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Measurement of the eco-efficiency of small business in the supply chain oil and gas, applying the taxonomy CE7

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ABSTRACT. This article intends to contribute to studies concerning environmental sustainability in the oil and gas industry by measuring the eco-efficiency of small business in the supply chain of oil and gas in Brazil. Eco-efficiency is an environmental management strategy that aims to reduce resource consumption, reduce the impact on nature and provide customers with quality products and services. For its measurement, the methodology called 'CE7' taxonomy was used, an acronym referring to the 'seven competences of eco-efficiency' that adapted the environmental strategies will show the level of eco-efficiency of the enterprises. The field research adopts as object of study forty-four companies of the productive chain of oil and gas Potiguar. Data were collected from August to October 2016, using the survey method. It was evidenced the absence of eco-efficient enterprises in the production chain and that the best level of delivery occurred for two companies that were diagnosed as 'almost eco-efficient'. The environmental strategies that promote eco-efficiency are energy efficiency, solid waste management plan, environmental care in supplier selection and environmental licensing. Eco-efficiency is not an institutionalized management practice in the reality of this productive chain.

Keywords: environmental management; sustainability; chaining; strategy; providers.

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Introduction

The segment of business that moves the oil industry is made of a productive chain that encompasses productive systems operating in different stages. It is recognized as a conglomerate of activities managing itself from the basic income to the final product, in which each segment is a ring in the productive chain most of the time having the MSB supplying products and services to a massive corporation in charge of managing projects and contracts through a productive chain (Souza, 2014; Andrade & Oliveira, 2015; D'Almeida, 2015).

The purpose of this article is to measure the eco-efficiency of micro and small businesses of oil and gas productive chain of Rio Grande do Norte. The specific objectives are: characterize the structure of oil and gas productive chain of Rio Grande do Norte State, create a system of levels of eco-efficiency based on comparison of environmental variables, identify benchmark of micro and small businesses that serve as reference to the productive chain.

Developing a study of the eco-efficiency of micro and small businesses in the oil and gas productive chain in Rio Grande do Norte is justified because of its evidence: all stages of the productive chain present significant environmental problems due to high polluting potential and risks; possibility of opening the market for the micro and small businesses in the segment to be able to operate in mature fields from the concession of wells by Petrobras, meeting the criteria and environmental requirements specified in the bidding documents; environmental legislation improving with increasing requirements demands; significant economic weight of activity in the state economy.

In this context, the article answering a key question: 'To what extent are Micro and Small Businesses (MBS) of the oil and gas productive chain of Rio Grande do Norte eco-efficient?' Furthermore, can the eco-efficiency be considered an appropriately institutionalized tool of management in the reality of MBS of the oil and gas productive chain of Rio Grande do Norte?

Literature review

Competitiveness has become a survival factor for any business and the adoption of new environmental technologies have become a key factor for standing out in the market and the imposition of adequate environmental standards can stimulate the adoption of innovations by businesses that reduce total costs of a product or increase its value, improving competitiveness. 'In other words, beyond environmental improvement, environmental regulations also reinforce business competitiveness conditions' (Young & Lustosa, 2001).

Munck, Galleli, and Souza (2012; 2013), emphasize that a business is sustainable when it makes profits to shareholders, protects the environment and improves quality of life of people around it. Those authors even report that sustainable actions performed by a business are the ones responsible for causing the least environmental impact throughout the period of operational activities, at the same time being concerned with promoting economic and social development and contributing with the survival of present and future generations.

According to Pimenta (2012), the measuring of environmental efficiency makes possible identifying MBS' strengths and weaknesses, threats, tendencies and improvement opportunities to be implemented towards its adequacy and opportunity in the marketplace. Alternatively, Adissi, Pinheiro, and Cardoso (2013), emphasize that, environmental management must be taken as a starting point for quantifying the impacts caused by the actions of businesses through quantitative information.

It is expected, upon the conclusion of these objectives, to contribute with strategies for the maximization of environmental efficiency, strengthening competitiveness of local businesses and support the improvement of environmental knowledge, evaluating its environmental efficiency and instituting mechanisms of self-evaluation and continuous improvement of developed practices, thus promoting actions towards the betterment of micro and small businesses sustainability and propose public policies activity.

According to Filardi, Freitas, and Dutra (2013), there are three important effects that micro and small businesses can have in city and regional development: collective cooperation generated by the participation in local productive chains favors its growth; these productive conglomerates improve collective learning process, cooperation and innovative dynamic of businesses, strengthening themselves to face challenges of the so-called information society; there is a concern in public policies, which is encouraging this kind of organization, with the purpose of developing local advantage, especially micro and small businesses.

