



Port environmental management: Innovations in a Brazilian public port

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Abstract

The purpose of this article was to identify the innovations developed at the Port of Rio Grande, according to the dimensions of the Oslo Manual, related to environmental management in the period 2010–2012. It also analyzed whether the possible innovations developed by the port relate to the assessment requirements of environmental management, proposed by ANTAQ. For this, we used a type of qualitative content analysis, with in-depth interviews applied to a population of thirty port managers, and a quantitative study which sought to examine whether the innovations obtained are related to the assessment requirements of environmental management. As a result, 45 innovations were identified, these being classified according to the Oslo Manual in: 2 product innovations; 14 process innovations; 5 marketing innovations; and 24 organizational innovations. Considering the frequency of occurrence of innovations in the sector, the requirement of ANTAQ implementing the environmental agenda presented the highest number of innovations, mainly related to process innovations.

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Introduction

In the evolution of relations between the city and the port, a set of changes can be seen, such as the reorganization of the environments and the emergence of the specific market (Monié & Vidal, 2006). Ports are institutions generating negative as well as positive impacts on the environment where they are located. Negative impacts are those that damage the environment, as for example, the changes in the movement of water and the marine ecosystem, problems caused by the effect of dredging, and the disposal of

residues. Positive impacts are noticed through local economic development, both regional and national, the generation of new jobs, investment by industries in local housing, an increase in specialized labor, and the installation of new companies (Crucey, 2006; Giner Fillol & Ripoll Feliu, 2009).

In the beginning of the 21st century, innovation became the key for profits and the market share in the business world. Innovations occur at a fast pace and become obsolete at the same pace, but governments only seek them when they need to organize the economy. The term innovation is difficult to define and even more to measure. Innovation can be considered as a creation of a product or an improvement of a process. Most of the successful entrepreneurs, though not the only ones to practice innovation, are still creating value by exploring some way of change in technology, materials, prices, taxes, demographic, or geopolitical issues (Carvalho, 2009; Mattos & Guimarães, 2005).

For a better definition of the term innovation, the Organization for Economic Co-operation and Development (OECD) and

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the European Commission, through a group of specialists from about 30 countries collecting and analyzing data about innovation, developed the Oslo Manual. The manual represents a tool, which addresses concepts, definitions and methodologies about the innovation process, and it aims to provide a structure where the existing research can evolve toward equivalence and help beginners. The manual also presents guidelines, which allow for the development of comparable innovation indicators in the countries of the Organization for the Economic Co-operation and Development (OECD, 2005).

Moving toward sustainability, several innovations adopted by an increasing number of companies have emerged, which include better production methods, decreased emissions and the search for environmentally friendly products or services. The ability of organizations to generate innovations that contribute to their competitiveness is called innovativeness, and comes from the decision-making carried out by companies, which also includes environmental issues (Krafta, 2008; Simon, 2008).

The Brazilian ports are undergoing a process of change aiming to increase competitiveness and the attention to aspects related to environmental actions, which are discussed by society more and more (Almeida, 2010). Giannetto (2004:47) affirms that, “the ports in Brazil need to build paradigms based on the most modern management tools, where respect for the worker, the environment, and the society must be imperative of changes.” Little by little, port managers are understanding the relevance of the relationship of their activity with the physical and social-economic space they take part in. Thus, it is a factor to be addressed within the planning, operational and commercial management of the port organization (ANTAQ, 2012).

This study had the Port of Rio Grande as its research object, being the southernmost seaport of Brazil. The referred port is located in the city of Rio Grande and has not only privileged natural characteristics but is also able to serve the ocean going vessels, as its access channel has great depth. The port has an excellent offer of transport infrastructure comprising road, waterways and airport modes. The multimodality of the Port of Rio Grande is an important factor in the reduction of costs and in the increase of logistic efficiency, aggregating more value to the goods going through its premises (Porto do Rio Grande, 2012; Quintana & Philomena, 2007).

According to Koehler (2008:61), “the reference point for the actions of environmental management in the Port of Rio Grande is the Operation Permit no. 03/97 issued by IBAMA in 1997, and renewed in 2005.” The environmental projects carried out in this port aim to comply with the conditions imposed by the permit.

In this sense, it must be observed that the ports cannot be isolated from the commercial reality of those using them, to avoid finding themselves disconnected from the social and environmental processes occurring inside and around the ports. For this, the incorporation of innovations in the processes becomes urgent and there is nothing more modern than the insertion of concepts and practices of environmental management. Therefore, the port modernization in Brazil will be incomplete while it does not face these challenges (Kitzmann, Asmus, & Koehler, 2014).

It should be noted that some improvements have occurred in the environmental area, such as the inclusion of environmental monitoring in the National Plan for Drainage. Although this aspect still represents only one environmental element being taken into consideration by the port administrations, other elements need to be observed from the aspect of strategic actions aimed toward the port environmental management (Lourenço & Asmus, 2015).

Situations like this in an environment of competition between ports, primarily those that are geographically close, might be a key point in the choice of where the handling of a certain product will occur. Therefore, the attention to port innovation becomes relevant, as the ports that are more environmentally prepared will obtain an extra advantage over the others (Kitzmann et al., 2014).

More specifically, considering the institutional aspect as the operational aspect, in the study of Lourenço and Asmus (2015), some of the weaknesses observed in the Environmental Management of the Port of Rio Grande were: the Port Administration (Superintendence) relation with the environmental agencies is still fragmented; the existence of bureaucratic issues compromising the flow and agility in the decision-making; little articulation between the Port Installations and Bonded Warehouse Licenses and the Organized Port License; lack of perception from some public servants as to environmental issues; discontinuity of staff of the Department of Environment, Safety and Health, causing management gaps; inadequate use or replacement of some conditions of the Environmental Permit, as is the case of the Environmental Monitoring Programs. In view of that, identifying innovations carried out in the Port of Rio Grande may be an important element of competitive differential.

