimination and participation and inclusion of vulnerable groups.

Relationships between the theme "working practices" and the constructs Environment, Biomechanical, Cognitive and Risk can be made on the issue of safety and health at work, with the construct Organization of Work the issue of employment and relationships at work, with the construct of the issues working conditions and social protection, human development and training in the workplace and, with external factors the issues working conditions and social protection and social dialogue.

The theme "environment" has relations with the constructs Environment and Enterprise and external factors in the issues pollution prevention, sustainable use of resources, mitigation and adaptation to climate change, protection of the environment and biodiversity and restoration of natural environments.

It is also possible to make relationships between the theme "loyal practices of operation" and the construct Organization of Work in the issue of promoting social responsibility in the value chain, and the Construct Enterprise on the issues responsible political involvement, fair competition, promotion of social responsibility in the value chain and, external factors in issues responsible political involvement, loyal competition, promotion of social responsibility in the value chain and respect for the right of property.

With the theme "consumer issues" are considered relationships with the Enterprise construct for loyal marketing issues, factual and non-biased information and fair contractual practices, protection of consumer safety and health, customer service and support and solution of complaints and controversies, protection and privacy of consumer data and, with external factors in consumer safety and health protection issues, sustainable consumption, care and support to the consumer consumer and solution of complaints and controversies, protection and privacy of consumer data, access to essential services, education and awareness.

For the theme "Community involvement and development" the issue of community involvement with the organization was related to the Enterprise construct by

proactively participating, job creation and training of community-owned professionals, support for technological development and access to information and communication technologies, wealth generation and income in the community, assistance in health promotion and maintenance, investment of organizational resources to improve social aspects; for external factors the involvement of the community with the organization by proactively participating, promotion and preservation of education and community culture, generation of employment and training of professionals belonging to the community, support for technological development and access to information and communication technologies, generation of wealth and income in the community, assistance in promoting and health maintenance and, for personal factors, the generation of employment and training of professionals belonging to the community.

It is understood that thes themes help in the establishment of organizational priorities so that the organization aligns its objectives with the needs and expectations of society and the environment for achieving Sustainable Development. Thus, the proposed model contemplates the intersection between all themes of Social Responsibility and the characteristics of macroergonomics, it is understood that the model achieves its objective of intersections between the two disciplines and contributes to Sustainable Development.

## *4.2 Application of the Theoretical Scheme*

The model presented in Fig. 1 was applied in the case study of Sasaki and Leite (2018) for its validation. The case study included the Billing sector of a Brazilian University Hospital. The sector in question has 19 employees who account for hospital accounts so that sufficient financial resources are raised for the maintenance of the hospital. In view of this, the work performed by workers is very stressful, requires a lot of responsibility and attention due to the realization of accounts is carried out by workers working in an office environment.

In the case study, the Macroergonomic Analysis of Work (MAW) method was applied, obtaining data on the perception of workers in the sector in relation to the tasks they perform, the environment and the post in which they work, to the organization (hospital), the risks that are exposed and the functioning of the organization in general. To obtain information related to the students' vision, interviews were conducted and questionnaires were applied. Thus, with macroergonomics application, internal factors (EBCORE), external factors and personal factors were considered as information for filling the matrix of the theoretical model. Figure 2 presents the relationships between macroergonomics and social responsibility themes for the Billing sector (with the ✓symbol).

According to Fig. 2 it can be noted that for the case study in question the themes "loyal practices of operation" and "consumer issues" were not considered. This fact occurs by the case study having been applied with a sample of workers from only one sector of the hospital, not involving management and high management posts, and

| Macroergonomics | Social Responsibility Themes: Organizational governance | Human rights | Working practices | Environment | Loyal operating practices | Consumer issues | Community involvement and development |
|---|---|---|---|---|---|---|---|
| Environment | | | ✓ | ✓ | | | |
| Biomechanical | | | ✓ | | | | |
| Cognitive | | | ✓ | | | | |
| Organization of Work | ✓ | | ✓ | | | | |
| Risk | | | ✓ | | | | |
| Enterprise | ✓ | | | | | | |
| External factors | | ✓ | | | | | |
| Personal factors | | ✓ | | | | | ✓ |

**Fig. 2** Relations between macroergonomics and social responsibility for the Billing sector. *Source* The authors

it is not possible so with the interviews conducted and in the questionnaires applied if these topics were addressed.

It is also noted that some intersections between social responsibility themes and the internal, external and personal aspects of macroergonomics were not indicated because they were not considered in the interviews and/or questionnaires applied in the Billing sector. However, these intersections cannot be considered non-existent for the entire organization.

It is observed that, although two themes of Social Responsibility are not present in the case study, the three objectives of Sustainable Development are contemplated. The environmental objective is represented by the existence of the relationship between the theme "environment" of SR and the construct Environment of macroergonomics. The economic objective is present in the intersections between "human rights" and external factors and, "community involvement and development" and personal factors. The social objective is contemplated in the intersections between "organizational governance" and the construct Organization of Work and external factors, between the theme "human rights" and external and personal factors, between "work practices" and the abcore constructs.

## 5 Conclusion

The search for the alignment of available resources and the needs of organizations in the context to which they are inserted, requires that surveys and research be carried out regarding the objectives of organizations and how best to conduct their activities in order to achieve, in addition to gains for stakeholders, to promote Sustainable Development.

For the Sustainable Development of organizations, the joint analysis of Social Responsibility with ergonomics and its intersections is in line with the objective

of this article with the proposition of a theoretical framework. In this theoretical framework, the information obtained in the study of Sasaki and Leite (2018) in the context of health was considered, proving the effectiveness for contributing to sustainable development of both organizations and society. Furthermore, it is evidenced the importance of the participation of those involved in the processes of the sector under analysis and the observation of the internal and external environment to which employees are submitted for the correct understanding of the relationship between them and the system to which they are inserted, so that the intersections are clear and well defined, ensuring the assertiveness of the proposed scheme.

In addition, the proposed model guarantees Sustainable Development, since it meets the objectives related to the environment, economic and social as represented by the existences of relations between social responsibility themes and macroergonomics.

Finally, for future work, it is suggested the application of the theoretical model in other organizations, sectors, consumers, employees of high management who are inserted in contexts different from that presented in this study. In order also to consider the issues related to loyal practices of operation and consumer issues, so that the theoretical scheme is reapplicable to any organisation in different contexts and contributing to the sustainable development of organisations and society.

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# Sustainability Hackathon: Integrating Academia and Companies for Finding Solutions for Socio-environmental Problems


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## 1 Introduction

Education on sustainability issues is crucial for generating awareness and changing the behavior of the academic community, enterprises, government and society towards a sustainable future. UNESCO has been promoting Education for Sustainable Development (ESD) since 1992, led the UN Decade for ESD from 2005 to 2014 and since 2015 is leading and coordinating the Education 2030 Agenda. ESD is explicitly recognized in the Sustainable Development Goal (SDG), as part of

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Target 4.7 of the SDG4, "Quality Education", which is one of the 17 goals of the 2030 Agenda for Sustainable Development adopted by the United Nations General Assembly in 2015 (United Nations 2015). ESD is acknowledged as essential to achieve all SDGs because it can shape sustainability change-makers, i.e., people with knowledge, skills, values and attitudes, which contribute to the dimensions (social, environmental, ecological, cultural, spatial, economical) of sustainable development. Unlike education that promotes only economic growth, which may lead to an increase in unsustainable consumption patterns, the ESD approach is the one that "empowers learners to take decisions and responsible actions for environmental integrity, economic viability and a just society for present and future generations" (UNESCO 2017).

However, "the interconnectedness of the SDGs and the complexity of sustainability as a concept make it difficult to relate the SDGs to educational learning outcomes" (Kioupi and Voulvoulis 2019), and there are internal and external barriers to the sustainability transformation of educational institutions, some of them being negative perceptions about sustainability, perceived high cost of implementing changes, lack of training and information, lack of leadership, lack of interest, and resistance because of work overload (Kioupi and Voulvoulis 2019). Pereira et al. (2014) found that bureaucracy and hierarchy refrain the sustainability culture at the Universidade de São Paulo.

Despite the obstacles, some higher education institutions (HEIs) around the world have committed to sustainability, signing agreements and establishing partnerships, for example, The Talloires Declaration (1990), The Halifax Declaration (1991), The Swansea Declaration (1993), The Kyoto Declaration (1993), the International Organization of Universities for Sustainable Development and the Environment OIUDSMAE (Rosúa-Campos and Serrano-Bernardo 2015), the Global Higher Education for Sustainability Partnership (GHESP 2000). Delgado and Vélez (2005) found 140 HEIs with environmental policies for both administrative and academic management, 10 of them being ISO 14001 certified.

In Brazil, the Universidade do Vale do Rio dos Sinos (UNISINOS) was the first ISO 14001 certified HEI in Latin America (Tauchen and Brandli 2006) and 52 HEIs (mostly federal universities) signed the Talloires Declaration (ULSF 2020). In Engineering courses, some initiatives for introducing sustainability in the curriculum can be depicted from Linsingen et al. (2003), Adeodato et al. (2004), Carletto (2009), Quelhas et al. (2011), Loureiro et al. (2016), Viana and Fonseca (2016), Resende et al. (2017), but Juliano et al. (2017) point out that the focus is mainly environmental. Pazmino and Santos (2017) noted that sustainability is not part of most curricula of Design courses in the state of Santa Catarina, or is approached in one discipline isolated from the others. Palma et al. (2011) found that only 13 out of 40 studied HEIs offer sustainability-related subjects in bachelor's degree courses in Business Administration at Brazilian federal universities.

Ciurana and Leal Filho (2006) proposed that curriculum greening might be achieved by: (1) reinforcing the commitment to transforming relations between society and nature; (2) taking into account the subject in the construction of knowledge; (3) considering the cognitive, affective and action aspects of people; (4)

integrating the paradigm of complexity in the curriculum; (5) contextualizing the curricular project; (6) introducing flexibility and permeability of the disciplines; (7) attempting to establish coherence and interaction between theory and practice; (8) working within a prospective orientation of alternative scenarios; (9) creating space for reflection and democratic participation; (10) adapting new teaching and learning methodologies. Many authors (e.g. Blake et al. 2013; Leal Filho et al. 2016; Lozano et al. 2017) highlight pedagogies and teaching techniques for developing sustainability competences and examples are pedagogies such as project and problem-based learning, active learning, community service learning, place-based environmental education; and teaching techniques such as case studies, concept maps, life cycle and supply chain analysis, participatory research, formation of interdisciplinary and interlinked teams, and teachers acting as facilitators of knowledge.

Considering that non-traditional techniques may also contribute to teaching sustainability, this article presents the experience of an academic marathon for creating solutions using residuals. Inspired by the hackathons, usually organized for software development, this one focus on sustainability issues, in order to stimulate the participants to think about real socio-environmental problems under the mentoring of teachers and with the support from companies' representatives.

## 2 Why a Hackathon?

A hackathon (from hacking + marathon) is generally defined as an event, typically lasting several days, in which a large number of people meet to engage in collaborative computer programming. It was first recorded on June 4, 1999, when a group of 10 Open Berkeley Software Distribution (OpenBSD) developers met in Calgary, Alberta, Canada (Wood 2013).

According Wood (2013), hackathons are highly engaging events that gained increasing popularity in the mid-2000s among software companies as a way to quickly develop new ideas. However, they have been criticized for being counterproductive, unhealthy, and stupid, with outcomes that are not necessarily useful for society and that will die as fast as they grew. For Wood (2013), although some criticism are valid, it is important to see the bigger picture: most participants will not reinvent the world in 48 h, but for many, it could be a first step for a new career, an opportunity to meet new people and to open their minds. Komssi et al. (2015) agree that hackathons are effective social and educational events since they provide participants with a way to learn or try something new. "An often understated by-product of hackathons is the participants' personal development and sense of achievement from working with new technologies, meeting and collaborating with people they otherwise wouldn't, and generally having a lot of fun. These bene-fits might even constitute the primary reason for the hackathon, owing to the event's potential for building strong communities and cultures" (Komssi et al. 2015).

Each hackathon is different, but most share some characteristics: team-based organization; intensity; creativity; problem solving; attention to users of a product or

solution (Clark et al. 2019). Although the hackathon format is not so popular outside the computing and technology community, according Clark et al. (2019), who organized a hackathon in history education, it was applied in the cultural heritage sector (Coding da Vinci 2014), business development and marketing (Calco and Veeck 2015; Spaulding and Caimi 2016), medical and public health education (Kienzler and Fontanesi 2017), legal education (Kessel 2019). In 2013, British Airways and Ideo launched the "Ungrounded" hackathon, when 130 top innovators (mainly from Silicon Valley) had to prototype, within three days, and in a flight from San Francisco to London, innovative solutions to increase the productivity that drives the global economy (Tsering 2013).

The idea of the Sustainability Hackathon was born at the end of May 2019, with the objectives of generating enthusiasm and awareness about sustainability issues, bringing together students with different background, skills and interests, empowering them to carry out original research and promoting collaborative work for innovation. It was considered an opportunity for reinforcing sustainability at Pontifical Catholic University of Paraná (PUCPR) mainly in the course of Industrial and Systems Engineering, which has only one discipline on the subject in the curriculum.

## 3 Method

The hackathon was prepared from June to September 2019, by three teachers, two graduate and two undergraduate students from the Center for Sociotechnical Practices and Entrepreneurship for Sustainable Development (SEEDS) of the Industrial and Systems Engineering Graduate Program (PPGEPS)/PUCPR. Their main tasks were to plan the format and goals of the hackathon, get authorization from academic authorities for hosting the event in the campus, set the event place and catering, map companies/organizations as potential collaborative partners, define guest speakers for the event, announce the event, give technical and academic support during the event, evaluate the event.

### *3.1 Defining Rules and Objectives*

The event program and regulation were submitted to the Teachers Chamber in August 2019 and, after approval, published in the SEEDS website (https://www.nucleoseeds.org/hackathon-2019) were candidates could register, for free, from 1 to 15 October 2019. After individual registration, the candidate should register his/her team, which has to be composed of a minimum of three and a maximum of six people. The event was announced via site (www.nucleoseeds.org), Facebook (https://www.facebook.com/seedsnucleo/), Instagram (https://www.instagram.com/nucleo.seeds/), through

direct email and posters all over the university campus. The website displayed all the necessary information as follows:

***Regulation***

(1) Each participant should spend at least 10 h in the event, and each team should sum up 50 h in the event. Doors will be shut by 11 pm each day and will be opened by 7:30 am next day. Therefore, the participants who do not stay overnight should sign the attendance list every time they leave and get back to the hackathon place, to allow for hours computation.
(ii) Participants should bring their working tools (such as notebook, smartphone, tablet, etc.) and equipment for bathing and resting (pillow, blanket, bed sheets, etc.).
(iii) Participants will get all necessary infrastructure: internet connection, info lab and technical support, stationary, desks, tables, chairs, working room, bathroom, shower, place to sleep, as well as three meals/day: breakfast, lunch and dinner, coffee, energy drinks.
(iv) It is permitted to use external information, obtained from the internet or social network, as long as the information is legal and do not violate any rights. Participants may also obtain any needed information from people outside the hackathon.
(v) It is not permitted to use any solutions, media, audio or arts, which were not developed by the teams, or have no formal authorization for use. It will not be accepted projects initiated before the opening of the hackathon.
(vi) Participants should sign a media consent form because the hackathon will be recorded for presentations, a documentary, etc.

***Objectives***

Each team has to create innovative solutions for residual materials focusing on the reduction of environmental impact, and the increase of social (generation of jobs, improvement of health, well-being and citizenship) and economic benefits.

Participants can select one or more residuals brought by nine companies/organizations (Table 1). Residuals will be displayed in one of the rooms of the hackathon area, and participants can talk, in person or by phone, to the companies' representatives in order to get all necessary information about the residuals.

## *3.2 Gamification*

Considering that competition, rules, challenges, and social interaction are gamification elements (Deterding et al 2011) that contribute to learning (e.g. Sailer and Homner 2019), the Sustainability Hackathon was gamified: the teams had five missions that involve challenges (Table 2) to be accomplished in order to move on to a next mission, i.e., to the next step of the project. They could hand in the results

**Table 1** Residuals to be used in the projects

| Company/organization | Residual |
|---|---|
| Ambiensys | Water with polyethylene |
| | Polyethylene powder |
| | Sewage sludge |
| | Locomotive filter |
| | Mate herb |
| APC/Hospital Cajuru | Infectious hospital residuals (group A/E) |
| | Hospital residuals (group B) |
| | Non-recyclable hospital residuals |
| APC/PUCPR | LED bulbs |
| | Plastic cups |
| | Gardening residuals |
| | Infectious residuals (group A/E) |
| | Infectious residuals (group B) |
| | Non-recyclables/organic (group D) |
| Emergia Engenharia e Cons. Ambiental | Paint sludge |
| | Contaminated plastic |
| | Contaminated solvent |
| | Contaminated solids |
| | Battery |
| | Clothing |
| Líder Consultoria e Serviços Ambientais | Pig snout |
| | Pig hair |
| | Pig hull |
| Erasto Gaertner | Titanium straw |
| Reciclatech | Tonner |
| | LCD screen |
| | VHS tapes |
| Ouro Fino | Water bottle (20 L) |
| SEBRAE/Rural Producers from Guaraqueçaba | Manipueira (residual from manioc flour) from the production process |
| | Manipueira from local infrastructure |
| | Manipueira from the equipment |

either directly to the organizing team or through the website and get points (SEEDS stamps) for every accomplished mission, which were evaluated by the organizing team and/or teachers.

A board, at the entrance of the hackathon place, displayed the scores of each team, which will later be converted on a scale from 0 to 10 in order to be added to

**Table 2** Missions/challenges to be accomplished during the hackathon

| | Mission 1 Define the problem | Mission 2 Search for existing solutions | Mission 3 Propose a sustainable solution | Mission 4 Detail the proposed solution | Mission 5 Present the project |
|---|---|---|---|---|---|
| | Name the team | | | | |
| | Elect the leader | | | | |
| | Add the number of WhatsApp and email address | | | | |
| Challenge 1 | Select one or more problems (residuals) from the list | Search the internet for existing solutions for the problem Post the file (in Word or PDF format) on the team drive | Explain what is sustainable development. (consider the triple bottom line) Post the file (in Word or PDF format) on the team drive | Describe the proposed solution in detail Post the file (in Word or PDF format) on the team drive | Fulfill the template "project overview" Post the file (in Word or PDF format) on the team drive |
| Challenge 2 | Register the selected problem(s) | Record a video about the existing solutions | Record a video on the proposed solution | Record a video detailing the proposal | Record a video (pitch) (up to three minutes) of the project presentation and post on the team drive |

(continued)

the project final score: the missions score will act as a 19° juror of the technical jury, therefore scores will account for 5.3% of the project final score. The objective of this game was to make the hackathon more exciting, and help participants to successfully complete each step of the project from beginning to end. It was also expected that they use the mission results (videos, documents etc.) in the final presentation of the project.

**Table 2** (continued)

| | Mission 1 Define the problem | Mission 2 Search for existing solutions | Mission 3 Propose a sustainable solution | Mission 4 Detail the proposed solution | Mission 5 Present the project |
|---|---|---|---|---|---|
| Challenge 3 | Post on the team drive:<br>(1) The selected problem(s), company name and contact<br>(2) The importance of the problem (make a video of up to 3 min)<br>(3) An interview, with the company representative, on the importance of a solution for the problem | Select just one problem and record an interview (up to three minutes) with the company representative. Tell the interviewee about the existing solutions and ask him/her about the positive and negative aspects of he solutions | Present the proposed solution to one of the mentors | Present the proposed solution to potential partners (the company representative etc.)<br>Print email, WhatsApp, text etc. | |
| Challenge 4 | | | | Present the proposal to the hackathon coordinator | |
| Mission Time | 6 h | 16 h | 8 h | 16 h | 8 h |

(continued)

## *3.3 Jury and Awards*

The final projects were evaluated by a technical jury composed by 18 members (10 female, 8 male), nine from academia (seven teachers from PUCPR, one from UFPR and one from UFRGS) and nine from companies/organizations, who rated the projects considering six parameters: (1) innovation; (2) technical and economic viability; (3) attention to social, environmental and economic pillars; (4) impact on society and environment; (5) quality of the solution in the face of the problem; (6) quality of the solution presentation.

**Table 2** (continued)

| | Mission 1 Define the problem | Mission 2 Search for existing solutions | Mission 3 Propose a sustainable solution | Mission 4 Detail the proposed solution | Mission 5 Present the project |
|---|---|---|---|---|---|
| Mission Value | | 1 Green SEEDS (for delivering by the deadline)<br>2 Green SEEDS (for delivering 1 h before the deadline)<br>−1 Green SEEDS (for delivering after the deadline)<br>1 Golden SEEDS (for recording and posting a practical example) | 1 Green SEEDS (for delivering by the deadline)<br>2 Green SEEDS (for delivering 1 h before the deadline)<br>−1 Green SEEDS (for delivering after the deadline)<br>1 Golden SEEDS (for presenting the solution creatively) | 1 Green SEEDS (for delivering by the deadline)<br>2 Green SEEDS (for delivering 1 h before the deadline)<br>−1 Green SEEDS (for delivering after the deadline)<br>1 Golden SEEDS (for the best video from challenge 2 as evaluated by the teachers)<br>Extra Green SEEDS (for the best team name according to the popular vote)<br>Golden SEEDS Media (for the teams that bring a TV channel to cover the hackathon) | |

Each project score was obtained from the average of the six parameters as given by the 18 jurors, and was worth 94.7% of the project final score. The other 5.3% of the final score was the score of the team on the missions' accomplishment. The prizes for the best solutions were: (i) R$ 4000.00 (≅U$1000) for the first-best; (ii) R$ 900.00 (≅U$225) for the second-best; (iii) R$ 600.00 (≅U$150) for the third-best. The technical jury also considered the projects' potential for patent registration and/or startup mentoring. The PUCPR Science and Innovation Agency was responsible for

advising the participants about intellectual-property-rights issues, such as trademarks and patents.