Nowadays in the market, eco-efficiency is a current term, being a management philosophy that encourages the business world to seek environmental improvements that provide economic benefits, generate business opportunities and allows companies to become more responsible from the environmental point of view and more profitable by stimulating innovation and therefore growth and competitiveness.

Bezerra and Miller (2015) highlight an important historical moment to the environment, which is the disclosure of UN's report, in 1987, entitled 'Our Common Future', also known as 'Brundtland report', defending the concept of sustainable development, understood as 'that which satisfies the needs of current generations not compromising the capacity of future generations of satisfying their own needs'. These authors considering business activity, sustainable development contains four implications according to (Bezerra & Miller, 2015): focus on the economy of opportunity, easing access to the market and technological capabilities – access to credit, markets, technology; focus on an economy of conservation that encourages inclusion of environmental values in commercial practices; focus on an economy that promotes long term investments and real profits, instead of short term profit maximization; and; change in economy to a culture of savings, different from a culture of immediate consumption.

The solution or minimization of environmental problems requires a change of attitude and a different behavior of entrepreneurs, always involving the environment in their decisions and incorporating technological and managing conceptions, not being a problem but part of the solution, making some businesses reconsider environmental impact in their activities (Koskela, 2015). However, introducing this variable does not occur homogenously (Donaire, 2013), whether the consideration of the environmental variable is associated with the nature of the business or because it depends on the degree of awareness of the general administration in regards to the environment (Rezende, 2015).

Reducing its costs, businesses raise stakes of competitiveness that allows charging lower prices. Furthermore, conquering new markets, the consumer will be more conscious and well informed in spite of

their environmental belongings and ecologically healthy productive processes leading to business sustainability (*Serviço Brasileiro de Apoio às Micro e Pequenas Empresas* [Sebrae], 2015).

Many author, (Koskela, 2015; Sueyoshi & Goto, 2015; Rezende, 2015; Sebrae, 2015), discussed the concept of business sustainability and must be seen as an opportunity for new business affairs. Conciliating economic progress, social equity and environmental preservation can create good shares, image and reputation, as well as contributing for the growth and perenniality of businesses affairs. However, this new posture, towards preservation of ecosystems and environment, requires great effort, innovation and, above all, change. It also consists in the ability of a business to manage its activity and create long-term values while creating social and environmental benefits to its stakeholders (Business Council for Sustainable Development [BSCD], 2013).

However, it is important to notice that not all businesses possess necessary skills and ability to reconfigure their processes so they can reduce waste, replacement of materials and other activities that lead to a change in operations of the organization, especially micro and small businesses (Amato Neto, 2011). In the perspective of Nascimento (2012) and Rezende (2015), use the definition of 'Triple Bottom Line' to explain that an enterprise is sustainable when operating on stakeholder's present and future interests, granting business good health and survival and their respective economic, social and environmental dimensions.

At the same time interrelation between environmental and economic pillars occurs, the concept of eco-efficiency emerges, which is the main subject of this article. Socio-environmental justice occurs when an organization can integrate simultaneously social and environmental pillars and social interaction between social and economic dimensions. These relationships are represented in Figure 1.

Inherent to the theme of sustainable development is the idea of eco-efficiency, for being efficient is a priority to any business, but if along with the development of a greater economic value to the business mechanisms for the reduction of business impacts to the environment and for a more responsible exploit of productive resources is created, a more efficient stage is achieved, in this case, eco-efficiency (Munck et al., 2013). In this context, eco-efficiency becomes an integrating part of business sustainability (Rezende, 2015).

Eco-efficiency is a model of environmental management introduced in 1992 by the World Business Council for Sustainable Development (WBCSD), to describe the minimization of the environmental impact in the production of goods and services, through using less resources, producing less residue and pollution, in other words, creation of more value with less impact. It is a management strategy that combines environmental and economic performance and wants to satisfy human needs and manage quality of life while reducing progressively ecological impacts and intensity of use of resources along its cycle (Lehni, 2000). According to Koskela (2015), there is a relationship between strategy and eco-efficiency, where eco-efficiency identifies potential and improvement on the environment and explores opportunities of business through sustainable strategies. Eco-efficiency can even contribute with the attainment of greater values for products and services, reducing the amount of materials, energy and emissions, in other words, producing more for less, strengthening the business position in the market, opening new markets and avoiding critics from stakeholders, increasing the time of survival of the businesses (Pimenta, 2012).