In this sense, the general aim of this research was to identify the innovations developed in the Port of Rio Grande according to the dimensions of the Oslo Manual, related to environmental management. Moreover, this study intends to analyze if the possible innovations developed by the port are related to the evaluation requirements of environmental management proposed by ANTAQ.

In order to have sustainable and economic development in the port area, it is essential to identify which innovations are happening in environmental management.

In the historical context, the Port of Rio Grande was the first Brazilian port to obtain the Environmental Permit. The main factors to comply with the licensing requirements are related to the compliance with environmental conditioning factors; thus, the studies related to the environmental actions developed in the ports are relevant. According to Lourenço and Asmus (2011:1), “the licensing is an integral part of the process of environmental control that does not end with the granting of the permit for operating of the undertaking, but monitors and follows up its operation.”

The theme of the research focuses on innovation, in this case, delimited by aspects related to innovations in environmental management. The object of this study is the Port of Rio Grande, based on the actions developed by the Department of Environment, Health and Safety (DMASS) and the Port of Rio Grande Superintendence.

Theoretical foundation

The theoretical foundation addresses the main theoretical concepts required to develop the work, through research and knowledge already raised and published, establishing the evolution of the subject and, so, supporting the theme being studied.

Innovation

Schumpeter, considered as one of the classical economists of the economic development theory, emphasized the offer of goods as relevant in the clarification of economic development. He stated that, while entrepreneurs accept new products and processes, the economy would tend to grow (Souza, 2005). For Schumpeter (1982:47), “the development is a distinct phenomenon, completely strange to what can be observed in the circular flow or in the tendency for equilibrium,” that is, a spontaneous and continuous change in the flow channels, which alter the existing condition of equilibrium.

The economy today is more complex and dynamic than in previous years. Innovation has emerged as the only way of operation differentiation and continuity between the companies throughout time. In view of this need, it is important to respond quickly to the new economic changes in the market, looking for the assistance from tools that simplify the context of reality (Silva, 2011).

Alongside the great innovations, a chain of small innovations happens. For some time, the analysis of Schumpeter was interpreted as centered only in the great innovations, but today, the neo-Schumpeterians, such as Fremann, recognize the relevance between the interaction of the great and small innovations (Chu, 2009; Silva, 1984).

Innovation has been receiving greatest attention from the social scientists, administrators, and public policies generators, because it is the driving force for the new changes in the social, political, economic, and society arrangements. According to Cooper and Argyris (2003:733), innovation is:

(. . .) the creation and implementation of an idea that can be related to a technological innovation (new technical tools, mechanisms or products), of processes (new services, programs or production procedures), or administrative (new institutional policies, structures or systems) (2003:733).

The Oslo Manual (2005), one of the main references on the subject, emphasizes that innovation is relevant for the economy, as well as having particularities, which differentiate it from the other scientific and technological activities. The Manual conceptualizes innovation as being:

(. . .) the implementation of a product (good or service) new or significantly improved, or a process, or a new method of marketing, or a new organizational method in the practices of business, in the organization of the work place or in the outside relations (OECD, 2005:55).

By definition, innovation is a set of ideas, or a process initiated by the perception in the creation of or improvements in products/services, or in the processes, or in the marketing

methods, or in the business practices; whether this perception is in the work environment or in its relations in the search for success. In order to make innovation part of the daily routine of an organization it is relevant, not only to have its definition clear, but also to identify and categorize it, thus understanding its process and changing it into something manageable (Carvalho, 2009; Generosi, 2011; Sakamoto, 2011).

Innovation is important for all types and sizes of organizations, because according to Bessant and Tidd (2009:20), “if we do not change what we offer to the world (goods and services) and how we create and offer them, we are at risk of being overcome by others doing it. Ultimately, it is a matter of survival.” According to the authors, innovation is associated with growth, where new businesses are instituted from the new ideas, by the generation of competitive advantages in which an organization can offer.

Generally speaking, all companies must be aware of the competition. If an entrepreneur is not aware of the market changes, he/she will notice a reduction in the number of clients, because consumers are more and more informed and demanding. The competition between organizations is a powerful incentive for the entrepreneurs to take measures, with the intention of attracting clients, and the most relevant initiative is to keep prices low. Another incentive for the consumer is improvements in the product, that is, the innovations (Baker, 2007).

If the innovation improves the well-being of the user and has significant value, it makes sense to consider the effect of the public policy in innovation for the user. The innovation, both for the user and for a group, can represent a great part of economic investment. Therefore, the effort performed to offer investments in innovation to the users, is not always registered in government statistics, but effectively occurs in innovations of products and services (Hippel, 2005).

In China, one of the causes for the growth rate is the exploration of technological development, which imposes more and more a need to win the sophisticated markets of goods, with innovative and high technological contents. China is becoming the main provider of goods, supported by a flow of direct foreign investment in the sectors of high technology (Lora, 2007). For Lundvall (2009), innovation is seen as a result of a collision between technological opportunities and the needs of the users.

According to the Oslo Manual, the types of innovation have evolved over the three editions: OECD 1992, 1997, and 2005. In the first two editions (1992 and 1997), innovation was determined on the focus of the technological product and process (TPP) innovation. In the third edition, the Oslo Manual (2005) was divided into four parts: product innovations, process innovations, organizational innovations, and marketing innovations (OECD, 2005).