A popular jury, voting on the web through the Seeds Instagram (@nucleo.seeds) also evaluated the projects, and the one with more "likes" won the popular jury category.

### *3.4 Talks/Guest Speakers*

In the opening night of the event, three invited speakers presented three important topics (one on the residuals to be used in the projects, one on social entrepreneurship and the third on the pillars of sustainability and the roots for achieving a circular economy) in order to make it clear the motivation, values and goals of the hackathon. In the night of the second day of the event, two speakers talked about social responsibility in a 4.0 Planet.

### *3.5 Technical and Scientific Support*

Three teachers acted as mentors (focusing on sustainable processes/products, and highlighting the values and attitudes needed for a sustainable society) and companies' representatives gave technical support to participants during the project's development. Social media (Instagram and Twitter) was used to post updates, event photos, and all outcomes. Popular voting (for the best team name and best project) was done through the SEEDS Instagram (@nucleo.seeds). Opening and closing ceremonies, as well as all talks, were held in the auditorium and video recorded with a professional camera. All three days of the event were recorded with cell phones.

### *3.6 Sustainability Hackathon Evaluation*

Participant students, teachers, organizing team and companies/organizations were interviewed about the organization and results of the hackathon.

Students were asked to record a video with their opinion about the event, by answering the questions: How did you like the hackathon? How likely are you to attend a future Sustainability Hackathon? They should also answer a questionnaire with: four open questions: (1) the motives for engaging in the hackathon; (2) what were the expectations; (3) the strong aspects of the event; (4) the weak aspects of the event. A question (5) where they should evaluate the event expectations (below the expectations/reached the expectations/above the expectations); and (6) either or not they would attend a future Sustainability Hackathon (yes/no/I do not know). Seven questions where, on a scale varying from 0 to 10, they should rate: (7) the talks they

attended to; (8) the quality of food; (9) the infrastructure (space, rooms, labs); (10) the technical resources; (11) the organization team; (12) the teachers' mentoring and; (13) the overall event.

## 4 Results and Discussion

The hackathon took place from 6:15 pm October 16 to 9 pm October 18 at the Polytechnic School/PUCPR building, as one of the activities of the Academic Week. As per Table 3, 64 undergraduate students (27 female, 37 male ageing from 18 to 28 years), from the first to the 12° period of 10 courses from PUCPR have registered, but seven did not participate in the hackathon. Therefore, 57 students organized themselves into 11 teams, which selected nine residuals from a list of 31. Table 4 displays the teams' composition, selected residuals, an abstract of each project and their awards.

The questionnaire was answered by 20 (35%) out of the 57 participants: 14 female, six male, 12 from the 10° period, four from the 2° and the others from the 4°, 5°, 7° and 8° periods. Reasons for attending the hackathon varied from personal enrichment (curriculum, experience, knowledge, opportunity for research and innovation, personal growth), the fun of a hackathon (competition, challenges, madness), and the chance to deal with real important problems (sustainability, the challenge of looking for solutions for a real problem, improve the world with innovation). They expected to learn, acquire experience, a moment for immersing in a project they could identify with, networking, teamwork and cooperation, dynamic activities and project development. Some respondents expected something more than they got in the hackathon, something "bigger", with more interesting challenges and interaction, solutions for information technology, and that the teams had more support and recognition. Other

**Table 3** Demographics of the participants of the hackathon

| Course | Male | Female | Total |
|---|---|---|---|
| Industrial engineering | 15 | 16 | 31 |
| Civil engineering | 7 | 6 | 13 |
| Mechanical engineering | 6 | 1 | 7 |
| Software engineering | 4 | | 4 |
| Mechatronics | 2 | 1 | 3 |
| Design | 1 | 1 | 2 |
| Biomedical engineering | | 1 | 1 |
| Computational engineering | 1 | | 1 |
| Computational sciences | 1 | | 1 |
| Pharmacy | | 1 | 1 |
| Total | 37 | 27 | 64 |

**Table 4** Composition of the 11 participating teams, projects' briefing and awards

| Team | Team composition course/period | Selected residual project briefing | Awards |
|---|---|---|---|
| Pegada Sustentavel | 4 Ind Eng/5°, 7°, 10°, 10°, 1 Mecathronics/2° 1 Biom Eng/2° | Mate herb<br>Mate herb will be used as a bactericide. The process was tested in the University lab and proved to be effective | 1° Best project<br>4° with potential for startup mentoring<br>Potential for a patent application |
| Hackathanga | 1 Ind Eng/8°<br>4 Ind Eng/10° | Manipueira (residual from manioc flour), mate herb<br>Manipueira added to mate herb would be transformed into food | 2° Best project<br>Potential for a patent application |
| Raia 4 | 3 Ind Eng/7°, 8°, 10°<br>1 Civil Eng/7°<br>1 Comp Science/7°<br>1 Design/4° | Battery, tonner, LCD screen<br>Marketplace platform for connection and logistics between the source of residuals and their destination. The platform has also a social goal, establishing strategic collect points (churches, schools, hospitals) for battery, tonner, LCD screen etc. therefore involving society in the process | 3° Best project<br>2° with potential for startup mentoring<br>Potential for a patent application |
| Hackathona Matata | 2 Mec Eng/2°<br>2 Mechatronics/2°<br>1 Comp Eng/2°<br>1 Ind Eng/2° | Polyethylene powder, sewage sludge<br>Marketplace platform and app for connecting those who have residuals to those who may use them | 1° with potential for startup mentoring<br>Potential for a patent application |
| Poe | 4 Ind Eng/10°<br>1 Civil Eng/10° | water bottle (20L)<br>Substitution of the water bottles for a delivering system of water by signature. The old bottles will be converted into tanks for collecting rainwater | 3° with potential for startup mentoring<br>Potential for a patent application |
| Retorna | 2 Ind Eng/2°, 10°<br>2 Civil Eng/10°<br>1 Pharmacy/8° | Gardening residuals<br>Gardening residuals will be transformed into paper | Best project for the popular jury |

(continued)

**Table 4** (continued)

| Team | Team composition course/period | Selected residual project briefing | Awards |
|---|---|---|---|
| Mecprod | 2 Ind Eng/10°<br>2 Mec Eng/10°, 12°<br>1 Systems/1° | Manipueira<br>Reduction of residuals by changing the starch and tucupi process | |
| Foguethon | 5 Civil Eng/10° | Sewage sludge<br>Sewage sludge will be used for producing construction bricks | |
| Ecobusters | 3 Software Eng/2°<br>1 Design/2° | Manipueira<br>Heating and pasteurization of the manipueira so it can be used in biotechnology centers, gastronomic centers etc. | |
| Integra | 4 Civil Eng/6°, 8°, 9°, 10° | Polyethylene powder<br>Conversion of polyethylene powder into solid bricks so they can return to the process. | |
| Comep | 3 Ind Eng/2°, 3°, 4°<br>3 Mec Eng/2°, 4°, 10° | Titanium straw<br>Titanium straw will be packed and sold as titanium straw sponge to be used in heavy cleaning. | |

respondents expected exactly what they got, while others were expecting less, a more boring event, what did not happen.

The event exceeded the expectations of four respondents (20%), was below the expectations of other four (20%), and attended the expectations of 12 (60%). Twelve respondents (60%) would attend a future Sustainability Hackathon, one respondent (5%) said "no", and the others did not know if they would attend. The mean score of the hackathon was 7.37 with strong and weak aspects as per Table 5. It is interesting to note that while some respondents did not like the hackathon organization, for others it was a strong aspect. Mean scores of items evaluated in the questionnaire were: quality of food, 8.24; infrastructure, 8.47; technical resources, 7.75; organization team, 7.56; mentoring, 7.85. The scores of the five talks varied from 5.97 to 8.72.

The reported weak aspects related to the missions/challenges dynamics (considered as a burden hampering the project development) were not expected since the intention of the game was to help participants keep track of each project step and reach the goal at the end of the hackathon. The missions asked for the participants to record each project step, so they could use the videos in the final presentation,

**Table 5** Participants' Evaluation of the Sustainability Hackathon

| Strong aspects | Weak aspects |
|---|---|
| Free food | Pizza as basic food |
| Guest speakers and talks | Lack of publicity about the event |
| Competition, teamwork | Ill-prepared security guards |
| Help and support | Organization team |
| Organization | Organization |
| Talks and support | Some aspects of the organization |
| Dynamics | Organization and sudden change of rules |
| Challenges, orientation and method | Stressful missions/challenges and little time for execution |
| Support from excellent teachers | Missions/challenges not well structured |
| Contact with teachers and companies representatives dealing with real problems | Missions/challenges were a waste of time |
| Integration of teachers and companies representatives dealing with real problems | Missions/challenges interrupting the project |
| Good to see the companies' representatives giving their time for supporting the students | Good projects did not win while non-innovative projects got prizes |
| Companies partnership and presence | I did not win |
| Contact with companies | Evaluation criteria are not the ones used in hackathons |
| Dynamic, interesting companies, full support, the overall effort | Difficult to participate while working |
| Relaxing, interesting | Would be better to adequate the activities hours to the working students |
| | Hackathons could be held in the weekend to allow for the participation of the working students |

what was reinforced by the teachers during the mentoring. However, only one team used the material, most of them built a traditional PowerPoint presentation, what consumed time that otherwise could be used for enriching the project.

Other weak points were the time scheduling of the hackathon that was not appropriate for the working students, and the evaluation system (different from traditional hackathons). The technical jury selected the projects for their completeness, innovation, impact on society and applicability potential, but there were complaints about the results. Although they were informed about the judgment criteria, some students did not understand why the teams that did better on the missions (earning more SEEDS stamps) did not win the hackathon. The missions' awards were a bonus for making the hackathon more exciting, but this was not clear enough and generated confusion. It seems that some students put more effort on winning the stamps, which were worth only 1/19 of the final score, than on the quality of the projects that would be evaluated by 18 jurors during the closing ceremony.

"Lack of publicity" was really a problem: it was restricted to Facebook, Instagram, the SEEDS site and emails, explaining why only a few PUCPR students, most from engineering courses, enrolled in the hackathon. As commented by many participants, it would be more challenging and more fruitful if students from other HEIs had participated in the hackathon, what should be pursued in the case of another edition of the event.

What should be highlighted about the results comes from the strong points: the idea behind the event was to introduce the students to real socio-environmental problems, gather them together into teams in order to find solutions in about 50 h with the mentoring of teachers and the support from companies' representatives. Most strong points are related to the engagement of students, teachers and companies during the projects development, confirming that the hackathon reached its goal.

Results from interviews and questionnaires revealed that the hackathon was successful. Students learned from both academic (talks, mentoring) and companies' representatives guidance, and enjoyed the event dynamics. Teachers and companies' representatives were impressed with the students' engagement and overall results and, especially, enthusiastic about the projects with potential for patent application and/or startup mentoring. Despite all the hard work, the organizing team considered a possible second edition of the event, with more publicity for engaging more students from different courses, including the ones from other HEIs.

The Sustainability Hackathon was reported in different media (TV, radio, newspaper, blog, post) from the first to the third day of the event, making it possible to communicate, to the general public, values and attitudes essential to a sustainable society.

## 5 Conclusion

This article presented the planning, execution and evaluation of a gamified hackathon with a focus on socio-environmental problems. During about 50 h, academy and companies gather together to find solutions using residuals that otherwise would be discarded. A game was embedded in the marathon aiming at helping the 57 participant students to organize and complete their projects. The experience showed that this kind of event is engaging, fun and educational, and a useful tool for raising awareness about important and complex topics that students probably will not deal with under a traditional curriculum. It is urgent to engage all society in the sustainability theme since the environment's health depends on society and vice versa.

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# Macroergonomics as a Way for Social Responsibility: A Study in a University Hospital


**Marcia Gemari Derenevich, Rosimeire Sedrez Bitencourt, Osiris Canciglieri Junior, and Victor Wu**

## 1 Introduction

Organizations have sought sustainability, not only because of the positive marketing it can make, but to attend the demands of a society that has been understanding the need for sustainable development and its relationship with private initiatives (Evangelista 2010). This trend can be evidenced in the relationship between industrial developments, which mark and modify how society behaves, and changes in the concepts of sustainable development and also, in the characteristics of work and well-being of humans.

The first industrial revolution was marked by the use of energy transformations in favour of humans and the unbridled use of nature and its resources. There were some conservationist movements in the United States concerning with the excessive use of these resources. At the end of this period, the term Ergonomics (from the Greek term ergon = work and nomos = natural laws) emerges from Jastrzebowski (1857), although there was still no concern about the worker as an individual in society because, as well as natural resources, the human being was (and still is)

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seen as an endless resource (Oliveira 2013). Ergonomics is the science that studies the interactions between the human and other elements of a system, and it aims to improve well-being and systems performance (International Ergonomics Association 2020).

The second industrial revolution brought reflections about how the development of organizations impacts on nature and humans, which started to be discussed in the third industrial revolution. Local movements in favour of the environment became common and were organized in NGOs, and economic development started to be seen as the opposite of environmental preservation. Physical ergonomics, that mainly deals with biomechanical issues related to the workplace, begins to be discussed, and the term Social Responsibility was evoked. In 1972, the UN Stockholm Conference took place and sustainability, expressed as eco-development, was defined by Sachs (1986, p. 113) as "the socially desirable, economically viable and ecologically prudent development". A year later, in what is now known as the Brundtland Report, Sustainable Development was conceptualized as "the use of resources to meet the needs of the present without compromising the ability of future generations to meet their own needs" (CMMAD 1991, p. 46), bringing into play the social and environmental interdependence. At this point, ergonomics was in its third evolutionary phase, known as cognitive, incorporating the cognitive aspects that influence work performance, as a result of the evolution in computers and demand for attention. More recently, in Agenda 21, the human being was allocated in the centre of sustainable development: it is necessary to consider people and their social, economic and environmental conditions. For corporations, based on the study by Bolis et al. (2014), the workers are important stakeholders, and should be considered central to their sustainable strategies, seeking for economic improvements and well-being. The historical evolution of ergonomics and sustainable development is shown in Fig. 1, based on Hendrick and Kleiner (2002).

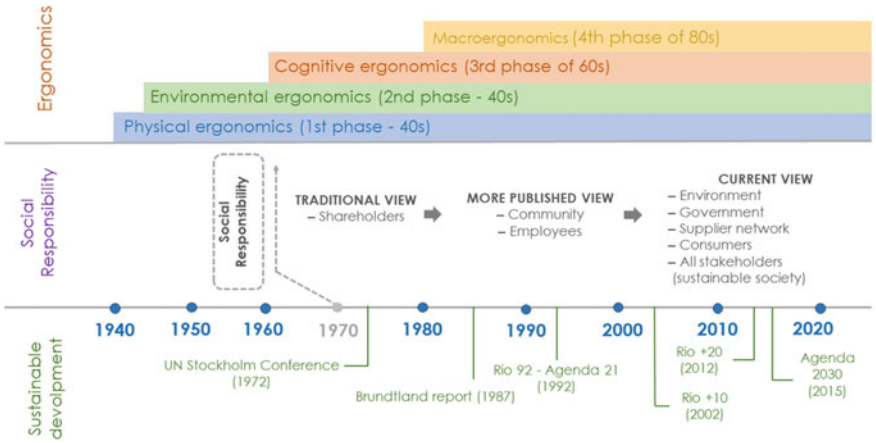



**Fig. 1** Timeline of ergonomics and sustainable development

Nowadays, social responsibility is an issue considered by organizations for achieving a sustainable work system, which suggests an interrelation between sustainability and work organization. Social responsibility is the legal and moral commitment that a company has towards the society. In promoting the well-being, quality of life and health of its stakeholders, whether internal (employees of the organization) or external (customers, suppliers, etc.) as well as the benefits of investing in social responsibility, it goes beyond profits, favoring the society as a whole (Salaiz et al. 2019; Moraes et al. 2017). The relationship between social responsibility and ergonomics is the promotion of the well-being and health of an organization's stakeholders.

Hendrick proposed the sociotechnical system evaluation as a way to achieve ergonomics goals and Macroergonomics, an approach using the sociotechnical model and participatory ergonomics (which considers the active involvement/participation of the stakeholders during the entire process of an ergonomic analysis or interventions) to improve system's performance and human well-being in the organization, what is being proved to be true by empirical studies (e.g. Derenevich 2017).

Guimarães (2004), based on Hendrick and Kleiner (2001), described the sociotechnical system of work, represented in Fig. 2, with three subsystems: technological, personal and work, that interacts with the external environment. The technological subsystem comprises production technology (unitary, continuous or mass), knowledge technology, which refers to the variability of knowledge requirements and procedures available for the execution of a given task, and integration with the workflow. The personal subsystem comprises the degree of professionalism/training,

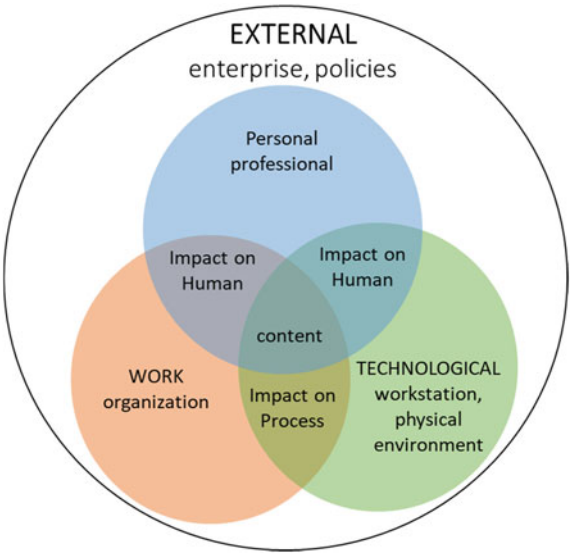



**Fig. 2** Socio-technical system representation

demographic factors and psychosocial factors. The work subsystem refers to the organization of the company. Finally, the external environment is geared by the ability to adapt to the environment, and is related to governmental factors, laws and public policies, among others, which generate uncertainties to the internal environment.

Macroergonomics can contribute to the implementation of Social Responsibility practice in organizations, generating indicators for the measurement of human well-being. Therefore, this article presents a macroergonomics intervention in the ambulatory of a university hospital.

## 2 Method

This is an applied macroergonomics research focusing on social responsibility with a case study, which took place in a university hospital of Brazil. The research was carried out using the Macroergonomic Work Analysis—MA (Análise Macroergonômica do Trabalho—AMT) proposed by Guimarães (2002), which consists of six steps, as described in Table 1.

The sociotechnical model and the ergonomic work demands constitute the EBCORE (Ambiental, Biomecânico, Cognitivo, Organizacional, Risco e Empresa—ABCORE) components (constructs) of the MA model: environmental, biomechanical, cognitive, organizational, risk and enterprise. Those constructs are detailed in Table 2, and may be used as indicators for comparison in future analysis, after changes are implemented. The indicators are also a reference for Social Responsibility, given that they can suggest factors of human well-being and compromise to the enterprise.

This research followed steps 1 to 4 of MA, from the beginning of the implementation until the proposal of solutions. The Project, registered in the Brazilian Ethical Committee under the number CAAE 85967618.4.0000.0020, was launched in 2018. The first step was explaining to the employees that the research aimed at improving the work environment and system performance, and ensuring that the collected data would be kept confidential. The employees were informed that the intervention could lead to their own well-being at work. At the second step of MA, researchers started conducting the interviews with 10% of workers of each sector (administrative and nursing), as it's defined by MA, totaling six interviews.

A semi-structured interview was conducted with one person from each sector (a total of six employees), with the following question: "Tell me about your work: what do you do? What are the positive things about it? And the negative things?" The results were used as basis for the development of three questionnaires: the first (a) evaluates the work satisfaction, where they should rate, by marking on a continuous 15 cm scale going from 'not satisfied' (0) to 'very satisfied' (15), questions involving work environment, work organization and enterprise; and from 'not at all' (0) to 'too much' (15) for questions about cognitive load and pain; the second questionnaire (b) assesses the importance of the evaluated items presented in the questionnaire a, in a scale of 'not important' (0) to 'very important' (15). The last questionnaire (c) was concerned of cognitive load and risk factors, as pain and discomfort. All employees

**Table 1** Steps of the macroergonomic work analysis (MA)—based on Guimarães (2002)

| Steps | Action | Objective or attended result |
|---|---|---|
| 1. Project launch | • Discuss ideas with the company's ergonomics committee and/or stakeholders<br>• Define the project schedule<br>• Clear up doubts about the actions to be taken | • Explain the study to participants, as well as its importance<br>• Definition and validation of Project schedule |
| 2. Initial survey | • Investigate the general work situation<br>• Identify problems (interviews, questionnaires)<br>• Identify, describe and evaluate the type and scope of the problem<br>• List ergonomic demands in order of priority | • Process map<br>• Problem identification<br>• Results of interviews and questionnaires<br>• Ergonomics demands list |
| 3. Diagnosis | • Generate a diagnosis based on the ergonomic demands list<br>• Propose a preliminary action plan to solve the found problems | • Main risk activities under observation<br>• Microergonomic analysis |
| 4. Proposal for Solutions | • Propose solutions<br>• Construction of a list of design items to be considered in the ergonomic design of the workplace and work system<br>• Determinate the strength of the relationship between ergonomic demand items and design items<br>• Ergonomic treatment of design items | • Solutions proposa<br>• Improvement project |
| 5. Validation | • Analyze possible changes<br>• Simulate environmental changes at the organization<br>• Validate proposals based on the analysis of the simulated changes of activities in a real work situation | • Validated project—ready for implementation;<br>• Impressions and improvements of simulation |
| 6. Repport | • Write up ergonomic analyses and the proposal;<br>• Systems optimization | • Final Ergonomic report |

(except the manager) from the nursing (25% of the total) and administrative team (75%) were invited to answer the questionnaires.