The seven following objectives of eco-efficiency are defined by the WBCSD (Song, Zhang, & Wang, 2015):

- 'Reduce consumption of resources'. Consumption of material and energy must be reduced to a minimum through the improvement of recycling abilities.

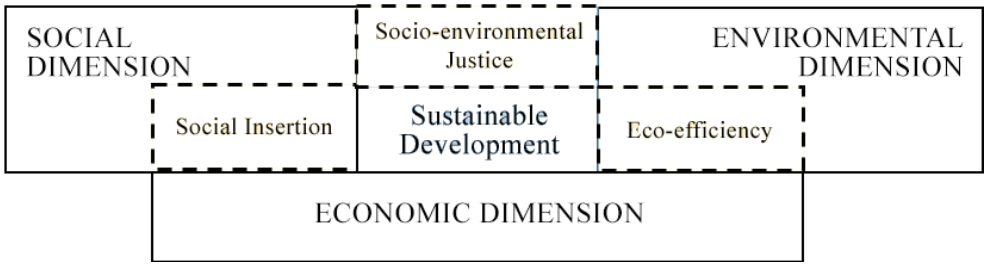

Figure 1. Elements of business sustainability. Source: self-adaptation based on the work of Munck et al. (2013).

- ‘Reduce the impact on nature’. Improvements can be obtained using renewable resources that are managed sustainably, as well as minimizing emissions, residue disposition and toxic substances.
- ‘Supply clients with products and services of higher quality’. The benefit to the client can be improved through making available additional services to the user, for instance, functionality and increasing global life span. However, it is important that the increasing benefit to the client do not interfere with the two aforementioned objectives.

In oil and gas productive chain, eco-efficiency can result in the mapping of economic aspects and environmental impacts identified down the chain (Pimenta, 2012). It also provides opportunities to rise along its production chain, through the following actions (Koskela, 2015):

- ‘Reengineering processes’: implies the reduction of consumption of resources and pollution, as well as lowering costs;
- ‘Sub product revaluation’: Wastes of a specific business can be run a second time for a secondary product. This cooperation produces a more efficient utilization of resources in the process, creating an additional financial benefit;
- ‘New product conception’: A more simplified conception process uses less material, thus facilitating in the future, to use and recycle;
- ‘Rethink the market’: Looking for better ways to attend the needs and expectations of the client.

Material and methods

Current research adopts as an object, the study of micro and small businesses (MBS) of the oil and gas productive chain of Rio Grande do Norte – Brazil that is part of the project ‘productive chain of oil, gas and energy in RN’, which provide services to Petrobras and are part of Redepetro RN. Data collection occurred from August to October of 2016, each being visited individually, totalizing 44 (forty-four) businesses.

The methodology of measurement for the eco-efficiency used to assess MBSs of the productive chain of oil and gas used a scale known as ‘CE7’ taxonomy, acronym referring to the ‘seven competencies of eco-efficiency[1]’ according Figure 2. A scale of measurement, according to Siena (2008), will be able to show the level of eco-efficiency development of businesses.

There are four stages of determining the level of efficiency of studied MBS in this thesis. They are described as the following methodological procedures:

Stage 1: identification of eco-efficiency supporting actions of MBSs.

The identification of eco-efficiency supporting actions of MBS is carried out through the verification form shown in Table 1.

Through Likert’s scale, with the options ‘always’; ‘very often’; ‘sometimes’ and ‘never’, it was identified the intensity of utilization of these techniques in the development of business activities for each individual variable.