Environmental management

The factors leading to an action from the environmental agencies, which the ports and premises are required to follow, are set out in several legal instruments, such as conventions, conferences, laws, decrees, resolutions, among others. In view

of that, it is important to know these dispositions to delimit the scenario in which the environmental management develops itself.

Historical context of the environmental issues

The Industrial Revolution can be considered as a worsening mark of the impact of human activity upon the environment and human health. Pollution through smoke emitted by the coal burners turned London into an unhealthy city. One of the adverse reactions to this insalubrity occurred within the Romantic Movement at the end of the 18th century, which consisted of the return to nature. Despite this movement toward nature, the technological evolution and the development of science did not provoke in man the necessary concern about the environment. This questioning took greater proportions, around the 20th century with the II World War, after the excessive and constant use of natural resources without proper care (Granziera, 2009).

For Granziera (2009:22), “the subject took such proportions that the United Nations Organization (UNO) decided in 1968 to organize an international conference to handle the subject of the environment, to take place in 1972.”

According to Silva (2010), in view of a new projection of the right to life, the preservation of the environmental conditions, which are the basis of its own existence, is understood. This new right was recognized by the Declaration on Environment, adopted by the United Nations Conference in June 1972 in Stockholm; it is composed of 26 principles of the Universal Declaration of Human Rights.

In 1987, the World Commission on Environment and Development (WCED), founded by the UNO, produced a report that came to become a landmark on sustainable economic development, originally called “Our Common Future.” This report was known as the “Brundtland Report,” referring to the commission president at the time. It established that the signatory governments would commit to environmental preservation and disseminate the concept of “Sustainable Development” (Guimarães, 2008; Krafta, 2008).

The concept of sustainable development, according to Nascimento, Lemos, and Mello (2008) is simple, but its implications are intense. The broadest meaning of this concept is that the current model of life should be placed on a basis founded in income generation and not in the destruction of assets. The process of constructing development depends on the acts of each individual in his/her daily life.

Twenty years after the Declaration of Stockholm, the need for a new pact between countries occurred, resulting in an international convention that took place in Rio de Janeiro, June 3–14, 1992, “Eco-92” or “Rio-92.” Here, two important documents were established: (i) the Declaration of Rio de Janeiro on Environment and Development, where the term “Sustainable Development” was consecrated; (ii) the Agenda 21, that introduced an environmental protection program for the 21st century, addressing the following subjects: social and economic dimensions of development, preservation and management of natural resources, strengthening of the role of groups, and implementation (Granziera, 2009; Silva, 2010; Sirvinskas, 2010).

In 1997, a conference called Protocol of Kyoto occurred, with the participation of 39 developed countries, comprising goals and limits related to the decrease or restriction of future carbon dioxide emissions as well as other gases responsible for the greenhouse effect (Silva, 2010).

In 2002, the United Nations Organization promoted another worldwide event, the Environmental Conference RIO+10, to deal with and evaluate the successes and failures that occurred in the actions regarding the environment and sustainable development in the ten years following the Rio-92 Conference. The conference took place in Johannesburg, South Africa, with the participation of 190 countries. The subjects addressed were: access to clean and renewable energy; the greenhouse effect; biodiversity preservation; access to drinking water, sanitation, and harmful chemicals. The main goal set out among the countries was to decrease the population without access to drinking water and basic sanitation by fifty per cent by 2015 (Gallo et al., 2012; Granziera, 2009).

In June 2012, Brazil held the Rio+20 (Conference of the United Nations on Sustainable Development) marking the 20-year anniversary of the Earth Summit in 1992 (Rio-92). This conference gathered politicians, leaders of social movements, and representatives of companies from all over the world. One of the goals of the conference was to renew the commitment toward environmental development, prioritizing some areas: creation of jobs, food safety, water, energy, sustainable cities, oceans, and natural disasters. Other important components were the global environmental governance and the adequacy of current governance structures to deal with the environmental challenges. Scientific knowledge for sustainability has been growing, but concrete measures to reach sustainability have been happening slowly (Langlois, Campbell, Prieur-Richard, Karesh, & Daszak, 2012; Minayo, 2012; Otto-Zimmermann, 2012; Slippers & Kassen, 2012).

RIO+20 states in its final document, in referring to the oceans and the seas, that the countries taking part were asked to go forward in the implementation of the Global Action Program. The program is for the protection of the marine environment and land activities, including the continued creation of capacity, and resource mobilization to invest in the treatment of human wastes and wastewater. The countries were also asked to develop a global action plan to fight marine pollution. Another point refers to implementing an international network of observation of ocean acidification. In addition, to fight illegal fishing, recognizing that there is already an agreement on the measure to be developed by the ports in order to prevent, restrain, and eliminate illegal fishing (RIO+20, 2012).

The administration or management of the environment, or simply environmental management, can be defined as the guidelines and the administrative and operational activities developed to obtain positive results about the environment, such as planning, direction, control, allocation of resources, among others. These well-defined guidelines allow for the reduction and control of impacts, introduced by entrepreneurs, upon the environment. In order to make environmental management effective, it is necessary to be linked to the performance cycle, which takes place from the conception until the elimination of

wastes and/or pollutants caused by the organizations, as well as a permanent strategy capable of innovation (Barbieri, 2012; Rossetti, 2008).

Port environmental management

Today, the opportunities for a good port environmental management are favorable. On the other hand, there is an uncertain tendency by the Brazilian port system to institutionally adopt them, not only for technical or personnel issues, but also because it is greatly related to the Brazilian port culture. It is understood that it is possible to adopt environmental management practices with institutional and financial sustainability, supported by the parties concerned in the process, but this is not obvious (Kitzmann et al., 2014).