**Table 2** Description of the ABCORE constructs

| | |
|---|---|
| A—Environmental | Noise, temperature, lighting, vibrations, air quality |
| B—Biomechanical | Posture, physical effort, workspace, machinery, equipment and tools, workplace conditions |
| C—Cognitive | Mental demand, information processing, memory, attention and decision making |
| O—Organizational | Relationship with managers and colleagues, management characteristics, work pace |
| R—Risk | Complaints, pain, dangerous work, the safety of equipment and tools |
| E—Enterprise and External Environment | Internal and external company policy, external environment that affects the company |

The answers to the questionnaires were tabulated numerically, and the importance and satisfaction of each item of EBCORE were correlated, generating the prioritization of the ergonomic demand items (EDIs). These EDIs were described, and an analysis of the consequences of ergonomic risks was outlined based on the literature.

The interviews showed that employees like what they do and that they understand their work as a way to help patients. This point of view is part of the culture transmitted by middle management.

## 3 Contextualization of the Case Study

The macroergonomic analysis was carried out at the ambulatory of a university hospital, which receives patients from the public sector, precisely from the Healthcare Unified System from Brazil (Sistema Único de Saúde)—SUS. In general, the patients of this hospital have low income and the ambulatory receives about 600 patients per week, in different specialties. The hospital has two different and distant locations, one for urgency and emergency care and the other, the ambulatory, for patients in need of specific treatment with specialists, or for those who need attendance after surgeries done in urgency and emergency situations by the main hospital. Patients for kidney transplant are also attended by the main hospital and the ambulatory.

The clinic operates from Monday to Friday during business hours, and receives doctors and medical students from the teaching hospital, which provide care to patients. The fixed employees work into two teams: administrative (reception, kidney transplant, support and audit) and nursing. It is the ambulatory's responsibility, among others, to monitor kidney transplant patients, receive and guide patients who come for appointments, confirm and schedule appointments and exams, performing procedures and others to assist doctors, maintain rooms and spaces prepared for care.

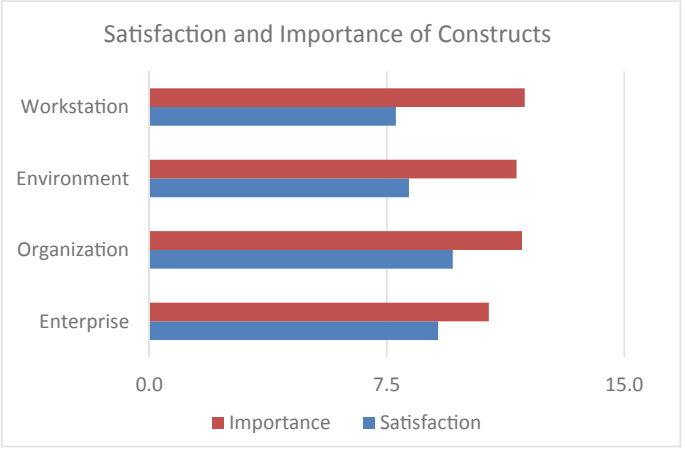
Employees interact with each other to carry out their work, and in some functions they need to communicate with the main hospital, for example, to request patient documentation, confirm availability for exams, monitor kidney transplant patients.

The agility of the support sectors directly impacts medical care, and the way to receive and care for patients impacts the care satisfaction indicators.

## 4 Results

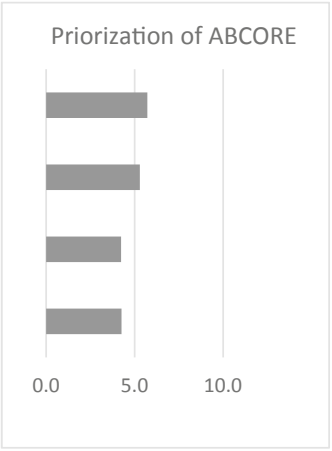
At the first phase, researchers explained employees about the intervention, and they agreed and signed the term of research participation. The results of the application of the MA phase 2, showed that employees like what they do and that they understand their work as a way to help patients. This point of view is part of the culture transmitted by the middle management. Information from the interviews was tabulated and provided information for the development of the questionnaires for the next step of MA. Those questionnaires were applied to all 24 workers. Final results of each EDI/construct were obtained from the average rating of the 24 employees. It is observed, on Fraphics 1 and 2, that the Workstation (Biomechanics) construct has a higher priority for the workers that interviewed six employees provided information for the development of the questionnaires for the next phase.

When analyzing the results on workstation satisfaction (Graph. 3 and 4), it is observed that employees are dissatisfied with the quality of the hardware and software they use to perform their work. The problem is external to the clinic, as SUS has different platforms for each type of request, and these platforms do not interact with each other. During informal conversations, workers revealed that as there are several interfaces, it is difficult to learn to use each one of them, which generates errors in their daily activities. According to the management, a digital interface for communication between these platforms would be implemented, improving the workers' performance and satisfaction.



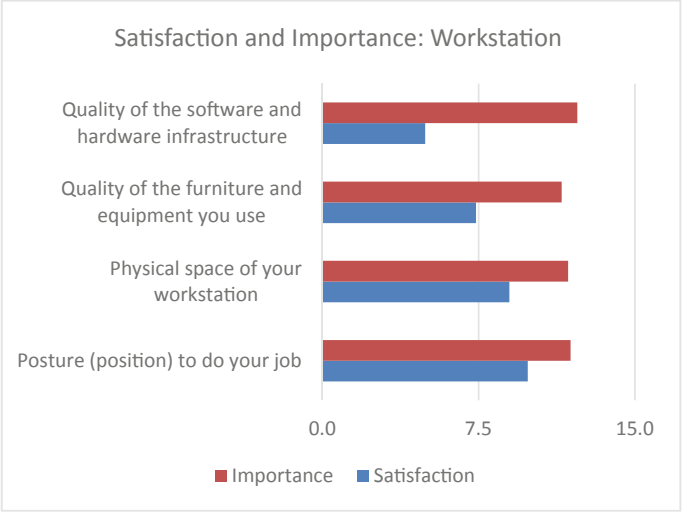

**Graph 1** Relation between satisfaction and importance of the analyzed sector

**Graph 2** Prioritization between the constructs of EBCORE

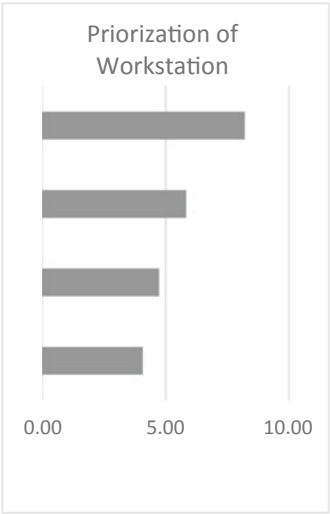



Regarding furniture and equipment, some workstations can be adjusted to anthropometric measures (adjustable chairs, wrist support, screen adjustment), but there was no training on what would be the appropriate height of the computer screen, or how to use the available ergonomic devices, what is important for employees from the administrative team, whose work is mostly static in front of a desk. For the nursing team, the resting rooms are not adequate. It doesn't have chairs enough and the existing ones are not anatomic.

The environment construct is the second priority. As it is shown on Graphics 5 and 6, the noise at the hospital bothers the employees. The sources of this noise are




**Graph 3** Relation between satisfaction and importance of the construct workstation

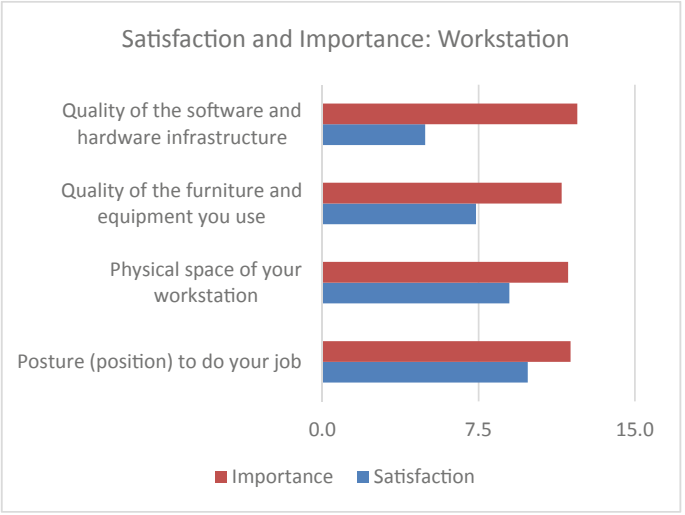



**Graph 4** Prioritization between the questions of workstation

diverse: patient talk, television (installed to distract patients who are very stressed due to service delay), and noise of the password call, among others. On the day of the week with the lowest volume of patients, and therefore the lowest noise levels, the values indicated by the Decibel meter reached 82 dB. According to Brazilian legislation, the noise level considered healthy is between 70 and 85 dB for a long duration (or continuous). Besides, in order for the patient to understand speech, the patient must speak 20 dB louder than the local noise, which either overlaps the health recommendations, or interferes with care, causing the masking of the voice and making it impossible to understand what the patient says. The place has equipment that emits a loud BIP to call patients by password, and it can cause the employees to be deconcentrated. Temperature is also a nuisance for employees. The space does not get much ventilation, and on hot days, the old building heats a lot. There is no air conditioning on site. The questionnaire was applied in early spring.

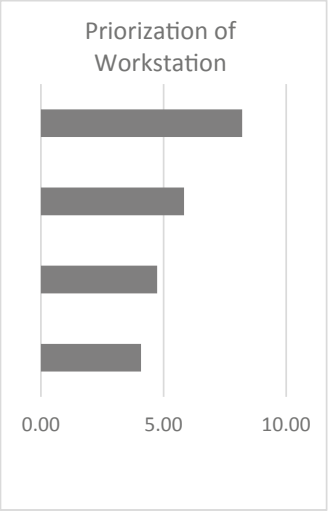
The EDI (which is part of the construct enterprise) which generates more dissatisfaction to all employees, as presented in Graphics 7 and 8, is the location of the restaurant. Employees do not have a cafeteria on site, but an improvised pantry with little circulation space. As a result, they need to walk 900 m. on streets with irregular pavement and risk of accidents, in order to reach the institution's cafeteria/restaurant. Lunch time is 60 min, and employees lose a third of that time (20 min) on the walk. Such difficulty favours the non-use of Personal Protective Equipment (PPE), since the safety shoe, closed and made of rubber, makes walking difficult. Clinic management took the issue to the responsible departments, but they claimed that, legally, they have to provide food vouchers when the restaurants are 1 km away, which is not the case.

In the organization construct, there is dissatisfaction with the number of patients to be attended, which is higher than the employees' capacity. In SUS hospitals of the




**Graph 5** Relation between satisfaction and importance of the construct environment

**Graph 6** Prioritization between the questions of environment




entire Brazilian territory, the demand is often much higher than the supply capacity, a problem that reinforces the need to apply methodologies for improving the country's health sector performance. It is a social responsibility problem at the national level since it can compromise the population well-being.

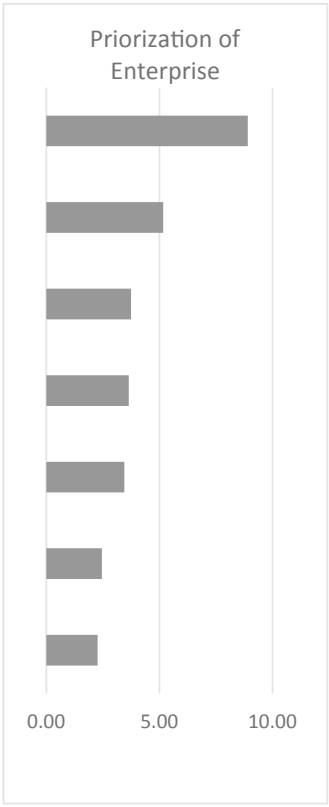
The analysis of cognitive factors, presented in Graphic 11, reveals cognitive overload, especially concerning work responsibility and required attention. The hospital environment is challenging, and dealing with patients in pain and discomfort is, in


**Graph 7** Relation between satisfaction and importance of EDIs from the construct enterprise

itself, stressful. At the same time, dynamism, sense of job security and appreciation are positive factors. According to the management, in order to assist employees in continuous improvement, they were invited to make an evaluation box. This box resulted in compliments made by patients, and these simple solutions have brought positive impacts to the organization.

The analysis of pain and discomfort showed differences between the two evaluated teams as can be depicted from Graphics 12 and 13, and therefore, they were analyzed separately. In the case of nursing, dissatisfaction was observed concerning pain with an index greater than 7.5, which qualifies for immediate intervention to reduce pain in the lower limbs: legs and feet. The work of this team is dynamic, demanding continuous standing and walking during 80% of the time, i.e. they spend a total of 7 h and 12 min in movement throughout the workday.

The employees from the administrative sector face opposite problems: their static work requires 90% of the time in a sitting position; therefore, they feel discomfort in the back as a consequence of the adoption of inadequate postures, exhausting routines and stress, which often cause contraction of muscles in the upper region.

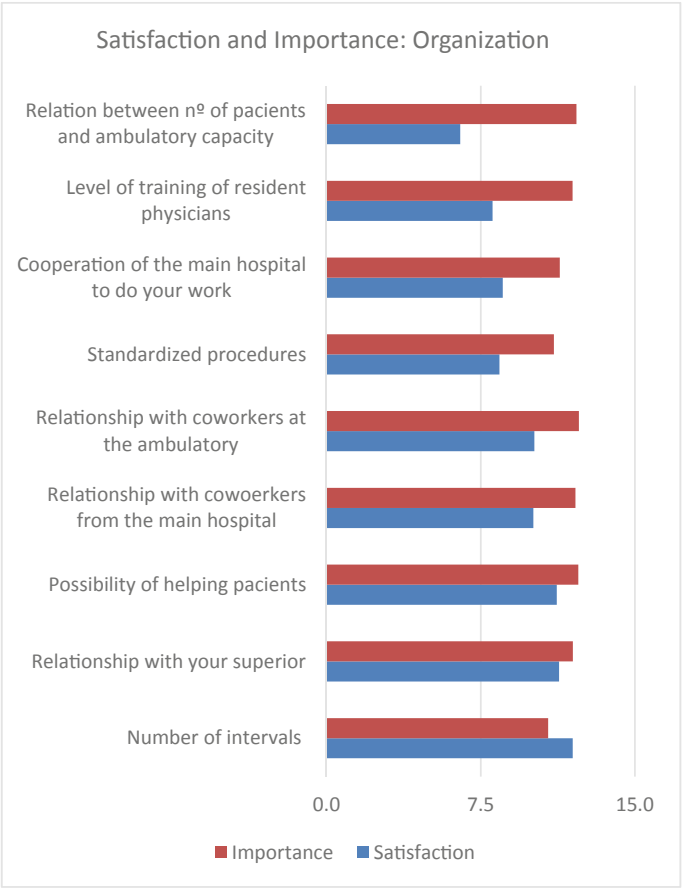



**Graph 8** Prioritization between the questions of enterprise

Nurses experience greater discomfort regarding temperature. In an informal conversation, they commented that it is a requirement to wear what they call pajamas, a white uniform made of little breathable and slightly transparent material, in addition to the lab coat. Due to the transparency, some wear clothes below this uniform, which justifies the greater sensation of heat. Once again, the verbalizations about pain/discomfort included complaints regarding the distance from the restaurant (the clinic's location is far from restaurants), and the route to get there is irregular, with unevenness that hinders the transfer and cause eventual injuries to the employees.

MA proved to be an assertive prioritization method and, based on the result, other ergonomics tools can be used for workplace analysis. It is suggested, for example, RULA, to identify the main causes of discomfort in the administrative sector. For the nursing sector, it was proposed to monitor the activities with the spaghetti diagram, which allows visualizing the waste in the process, and in this case, the wear and tear caused by excessive walking.

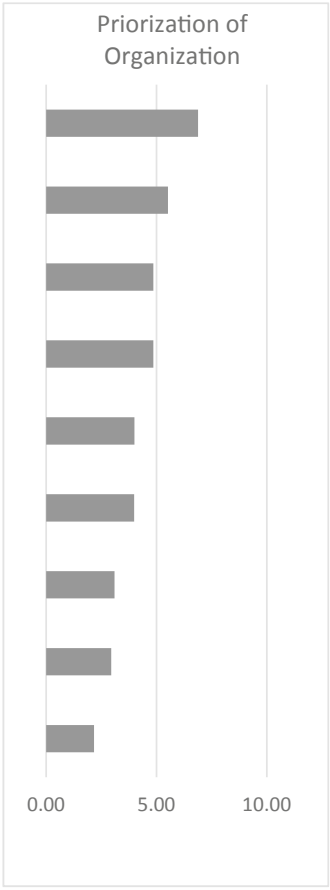
Giving the socio-technical system, the technical subsystem was approached by analyzing the workplace, in which noise, as well as hardware and software technologies, were considered as main problems. In the work subsystem, it was observed that




**Graph 9** Relation between satisfaction and importance of the construct organization

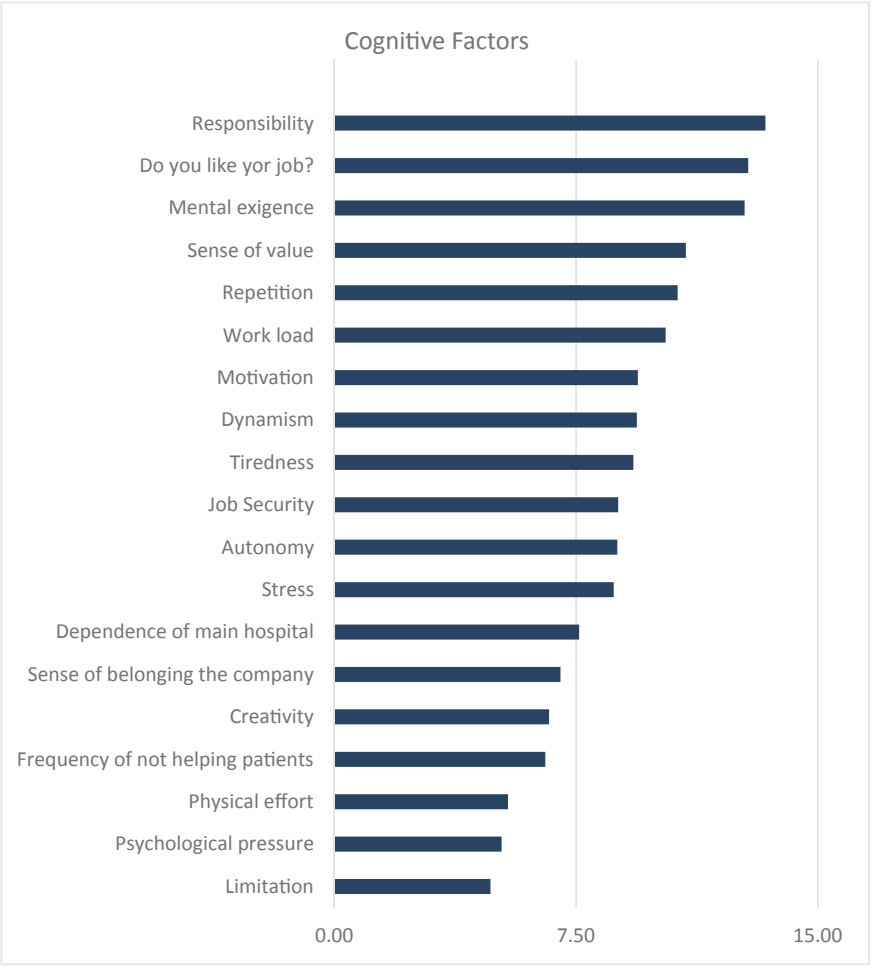
there is work overload and cognitive analysis showed that work is repetitive and tiring, requiring too much mental effort. In the personal subsystem, psychosocial characteristics and employees' pains and complaints were observed. The evaluation of the external environment involves dissatisfaction with the location of the restaurant, something that although allowed by law, causes discomfort and dissatisfaction.

By dismembering the definition of a company' social responsibility, as presented in the introduction of this article, it can be listed: legal commitment, moral commitment, promotion of well-being, health promotion, promotion of quality of life, internal public and external public. As can be derived from this application of MA, the legal commitment is achieved by adapting to the requirements of ergonomics, appropriate work to the human being, provided for in Regulatory Standard 17. Moral commitment can be translated into listening to the speech and respect for employees.




**Graph 10** Prioritization between the questions of organization

Promotion of well-being and health are a consequence of the implementation of solutions that lead to improvements when the factors that generate dissatisfaction are known. Quality of life is the result of a satisfactory work environment. The internal public is the hospital employees, the main beneficiaries of possible future solutions, and also the company, which will gain from better employees' performance as a result of work improvements. Finally, the external public is favoured, as disease indicators may drop with the implementation of ergonomics in organizations. Improvement of the system's performance may enable higher quality care for patients in the public health care sector.



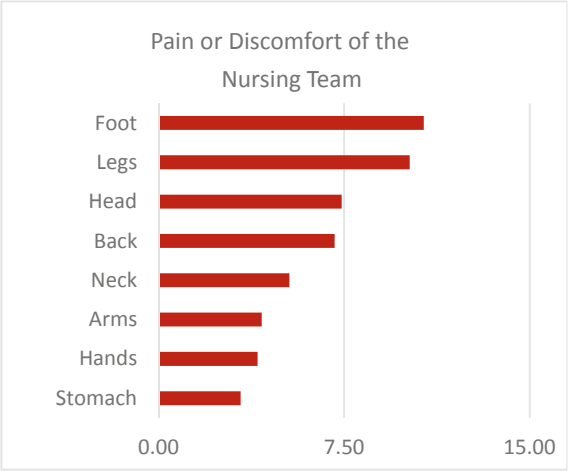

**Graph 11** Expression of cognitive factors

## 5 Conclusion

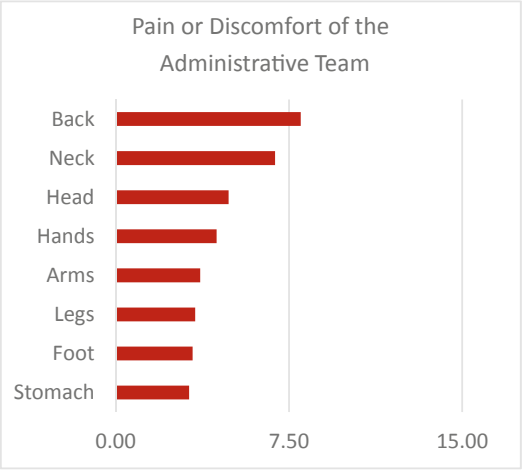
Social Responsibility is one of the ways of how companies act to contribute to sustainable development. One way of meeting social responsibility is by improving the well-being of internal and external stakeholders. This work applied a macroergonomics method as a means to contribute to an organization's social responsibility. It was observed that there is work dissatisfaction, mainly with the tools used to carry out the activities as well as the location of the restaurant.