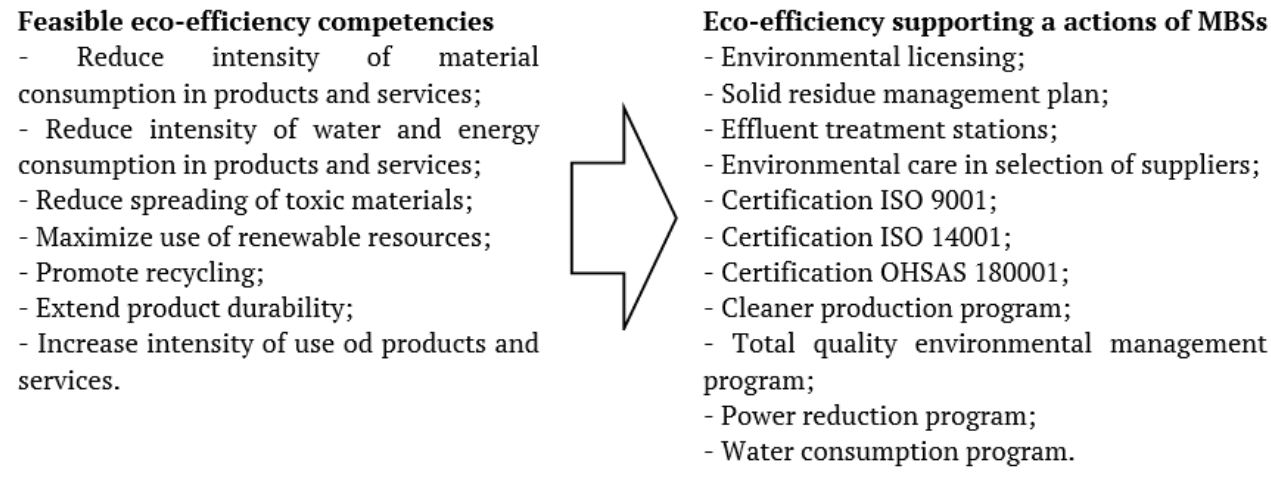

Figure 2. Eco-efficiency supporting competencies. Source: Self elaborated.

[1]Seven competences of eco-efficiency.

Table 1. Verification scale of eco-efficiency supporting actions.

Variables	Verification scale			
Environmental licensing	☐ Always	☐ Very often	☐ Sometimes	☐ Never
Solid residue management plan	☐ Always	☐ Very often	☐ Sometimes	☐ Never
Effluent treatment station	☐ Always	☐ Very often	☐ Sometimes	☐ Never
Reuse of treated effluent	☐ Always	☐ Very often	☐ Sometimes	☐ Never
Environmental care in selection of suppliers	☐ Always	☐ Very often	☐ Sometimes	☐ Never
Certification ISO 9001	☐ Always	☐ Very often	☐ Sometimes	☐ Never
Certification ISO 14001	☐ Always	☐ Very often	☐ Sometimes	☐ Never
Certification OHSAS 18001	☐ Always	☐ Very often	☐ Sometimes	☐ Never
Cleaner production program	☐ Always	☐ Very often	☐ Sometimes	☐ Never
Total quality environmental management program	☐ Always	☐ Very often	☐ Sometimes	☐ Never
Power reduction program	☐ Always	☐ Very often	☐ Sometimes	☐ Never
Water consumption program	☐ Always	☐ Very often	☐ Sometimes	☐ Never

Source: Self elaborated.

In the application of this type of scale, the items are selected, and for each of them it is attributed an affirmation based on which the evaluated must express a degree of agreement, which varies between total agreement and total disagreement (Costa, 2011). For each option, there is a score attributed, being so defined, according to the researcher criteria, due to the necessity of converting the options into quantitative units making evaluation possible, expressed as the following.

- 'Always', corresponds to 100 (one hundred) points, as maximum possible score;
- 'Very often', equals 75 (seventy-five) points;
- 'Sometimes', equals 25 (twenty-five) points;
- 'Never', refers to the lack of execution of the activity, obtaining 0 (zero) points.

The maximum score allowed by the verification form, in this study is 1,200 (One thousand and two hundred) points, for the twelve techniques verified with the maximum limit of 100 for each variable.

Stage 2: Statistical analysis of MBS.

The statistical analysis of the MBSs comprehends the verification of the individually obtained score from each business, and next, conduct the conversion of the representativeness of such scores.

The total score of each business corresponds to the total of items in the verification scale Equation 1:

$$\sum = v1 + v2 + v3 + v4 + v5 + v6 + v7 + \cdots + vn \qquad (1)$$

The representation corresponds to Equation 2:

$$Representativeness = \frac{\sum(v1 + v2 + v3 + \cdots + v12)}{\sum verification\ items} x100\% \qquad (2)$$

Stage 3: Transferring data to 'CE7' taxonomy.

Representativeness, in percentage, corresponds to the level of total delivery of the proposed business' eco-efficiency supporting actions, therefore, according to the resulting level, the MBS will be classified in accordance to the level of representativeness delivery, as shown in Figure 3.

Stage 4: Business eco-efficiency state verification.