The port sector causes a number of impacts deriving from its multiplicity of activities, in which a great volume of the environmental areas is affected. Differently, in view of its geographic dispersion and of the importance in the economy, the environmental port performance has a relevant reflex at a national level. The insertion of these aspects in the management of ports is carried out through management practices and environmental performance evaluation, which provide the possibility of evaluating and measuring these impacts, and serve to collaborate in the processes of decision-making. However, there is not sufficient quantity of studies at a national level that seek to establish these relations (Nunes, 2015).

In the international context, the evolution of port environmental management, in particular in European and North-American ports, arise from multilateral initiatives or from managers of an isolated port. The American Association of Port Authorities – AAPA, who gathers port authorities from Canada, the Caribbean, Latin America and the United States, is responsible for relevant environmental actions, highlighting: the preparation of the Environmental Management Handbook, a guide with port management tools and practices linked to the prevention and remediation of environmental impacts; and, the creation of the Environmental Improvement Awards, which recognize and encourage activities focusing on environmental improvement, community engagement, and environmental management (Kitzmann et al., 2014).

Another essential point for the advancement of better environmental performances in the port systems is the insertion of environmental education, whether formally or informally, because then will there be an effective change in the actions of the port workers. It must be taken into consideration that the training activities and qualification of employers the companies carry out are informal education activities; so, these companies should also include environmental education in their management processes (Almeida, 2010).

In 2013, with the Law no. 12.815 (new Law of the Ports), some environmental elements were originally contemplated in the management of ports: the issuance of a reference term for the environmental studies aiming at the port premise; environmental monitoring as one of the National Program of Drainage activities; competence of the port administration in watching the execution of activities related to the environment. All of these

are innovative actions aiming at port environmental management (Lourenço & Asmus, 2015).

Methodology

The research method adopted in this work is the case study. According to Yin (2010:24), “as a research method, the case study is used in many situations, to contribute to our knowledge of individual, group, organizational, social and political phenomena and the like.” In this research, the case study was carried out in the Port of Rio Grande, located in the state of Rio Grande do Sul. The outlining of the research predicts the use of data collection techniques, such as in-depth interviews with the managers working in the port.

Building up research from a case study demands more attention and skills from the researcher than research with a conventional methodological approach, because in the case study, the procedures are not routinized. The essential factor for a case study to succeed depends on the persistence, creativity, and critical reasoning of the investigators to establish description and original explanations, allowing the careful extraction of conclusions (Martins & Theóphilo, 2009).

The study attempted to identify which innovations were developed in the Port of Rio Grande, as per the Oslo Manual dimensions, during the environmental management. Data was collected in in-depth interviews, through the application of a semi-structured questionnaire to a group of 30 managers of the port for three years. According to Oliveira (2003:71), the questionnaire is one of the most used data collection and research techniques, “the questionnaire consists of an ordered series of questions related to a central theme.”

The research tool was based on the work of Nodari (2010), in accordance with Cervo, Bervian, and Silva (2007:51), “the interview is not just a simple talk. It is a talk targeting at a defined objective: to collect data for the research through an interrogation of the informant.” Today, the interview has become an important tool for the social sciences researchers to obtain data, which are not found in documents and records. With that, the data is used for both the studies of facts and of cases.

This work is characterized by a type of descriptive research. According to Cervo et al. (2007:61), the descriptive research “observes, registers, analyses and correlates facts or phenomena (variable) without manipulating them,” depending on what is intended to be described, which are the innovations related to the environmental management of the Port of Rio Grande.

The descriptive research is characterized as an exploratory research, because part of its theoretical foundation refers to laws, rules, and resolutions, as well as by the innovative aspect of the environmental management in the port area. As per Gil (2007:43), “the main purpose of exploratory research is to develop, clarify and modify concepts and ideas, considering the formulation of more precious problems or hypotheses for further studies,” involving the bibliographic and documental collections.

According to Bardin (2011), content analysis is an empirical method, depending on the type of speech that is intended and

Evaluation requirements of the environmental management (ANTAQ)	Dimension of innovation (OSLO MANUAL)
Dependent variables	Independent variables
<ul style="list-style-type: none"> ✓ Execution of agreements ✓ Execution of environmental agendas ✓ Preparation of environmental studies ✓ Institution of environmental quality indicators ✓ Reduction of the environmental liabilities ✓ Strengthening of environmental awareness 	<ul style="list-style-type: none"> ✓ Product innovation ✓ Process innovation ✓ Organizational innovation ✓ Marketing innovation

Fig. 1. Dependent and independent variables.

Source: Own preparation.

the type of interpretation that is intended as the objective. For the author, there is no ready thing in content analysis; it seeks to know what is behind the words.

As per Vergara (2010:7), “content analysis is considered a technique for the treatment of data, aiming to identify what is being said regarding a certain subject.” For Martins and Theóphilo (2009), content analysis searches for the essence of a text in the details of the information, data, and evidence available, with the word as the object of study, in their individual and current aspects.

Through the content analysis, it was possible to identify the innovations in environmental management, which occurred in the Port of Rio Grande from 2010 to 2012. After the interviews were carried out, the transcribed texts were analyzed, attempting to interpret the information generated from the reports of the respondents.