Issues related to the improvement of work and human well-being, which lead to improved company performance, are part of the scope of the Corporate Social Responsibility and can be identified and evaluated by applying the MA method. The

**Graph 12** Expression of pain or discomfort among the nursing team




**Graph 13** Expression of pain or discomfort among administrative team




participatory approach allowed the identification socio-technical factors related to an ambulatory work system. Another benefit of this method is to enable the creation of indicators, which are essential to support management and the monitoring of the progress of improvement actions that may be implemented, through in-depth analysis. Indicators allow a better understanding of the complex sociotechnical scenario that permeates the public health organization. Problems that may impact both the well-being of employees and the quality of patient care were correlated. The MA method brings management and employees closer together, translating their needs into indicators and correlating the impact of their pain, discomfort and dissatisfaction on productivity.

This article was limited to steps1 to 4 of the MA method. According to the premise of participatory ergonomics, a solution's proposal must take into consideration all those involved, ensuring the best solution from the point of view of both employees and organization. It is suggested to propose improvements together with employees, management and ergonomics team. Engineering and other ergonomics tools can help find optimal solutions by identifying the root cause of the highlighted problems. MA acts in the social aspect of sustainable development, contemplating social responsibility, and, considering the economic aspect, applications of macroergonomics can improve systems performance.

Finally, this study continuity is important in order to analyze possible changes; simulate environmental changes at the organization and validate proposals based on the analysis of the simulated changes of activities in a real work situation, what corresponds to the fifth step of MA. Then, move to the sixth step, writing up the ergonomic analysis report, the proposal of solutions to promote the optimization of systems performance, with the collaboration of the ambulatory team. In order to meet the tripod of sustainable development, the ecological aspect should be considered in these solutions.

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# Social Responsibility in a University Hospital: An Application with a Socio-Technical Focus


**Camilla Buttura Chrusciak, Cristoffer Rodrigues Poncini, Rosimeire Sedrez Bitencourt, and Osiris Canciglieri Junior**

## 1 Introduction: The Contribution of Social Responsibility to Sustainable Development

Organizations are increasingly looking for differentials that keep them in the market. The increasing globalization and expansion of knowledge make consumers more demanding for quality products and for companies that seek not only profit but a commitment to society, constantly seeking Sustainable Development [SD] (Garcia 2017).

SD is important for organizations as they all directly impact the environment, whether social, environmental or economic, in which they operate, generating a greater need for sustainable management. According to Elkington (2001), sustainability is the balance between the environmental, economic and social pillars. For that reason, to engage in the search for sustainable management and development, organizations need to adopt practices that contribute to the effectiveness of the improvement actions and impact reductions, but always thinking about adding value to their customers and not only in the profitability (Garcia 2017).

Regarding the social pillar, the movement in favor of organizational social responsibility deserves mention. A company concerned with sustainability must respect its

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employees and offer good working conditions as well as human well-being, flexibility, fair remuneration, benefits, inclusion and diversity among others (Ferreira 2019).

One of the areas that has been concerned with human well-being and the better performance of the organization's system as a whole is Ergonomics, which according to Chrusciak et al. (2019 *apud* Storey and Rea 1987) is "a set of concepts that help to maximize the design of the interaction between human beings and machines, systems, working methods, and environments while taking into account the physical security, mental capacity and the productive potential of the same workers", and that in its macro focus considers the socio-technical system. A socio-technical analysis seeks to contribute to the understanding of the interactions between the external and internal environment of the organization, and how adjustments are made to meet the demands of these interactions. One method that considers the socio-technical system as one of its premises is the Macroergonomic Work Analysis [MA], proposed by Guimarães (2002), that aims to identify, monitor and change any situations that compromise the quality of life at work and which can become a risk to workers' health and a source of reduced productivity.

Studies as Leite et al. (2019) point out that MA provides the possibility of finding a relationship between the cognitive ergonomic demands and the physical pain stated by workers, which would need immediate intervention as they are a risk for the worker's health. Poncini et al. (2019) show that the application of MA revealed that the high temperature and lack of ventilation in the workplace could cause greater muscle fatigue, dehydration, physical tiredness, and stress, being a source productivity reduction.

Another premise of MA is the participatory approach, which proposes the participation of workers in all moments of studies and ergonomic interventions. According to Nagamachi (1996), "if people in the organization participate in decision-making, they are able to experience the use of their skills and judgment". As a result, this kind of situation provides people with a sense of responsibility and commitment to the organization. Studies by Leite et al. (2019) and Poncini et al. (2019) point out the importance and effectiveness of employee participation in the application of MA, presenting more realistic results regarding the employee situation.

On the other hand, there are still few publications that present the benefits of applying macroergonomics in a participatory way. Guimarães et al. (2019) present an overview of academic publications in Brazil in ergonomics and demonstrate that the practical application of ergonomics is small, and considering its macro approach, it is even less.

Thus, this research aims to contribute scientifically to the area by presenting an application of a method of a socio-technical and participatory character, MA, proposing improvements to the work system and the implementation of social responsibility.

## 2 Sustainable Development

Sustainable development is a process of transformation in which the exploration of resources, the direction of investments, the orientation of technological development and institutional change are harmonized and reinforces the present and future potential to meet human needs (Estender and Pitta 2008). For Elkington (2001), even with the formulated concept, the idea of sustainable development was understood as the harmony between the financial and environmental issues. Many companies adhered to this concept, as they believed that it was a challenge of making business more efficient and reducing costs.

According to Elkington (2001), in the late 1990, ten years after the Brundtland Commission where the report "Our Common Future" was published, it was realized that only the resolution of environmental issues—which so worried society and the organizational environment—would not solve the problems of a sustainable global economy, it would be necessary to reach other means to achieve sustainability.

> Those Who Think that Sustainability is Only a Matter of Pollution Control Are Missing the Bigger Picture (Hart 2005)

## 3 Social Responsibility

For some decades, the topic of social responsibility has been the subject of numerous debates in the academic and business world (Serpa and Fourneau 2007). However, over the years, there has been a transformation in the concept itself—from a concept previously based on charity and altruism to an association between social responsibility and business strategy (Smith 1994). In other words, acting as a society-transforming organization has come to be considered by companies an important source of competitive advantage.

For Donaire (1999), the concept of social responsibility of organizations concerns "the economic, legal, ethical and social expectations that society expects companies to meet, in a given period". In this way, the role of the company in relation to society must encompass both economic development and participation in the social and environmental context, seeking improvements in the living conditions of the population (Buffara and Pereira 2003).

Social responsibility brings several direct and indirect benefits to all stakeholders. Thus, adherence to social responsibility only shows the respect and commitment of companies so that their clients, employees and community have a fairer society. The actions designed and applied to development will reflect not only on those directly benefited from them, but also on the companies' growth and revenue.

## 4 Socio-Technical Systems and Macroergonomic Work Analysis

An organization's social system includes the human beings who work there, with all their psychological and social characteristics such as values, education, and needs. The technical system includes all the tools, techniques, devices, methods, procedures and knowledge used by members of the organization to perceive inputs, transform inputs into outputs. One of the basic precepts of the socio-technical theory states that the design and implementation of a system require the joint consideration of social and technological aspects, which must be treated as interdependent (Clegg 2000).

The socio-technical perspective, in conjunction with macro-economic interventions, which according to Hendrick (2003) is an approach to socio-technical systems, brings benefits to companies. Reducing the error rate is one of these benefits since it is associated with increased productivity, decreased number of accidents, injuries, personal injuries and damage to equipment. Other benefits can be included in this context such as reduced turnover, reduced absenteeism, reduced maintenance time, significant increases in productivity, among others.

One way to obtain these benefits is through the Macroergonomic Work Analysis method, proposed by Guimarães (2002), which consists of a method of ergonomic action with a participatory approach. This method helps to identify, monitor and change any situations that compromise the quality of life at work, which can become a risk to the worker's health and a source of reduced productivity. MA can be considered a sociotechnical methodology because it uses the participatory process throughout the study, involving users and it also uses in its methodology the ABCORE constructs [A—environment; B—biomechanics/workstation; C—work content; O—work organization; R—risk; E—enterprise]. These constructs allow the evaluation of the most diverse factors that involve work, mainly social and technical factors, main aspects of the socio-technical approach (Guimarães 2002). This evaluation takes place through quantitative data that are the result of the analysis of qualitative data obtained in a participatory way.

## 5 Quality of Life and Satisfaction at Work

The evaluation of a working system is based on the ability to adapt work to man and man to work (Guérin et al. 1997). One of the aspects that interferes with the ability to adapt is job satisfaction, which according to Fischer and Paraguay (1989), refers to integration, autonomy, motivation, involvement and the use of physical and mental capacities.

According to Locke (1976), job satisfaction is an emotional state because emotion derives from the assessment of the individual's values, and because it is an emotional state, satisfaction has two phenomena: joy (satisfaction) and suffering, displeasure (dissatisfaction). Although the author reports that job satisfaction is an individual

phenomenon, he emphasizes that the causal factors can be classified into two major groups: (a) events and conditions of work (work itself, payment, promotion, recognition, working conditions, workplace) and (b) labor agents (colleagues and subordinates, supervisors, company/organization), pointing out that the causal factors must be analyzed in their interrelationships. The author also states that job satisfaction can have consequences for both the individual and the organization, affecting behavioral aspects and the physical and mental health of the worker.

Some of these consequences can be seen in the works of Bauk (1985), O'Driscoll and Beehr (2000), Wright and Cropanzano (2000), and Rahman and Sem (1987). For Bauk (1985), factors that contribute to the increase in stress and job dissatisfaction are the lack of knowledge about opportunities for progress and promotion at work and the excessive workload.

According to O'Driscoll and Beehr (2000), the causes of job dissatisfaction are related to factors such as job stability, salary, and benefits, social relationship at work, relationship with the boss, physical and mental workload, perspective of career, physical work environment, work routine (variety/monotony), challenges at work, autonomy and opportunity for professional development.

The study of Wright and Cropanzano (2000) shows that good social relationships in the workplace and the boss had a statistically significant association with job satisfaction. The authors Rahman and Sem (1987) address the issue of absenteeism and state that absenteeism is lower among those who have greater job satisfaction.

According to the above, the factors involved in job satisfaction are diverse, deserving more studies so that alternatives and solutions can be created. According to Martinez (2002), one should not ignore individual differences and perceptions as they determine job satisfaction and are inserted in a historical and cultural context, which have values and opportunities. There is, therefore, not a single determining factor for satisfaction; these factors depend on the environment and working conditions, as well as the personal assessment of the worker but identifying them is crucial for effective job satisfaction improvement programs.

## 6 Method

### *6.1 Methodological Procedures*

This is an applied macroergonomics research, using Macroergonomic Work Analysis [MA], which consists of five phases: Phase 0—Launch of the project (explanation to the workers of the project's objective, phases, methods and techniques that will be used); Phase 1—Macroergonomic Appreciation, which is an exploratory phase that comprises the initial mapping of the company's macroergonomic problems; Phase 2—Macroergonomic Analysis or Diagnosis (deepening and prioritizing the problems raised in the assessment), consists of mapping the Ergonomic Demand Items [EDI's]); Phase 3—Macroergonomic Design; Phase 4—Evaluation or Validation

of the implemented proposals. It should be noted that this article is limited to the presentation of Phases 0 and 1.

## 7 Collection of Data

The methodology used for data collection followed the phases described in the stages of the MA. Initially, the researchers situated the participants on the importance and purpose of the research (Phase 0). The assessment phase (Phase 1) consisted of an initial survey with the direct participation of employees, based on interviews and questionnaires. The open interview allowed the collection of items of ergonomic demand from a sample of 6 employees. Questions were made in a non-induced way and recorded with the interviewees' authorization.

Based on the prioritization of these items, structured questionnaires were developed based on the EDI's ranking and were answered by marking an "X" on a continuous 15 cm scale, with two anchors, one at the beginning and one at the end of the line (as shown in Annex 1). Then, it was applied to a sample of 13 employees (from a total of 15 employees) of the hygiene sector of a university hospital in the city of Curitiba/PR—Brazil, to evaluate the level of satisfaction, importance, and pain. A value was obtained from the arithmetic mean of the responses of the entire sample of employees for each item evaluated. In this way, it was possible to tabulate the data through graphs in order of priority. Finally, to assess the reliability and stability of the data collected through the questionnaires, since these are answered individually and by non-staggered measurement, a statistical study was carried out using Cronbach's Alpha coefficient to verify the internal consistency through the magnitude correlated items (Cronbach 1951).

## 8 The Context

The study was conducted in a university hospital, 100% public service, with private philanthropic management. The group that manages the hospital has its values focused on the love of work, family spirit, sustainability and solidarity that culminate in social responsibility. The hospital has as expertise the surgical procedures of trauma, orthopedics, and neurology and receives patients who are brought in by integrated medical system of urgency and emergency care. It consists of the Emergency Room, Intensive Care Unit [ICU], Surgical Center, hospitalization, laboratory, pharmacies for internal use, among others. Therefore, a hygiene team is necessary to keep the environment sterile and clean, with a team of 15 professionals divided into two intercalated shifts (morning and night). This team has been showing a high turnover and absenteeism rate of 2.7 and 2.2 people per month, which corresponds to a total of 20% of the monthly workforce. These problems cause work overload,

dissatisfaction, and low productivity, which are worrisome factors for the hospital management.

## 9 Results: Application of MA

The project started in Phase 0, which consisted of explaining to the workers the purpose of the project, its phases, methods, and techniques that will be used. Following, Phase 1 consisted of understanding and mapping the system's macro-economic problems.

This survey was conducted directly, through the participation of employees, and indirectly, by incorporating the opinion of 2 experts and 2 researchers. Direct observation is followed by three steps, based on the Macroergonomic Design [DM] defined by Fogliatto and Guimarães (1999). The first step is user identification and organized collection of information from a representative sample of users (collection of the user's voice through non-induced interviews); the second is the prioritization of the EDI's identified by the user and finally the incorporation of the experts' opinion on the questionnaires. The indirect survey was carried out with researchers' visits at different periods in both shifts and scales in the hospital, where it was possible to analyze and identify problems related to the environment and job, considering the conditions of the environment, work organization and general aspects of the company.

For the initial collection of information, interviews were held with 6 employees who clean the place. Then, the positive and negative points mentioned by the interviewees were analyzed and listed in the order they were mentioned.

In this stage, three surveys were prepared. The first one was related to the employee's satisfaction considering environmental, biomechanics, work content, work organization, risk, and enterprise aspects. The second survey was developed based on the model proposed by Guimarães (2000) (from the Body Part Discomfort method of Corlett and Bishop (1976)), which seeks to analyze in detail the discomfort and pain in employees, considering anthropometric differences, such as age.

The third and last survey was prepared based on the first questionnaire, where the importance of some environmental, biomechanical and business items for employees was analyzed.

The three survey were applied to a sample of 13 people, from a total of 15 employees. Afterward, each questionnaire was tabulated individually, and the results were classified by constructs the following ABCORE classification (environmental, biomechanics, work content, work organization, risks, and enterprise) and subjected to statistical analysis, using Cronbach's Alpha coefficient, for each set of questions. The consistency of the responses is shown in Table 1.

Cronbach's Alpha coefficient showed values greater than 0.6, which represents data stability and reliability. After the results were recorded and classified, as proposed by the MA, the degree of prioritization of each of the requirements was calculated, considering the assessment of satisfaction and importance, obtained

**Table 1** Cronbach's Alpha. *Source* Authors, 2020

| Construct | Cronbach's Alpha |
|---|---|
| General | 0,955,399,954 |
| Environment | 0,818,716,897 |
| Biomechanics | 0,875,334,319 |
| Work content | 0,608,543,986 |
| Work organization | 0,890,322,714 |
| Risk | 0,633,263,394 |
| Enterprise | 0,877,536,043 |

through the questionnaires. The formula used to obtain this priority indicator is indicated in (1). The formula considers the divergence between the results of satisfaction and the importance of the factors evaluated by the respondents, so, the greater the divergence, the greater the priority.

$$Priority = \frac{((15 - satisfaction) * importance)}{15} \quad (1)$$

From the prioritization formula, a graph was elaborated, allowing a better interpretation of the results for the constructs A—environment, B—biomechanics, O—work organization and E—enterprise, as presented in Fig. 1.

In general, the analysis of Fig. 1 showed that is possible to identify a high priority in the "enterprise" construct because there was a difference between the satisfaction and importance assessment for employees in this area, that is, at the same time that they evaluate some criteria as important, they feel dissatisfied with the way their work is and their workplace, which leads to a high rate of prioritization. Then, the graphs were elaborated for each ABCORE factor to explore each of the constructs. The results of the environmental factor are shown in Fig. 2.

Based on Fig. 2, it was possible to identify that the highest priority item in the "environment" construct is air quality. The reasons for these results are unknown,

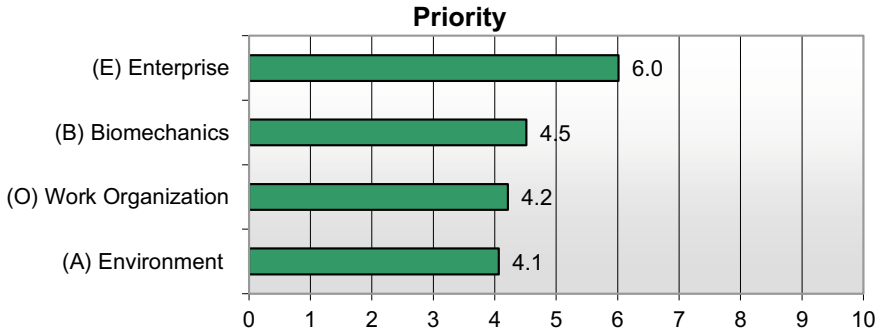


**Fig. 1** Priorities by construct. *Source* Authors, 2020

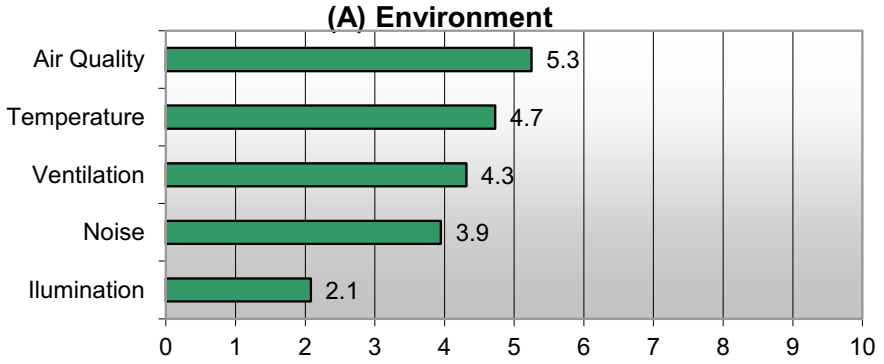


**Fig. 2** Priorities for the environment. *Source* Authors, 2020

requiring further investigation, which will be carried out at the diagnosis stage. Next, the results for the biomechanical factor is presented in Fig. 3.

Based on Fig. 3, it is possible to identify that the items with the highest priority are (a) material dimensions, which refers to the weight and dimensions of the materials used at work, such as trolleys, buckets, brooms, among others, and (b) posture, which refers to the position to get the job done. Employees often need to be in a squat position for a long time or reach very high places, maintaining positions that can cause bodily harm to them.

Regarding cognitive aspects, the survey was applied to measure only how employees evaluate the characteristics of their functions. In this case, the scale used was 0 (little) and 15 (much). The results are shown in Fig. 4.

In the analysis of Fig. 4, it can be concluded that the work of the hospital's hygiene team has a high workload, is stressful, tiring, it requires a lot of responsibility, demands high physical effort, it is repetitive and, consequently, monotonous.

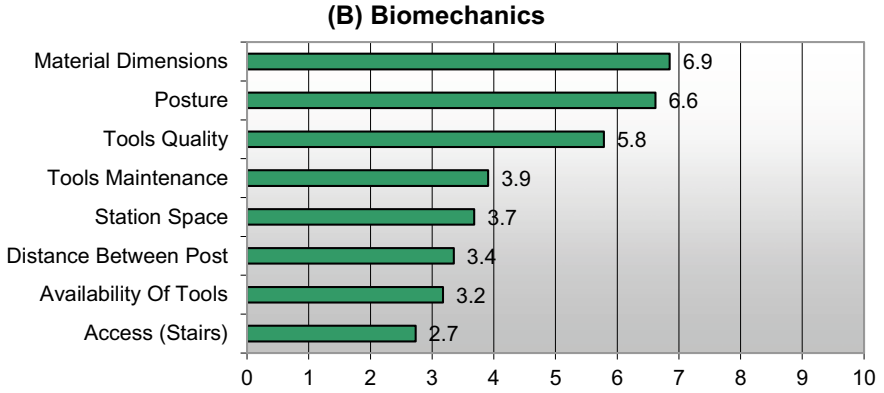


**Fig. 3** Priorities for biomechanics. *Source* Authors, 2020

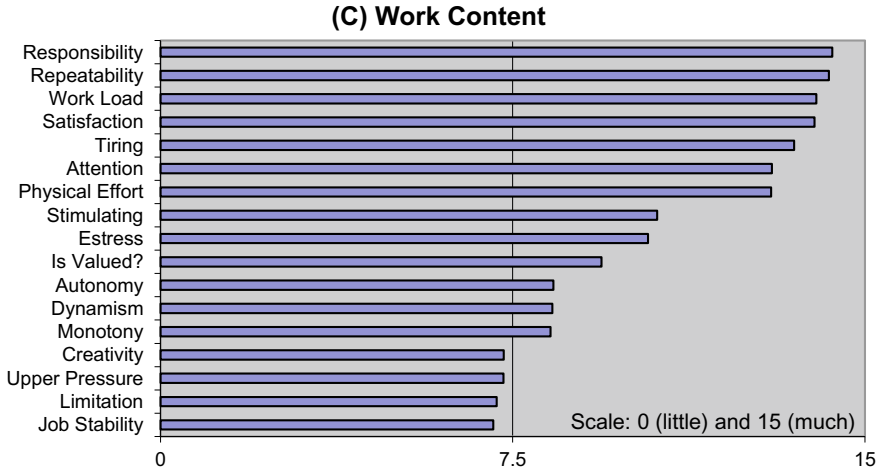


**Fig. 4** Evaluation of cognitive factors. *Source* Authors, 2020

Employees considered that they still do not feel safe in their jobs, this means that the guarantee of having a job is unstable.