Taxonomy CE7 is composed by the following configuration with a base of zero and an extreme of one hundred; 0 (zero) represents lack of delivery; 20, an insufficient delivery; 40 indicates a weak delivery; 60, a regular delivery; 80 represents a good delivery; and lastly 100 means a great delivery of organization towards hitting the target goal, thus developing the respective competence.

In the following analysis, it is verified that in the interval between 0 and 20 the business state is non-eco-efficient; between 21 and 40, almost non-eco-efficient; between 41 and 60 the organizational state is of intermediary eco-efficiency; between 61 and 80, almost eco-efficient; and, finally, between 81 and 100 the state is of complete development of the eco-efficiency focus competence, as shown in Figure 4.

Results and discussion

Regarding the size of businesses in the productive chain of oil and gas, 81.82% of them are small business and 18.18% Micro enterprises. The main stages of oil and gas productive chain where MBSs

operate more frequently are resale (27.27%), production (27.27%) and production development (20.45%).

Other stages in a lower percentage of occurrence are activities related to exploratory survey (13.64%), assessment and processing of exploratory data (13.64%), outflowing (6.82%), maintenance (6.82%), transportation (6.82%), exploratory interpretation (6.82%), machining (4.55%), refining (4.55%), reservoir studies (4.55%), delimitation of fields (4.55%), civil construction (2.27%), training of manpower (2.27%), electrical services (2.27%), communications (2.27%), pest control (2.27%), consulting (2.27%), insurance (2.27%) and distribution (2.27%).

Regarding environmental issues, the starting concern was to identify how many businesses have an environmental affairs sector, and it was observed that 52.39% of all these businesses lack a sector that deals with environmental affairs and 4.76% are deactivated.

The main difficulties for the implementation of an environmental management program are the lack of financial resources (37.50%), lack of planning (25.00%), lack of information about the program (25.00%), lack of technical orientation (20.83%) and lack of a professional level of formation (4.17%). In 41.67% MBSs the direction staff does not see the need of implementing a quality management program.

The environmental impact caused by these businesses is evaluated as meaningless, according to the opinion of 52.38% of entrepreneurs. Likewise, 35.72% evaluate the environmental impact caused by the business as of small significance, 9.52% as significant and 2.38% as of great significance.

The tools and strategies used for the improvement of business environmental management are: Power saving program (52.27%); Solid residue management plan (33.33%); environmental care in selecting suppliers (33.33%); water saving program (29.55%); environmental licensing (28.57%) and certification ISO 9001 (28.57%).

The eco-efficiency status of the MBSs in the oil and gas production chain is described in Figure 5, showing the total absence of eco-efficient companies. In the study, the best level of delivery was obtained from 'almost eco-efficient' companies and represents 4.55% of the MBSs.

The best level of eco-efficiency delivery was 'Almost efficient' for companies E5 and E16, which are the companies with the best level of eco-efficiency obtained. Regarding the level of eco-efficiency grouping, we have 59.09% of non-eco-efficient MBSs, 22.73% are almost non-eco-efficient, 13.64% are intermediate, and 4.55% are almost eco-efficient companies. No businesses with a great level of eco-efficiency were identified, which characterizes an eco-efficient business. Therefore, the MBSs of the oil and gas productive chain of Rio Grande do Norte are non eco-efficient.

In the present study, benchmark companies E5 (r = 75.00%) and E16 (r = 60.42%) were selected as having an 'almost eco-efficient' level of eco-efficiency with a great level of deliveries. The company E5 obtained a maximum score in nine of the twelve evaluated items. It has environmental licensing, has a solid residue management plan, and conducts effluent treatment. In the selection stage of suppliers, it is always concerned with environmental care in the selection process. It is ISO 9001 and OHSAS 18.001 certified and develops Cleaner Production programs, Total Quality Environmental Management program and energy efficiency program to improve environmental management.

Company E16 has environmental licensing and develops a solid residue management plan. It usually makes use of the effluent treatment plant and sometimes reuses treated effluents. It is always concerned with environmental care in the selection of suppliers. It is ISO 14001 certified and develops energy efficiency and water consumption programs efficiently. There is a need to start the process of obtaining ISO 9001 and OHSAS 18.000 certification, to improve the use of Cleaner Production practices, and to develop a total quality environmental management program.

The activities that contribute most to the eco-efficiency of the oil and gas production chain in the RN are power reduction programs, environmental care in the selection of suppliers, solid waste management plan and environmental licensing.