Under the quantitative aspect, the intention was to analyze if the innovations obtained in the in-depth interview carried out with managers of the Port of Rio Grande, are related to the mid-term evaluation requirements of the environmental management, proposed by ANTAQ. These requirements are: (i) execution of agreements with technical and scientific institutions, for the constitution of a socio-ecological economic database, related to the port activity; (ii) execution of the environmental agendas, both local and institutional, regarding the Plan of Development and Zoning; (iii) preparation of environmental studies; (iv) institution of environmental quality indicators, supported by monitoring programs; (v) reduction of environmental liabilities; and (vi) strengthening of the environmental awareness of the port agents. For a better visual presentation of the requirements, they were presented respectively, as shown in Fig. 1.

The research has the task of discovering and expressing the relations between the phenomena that is the relation between the variables. The types of variables are emphasized by their importance: (i) the independent variables (x) is the factor, cause or precedent that determines the occurrence of the other phenomenon, effect or consequence; (ii) dependent variables (y) is the factor property, effect or result arising from the action of the independent variable (Cervo et al., 2007).

In this study, the independent variables are the dimensions of innovation, that is, of product, of process, of marketing, and organizational, as defined in the Oslo Manual. The evaluation requirements of the environmental management defined

by ANTAQ were determined as dependent variables. This entity aims to produce a general view of port environmental management in Brazil. ANTAQ, through the Management of Environment, has been making a series of routine visits to organized ports, together with their Port Administrations and the Regional Administrative Units, in order to evaluate the environmental management of those Administrations, responsible for the transit of cargoes destined to those ports. These visits intend to ascertain the condition of the port environmental management art, to indicate their strengths and weaknesses, and to outline measures for its improvement (ANTAQ, 2016).

In this sense, the intention was to verify if the compliance of the evaluation requirements of environmental management could be accomplished through the development of innovations. It was necessary to carry out a statistics test to check the dependence of the variables required by the evaluation of the environmental management, in relation to the occurrence of the innovations. To confirm this relation, the chi-square test was used which according to Fávero, Belfione, Silva, and Chan (2009:149), “can be used as an extension of the binominal test and is applied to a sample in which the nominal variable assumes two or more categories.”

Analysis and interpretation of results

This chapter addresses the description of the data collection operationalization, as well as the analysis and interpretation of the data.

Data was collected through individual in-depth interviews to 30 managers of the 13 sectors selected for this study, which enabled the identification of existing innovations, as stated in the methodology. The research tool used was a semi-structured questionnaire, aiming to identify the innovations classified in product and/or service, process, marketing and organizational, which occurred in the environmental area of the Port of Rio Grande.

At the time of the data collection, each respondent was informed that the research was confidential. For a better visual presentation of the sectors throughout the text of this work, the identification codes of the sectors used have been described in Fig. 2.

The identification of the sectors was outlined as per the information obtained from the Head of the Administrative

Port sectors	Identification code
Administration	Sector A
Warehouse and purchases	Sector B
Scales	Sector C
Department of environment, health and safety (DMASS)	Sector D
Department of information technology	Sector E
Supervision and watch keeping	Sector F
Garage and berthing	Sector G
General cargo import and export	Sector H
Dangerous cargo import and export	Sector I
Workshop	Sector J
Property	Sector K
Service specialized in safety engineering and occupational health (SESMT)	Sector L
Outsourced services	Sector M

Fig. 2. Rio Grande port sectors.

Source: Own preparation.

Department and the Head of the Department of Environment, Health and Safety of the port, as there is no formally detailed organizational chart. According to this information, the port has 42 sections comprising the 13 sectors described in Fig. 2.

Analysis and interpretation of interviews

In this stage, the study attempted to analyze and interpret the data coming from the individual in-depth interviews. For better progress, the interviews were scheduled in advance and carried out from October to November 2012, according to the availability of the respondents. The interviews lasted from 45 min to 1 h 10 min and were recorded by electronic means. At the moment of the interview, it was explained to the respondent the concepts of product, process, marketing and organizational innovations, according to the Oslo Manual (2005) definitions. To identify the information obtained, the interviews were further transcribed and analyzed through content analysis.

The innovations reported by the respondents concern the period of 2010 up to the date of the interviews. In the analysis of the in-depth interviews, a total of 45 innovations were identified, these being 2 product innovations (good or service), 14 process innovations, 5 marketing innovations, and 24 organizational innovations. These innovations were analyzed and validated by the head of the Department of Environment, Health and Safety for the Port of Rio Grande.

Next, the items characterizing the presence of innovations in the environmental management of the Port of Rio Grande are introduced.

Product innovation (good or service)

The study identified the introduction of two product innovations in the period of 2010–2012.

- 1) Purchase of new buoys. The red buoys are those which mark the access channel of the port's entrance and departure. It was identified as a product innovation in Sector J, in 2012;
- 2) Hiring of a company specialized to attend to the port's Emergency Plan. It was identified as a product innovation in Sector D and in Sector F.

Process innovations

Thirteen sectors of the port introduced process innovations from the conceptualization and understanding of the definition by the Oslo Manual; through the analysis of the in-depth interview, 14 innovations were identified. These correspond with the development of new means in the productive process, assuring more agility in the services rendered to their clients:

- 1) Water monitoring and treatment were described in 23% of the sectors;
- 2) Change of the cleaning service company was identified as process innovation in 2 sectors;
- 3) Investment in the port's scales sector was identified as innovation by Sector C in 2011;
- 4) Modernization of the access gates to the port consists of a process innovation;
- 5) Implementation of an electronic system for the entrance and departure of vehicles at the storage yards through the acquisition of electronic reading devices. With this type of reading, it will not be necessary to light the entire yard;
- 6) Evolution in the cleaning of the port, being reported as one of the main contributions to the effectiveness of the Plan of Solid Waste Management (PGRS), which consists of process innovations in 7 sectors;

- 7) Placement of protection barriers between the vessel and the pier at the moment of discharge. This innovation was identified by Sector F;
- 8) Traffic of trucks, only with tarpaulins, was identified as a process innovation for Sector F;
- 9) Limit in cargo height in the truck's trailer was a process innovation identified in Sector F;
- 10) Care with the wood in which the import cargo is stowed was identified as a process innovation in sector H;
- 11) The requirements necessary for the access to the port's entrance gates by the trucks which ensure cargo and pedestrian safety within the port, was characterized as a process innovation in Sector F;
- 12) Placement of detention barriers at the moment of the vessel's bunkering, was reported as process innovation;
- 13) Changing the internal pipelines of the port for water provision is a process innovation in 15% (2 sectors);
- 14) Painting of the crafts with antifouling paint was introduced and identified as a process innovation by Sector J. It enables a reduction in environmental impacts, representing 7% of the population.