Figure 5 shows the results of the assessment of the organizational factor, which evaluates items such as cooperation from co-workers, relationships with the different levels (doctors, nurses, bosses and function colleagues) and the number of people available to clean the place.

Based on Fig. 5, it is possible to identify that the item with the highest priority is "quantity of people to perform", this means that the number of people is low for the number of tasks required from the team. This item emphasizes the workload of employees, which can also be identified in Fig. 4 under "workload". The work

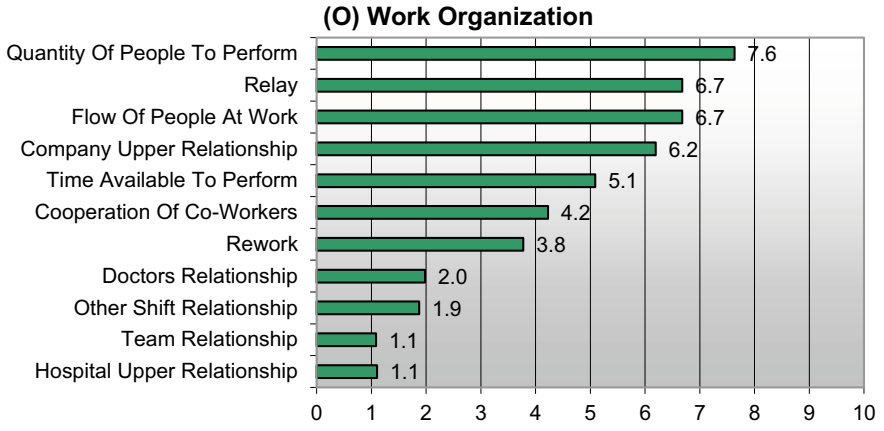


**Fig. 5** Priorities for work organization. *Source* Authors, 2020

overload and other related items are linked to the high turnover, absenteeism, and rework, which are the main causes of the low productivity and demotivation of employees (Iida 2005).

The next evaluated construct was the risks. For this evaluation, the method of Corlett and Bishop adapted by Guimarães (2002) was used as basis. It evaluates the intensity of pain in each part of the body on a scale from 0 to 8. The results are shown in Fig. 6.

In Fig. 6, it is possible to identify the regions that the employees experience most of the pain. According to Guimarães (2002), results above 4 are the ones with the highest Repetitive Strain Injury [RSI] risk, requiring immediate intervention, but in this study, no immediate intervention pain was identified. Thus, the regions of the upper trunk (left and right shoulder) and right wrist are the parts that the employees most complained of discomfort. According to Iida (2005), pain in the upper limbs, especially in the shoulders, is directly related to stress. This link can be confirmed by analyzing the stress factor in Fig. 4, which showed a high rate of dissatisfaction.

The last, the "enterprise" construct evaluates issues related to the company such as promotion, security, salary, among others. Figure 7 shows the results obtained for this group of constructs.

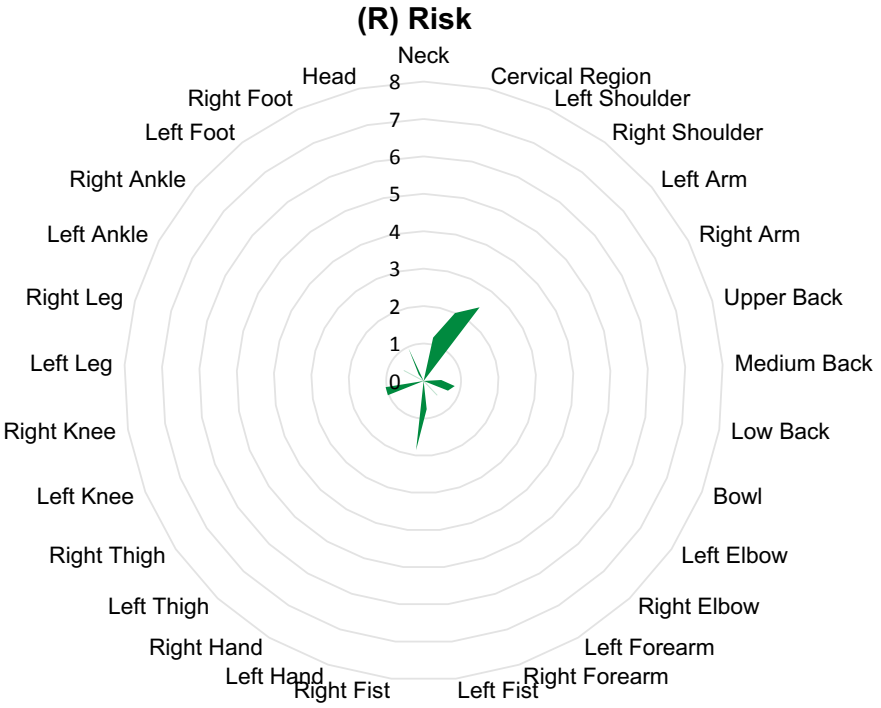


**Fig. 6** Intensity of pain. *Source* Authors, 2020

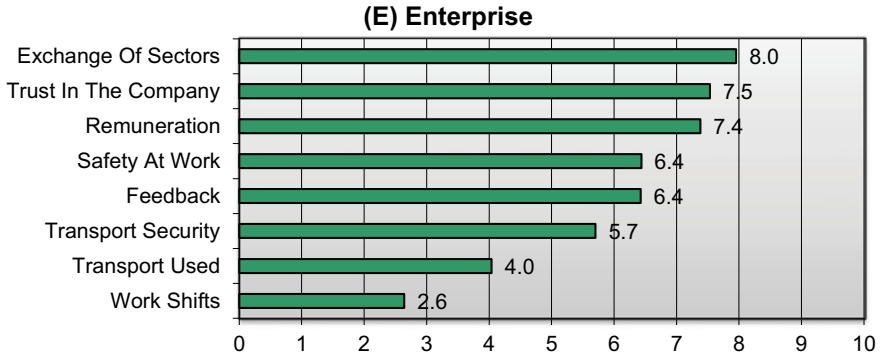


**Fig. 7** Importance and satisfaction with the enterprise. *Source* Authors, 2020

In Fig. 7, the item of highest priority is dissatisfaction regarding the change of sectors and promotions carried out in the company. Dissatisfaction was also presented concerning the company's confidence in them, in the sense of remaining employed, and regarding the salary and benefits.

Therefore, the data presented for all ABCORE constructs fully consider both the internal and external, direct and indirect perspectives of the work system. As a result, it can be concluded that the work of the hygiene team is tiring, stressful, repetitive and monotonous.

According to Guimarães (2002) tiredness, or fatigue, one of the main factors that contribute to reducing productivity due to the decrease in the capacity of the human organism. This is caused by a complex set of cumulative factors: Physiological factors (intensity and duration of physical and mental work) Psychological factors (repetitiveness, monotony, and others), Environmental factors (lighting, noise, and others) and social factors (relationship with co-workers) and higher).

Stressful work, according to Iida (2005), starts to influence work performance, reducing productivity and quality, and may also increase the risks of accidents, absenteeism and worker turnover. The causes are diverse and can cite pressure, high responsibility, feelings of inability to meet demands, inability to obtain the resources or support necessary to carry out the work, excessive heat, exaggerated noise, pressure from superiors, wages, career, schedule among others.

Grandjean (1981) approaches in his studies monotonous work as a complex mental state that presents physical and mental symptoms, such as lethargy, fatigue, decreased alertness and increased reactivity time, thus contributing to lower productivity. Guimarães (2002) shows that some circumstances favor the state of boredom as repetitive work, associated with a low level of difficulty and prolonged activities.

## 10 Conclusion: The Contribution of MA for Social Responsibility

With this study, it was possible to conclude that the Macroergonomic Work Analysis (MA) contributes to social responsibility because it covers both the perspective of the system's performance and human well-being. The methodology promotes indicators, transforming subjective aspects into quantitative ones, which allow better management of the main factors that make up an organization, to optimize the interaction of man with work, improving the system mutually and uniformly.

This research brought an initial perspective on the problems presented in the work of the hygiene team of the studied hospital, in addition to identifying which were the most critical points from the employee's point of view. It was also concluded that the work in the hospital is very dynamic and has particularities by sectors, shifts, and scales. Also, the incorporation of the method presented in the organization's social responsibility strategy.

Finally, the research will continue following the next steps of the MA method to implement improvements, as well as investigate environmental issues related to the ecological aspect, seeking to contribute to sustainable development in the company.

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# Annex 1

**Survey to assess employees' perception of current working conditions**

**Dear friend!**

This questionnaire is not mandatory, but your opinion about your work is VERY IMPORTANT. Please answer the survey following the example, marking an X at any point on the scale, in the answer that best represents your opinion.

*Do not put your name on the questionnaire. The information is confidential.*

**EXAMPLE**

**0. Company football team**

Dissatisfied X Satisfied

*Mark your SATISFACTION on the scale regarding the following questions:*

1. **Temperature of your workplace**

dissatisfied satisfied

2. **Ventilation of your workplace**

dissatisfied satisfied

3. **Air quality at your workplace** (clean air, smell of products, …)

dissatisfied satisfied

4. **Noise level in your workplace**

dissatisfied satisfied

5. **Illumination at your workplace**

dissatisfied satisfied

6. **Quality of the furniture, tools and equipment you use to do your job**

dissatisfied satisfied

7. **Posture you need to stay to do your job**

dissatisfied satisfied

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# Use of GIS to Estimate Socioeconomic Losses Caused by Urban Floods: A Tool for Improving Disaster Management


**Gabriel Troyan Rodrigues and Edilberto Nunes de Moura**

## 1 Introduction

Floods are the types of disasters that most occur in Brazil, with 58% of the total registered events, and an estimated loss of 9 billion dollars, considering the period between the years 1900 and 2015 (OFDA/CRED 2015). Despite this scenario, flood loss assessments in Brazil are still carried out using information forms about the disaster. This is a time-consuming and subjective method, which leads to inaccurate assessments and results aimed at post-disaster actions instead of preventing and mitigating the event.

The estimation of economic damage from flooding is gaining great importance as flood risk management is becoming the dominant approach to flood control policies on the European continent (Merz et al. 2010).

Studies by Dutta et al. (2006) on flood impacts in urban and rural environment in the Ichinomiya River basin in Japan, used a model based on Geographic Information System (GIS) to estimate economic losses before and after the implementation of a flood control plan. And the results pointed to a reduction of up to 70% in damages, due to the implementation of those control actions.

The mapping of areas susceptible to flooding is a resource that has been gaining prominence in the reading and understanding of floods, which, if properly used, can minimize the resulting impacts. Another important tool is flood alert systems, which combine meteorological, hydrological and hydraulic models to anticipate knowledge

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about flood waves and reduce the impacts of these events. For this reason, it is considered of great importance for urban planning, modeling and simulation of these events, which occur in natural or artificial drainage channels, as well as the analysis of interactions with the surrounding plains (Cabral et al. 2016).

GIS have been successfully applied in mapping areas vulnerable to floods and floods, and in assessing their impacts. The integration between hydrological and/or hydraulic models to the GIS, is being used in an increasing way in the last years, especially in mapping of flood areas, be it in urban or rural areas, due to the potential that this tool presents in data integration of different types and formats (Cabral et al. 2016).

This work presents the procedures for integrating hydrological, hydraulic data of an urban river with the terrain relief, and urban occupation structures. And for that, computational tools for hydrodynamic modeling of rivers and channels, associated with a GIS, were used.

The objective of the article is to create flood scenarios with subsequent estimation of damage caused by such an event within the study area.

It is believed that this procedure can be adopted as a support in the design of risk maps, ensuring resources in the planning of emergencies, responses to the disaster and indicative of the losses more quickly and less subjectivity.

## 2 Literature Review

The simulation of floods performed by the interaction of hydrological, hydraulic modeling and the Geographic Information System (GIS), proved through several studies the possibility of developing a methodology for mapping floods in urban basins, based on digital data, satellite images and a network of monitoring sensors.

Most of the works are carried out for case studies in the locations of the countries of Europe and the United States, where the precision of modeling is currently discussed and the most suitable for application, among which the articles stand out: Horritt and Bates (2002), Knebl et al. (2005) and Cook and Merwade (2009).

In Brazil, the absence of a range of works and studies referring to flood simulations is noted, however, it is possible to mention some works developed, such as those by Monteiro (2015), Monte et al. (2016), Cabral et al. (2016), Moura and Rozelle (2019).

In the construction of the flood spot simulation model, three integrated computational tools were used, the GIS ArcGIS®, HEC-HAS and HEC-GeoRAS.

HEC-GeoRAS is a set of procedures, tools and utilities for processing geospatial data in ArcGIS. It is an extension tool of the HEC-RAS, programmed by the Hydrologic Engineer Center, belonging to the Department of the Fire Department of the United States of America.

Despite being an extension tool for HEC-RAS, the program is compatible with ArcGIS. HEC-GeoRAS allows the creation, manipulation and preparation of geometric data for easy export to HEC-RAS.

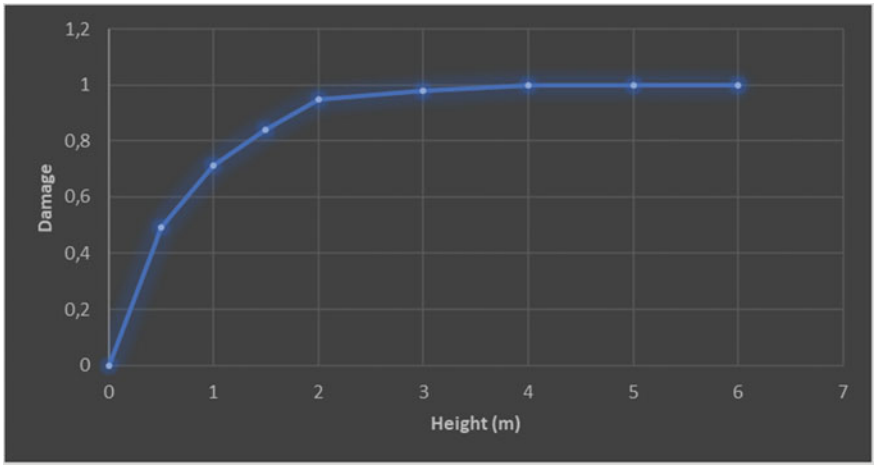


**Fig. 1** Average residential damage curve for Brazil. *Source* Adapted from Huizinga et al. 2017

HEC-HAS uses hydraulic and hydrological data from a watercourse and simulates its one-dimensional flow. With the product, the flood spot of the study area, which is exported to the GIS, facilitating its visualization and overlap with data from urban occupation structures. And from there, be able to estimate the losses due to the flood event.

In order to measure the damage caused by floods, the European Union encouraged the development of a methodology for the development of a globally consistent database of damage curves in relation to the maximum height of the water, enabling the comparison between countries and supranational assessments, since the methodology also contemplates the possibility of converting the currency of the affected country into euros (Huizinga et al. 2017).

This data set contains damage curves that represent the fractional damage function in relation to the height of the water, as well as the maximum damage values for a variety of land use and occupation classes.

Among the various curves made available by the referred methodology, for the present work only the average damage curve for a residence in Brazil was adopted. They are illustrated by Fig. 1.

From the damage measured according to the water altimetry, the methodology makes it possible to estimate the economic loss in relation to the affected area ($m^2$) of the households.

## 3 Methodology

The area under study is the Ribeirão dos Padilhas Hydrographic Basin (Fig. 2). It is a sub-basin of the Iguaçu River, which has its geopolitical location in the southern

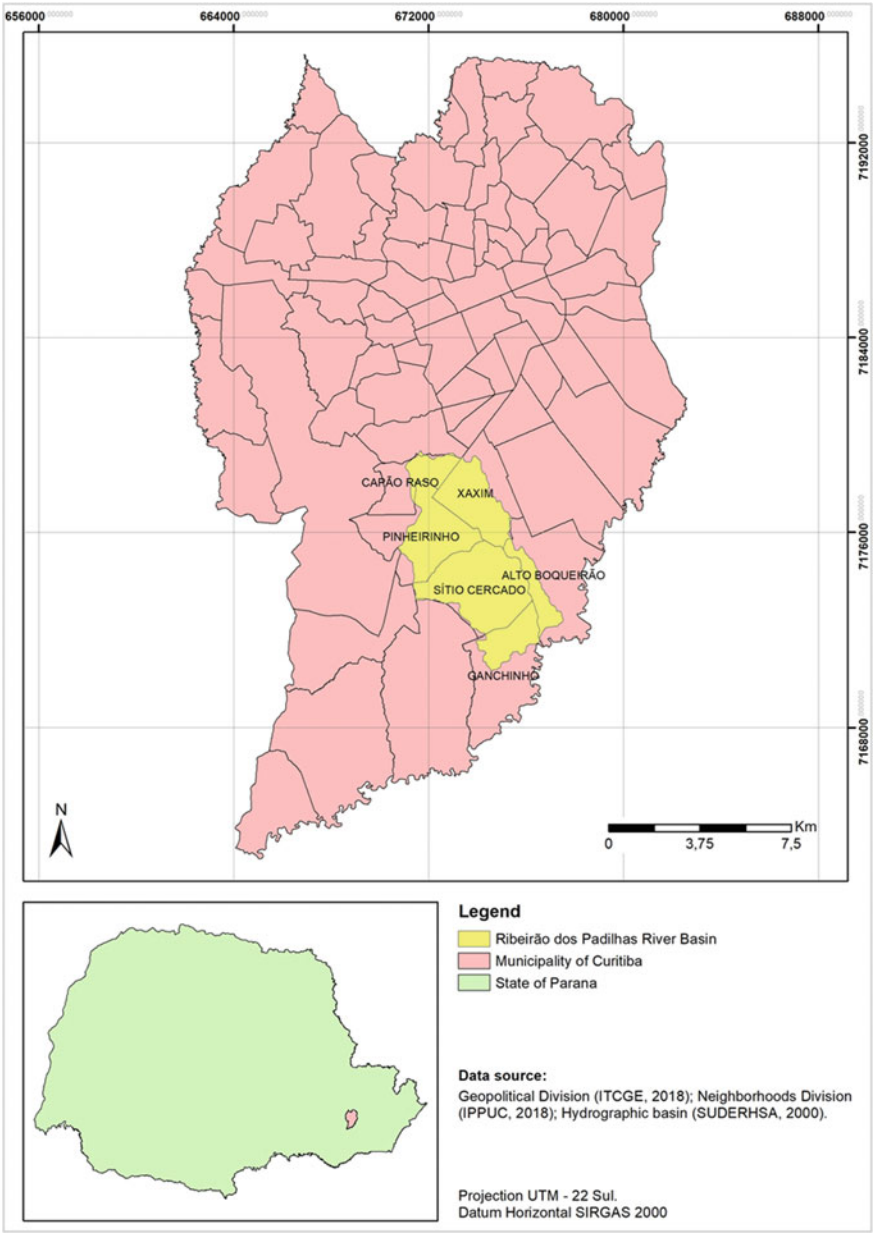


**Fig. 2** Location of the Ribeirão dos Padilhas Hydrographic Basin. *Source* (ITCG 2018), IPPUC (2018), Suderhsa (2000), modified by the author

region of the city of Curitiba (PR). The main water body in the basin is Ribeirão dos Padilhas. It was chosen because it is the body that receives rainwater from the hydrographic basin and because it covers a large part of its extension in the open, contradicting the reality of water bodies in urban centers.

## *3.1 Hydrological and Hydraulic Study*

To estimate the flow of the water body in question, historical data on the intensity, duration, frequency and distribution of rainfall across the hydrographic basin were used, over a period of ten years (2008–2018), obtained on the Internet portal of the Instituto das Waters of Paraná. It is also noteworthy to carry out an on-site visit to the Hydrographic Basin and to monitor the entire length of Ribeirão dos Padilhas to observe the water drainage channel and its surroundings for the adoption of parameters used in the computational modeling equations.

Thus, the hydraulic study was carried out to determine the peak flow, the Concentration Time (Kirpich and Ribeiro methods), the Surface Flow coefficient and the Full Flow (Rational Method and I-pai-wu Method), considering a recurrence time of 100 years, thus portraying the worst situation to be faced (TUCCI 2007).

The peak flow adopted was 186.50 $m^3/s$, for a concentration time of 166.54 min. Also noteworthy is the calculation of the superficial runoff of the Canal, which according to Arcement and Schneider (1989), it is possible to determine the roughness coefficient based on Cowan's equation (1956), resulting in the coefficients of 0.037 for channel stretches (channeled totally or partially) and 0.084 stretches of plain (natural runoff).