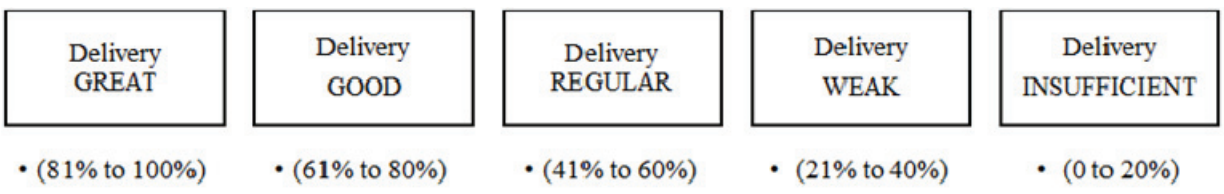

Figure 3. Classification of representativeness by level of delivery. Source: Self adaptation based on the work of Munck et al. (2012; 2013).

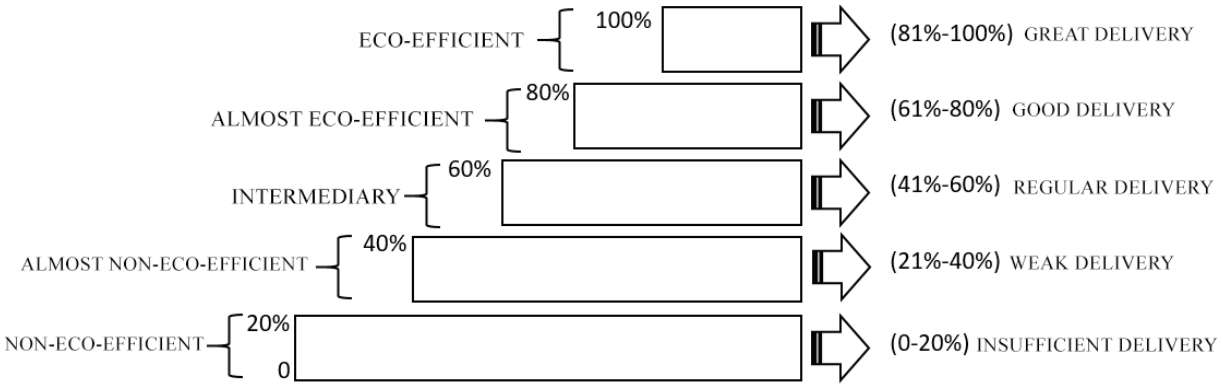

Figure 4. CE7 taxonomy. Source: Munck et al. (2012; 2013).

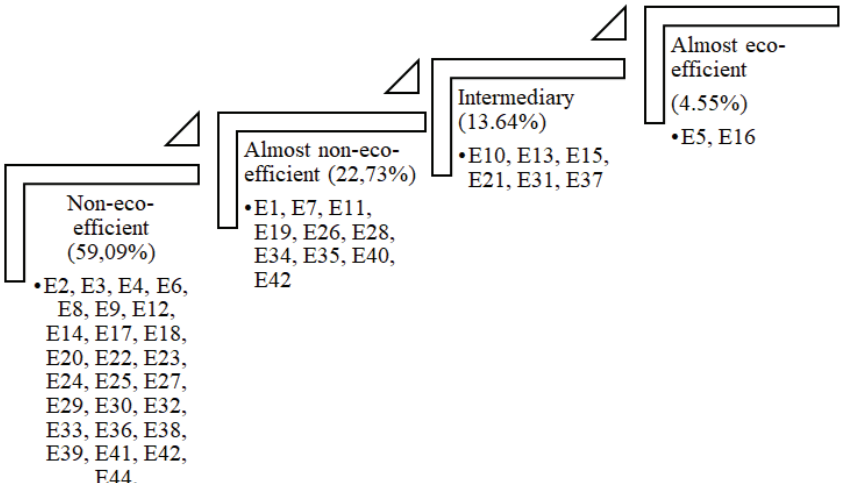

Figure 5. MBSs state of eco-efficiency in the oil and gas productive chain of RN-Brazil. Source: Field Research – October, 2016.

Conclusion

When we questioned whether eco-efficiency could be considered a properly institutionalized management tool in the reality of MBSs in the oil and gas productive chain of Rio Grande do Norte we can consider it negative.

To achieve the sustainability of micro and small companies, an action plan of activities with defined critical milestones was elaborated, addressing the importance of sustainable development through lectures and courses with employees and managers, individualized consultancy to install a responsible area to deal with environmental issues and finally, definition of environmental management actions that must be implemented to achieve eco-efficiency.

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