Marketing innovations

Thirteen sectors of the port introduced marketing innovations and through the analysis of the in-depth interview, five innovations were identified from 2010 and 2012.

- 1) Taking the perception of the importance of environmental issues to all the sectors; action of internal marketing of the Department of Environment, Health and Safety, identified as a marketing innovation in 38% (5 sectors);
- 2) Creation of a blog, a tool to supplement one of the problems raised in the Dialogue Circles, working over the information and communication issue, was identified as a marketing innovation in 8% of the sectors (Sector D);
- 3) Planning of Sustainable Tourism Development project at the Molhes da Barra, an enterprise of the Port of Rio Grande together with NEMA (Center of Environmental Education and Monitoring) from FURG, created in 2012, was identified as a marketing innovation in Sector D, representing 8% of the population;
- 4) Port pier revitalization project, involving the paving of the entire pier was identified as a marketing innovation in 2012, in 15% (2 sectors) of the respondents;
- 5) An agreement of technical cooperation with the United Nations Organization for Education, Science and Culture (UNESCO) was identified in Sector D, as a marketing innovation.

Organizational innovations

Thirteen sectors of the port input organizational innovations, as per the definition of the Oslo Manual, and through the analysis of the in-depth interview, 24 innovations were identified from 2010 to 2012:

- 1) Creation of the Dialogue Circles, which are monthly meetings at the DMASS head office between the environmental educators and the responsible parties for each port sector, was identified as an organizational innovation in 23% (3 sectors);
- 2) Outsourcing of the washing of the port's internal use vehicles of internal use was identified as an organizational innovation in 15% of the sectors (2 sectors);
- 3) Acquisition of a collecting and scavenging machine (*bobcat*) by the port's cleaning service provider. The machine is small, with several wire brushes and as it passes by it pulls out the lawn between the paving stones. This was identified as an organizational innovation in 8% of the sectors (Sector M);
- 4) Care in the use of cleaning products was identified as an organizational innovation according to Sector M and Sector J;
- 5) Modernization of the port's Information System consists of organizational innovation in 38% (5 sectors);
- 6) The archival project. This is a joint project with FURG (Universidade Federal do Rio Grande), where the main idea is to dig up all that the port has, select the documents and organize the material. It was an organizational innovation for 15% of the sectors (Sector A and Sector K);
- 7) Creation of a collection about the environment in the library was an organizational innovation introduced and identified by Sector A, representing 8% of the population;
- 8) The attitude of not printing e-mails regarding the purchase requests was identified as organizational innovation in Sector B, representing 8% of the population;
- 9) Organization and maintenance in the storage of warehouse items, identified as innovation in Sector B, representing 8% of the population;
- 10) Reformulation of the Program of Environmental Education (PROEA). It is a pilot project at a national level of demand, and since its implantation in the Port of Rio Grande, was required by the other ports of Brazil. This innovation was identified as an organizational innovation in Sector D;
- 11) Creation of a technical team within the program of environmental education, identified as an organizational innovation by Sector D, representing 8% of the population;
- 12) Selection process of new environmental educators for the port, where they stopped allowing the random selection to actually having a selection in search of qualified professionals of the field. This innovation was identified as organizational innovation by Sector D in 2011, representing 8% of the population;
- 13) Implementation of the Paper-free Port, an initiative of the government through the SEP (Special Department of the Ports), to reduce bureaucracy in port actions, in accordance with the environment, introduced in 2012, and corresponded to an innovative identification carried out in 23% (Sector E, Sector F and Sector M);
- 14) Scheduling of the truck entrance in the port, identified as an organizational innovation in Sector E;
- 15) Reduction of paper use in the general cargo import sector, identified as organizational innovation by Sector H,

Table 1
Innovations by sector.

Sectors	Product innovation	Process innovation	Marketing innovation	Organizational innovation	Totals of innovations	%Totals
A	0	0	0	3	3	4.0%
B	0	4	1	4	9	12.1%
C	0	1	0	0	1	1.4%
D	1	0	4	7	12	16.3%
E	0	2	0	2	4	5.4%
F	1	6	1	1	9	12.1%
G	0	3	0	1	4	5.4%
H	0	1	0	3	4	5.4%
I	0	2	1	2	5	6.8%
J	1	1	2	4	8	10.8%
K	0	2	0	3	5	6.8%
L	0	1	0	0	1	1.4%
M	0	1	1	7	9	12.1%
Total	3	24	10	37	74	100.0%

enabling more agility in the internal service, as from an ecological awareness;