## *3.2 Computational Procedures*

The geopolitical division data of the municipality (IPPUC 2018), the hydrological cartography data and the Digital Elevation Model (Suderhsa 2000) used in this work were all acquired in vector format, which facilitated their organization and processing. They were initially manipulated in the GIS ArcGIS®, with the objective of organizing the information related to the Hydrographic Basin and grouping them in a single spatial reference system.

The next step involved the use of the HEC-GeoRAS software, a set of procedures, tools and computational utilities for processing hydraulic and hydrological data with geospatial reference and integrated in ArcGIS®. The HEC-GeoRAS is used to draw the geometry of the water flow structures in the rivers and channels of the study area, and thus can be worked on later in the simulation of this flow in a computational environment of the HEC-RAS.

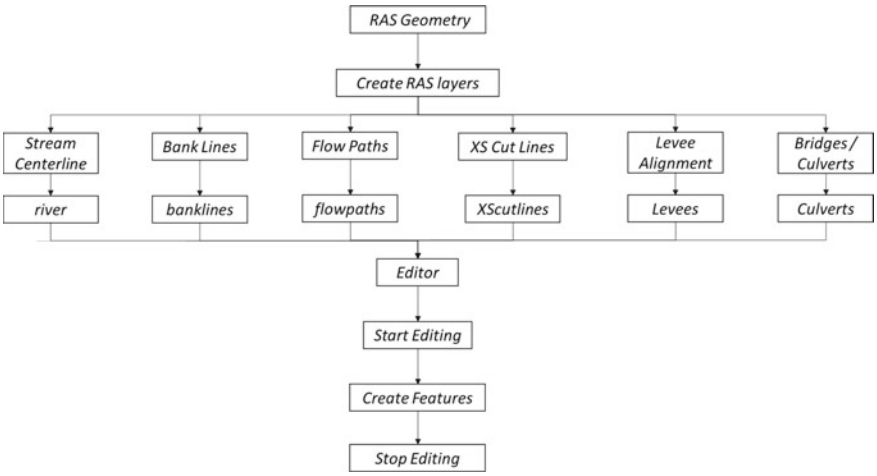


**Fig. 3** Construction of Geometry in Hec-GeoRAS. *Source* The authors

The geometry is composed by the course of the water body, flow direction, design of the cross-sectional sections of the water runoff channels and possible obstructions of the runoff flow.

It's Fig. 3 shows the organization of the steps that comprise the creation of the geometry of the water flow structures in the study area.

After finalizing the manual creation of vector data, it was necessary to integrate these data with the Digital Elevation Model, which represents the relief of the study area. And so, being able to produce the elevation points in the terrain through which the flow of water from the river flows and other information. From there, the data was exported to HEC-RAS.

The work at HEC-RAS begins with the treatment of data from that geometry, where it is possible to adjust the cross sections of the drainage channel and flow obstructions in order to increase the accuracy of the simulation results. It also allows the inclusion of hydrological and hydraulic data previously calculated according to the sections and stretches of the water drainage structures.

It is noteworthy that in addition to the flood spot, the HEC-RAS also generates hydrographs to facilitate the visualization of the user along the propagation path of the water flow and the behavior of this flow by flow section. Another advantage of this type of information is the ease of viewing important information such as peak flows, water level in the river and the time it takes for this flow to reach each section of the channel.

It's Fig. 5 illustrates all stages of the work that were carried out at HEC-HAS.

At the end of the simulation in HEC-RAS, the spot was exported again to ArcGIS, due to the software capacity that allows the elaboration of the geospatial map, and the intersection of the flood spot with the other data.

In the present work, the designed spot will be used to superimpose the urban subdivision of Curitiba in order to assess the height of the flood in the affected lots.

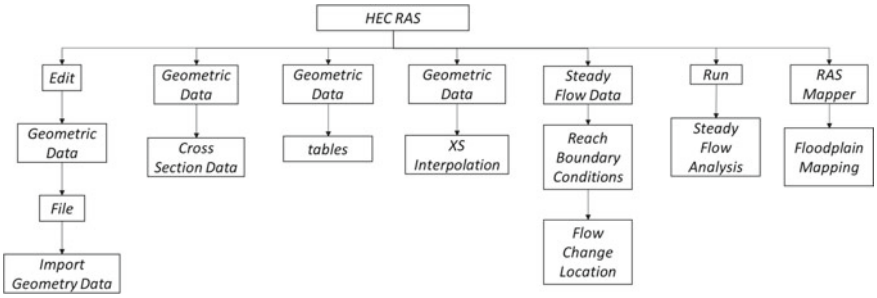


**Fig. 5** Development and execution of the flood spot simulation project with the HEC-RAS program. *Source* The authors

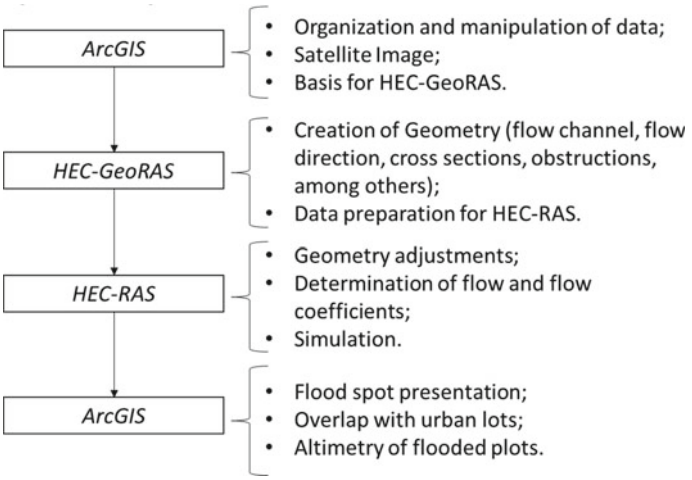


**Fig. 6** Flow diagram of the flood spot simulation. *Source* The authors

Finally, in order to demonstrate the work done, Fig. 6 presents the constructive stages of computational simulation.

## 4 Results

The HEC-RAS has a limited graphical capacity, and as described in the previous steps, the flood spot is shown in the GIS ArcGIS, where water heights can be observed throughout the flood spot (Fig. 7).

The results obtained from the created flood spot are highlighted, as well as the precision obtained using the Digital Elevation Model (DEM).

- Flood Area—1,019,216.39 $m^2$ (with the drainage area);

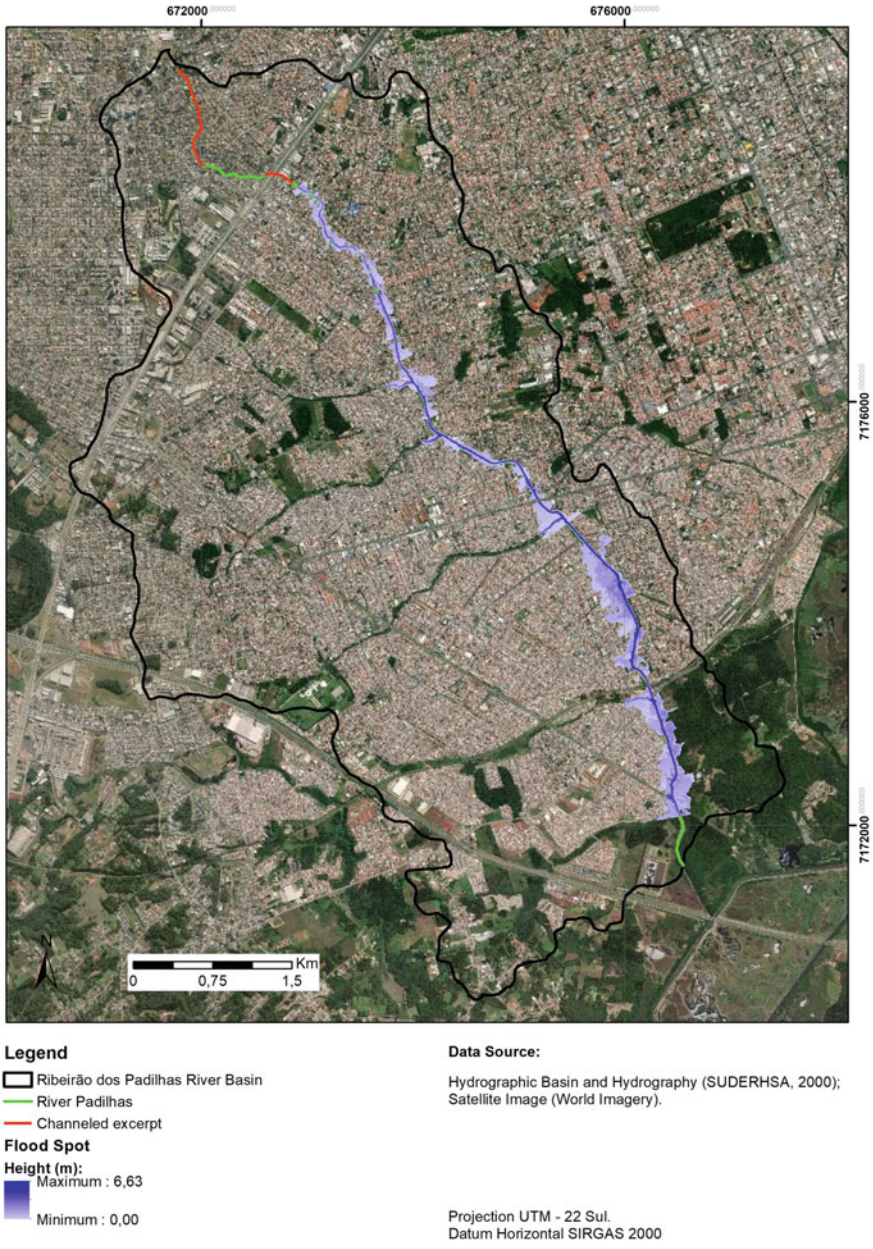


**Fig. 7** Flood area (height). *Source* The authors

- Maximum flood height—6.63 m;
- Minimum height of flooding—0.00012 m.

It should also be noted that the resulting higher heights are found within the drainage channel, in the region of the flatter relief of the hydrographic basin. In addition to the relief, it is also observed that the flood spot has greater coverage in the western region of the water body in question.

From the flood spot, overlapping urban plots made available by IPPUC (2019) was made. However, since the format of the flood spot data is of the matrix type, it was necessary to reclassify this data to whole numbers and transform it to the vector format. And so, create the overlap of these data, resulting in the height of flood water for each urban structure affected.

Due to the referred conversion, the flood spot has its precision reduced, where it was necessary to establish six classes of water height, which were conveniently adopted according to the proposal prepared by the European Union. Table 1 shows the classification of the flood spot according to the height and the average damage factor to the structures.

With the combination of the flood spot and urban structures, it was possible to identify 5,591 structures affected with the proposed class limitation, of the most diversified uses and territorial occupation. It is noteworthy that a considerable part of the lots does not have identification of use and occupation, which limits and partially compromises the analysis because it does not consider the economic dimension of the structures. Of the named lots, there were 489 areas of flooded lots registered as residential, which were chosen to apply the economic loss methodology (Huizinga et al. 2017).

The European Union methodology also provides an estimate of economic losses per square meter according to the average damage, making it possible to estimate it according to the areas obtained.

Finally, by establishing the ratio of the flooded area ($m^2$) by type of class in relation to the Average damage factor, economic losses can be estimated according to the referred methodology (Table 2).

It should be noted that the lack of identification of the lots, made it impossible to make a more accurate estimate, using only the damage separately per lot. It is also noteworthy that in the analysis of the data, it was observed that the largest flood structure in the same class was 7,039.69 $m^2$ classified as class 1, and the smallest structure with 0.000123 $m^2$ classified as class 4.

## 5 Conclusion

The present study demonstrated the possibility of carrying out the mapping of flood areas according to the intense rains. However, it is a mathematical model that lacks input data, which requires monitoring, which is not always accessible or existing, but which determines the accuracy of the result.

The computational visualization of flood risks made possible by the referred work, through flood maps and damage elevation profiles, provides a simple and effective idea of flood risk communication, supporting those involved in the planning of urban land use. This ability to view the problem provides the population and decision makers with a better understanding of the problem, both individually and for the whole community (Cummings et al. 2012).

It is noteworthy that it consists of a promising systematization of data, but it still finds limitations due to the lack of monitoring and frequent records of flood events for its calibration and validation, in addition to the limitation of the computational tools employed at work, which can present deviations, since they result from mathematical models.

The altimetric precision obtained with the systematization of data for the formation of the flood spot can be used in future works to determine the altimetric limit of the capacity of the river channel, maximum flow and consequently the precipitation, that is, allowing the prediction of floods and floods. affected areas.

This fact will help to differentiate the occurrence of a flood or flood, in the monitoring of occurrences, enabling the implementation of mitigating measures to society. The altimetric precision obtained in the modeling can also be applied to design preventive structural measures.

In the present work, the methodology was applied to Ribeirão dos Padilhas, resulting in a flood spot with an extension of 1,019,216.39 $m^2$ (with the drainage area). Also noteworthy is the value of economic losses estimated at R $ 22,664,538.60 for the total area affected.

The damages obtained from the analysis of the results exemplify the importance of mapping the flood areas, estimating the damage caused by the flood, harnessing the altimetry of the flood spot to measure the economic loss, and thus making it possible to estimate the losses caused by the simulated flood.

Thus, it is emphasized that the systematization developed in the work can be applied in other locations, due to its extensive characteristic adapting to the diversities, as long as the input data are previously monitored, highlighting the need for effective public policies aimed at preventing urban flooding.

Although floods can be measured financially as demonstrated in this paper, the data provoked transcend the economic sphere by impacting socially vulnerable populations with greater force, which lack their own resources and need external interventions to mitigate the occurrence of floods.

**Table 1** Flood spot classes

| Height range of flood spot (m) | Class | Average damage factor |
|---|---|---|
| 0.00012–0.5 | 01 | 0.49 |
| 0.5–1.0 | 02 | 0.71 |
| 1.0–1.5 | 03 | 0.84 |
| 1.5–2.0 | 04 | 0.95 |
| 2.0–3.0 | 05 | 0.98 |
| 3.0–6.63348 | 06 | 1.00 |

*Source* Adapted from Huizinga et al. 2017

**Table 2** Estimated losses

| Class | Number of structures flooded | Flooded area ($m^2$) | Estimated economic losses (€/$m^2$) | Estimated Economic Losses (€) | Estimated Economic Losses (R$) |
|---|---|---|---|---|---|
| 01 | 234 | 37.756,90 | 67.25 | 2.539.151.53 | 11.248.441.26 |
| 02 | 106 | 15.550,14 | 95.82 | 1.490.014.63 | 6.600.764.80 |
| 03 | 65 | 5.035,54 | 117.25 | 590.416.63 | 2.615.545.67 |
| 04 | 47 | 2.779,51 | 124.39 | 345.743.61 | 1.531.644.19 |
| 05 | 28 | 806,97 | 145.82 | 117.671.90 | 521.286.50 |
| 06 | 9 | 227,34 | 145.82 | 33.150.38 | 146.856.19 |
| Total | 489 | 62.156,40 | – | 5.116.148.67 | 22.664.538.60 |

*1 euro = 4.43 Reais (29/10/2019)
*Source* Adapted from Huizinga et al. (2017)

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# Sustainability Insertion in Higher Education: An Analysis of Research Performed in the Brazilian Context


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## 1 Introduction

Sustainability has increasingly gaining importance in organizational strategy (Eide et al. 2020, Galleli and Hourneaux Junior 2019). Performance indicators that used to be focused exclusively on financial aspects, in recent decades need to consider social and environmental aspects too (Ates 2020; Tasdemir et al. 2019). In this sense, Corporate Social Responsibility (CSR), specially due to society pressure, became mandatory for companies (Jean et al. 2020). This reality gained strength after the publication of the 17 Sustainable Development Goals (SDGs), by United Nations (UN) (Martins et al. 2019). These goals establish targets to guide actions of governments, companies and society towards a better future (UN 2019). Among these goals, "Quality education" (4th SDG) can be highlighted. Quality education

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is understood as one that provides citizens with the means to evolve and contribute to global development in a sustainable manner. These aspects must be debated and inserted at all educational levels, including higher education (Leal Filho et al. 2019; UN 2019; UNESCO 2017).

In this line of reasoning, the manner that Higher Education Institutions (HEIs) should prepare their students towards sustainable development is increasingly being debated by professors, responsible for structuring pedagogical projects, and researchers (Guerra 2017; Quelhas et al. 2019; Zorio-Grima et al. 2018). Competences such as critical and systemic thinking, problem-solving skills, transdisciplinarity/interdisciplinarity knowledge, collaboration, self-directed learning, among others are increasingly required in the qualification of future professionals (Guerra 2017; Quelhas et al. 2019).

Focusing on organizational environment, professionals are increasingly demanded to have knowledge related to sustainable management systems adoption (Rampasso et al. 2019a), such as: standards for CSR adoption, standards for sustainable reports publishing, techniques for cleaner production adoption, among others (Jean et al. 2020; Larrán Jorge et al. 2019; Matos et al. 2018). In Brazil, there are HEIs preparing future professionals to dominate the competences previously mentioned, inserting these competences into their curricula (Friman et al. 2018; Rampasso et al. 2019a).

Additionally, Brazilian HEIs are also seeking to develop research to provide a better qualification for students in the current reality. In order to contribute with the debates related to this subject, this study aims to establish an overview of the research developed regarding new professionals training on this conception in Brazil. Complementarily, it is pointed out exiting research gaps that can be addressed by future studies.

Besides this introduction, this work is composed of four more sections. Section 2 presents the theoretical background of the theme. Section 3 presents the methodological procedures used to conduct this research, in order to provide traceability of the steps performed and to allow the replication of this study by other researchers. Section 4 shows the results of this study, with the overview of the analyzed articles and the gaps that can be explored in the context of the Brazilian reality. Section 5 presents the main conclusion and final considerations on the subject, followed by the reference list.

## 2 Theoretical Background

This theoretical background aims to show the studies related to the mentioned thematic. These studies can contribute to a better evaluation of higher education courses to better align students' qualification with the SDGs.

Quelhas et al. (2019) performed an analysis to identify the skills required to be inserted and improved in engineering education courses to align students' training with sustainability aspects. Through a survey with 30 experts in the area, parameters

were evaluated regarding their importance to professional qualification. As result, they validated the following skills to be inserted: "systemic thinking, problem-solving ability (integrated resolution), ability to work in interdisciplinary group (collaboration), critical thinking, normative competence, competence of self-knowledge, strategic competence and contextualization and vision of the future" (p. 626). The findings can be useful for professors to evaluate the pedagogical projects of their courses.

In the study of Howlett et al. (2016), authors highlight the need of changes to align higher education for sustainability. They emphasize the need to stimulate critical thinking in students to make this alignment. Although there are several definitions of this skill, critical thinking can be understood as a way of thinking in which information is analyzed, assessed and improved. Through a case study, the authors show an experience carried out in an Australia HEI in which a constructivist approach was used to teach an interdisciplinary content and to stimulate critical thinking in students. As result, Howlett et al. (2016) stand out the modification obtained in students perception and knowledge about sustainability. Wilkin (2017) also addresses the need to develop critical thinking in students. In her research a case study is conducted to verify a problem-based assessment use for post-graduate accounting students. According to study's findings, the approach was effective to stimulate students critical thinking.

Analyzing the patterns and trends of sustainability insertion into engineering education, Tejedor et al. (2019) identified that "Institutional and policies" and "Education strategy" were the categories most identified in their keywords analysis. However, both items have been decreasing in the last years. At the same time, items such as training of university professionals and the use of learning strategies have increased in recent publications. Among the topics that stands out in their study, transdisciplinarity can be mentioned. It is considered an important mean to insert sustainability into engineering education.

Focusing on Brazilian reality, there are studies addressing the improvement of undergraduate students' qualification. Rampasso et al. (2019a) presented an approach to insert sustainability aspects into disciplines related to productive systems. The authors performed an action research in a Brazilian university, showing the mentioned insertion and compared their findings with the results from Chalmers University of Technology (in Sweden). Although the didactic material in Sweden were better prepared for the referred insertion in Sweden, social sustainability debates were better evaluated in the Brazilian experience.

Regarding the difficulties associated to sustainability insertion into higher education, analyzing Brazilian engineering courses, Rampasso et al. (2018) and Rampasso et al. (2019b) realized complementary studies. In the first one, the difficulties were analyzed according to professors' perception and a relationship among the difficulties were established. In the second research, the analysis focused on students perception regarding the difficulties.

## 3 Methodological Procedures

This research was based on a systematic literature review to collect the articles for analysis. After documents collection, a content analysis was performed according to the guidelines of Elo and Kyngäs (2008). For article's search, the combination of the string in the abstracts: "higher education" AND "sustainability" AND "Brazil". The databases used were: "Science Direct", "Emerald Insights" and "Scopus". A total of 51 articles were found. After excluding duplications and analyzing if they fit into this research scope, 30 articles were selected. For these articles, the content analysis was conducted.

According to Elo and Kyngäs (2008), the content analysis should have three phases: preparation phase, organizing phase and reporting the processes and results phase. In the preparation phase, the unit of analysis need to be selected. For this study, the unit of analysis was defined by the theme "Sustainability insertion in higher education in Brazilian context". Also in this phase, Elo and Kyngäs (2008) emphasize the need to obtain a representative sample. To ensure it, this search for articles was performed in important databases. Finally, the researchers must know well the information in the documents to be analyzed. For this, the authors read the articles to be analyzed.

In the second phase (organizing phase), the research approach needs to be classified (deductive or inductive). Due to the fragmentary character of studies related to "sustainability insertion into higher education in Brazilian context", this research can be classified as inductive. Thus, it takes specific cases to establish generalizations about the subject. In the inductive content analysis, open coding, categories creation and abstraction. In the open coding, it was done a careful analysis was performed in the articles collected and the following information were gathered: title, objective and method. It is important to highlight that there were articles in which formal definitions of the used research strategies were not presented; however, analyzing the articles' details, the strategies were identified by the authors of this study. The information collected in the articles were grouped and categorized. From these categories, discussions, debates on research gaps and future research guidelines were reported.

## 4 Results

As mentioned in the methodological procedures section, 30 articles were selected from literature review. The information collected in these articles for the inductive content analysis are presented in Table 1.

Regarding the method of analysis used in the articles presented in Table 1, it is possible to verify that case study is the most used method (37%). The second most used method was survey (23%). These research strategies are interesting to provide different kind of overviews, the first one presents a qualitative approach while in

**Table 1** Information collected from the articles

| Reference | Title | Goal | Method |
|---|---|---|---|
| (de Almeida et al. 2015) | Sustainability: A Study of the Level of Ecological Behavior of Postgraduate Students in Brazil | "to identify the environmental behavior (…) [level] of graduate students from a Brazilian federal institution of higher education" | Survey + Statistical techniques (mean, standard deviation, and correlation coefficient) |
| (Vieira et al. 2018) | An exploratory study of environmental practices in two Brazilian higher education institutions | "to identify the barriers and motivations that influence the adoption of sustainable practices in higher education institutions (HEIs)" | Multiple case study |
| (Gustavo de Lima et al. 2016) | A sustainability evaluation framework for Science and Technology Institutes: an international comparative analysis | "to analyze to what extent are the Science and Technology Institutes contributing to the spread of sustainable practices, making a comparison between MIT, ETH-Zurich and the STIs of southern Brazil and verifying, through an evaluation model, the selected STIs' contributions in the social, environmental and economic impact of their activities" | Case studies + documental analysis |
| (Avila et al. 2020) | Barriers, potentialities, and actions for implementation of sustainable energy procedures in Brazilian federal universities | "provides an overview of barriers, potential factors, and activities to develop and implement sustainable energy processes in public higher education institutions (HEIs) in Brazil" | Survey + Discriminant analysis |
| (Khalifa and Sandholz 2012) | Breaking barriers and building bridges through networks: An innovative educational approach for sustainability | "deals with the question of how international research and education networks can narrow the distance between countries and promote awareness of sustainability" | Literature review + Analysis of a project |

(continued)

**Table 1** (continued)

| Reference | Title | Goal | Method |
|---|---|---|---|
| (Rebelatto et al. 2019) | Energy efficiency actions at a Brazilian university and their contribution to sustainable development Goal 7 | "to analyse recent actions of energy efficiency implemented by University of Passo Fundo, a higher education institution located in the south of Brazil, and their contributions to Goal 7" | Case study |
| (Rodrigues and Payne 2017) | Environmentalization of the physical education curriculum in Brazilian universities: culturally comparative lessons from critical outdoor education in Australia | "examine the potential for change in Brazilian approaches to physical and sport education by critiquing broader 'environmentalizing' issues as they have occurred historically within the Australian outdoor education context in the university and secondary schooling sectors" | Document and literature analysis |
| (Engelman et al. 2019) | Environmental management in Brazilian higher education | "to investigate how the higher education institutions in Brazil are dealing with environmental issues" | Survey + Descriptive analysis (frequency distribution) + Statistical test (ANOVA) |
| (Rohrich and Takahashi 2019) | Environmental sustainability in Higher Education Institutions, a bibliometric study on national publications | "to investigate the profile of research and the development of the theme of environmental sustainability in HEIs located in Brazil" | Bibliometric analysis |
| (Jabbour 2010) | Greening of business schools: a systemic view | "to present a model for the analysis of business schools as creators, disseminators, and adopters of knowledge on environmental management" | Model proposition |

(continued)

**Table 1** (continued)

| Reference | Title | Goal | Method |
|---|---|---|---|
| (Pereira et al. 2014) | Greening the campus of a Brazilian university: cultural challenges | "This study examined the relationship between environmental management practices developed at a campus of a Brazilian university (University of Sao Paulo) and the greening of its organizational culture. The paper aims to discuss these issues" | Case study |
| (Cronemberger de Araújo Góes and Magrini 2016) | Higher education institution sustainability assessment tools: Considerations on their use in Brazil | "to gather elements to propose a sustainability assessment tool (SAT) to be used in higher education institutions (HEIs) in Brazil and the related program to be created for SAT dissemination and HEI monitoring, publication of results and benchmarking | Analysis of eight sustainability assessment tools (SATs) |
| (de Campos et al. 2018) | Higher education in Brazil: an exploratory study based on supply and demand conditions | to assess the context of Brazilian higher education institutions, its undergraduate courses and students, comparing their supply and demand conditions" | Documental analysis |
| (Junger da Silva et al. 2020) | How green is accounting? Brazilian students' perception | "to evaluate the undergraduate and graduate accounting students' perceptions of sustainable (or green) information technology (IT) and information system (IS) practices and their contribution to its implementation" | Survey + Internal consistency tests + Descriptive statistics + Spearman's correlation |

(continued)

**Table 1** (continued)

| Reference | Title | Goal | Method |
|---|---|---|---|
| (Moreira et al. 2018) | Solid waste management index for Brazilian Higher Education Institutions | "to present how SWaMI [Solid Waste Management Index] was developed, to apply the Index in three different universities in Brazil and one in United States, to statistically compare the results and to present an analysis of these HEIs under the SWaMI assessment dimensions perspective" | Case studies + Composite index deployment [Linear Aggregation Method + ANOVA with Turkey test] |
| (Rampasso et al. 2019a) | Some of the challenges in implementing Education for Sustainable Development: perspectives from Brazilian engineering students | "to analyse some of the main challenges evidenced in the insertion of sustainability in engineering courses" | Survey + TOPSIS |
| (Friman et al. 2018) | Steering sustainable development in higher education – Outcomes from Brazil and Finland | "to assess (1) national and international SD policy-making, i.e., the top-down steering elements, which might be relevant to the development of higher education; (2) whether this steering has impact on HEI's own SD policy and operational managing, and (3) whether in-house operations affect the SD content of curricula as a "reaction norm" of the degree program to the steering efforts" | Case studies |

(continued)

**Table 1** (continued)

| Reference | Title | Goal | Method |
|---|---|---|---|
| (Ramos et al. 2015) | Strategic Environmental Assessment in higher education: Portuguese and Brazilian cases | "to characterize the profile of Strategic Environmental Assessment in higher education in two distinct situations; Portugal and Brazil" | Survey + Frequency analysis + Content analysis |
| (Berchin et al. 2017) | Strategies to promote sustainability in higher education institutions—A case study of a federal institute of higher education in Brazil | "to analyze strategies that promote sustainability in higher education institutions (HEIs), focusing on the case study of a federal institute of higher education in Brazil" | Case study |
| (Drahein et al. 2019) | Sustainability assessment of the service operations at seven higher education institutions in Brazil | "to test a procedure for assessing the adoption of sustainable practices in higher education technological institutions services, known as institutes of technology and polytechnic universities" | Case studies |
| (Moura et al. 2019) | Sustainability in Brazilian HEI: practices overview | "to verify how Brazilian HEIs apply sustainability practices, as means to improve their effects towards society, making clear to the public, including current and future students, what the university is doing and how it is concerned with sustainability" | Documental analysis |

(continued)

**Table 1** (continued)

| Reference | Title | Goal | Method |
|---|---|---|---|
| (Bizerril et al. 2018) | Sustainability in higher education: A review of contributions from Portuguese Speaking Countries | "to answer the following questions: (1) What kind of knowledge has been produced by the Portuguese Speaking Countries (PSC) about sustainability in higher education? (2) What is the contribution of this knowledge to the global discussion on the subject? In addition, the paper discusses the extent of cooperation between PSC in the production of this knowledge" | Literature review |
| (Walter Leal Filho et al. 2018) | Sustainable development policies as indicators and pre-conditions for sustainability efforts at universities Fact or fiction? | "to examine the evidence which currently exists to support this assumption. It surveys a sample of universities in Brazil, Germany, Greece, Portugal, South Africa and the UK and the USA to ascertain the extent to which universities that are active in the field of sustainable development have formal policies on sustainable development, and whether such policies are a pre-condition for successful sustainability efforts" | Document analysis + Questionnaires + Interviews |

(continued)

**Table 1** (continued)

| Reference | Title | Goal | Method |
|---|---|---|---|
| (Berchin et al. 2018) | The importance of international conferences on sustainable development as higher education institutions' strategies to promote sustainability: A case study in Brazil | "analyzes the significance of international conferences for higher education institutions (HEIs)' promotion of sustainability" | Literature review |
| (Correia et al. 2010) | The importance of scientific literacy in fostering education for sustainability: Theoretical considerations and preliminary findings from a Brazilian experience | "presents an epistemological framework to show the role of scientific literacy in fostering education for sustainability" | Action research |
| (Leal Filho et al. 2018) | The role of transformation in learning and education for sustainability | "to present how transformation in learning in education for sustainability requires the commitment of Faculty and the engagement of students. To do this, a set of qualitative case studies were used in higher education institutions across seven countries (Brazil, Serbia, Latvia, South Africa, Spain, Syria, UK)" | Case studies |
| (Almeida et al. 2013) | The roles, perspectives and limitations of environmental accounting in higher educational institutions: an emergy synthesis study of the engineering programme at the Paulista University in Brazil | "This study applies emergy synthesis to assess the engineering programme at Paulista University" | Emergy synthesis |

(continued)

**Table 1** (continued)

| Reference | Title | Goal | Method |
|---|---|---|---|
| (Severo et al. 2019) | The teaching of innovation and environmental sustainability and its relationship with entrepreneurship in Southern Brazil | "to analyse the relationship between the constructs innovation teaching, environmental sustainability teaching and entrepreneurship, in the perception of students of higher education institutions (HEIs) in Southern Brazil" | Survey + SEM (Structural Equation Modeling) |
| (Marinho et al. 2014) | Water conservation as a tool to support sustainable practices in a Brazilian public university | "This work reports on a water saving program case study, led by a research group at a university in the northeast of Brazil" | Case study |
| (Akoojee and Nkomo 2011) | Widening equity and retaining efficiency: Considerations from the IBSA southern coalface | "to explore how initiatives for increased access to higher education are experienced in India, Brazil and South Africa" | Literature and document analysis |

the second strategy, quantitative analysis are usually used to statistically analyze the data. A method few used is action research, only a single article used this method. This approach may be interesting since researchers can describe different teaching approaches used by them in classes and debate these approaches in an international scale.

Analyzing articles' goals, it was possible to group them into five categories, according to their similarities. The categories created are: "Evaluation models and/or comparisons"; "Sustainable practices in HEIs"; "Broad debates about sustainability insertion in Brazilian HEIs"; "Students' behavior"; "Overview about sustainability insertion in Brazilian HEIs". Table 2 presents the category attributed for each article. In the sequence, in Table 3, these categories are presented as well as the percentage of articles allocated in each category.

As it is possible to verify, most of the studies are dedicated to analyzing issues related to evaluation models or to compare Brazilian universities with universities from other countries. In this sense, it is possible to identify opportunities for research in areas less explored, such as: adoption of sustainable practices in HEIs; broad debates about sustainability insertion in Brazilian HEIs; students behavior; and the establishment of overviews about sustainability insertion in Brazilian HEIs that can be used as bases for other studies.

**Table 2** Categories allocation per article

| Reference | Category |
|---|---|
| (de Almeida et al. 2015) | Students' behavior |
| (Junger da Silva et al. 2020) | Students' behavior |
| (Severo et al. 2019) | Students' behavior |
| (Khalifa and Sandholz 2012) | Broad debates about sustainability insertion in Brazilian HEIs |
| (Rodrigues and Payne 2017) | Broad debates about sustainability insertion in Brazilian HEIs |
| (Engelman et al. 2019) | Broad debates about sustainability insertion in Brazilian HEIs |
| (Berchin et al. 2017) | Broad debates about sustainability insertion in Brazilian HEIs |
| (Berchin et al. 2018) | Broad debates about sustainability insertion in Brazilian HEIs |
| (Correia et al. 2010) | Broad debates about sustainability insertion in Brazilian HEIs |
| (Gustavo de Lima et al. 2016) | Evaluation models and/or comparisons |
| (Jabbour 2010) | Evaluation models and/or comparisons |
| (Cronemberger de Araújo Góes and Magrini 2016) | Evaluation models and/or comparisons |
| (Moreira et al. 2018) | Evaluation models and/or comparisons |
| (Friman et al. 2018) | Evaluation models and/or comparisons |
| (Ramos et al. 2015) | Evaluation models and/or comparisons |
| (Drahein et al. 2019) | Evaluation models and/or comparisons |
| (Bizerril et al. 2018) | Evaluation models and/or comparisons |
| (Leal Filho et al. 2018) | Evaluation models and/or comparisons |
| (Walter Leal Filho et al. 2018) | Evaluation models and/or comparisons |
| (Almeida et al. 2013) | Evaluation models and/or comparisons |
| (Akoojee and Nkomo 2011) | Evaluation models and/or comparisons |
| (Rohrich and Takahashi 2019) | Overview about sustainability insertion in Brazilian HEIs |
| (de Campos et al. 2018) | Overview about sustainability insertion in Brazilian HEIs |
| (Rampasso et al. 2019a) | Overview about sustainability insertion in Brazilian HEIs |
| (Vieira et al. 2018) | Sustainable practices in HEI |
| (Avila et al. 2020) | Sustainable practices in HEI |
| (Rebelatto et al. 2019) | Sustainable practices in HEI |
| (Pereira et al. 2014) | Sustainable practices in HEI |
| (Moura et al. 2019) | Sustainable practices in HEI |

(continued)

**Table 2** (continued)

| Reference | Category |
|---|---|
| (Marinho et al. 2014) | Sustainable practices in HEI |

**Table 3** Percentage of articles per category

| Category | Percentage of articles |
|---|---|
| Evaluation models and/or comparisons | 40 |
| Sustainable practices in HEIs | 20 |
| Broad debates about sustainability insertion in Brazilian HEIs | 20 |
| Students' behavior | 10 |
| Overview about sustainability insertion in Brazilian HEIs | 10 |

Punctually, although the theme "evaluation models" stands out, clear, focused and objective mechanisms to evaluate sustainability aspects insertion into undergraduate courses are still required to provide information for professors and coordinators to make decisions. Regarding students' behavior, comparisons of the behavior of students from different courses are required. Additionally, there are few studies using statistical methods to evaluate causal relationships among constructs related to students' behaviors and their causes. For broad debates about sustainability insertion into Brazilian higher education, it should be recommended a deeper analysis of public policies developed in Brazil to improve professionals' qualification for sustainable development. In relation to sustainable practices, the analyzed articles showed interesting activities that can greatly contribute to enhance students' qualification. However, generally, the activities are developed separately from curricular matrices, without a transdisciplinary approach for the theme. The present research aimed to address the category regarding "Overview about sustainability insertion in Brazilian HEIs", that is one of the least addressed categories. No articles from this category did an analysis similar to the one conducted in this research.

## 5 Conclusion

As highlighted in the introductory section, this research aimed to draw an overview of the research being developed regarding new professionals training on this conception in Brazil and point out the exiting research gaps. Through the presented results, it can be verified that this objective was achieved.

The main conclusions obtained are following presented. There is a large concentration of research on models for assessing the insertion of sustainability into Brazilian

HEIs and comparisons between Brazilian and foreign institutions. Specially for evaluation models, it can be observed that it is required more objective frameworks and performance indicators focused on the insertion of sustainability into courses in HEIs that may contribute with professors and coordinators in their decision making. For categories in which a smaller number of articles are observed, the following opportunities can be observed: analysis of students behavior, comparing the behavior of students from different courses or analyzing causes for their behavior through statistical techniques; studies regarding public policies developed by the Brazilian government to improve professionals qualification for sustainable development; and development of sustainable practices in a transdisciplinary manner in higher education courses. The present research addressed the category regarding "Overview about sustainability insertion in Brazilian HEIs", that is one of the least addressed categories. No articles from this category did an analysis similar to the one conducted in this research, which highlights the contribution of this research to the literature. In addition to show an overview of studies developed regarding new professionals training on this conception in Brazil, this literature review presents relevant gaps to be addressed by future research.

The limitation of this study lies in the number of databases analyzed. However, the authors of this article used relevant databases that provided interesting articles about the theme.

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# Bike Sharing as a Solution for Mobility Issues in São Paulo: Benchmarking with International Experiences


**Renata Hamilton de Ruiz and Luiz Eduardo R. C. Rielli**

## 1 Introduction

Bike sharing is an alternative and sustainable means of transport that contributes to the creation of healthy cities. Its popularity can be explained by the fact that bike sharing systems (BSS) are associated with several numbers of social, environmental and economic benefits such as flexible mobility, traffic jam reduction, less fuel consumption, reduced $CO_2$ emissions, improvement in user health and decrease of sedentary lifestyle diseases (such as obesity, heart disease, diabetes, among others), reduction of noise pollution, individual financial savings and support for multimodal transport connections, encouraging greater use of public transport (Scott et al. 2019; Zhang and Mi 2018; Shaheen et al. 2010; Caggiani et al. 2019; Fishman et al. 2014).

The BSS operators' value proposition is to offer low-cost options for passenger travel, making it a cost-effective alternative to the "last mile" of daily commute—the distance between user's home or workplace to public transport, which in many cases is too long to walk (Rielli et al. 2019; Si et al. 2019; Pritchard et al. 2019). The conventional BSS market, and more recently, the electric bicycle and scooter market, has been expanding rapidly, albeit with business and operating models still in validation. In 2010, 250 BSS were in operation worldwide, jumping to over 1,700 in 2017 (SLOCAT 2018).

The fiercely competitive and dynamic market, low entry costs and pioneering benefits have led operating companies to offer services even before identifying,

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measuring and evaluating the relationships with urban planning, the associated risks and social and environmental impacts of BSS (Rielli et al. 2019). Therefore, while the new transport modal brings benefits to cities and people, it can generate negative social and environmental impacts so far unknown or irrelevant.

The allocation of bicycles must be actively managed by the BSS operator to ensure efficient system operation (Caggiani et al. 2019). Therefore, in order to actually reduce emissions, bicycle travel must necessarily replace trips that would be made in other modals, specially cars. If a BSS cannot replace the use of vehicles at a sufficient rate to compensate for the extra travels for bike redistribution, the system is causing additional environmental impacts and congestion (Luo et al. 2019). In London, for example, the adoption of BSS registered an additional nearly 800,000 km of motor vehicle usage in the city, due to the low replacement rate of cars and the high use of trucks for bicycle relocation (Fishman et al. 2014).

In addition, the manufacture of bicycles and electronic components and the sharing infrastructure demand resource and energy use that generates waste and emissions. Production above demand can also lead to the waste of resources and waste management issues (Luo et al. 2019), as happened in Shanghai, a case that will be discussed later in this paper.

## 2 Brief History of Bike Sharing Systems (BSS) Worldwide

Bike sharing systems (BSS) are a set of stations spread throughout the urban network, containing bicycles available for the users to travel (Saraiva et al. 2019).

The evolution of bike sharing is usually divided into four generations. The first generation of BSS, called "White Bikes" or "Free Bike Systems", started in Amsterdam in 1965. Ordinary bicycles were left around the city unlocked and could be used for free. Constant thefts, however, motivated the emergence of the second generation of BSS, the "Coin-Deposit Systems". So, in 1995, the city of Copenhagen launched the first large-scale BSS, which had bikes placed in stations around the city that were unlocked by a coin deposit of approximately US$ 3, refunded upon bicycle return. These systems did not have a time limit, which often resulted in long-term use or bikes not being returned, a fact commonly attributed to the anonymity of program users (Shaheen et al. 2010; Si et al. 2019; Scott et al. 2019).

These two generations were considered unsuccessful, but their shortcomings served as learning for the next generation of BSS, the "*IT Based Systems*", which use advanced technologies for bicycle reservations, pick-up, drop-off and information tracking and popularized bike sharing throughout the world. The use of technology information has helped prevent bicycle theft by removing anonymity and allowing fines to be charged if the bicycle is not returned. The success of the third generation has increased the number of providers of this service and, consequently, developed new business models and specific technologies. Operators range from local governments, transportation agencies, advertising agencies, and for-profit or non-profit entities. BSS are funded through advertisements, user fees, city halls and/or public–private

partnerships and subsidies. As the third generation continues to expand worldwide, a fourth generation of BSS, called "*Demand-Responsive, Multi-Modal Systems*", which uses even modern technologies such as GPS tracking, touchscreen stations, better integration with the public transport system, electric bicycles, among other improvements (Shaheen et al. 2010; Si et al. 2019; Scott et al. 2019).

Despite the success of the BSS, one of its largest concerns is the low predictability of resources—for example, when a user arrives at the station and is unable to find an available bike, or when the station is full and the bike cannot be returned. Bike allocation must be actively managed by the BSS operator, to ensure efficient operation becoming a viable alternative to other transport modals (Caggiani et al. 2019). Therefore, in 2016, a new dockless BSS model emerged in China, which benefited from the development of technology information, integrating mobile payment and big data GPS tracking, and enabling the return of bicycles wherever their parking is allowed. The BSS then gained unprecedented scale, resulting in a large number of bikes available and ultimately undermining the efficiency of the system as a whole (Si et al. 2019).

The dockless model was designed in order to make life easier for its users, allowing them to go door to door with a shared bike. However, it becomes harder to ensure the offer of vehicles at the same place and time every day, something vital to retain public and, therefore, receive predictable revenue (Balago 2020). Despite some socioeconomic and environmental benefits, dockless BSS have brought new urban difficulties, such as bike returns in inappropriate locations. To solve this problem, "virtual fences" delimiting the area of operation without a physical installation are being predetermined by operators (Zhang et al. 2019).

The operation models have characteristics that must be evaluated by the agents involved in the implementation of urban mobility solutions and policies. The effects on economic, environmental and social aspects, as well as the operational viability, shall be considered by all agents involved in the implementation of this new micromobility solution, adapting to the specificities of each city or region.