- 16) Improvements in the work environment conditions corresponding to the organizational innovation, identified in 15% of the sectors;
- 17) Change to reusable mechanical towels, identified in 2012 as an organizational innovation in 8% of the sectors;
- 18) Organization of the assets sector of the port, identified as an organizational innovation in 15% (2 sectors) of the respondents;
- 19) Mapping of all cesspools in the public port area. This innovation was identified as an organizational innovation by Sector M in 2012, representing 8% of the population;
- 20) Reuse of computer spare parts, identified as an organizational innovation, identified by Sector M, corresponding to 8% of the sectors;
- 21) Actions in the control of rodents, as many rats and noxious animals appear in the port, identified as an organizational innovation to 23% of the sectors (3 sectors);
- 22) Creation of a Council of Integrated Management. This innovation corresponded to 8% of the sectors as an organizational innovation;
- 23) Updates in legislations about environmental issues, identified as an organizational innovation in Sector A;
- 24) Implementation of an environmental action Plan of Potentialization for the Port of Rio Grande. Those actions contribute to the performance of important environmental programs, which, along with the qualification of the associated infrastructure and an integrated and committed management, should become a national reference for port environmental management. It was identified as an organizational innovation in Sector D, in 2012.

Lastly, a summary of the innovations that occurred in each sector is presented, enabling the analysis and interpretation of which sectors the innovations occurred in and what type of innovation, as described in Table 1.

Table 1 shows that Sector D was the unit where the highest number of innovations (12) occurred, highlighting the marketing

and organizational innovations. Sector D is the Department of Environment, Health and Safety (DMASS) of the Port, thus, as this unit is the closest to the environmental aspects, it was expected that it would be the place with the most innovations.

Analysis of the data on the possible relation between the innovations and the mid-term evaluation requirements of the environmental management proposed by ANTAQ

This stage of the study intended to analyze whether the innovations obtained in the in-depth interview, described by the managers of the Port of Rio Grande, relate to the mid-term evaluation requirements of the environmental management proposed by ANTAQ. The mid-term requirements were chosen because they are in accordance with the current stage of evaluation in which the Port of Rio Grande is at, in view of the stages regarding the development of the port environmental management process. According to ANTAQ, this evaluation (mid-term) arises from a second stage of the improvement process of the actions in the port environmental management in Brazil. This evaluation process consists of three stages: short-term requirements (1st stage), mid-term requirements (2nd stage) and long-term requirements (3rd stage).

The mid-term requirements are: (i) execution of agreements with technical and scientific institutions for the constitution of a socio-ecological economic database related to the port activity; (ii) execution of the environmental agendas, both local and institutional, regarding the Plan of Development and Zoning; (iii) preparation of environmental studies; (iv) institution of environmental quality indicators, supported by monitoring programs; (v) reduction of environmental liabilities; and (vi) strengthening the environmental awareness of port agents. These requirements represent the dependent variables of the study. For the definition of the independent variables, the innovations obtained in the interviews were grouped according to its suitability to the corresponding requirements, as presented in Fig. 3. To allow for the identification of the relations between the variables, the frequency of occurrence of the innovations in several sectors was assessed, as shown in Table 2.

Evaluation requirements of the environmental management (ANTAQ)	Dimensions of innovation (OSLO MANUAL)	
Dependent variables	Independent variables	
Execution of agreements	Product innovation	Hiring of a company specialized to attend to the port's emergency plan
	Marketing innovation	An agreement of technical cooperation with the united nations organization for education, science and culture (UNESCO)
	Organizational innovation	Archival project Implementation of an environmental action plan of potentialization for the port of rio grande
Execution of environmental agendas	Process innovation	Changing the internal pipelines of the port for water provision
		Water monitoring and treatment
		Change of the cleaning service company
		Modernization of the access gates to the port
		Evolution in the cleaning of the port
		Placement of protection barriers between the vessel and the pier at the moment of discharge
		Traffic of trucks, only with tarpaulins
		Limit in cargo height in the truck's trailer
		Care with the wood in which the import cargo is stowed
		The requirements necessary for the access to the port's entrance gates by the trucks
	Placement of detention barriers at the moment of the vessel's bunkering	
	Organizational innovation	Modernization of the port's information system
		Reformulation of the program of environmental education (PROEA)
		Selection process of new environmental educators
Implementation of the paper-free port		
Creation of a council of integrated management		
Preparation of the environmental studies	Organizational innovation	Creation of a technical team within the program of environmental education Mapping of all cesspools in the public port area
	Marketing innovation	Planning of sustainable tourism development project at the molhes da barra Port pier revitalization project
Reduction of the environmental liabilities	Product innovation	Purchase of new buoys
	Process innovation	Investment in the port's scales sector
		Implementation of an electronic system for the entrance and departure of vehicles at the storage yards
		Painting of the crafts with antifouling paint
	Organizational innovation	Outsourcing of the washing of the port's internal use vehicles of internal use
		Acquisition of a collecting and scavenging machine
		Care in the use of cleaning products
		The attitude of not printing e-mails regarding the purchase requests
		Organization and maintenance in the storage of warehouse items
		Scheduling of the truck entrance in the port
		Reduction of paper use in the general cargo import sector
		Change to reusable mechanical towels
		Organization of the assets sector of the port
		Reuse of computer spare parts
Actions in the control of rodents		
Strengthening of environmental awareness	Marketing innovation	Creation of a blog Taking the perception of the importance of environmental issues to all the sectors
	Organizational innovation	Improvements in the work environment conditions
		Creation of a collection about the environment in the library
		Creation of the dialogue circles
		Updates in legislations about environmental issues

Fig. 3. Dependent versus independent variables.

Source: Own preparation.

Table 2

Results of the frequencies matrix in the relation between innovations and the evaluation requirements of environmental management.