## 3 Market Panorama

The world bicycle demand has been growing rapidly recently, with 130 million units sold in 2018 (Sharma 2019). This growth is mostly driven by the Asian market and the launch of new electric models. In 2017, 34 million electric bikes were sold, and 40 million units are expected to be sold in 2023 (STATISTA 2014).

China continues to be the main market for bicycle production and consumption. In the country, 80 million units were sold in 2018, over 60% of the global market (Sharma 2019; Cai 2017). China was the pioneer in the dockless BSS model, enabling its expansion globally.

In Europe, there is a growing incentive to use the modal, especially in large urban centers. Copenhagen is the leader in cycling, with 33% of total trips, followed by

Amsterdam (32%), Berlin (13%), Seville (8%), Vienna (6%), London (3%) and Paris (3%) (SLOCAT 2018).

In the United States, 37 million trips were made through BSS in 2017, a 25% increase over the previous year. The rapid growth in demand encouraged five new operators to enter the American market, adding to the three already in business. Starting from 42,500 bicycles in 2016, the US ended 2017 with approximately 100,000 bicycles operating in BSS, of which 44,000 in dockless systems. Despite rapid adoption, the dockless model accounted for only 3.5% of BSS 84 million trips in 2017, despite accounting for 44% of all bikes available. To a large extent, bicycles have been replaced by electric scooters, which in one year of operation have accounted for 45% of trips (NACTO 2018).

The BSS expansion model is supported by the easy access to financial capital. Small businesses and start-ups have grown into major global operators by leveraging resources from investors eager to participate in scalable, replicable and fast-return models (Rielli et al. 2019).

## 4 Brazilian Market

The companies Serttel and Tembici were pioneers in offering shared bikes in Brazil. The adoption of BSS in a larger scale took place in the country as of 2012, gaining faster expansion in 2017, with the beginning of the dockless system implementation (Rielli et al 2019).

As of January 2019, thirteen Brazilian capitals had BSS with fixed stations, totaling almost 1,000 stations and 7,900 bicycles available on the country's streets. Another five Brazilian cities have BSS, totaling over 40 stations and 500 bicycles. Considering the equipment in maintenance and in stock, the total amount of vehicles is approximately 18 thousand bicycles throughout the country (Rielli et al. 2019, Aliança Bike 2018). The companies with operational BSS in Brazilian cities can be seen in Table 1.

The availability of specific bicycle spaces contributed to the addition of the new modal in the country. The circulation infrastructure includes cycle lanes, cycleways and cycle routes, with variations in denominations and technical specifications according to local government. The trend of expanding cycle paths can be noticed throughout Brazil. In only three years, the cycling network of the country's capitals has more than doubled in size, from 1,414 km in 2014 to 2,934 km in 2017. Despite the progress, bike lanes represent only 2.7% of the total road network of cities (Velasco e Reis 2017).

With the expansion of public infrastructure and the supply of bicycles, demand has increased, indicating there is a pent up demand (Rielli et al. 2019). In addition, the infrastructure expansion allows users with a different profile to adopt the modal, in commutes greater than the last mile (Lazzeri 2018).

**Table 1** Major bike sharing system operators in Brazil (as of January 2019)

| Operator | Model | Cities |
|---|---|---|
| Tembici | Fixed stations | São Paulo/SP, Rio de Janeiro/lRJ, Belém/PA, Porto Alegre/RS, Salvador/BA, Recife/PE, Olinda/PE, Jaboatão dos Guararapes/PE, Vila Velha/ES, Manaus/AM, Bertioga/SP and Sorocaba/SP |
| Grow* | Dockless | São Paulo/SP, São José dos Campos/SP, Rio de Janeiro/SP, Florianópolis/SC, Belo Horizonte/MG, Campinas/SP, Ilhabela/SP, Brasília/DF, Curitiba/PR, Goiânia/GO, Porto Alegre/RS, Recife/PE, Santos/SP and Vitória/ES |
| Trunfo | Fixed stations | São Paulo/SP |
| Serttel | Fixed stations and Dockless | São José dos Campos/SP, Belo Horizonte/MG, Fortaleza/CE, Goiânia/GO, Petrolina/PE, Santos/SP and Vitória/ES |

*Source* adapted from Rielli et al. (2019)
*The company temporarily interrupted its bike operation in Brazil by the end of January, 2020 (Balago 2020).

## 5 Transportation and Bike Sharing in São Paulo, Brazil

São Paulo has around 12 million inhabitants, being the most populous city in South America. It covers an area of 1,521 square kilometers and has a demographic density of 7,890 inhabitants per square kilometer. The city's GDP in 2016 was R$ 690 billion (about US$206 billion at the 2016 exchange rate), accounting for 3.8% of the national total, the highest in Brazil (IBGE 2019).

The transportation sector is the main source of air pollutants emission in the city. $CO_2$ emissions from this sector increased by 26% between 2000 and 2013. To reduce $CO_2$ emissions from transportation, the city should focus on public policies to encourage clean and public transport and further limit fossil fuel usage. The main fuel used in the city is ethanol, considered clean in relation to gasoline, but the increase in the vehicle fleet has contributed to the rise in fuel consumption and thus to local pollution. The number of deaths related to air pollution in the city is three times higher than those caused by traffic accidents (Costa et al. 2018).

Construction of the city's subway system began in the 1970 (Sá et al. 2019), however, individual transport incentive policies—which include highways and freeways construction, vehicle financing programs, fuel subsidies and provision of parking spaces—have resulted in individual transport preference by users and, consequently, lower urban transport efficiency (Prefeitura de São Paulo 2015). A result of these policies has been the relative increase in the cost of public transport, the fares of which have risen above inflation (Sá et al. 2019).

The city adopted a vehicle restriction policy since 1996, restricting circulation of passenger vehicles once a week in peak hours, based on the license plate number. The city's vehicle fleet, however, grew almost 60% between 2003 and 2010 and

is the largest in Brazil (Costa et al. 2018). São Paulo currently has a total fleet of 8.9 million vehicles, of which 6.2 million cars and 49 thousand buses (DETRAN SP 2019). Of the total daily commutes in the city, 30% are made by foot and less than 1% by bicycles. Of all motorized commutes, about 44% use individual transportation, while 56% use public transportation. Travels by individual transport last on average half the time than travels in public transport (Prefeitura de São Paulo 2015).

To improve this situation, public transport needs to be expanded, but it must also offer comfort, reliability, safety, accessibility and connectivity between modals, as well as being environmentally friendly. In this manner, public transportation can attract private car users, reducing pressure on urban roads and traffic jams (Pedroso et al. 2018).

In the last decades, some attempts have been made to promote alternatives to private vehicles in the city of São Paulo, including plans to expand and interconnect public transport, renovate bus and train fleets, create dedicated busways and promote dedicated bicycle and walking infrastructure (Sá et al. 2019).

The Urban Mobility Plan of the Municipality of São Paulo 2015, which fits the National Urban Mobility Policy (Law nº 12.587/2012), has as its main objectives the implementation of an environment suitable for active travel, which promotes environmental, economic and social gains, benefiting users and the city. The cycling system guidelines include promoting the use of bicycles as a means of transport and integrating it as a modal into the public transport system through its terminals and stations (Prefeitura de São Paulo 2015).

Bicycle incentive policies have been on the municipal agenda of the city of São Paulo since the 1980, but the first cycling infrastructure was built in the mid-1990 in city parks, focusing on leisure. Only in the mid-2000 this infrastructure planning was incorporated into transport policies (Sá et al. 2019). Between 2013 and 2016, the cycling network in São Paulo had a six fold increase (Krecl et al. 2019) and currently consists of 473 km of bicycle lanes and paths for bike use along with other cycles and pedestrians, and 30 km of cycling lanes on roads (a designated part of the road intended for bike use, shared with other vehicles). To facilitate modal integration, the city also has 102 public bike racks located in bus terminals, train and subway stations and parking lots of the Traffic Engineering Company (CET SP 2019).

In the Urban Mobility Plan of the city of São Paulo, bike sharing is seen as a very efficient transportation alternative, either for exclusive trips or for integration with public transit. Targets for expansion of the structural bicycle network are presented by the year 2028, when BSS are expected to cover 100% of the city's territory (Prefeitura de São Paulo 2015). The new Cycle Structure Plan launched on December 2019 intends to add 173 km to the cycle network and improve 310 km of existing paths (CET-SP 2019).

The city of São Paulo, Brazil's largest bicycle-sharing market, pioneered the adoption of BSS in the country with the launch of the BikeSampa program in 2012 by the company TemBici. The following year, the company Trunfo launched CicloSampa BSS in the city. Both have fixed stations. In 2018, the company Yellow entered the market bringing to Brazil the *dockless* model, which started with 500 bicycles in São Paulo, aiming to expand this number to 20,000 units by the end of that year, almost

ten times more units than BikeSampa, the city's main shared bicycle network so far. Two other companies are registered to launch similar services in the city, the Chinese Mobike, one of the largest in the world, and Serttel, but have no start date defined yet. In 2019, Yellow, which also offers electric scooters, included in its portfolio shared electric bicycles in the *dockless* model. The company, that merged with Grin in 2019 creating the new company Grow, covers an area of 21 square kilometers in São Paulo in which bicycles and scooters can be used (G1 2019; Miotto 2019; Médici 2018; Barifouse 2018; Caputo 2019). On January 22, 2020, however, Grin has temporarily interrupted all its bike sharing services in Brazil and has also stopped offering electric scooters in almost all Brazilian cities, except for São Paulo/SP, Rio de Janeiro/RJ e Curitiba/PR. This decision was made after local newspapers started publishing pictures of an abandoned lot acquired by the company in Curitiba, in which hundreds of damaged bikes were being abandoned (Balago 2020; Silveira 2020).

## 6 International Experiences

### *6.1 Berlin, Germany*

Germany is a traditional market for mobility inventors, manufacturers and suppliers. Car appreciation is part of the German culture and is associated with the way cities and their means of transportation were structured. Berlin, however, is not the birthplace of major automotive industries and its population has a cosmopolitan profile, open to new global trends such as sustainability (Rielli et al. 2019). In 2017, Berlin's GDP reached €136 billion (about US$163 billion at the 2017 exchange rate), accounting for 4% of the national total GDP (European Comission 2019).

Berlin, with its area of 892 square kilometers (Deloitte 2018), has geographical features that make it easy to implement new mobility models, especially low-impact ones such as bicycles and walking. The city has a polycentric urban structure and flat topography, which reduces displacement efforts. It has 344 passenger cars per 1000 inhabitants, which is low compared to other large cities, meaning alternative transport options are essential. The number of new mobility options, such as free-floating car sharing, rental bikes or electric scooters, has been growing for several years (Oostendorp e Gebhardt 2018).

It has 3,55 million inhabitants with a population growth tendency (Oostendorp e Gebhardt 2018) and it receives 13,5 million tourists annually, being one of the most visited cities in Europe (STATISTA 2014). The increase in demographic's figures has been reflected in the time spent in traffic jams. On average, people in Berlin make 3.5 trips per day, and spend about 80 min in traffic (McKinsey and Company 2016).

The city offers a wide range of mobility services, based on a large public transport network. The modal split in Berlin is composed of 31% trips on foot, 30% by car, 27% by public transport and 13% by bike. The car fleet has been growing by over 5% since

2012, reaching almost 1,2 million passenger cars in 2017 (Oostendorp e Gebhardt 2018). The city also has 2,900 cars available in car sharing systems (McKinsey and Company 2016). The bicycle infrastructure is made of 27 thousand stopping points in metro stations, trains and specially defined places, 963 km of cycling paths, 286 km cycling lanes on roads and 216 km of joint pedestrian and cycling paths (Berlin Senate 2017).

The promotion of cycling as transport modal has received attention from national public policies, with the National Cycling Plan, led by the Ministry of Transportation and Digital Infrastructure. In Berlin, the first broad public policy to promote cycling as a mode of transport took place during November 2004 with the Transport Development Plan. The Cycling Strategy is launched as an integral part of public policy and updated in 2013. In June 2018 the Berlin Mobility Act institutionalizes the relevance of cycling and new modes (electric light mobility) as fundamental to the city. The objectives of the Cycling Strategy include: increasing cycling participation from 13% in 2008 to 20% in 2025, an annual increase of 3 to 4%; transfer of long-distance travel from 3.7 km to 4.6 km in 2025; Increase integration between public transport and bicycles from 3% of trips to 5%; significantly reduce accidents; continue expanding and improving cycling infrastructure.

Bike sharing began in the 2000 in Germany with the Munich operation of NextBike and Call-a-bike, both of Deutsche Bahn. One operator. The system was based on public tenders and government support. Berlin has initially adopted the Call-a-bike model, but since 2016 switched to NextBike, which operates a BSS in the dock-station model. Currently, about 18,000 bikes are available for sharing, operated by NextBike (5,000) and dockless BSS operators, Call-a-bike (3,500), oBike (680), Mobike (5,000), Lime (1,000) and Donkey Republic and Byke (2,800). There is a growing demand for electric mobility, with 600 electric bicycles available for sharing by Lime, JUMP, Lidl and NextBike (Rielli et al. 2019).

Despite rapid growth observed in recent years, BSS have faced difficulties in acceptance and regulatory compliance. Chinese company ofo, for example, ended its activities in Berlin after starting with more than 2,000 bicycles, claiming low acceptance of its business model by several agents.

## 7 Shanghai, China

With an area of 6,341 km$^2$ and a population of 24.26 million, Shanghai is one of the largest cities in the world and China's economic center. Shanghai's GDP in 2016 was 2.8 trillion Yuan (about US$415 billion in the 2016 exchange rate), accounting for 3.6% of China's total GDP. It has a high-speed road surrounding the most part of the city, called the Circle Road (Zhang e Mi 2018).

Shanghai adopted a vehicle restriction policy as early as 1994, when there were only 8 passenger vehicles for every 1,000 persons in China, and private ownership of vehicles was non-existent. This policy determines that car buyers have to bid through a "controlled auction" to acquire a license plate for conventional gasoline

vehicles. A bidder must try on average for 20 months and spend about US$ 12,000 for a license plate. Even with this restriction policy, the number of cars in Shanghai grew immensely, reaching 2.72 million vehicles or 118 per 1,000 persons, including 1.41 million privately owned vehicles, ranking 5th among Chinese cities. Electric car buyers are allowed to bypass this controlled auction system, thus saving reasonable time and money. Even with the growing number of electric cars, concerns with traffic jams, however, still exist, since the number of license plates for conventional cars was not reduced (Wang et al. 2017).

Before its great economic growth and high levels of urbanization, China was considered to be the "kingdom of bicycle", which was the mean of transportation for most people. The adoption of motor vehicles in the last decades contributed to the deterioration in air quality, so the government has been improving bike-friendly infrastructure, such as lanes and traffic signals created solely for cyclists (UN News 2019). In recent years, there has been a revival of the bicycle usage across China, with an increasing number of people choosing cycling instead of driving (Jie and Wei e Jiang 2020). The current journey modal split in the city of Shanghai is composed of 25% trips on foot, 19% by car, 32% by public transport and 16% by bike.

As of July 2017, Shanghai had 1.5 million dockless bikes, making it the largest bike-sharing market in the world. Zhang e Mi estimated that in 2016, bike sharing in the city saved more than 8 thousand tons of oil, avoiding the emission of 25,000 tons of $CO_2$ and 64 tons of NOx, considering only one bike-sharing company, Mobike. The authors used big data techniques to estimate the total distances of all bicycle rides and fuel usage data taking into account their entire value chain, from production to distribution. Estimated environmental benefits were greatest in more developed neighborhoods of the city, where population density is higher (Zhang e Mi 2018).

However, the unplanned distribution of sharing bicycles aggravates the consumption of environmental resources (Jie and Wei e Jiang 2020). The excess of bikes in the streets brought unexpected problems, such as illegal parking and a large number of bicycles blocking sidewalks. The city's authority had to forbid BSS companies to allocate more bikes and started removing bikes from areas such as transportation hubs, metro and bus stations and hospitals (Shanghai City News 2017). Many of those bikes ended up in places now known as "bike graveyards". In addition, the bankruptcy of an BSS company (Bluegogo) led to the disposal of thousands of bikes, causing a huge waste of resources and waste management setbacks to the city (Haas 2017). Rather than becoming garbage, those excess bicycles could actually be seen as an opportunity for exploiting new markets, so more cities could benefit from bike sharing. Reasonable allocation of the bicycles can promote the utility efficiency of natural resources and strengthen the sustainability of economic development (Jie and Wei e Jiang 2020).

In June 2018, Mobike worked with the city government and traffic police to monitor and regulate bike parking with geofencing. A pilot project banning dockless bikes from parking in downtown areas resulted in a 30% decrease in illegal parking within two months, making street space more functional for all users (Jiang e Jamba 2019).

## 8 Discussion

This paper seeks to encourage the efficient and effective adoption of BSS in São Paulo, Brazil. Two international cases will serve as guidelines for the development of an expansion plan for BSS in the city. The Berlin experience can be considered a success case in the adoption of BSS, even though there is still place for growth. Shanghai, on the other hand, suffered from a series of excesses on the part of the service providers part, which ended up troubling the population. Some characteristics of the cities have been compiled in Table 2.

Berlin has a considerably smaller area than the other two cities studied and has a polycentric urban structure and flat topography, which reduces active displacement efforts. São Paulo has an area about 70% larger than the German city, possesses a steep and uneven topography that makes bike use difficult even when exclusive bike paths are available. These characteristics may partly explain why less than 1% of trips are made by bicycle in the Brazilian city. The urban expansion in São Paulo favored car use, and urban planning wasn't effective, resulting in large commercial zones close to one another and far from residential areas, forcing most people to commute in the same direction simultaneously, causing major congestion at peak times.

In Shanghai, despite the city being fourfold larger than São Paulo, 16% of trips are made by bike, which can be explained by the country's past, once known as the "kingdom of bicycle". Bicycle usage was a big deal in China before the country's extraordinary economic growth, when car ownership was not an option for most Chinese people. The air quality descent and the need to reduce car use make the bike sharing market seem too easy to enter. The emergence of the dockless model favored the entry of too many agents due to its low upfront investment.

European countries tend to adopt new technologies in a more balanced way than China. The bike sharing market is developing and expanding in the continent since the 1960. This conservative approach allows for better understanding of supply and demand dynamics, avoiding unpleasant surprises, like Shanghai's recent experience with BSS offer way above user demand. Bike sharing began in the 2000 in Germany, and the first broad public policy to promote cycling as a transport modal in Berlin took place in 2004. This means the market has matured for over ten years before the disruptive dockless bike sharing model emerged.

**Table 2** Summary table of some characteristics of the cities studied

| | Total area (sq km) | Population (million inhab) | GDP (billion U$) | Trips by bike (% of total trips) |
|---|---|---|---|---|
| Berlin, Germany | 892 | 3.6 | 163 | 13% |
| Shanghai, China | 6,341 | 24 | 415 | 16% |
| São Paulo, Brazil | 1,521 | 12 | 206 | < 1% |

## 9 Recommendations

How can São Paulo, the biggest city in a developing country, adapt to this reality, now that the micromobility market is in retraction, with companies interrupting their operations? The implementation of BSS in the city is still in an early stage, when compared to Berlin and Shanghai, but since São Paulo is known for influencing the rest of the country, the success or failure of a new technology will shape its expansion in Brazil.

The São Paulo municipality should enable the entry of different BSS operators, favoring healthy competition, but keeping an eye open for oversupply, especially when it comes to dockless systems. Employing a low impact bike reallocation method is also crucial to ensure the environmental sustainability of the whole system.

Permanent research in urban transportation planning must be conducted, in order to incorporate new modals and technologies that reduce traffic jams, improving environmental conditions and thus making quality of life better for the population.

The city hall could develop a "Plan for Bike sharing expansion", including topics like:

1. Demand management—would allow a better understanding of the consumer profile, making the system more efficient, reducing relocation needs and avoiding excess or shortage of bikes in the main points of interest.
2. System management—search for more efficient bike relocation, evaluating environmental, social and financial impacts of the system from a life cycle perspective.
3. System modernization—fourth generation adoption, GPS usage favoring data generation that would allow for a constant improvement of the expansion plan.
4. Contracting services models—creation of a contracting model that avoids excessive fees that hinder the company permanence in the market. Different kinds of agreements could be made since the BSS is integrated into the public transport system and is considered a public service. The BSS operating companies could be responsible for financing the expansion of bike infrastructure in the city, for example, or data transparency could be mandatory.

## 10 Conclusion

This paper encourages the adoption of BSS in São Paulo. The specific case of the city and the players involved was compared to the implementation of BSS in Berlin and Shanghai so we can learn from these international experiences.

While this new transport modal brings benefits to cities and people, it can generate negative social and environmental impacts so far unknown or irrelevant. The fiercely competitive and dynamic market, low entry costs and pioneering benefits have led operating companies to offer services even before identifying, measuring and evaluating the relationships with urban planning, the associated risks and social and environmental impacts of BSS.

With the emergence of the dockless model, BSS gained unprecedented scale, resulting in a large number of bikes available and ultimately undermining the efficiency of the system as a whole. Production above demand lead to the waste of resources and waste management issues, as happened in Shanghai.

The operation models have characteristics that must be evaluated by the agents involved in the implementation of urban mobility solutions and policies. The effects on economic, environmental and social aspects, as well as the operational viability, shall be considered by all agents involved in the implementation of this new micromobility solution, adapting to the specificities of each city or region.

The implementation of BSS in São Paulo is still in an early stage, when compared to Berlin and Shanghai, but since São Paulo is known for influencing the rest of the country, the success or failure of a new technology will shape its expansion in Brazil.

Permanent research in urban transportation planning must be conducted, in order to incorporate new modals and technologies. The São Paulo municipality should enable the entry of different BSS operators, favoring healthy competition, but keeping an eye open for oversupply, especially when it comes to dockless systems.

In order to encourage this new modal, the city hall could develop a "Plan for Bike sharing expansion", including topics like demand management, system management, system modernization and contracting services models. The results found in this plan would pave the way for a transportation system of the future: sustainable, healthy and economical.

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