ANTAQ requirements	<i>f</i> of product innovation	<i>f</i> of process innovation	<i>f</i> of marketing innovation	<i>f</i> of organizational innovation	<i>f</i> of total innovations	% of total innovations
Execution of agreements	2	0	1	3	6	8.1%
Execution of environmental agendas	0	21	0	9	30	40.5%
Preparation of environmental studies	0	0	0	2	2	2.7%
Institution of environmental quality indicators	0	0	3	0	3	4.1%
Reduction of environmental liabilities	1	3	0	16	20	27.0%
Strengthening of environmental awareness	0	0	6	7	13	17.6%
Total	3	24	10	37	74	100.0%

Source: Own preparation.

f, frequency.

As per the information obtained in the interviews, in relation to the number of innovations, by aggregating the frequency of occurrence of the innovations in different sectors, it was possible to prepare Table 2.

In this study, the matrix was carried out to identify the relations between the qualitative variables, through the chi-squared test (χ^2_{cal}), of the evaluation requirements of the environmental management from ANTAQ, with the dimensions of the product, process, marketing and organizational innovation.

In this sense, the frequencies (*f*) of occurrence of the innovations were assessed, with the intention of comparing the proportions in the 13 sectors of the port, considering whether they significantly deviate or not from the frequency with which they are expected. From the results presented in Table 2, using the *Software Stata* 12, the $\chi^2_{cal} = 80.1479$ with $p < 0.0001$ was obtained, confirming the presence of a high relation between the requirements of evaluation in the Environmental Management of ANTAQ and the types of innovations, identifying that there is a dependence between the variables.

In Table 2, considering the frequencies, it is noted that of the innovations, which have occurred in the port sectors, the organizational innovations represent 50%, and the highest occurrence (43.24%) refers to the reduction of environmental liabilities. According to Damanpour (1991:557), “innovation is a way of changing an organization, whether it be an answer to a change in its internal or external environment, or as a preventative action taken to influence an environment.” In this sense, the organizational innovations contribute to the port so that it can accomplish the obligations with nature and with society, collaborating to promote investments in the benefit of the environment. This situation represents a differential for the Port of Rio Grande, because as exposed by Kitzmann et al. (2014), the innovations might be a key point in the choice of where the handling of a certain product will occur. In view of this, the attention to port innovation becomes fundamental, as the ports that are more environmentally prepared will obtain an extra advantage over the others (Kitzmann et al., 2014).

Product innovations have the lowest portion of total innovations with 4.11%, with the execution of agreements having the largest occurrence (66.66%). This means that the hiring of a qualified company to execute the Emergency Plan of the port represents a relevant action in the process of environmental management. According to Den Hertong, Van Der Aa, and Jong

(2010), the service providers can innovate according to a new concept of service, new interaction with the client, and with new business partners.

The process innovations represent 32.88%, where the highest occurrence (87.5%) is in the requirement of the execution of environmental agendas. According to Solow (1956) and Romer (1986), innovations are of a technical character, which present changes in the production methods and processes. These might have been provoked by the capacity of the technology and information area, while Mossini (2005) affirms that the Port Environmental Agenda shows concern about the formation of human and technological resources. It is evident, therefore, as to the aspect of technology use, the relation between the process innovations and the execution requirement of the environmental agenda.

Finally, the marketing innovations represent 13.70%, with the highest occurrence in the issue of strengthening environmental awareness (60%), leading all sectors to the perception of the importance of environmental issues, an essential element in the intraport actions, which reflect in the view the port managers have in relation to environmental management. Kitzmann (2009) confirms that the implementation of the port environmental management is linked to the initiatives of Environmental Education, both by private entities and by the government.

Conclusions

This present study sought to identify the innovations in environmental management developed in the Port of Rio Grande, according to the dimensions of the Oslo Manual. Therefore, from the in-depth interviews with the port managers, it was possible to identify which are the innovations in environmental management that occurred in the port from 2010 to 2012. Forty-five innovations were identified and classified according to the Oslo Manual in: 2 product innovations; 14 process innovations; 5 marketing innovations; and 24 organizational innovations, identified and validated by the head of the Department of Environment, Health and Safety for the Port of Rio Grande.

As can be seen, the organizational innovations represent over fifty per cent of the innovations found in the port, significantly proving that the Port of Rio Grande is developing new environmental methods for the organization of its routine and procedures, reflecting in the improvement of its port

environmental management. In this regard, the implementation of computer system modernization is emphasized, contributing to all the port's operation activities, mainly in the sense of providing on-line information about port movement for the control and supervision departments. Therefore, the organizational innovations bring a differential to the Port of Rio Grande.

Another objective of this study was to analyze if the possible innovations developed by the port relate to the evaluation requirements of the environmental management proposed by ANTAQ. In order to do that, the matrix was carried out to identify the relations between the qualitative variables, through the chi-squared test (χ^2_{cal}), of the evaluation requirements of the Environmental Management from ANTAQ, with the dimensions of innovation, according to Oslo Manual, obtaining as a result a high relation.

Considering the frequency of occurrence of the innovations in the sectors, the requirement "execution of the environmental agenda" presented the largest number of innovations, mainly related to the process innovations.

Among the innovations identified in the port sectors, it is observed that the organizational innovations had the highest incidence with 53% of the total of innovations identified. In addition, it is noticed that considering the frequency of innovations in the sectors, the organizational innovations had a higher percentage, resulting in 50%. The largest occurrence of organizational innovations took place in the requirement "reduction of environmental liabilities." The changes caused by the organizational innovations bring reductions to the environmental liabilities generated by the port, thus contributing to the compliance with the obligations with nature and society.

Product innovations have a lower portion of the total innovations, and the greatest portion of these innovations is related to the requirement "execution of agreements," with emphasis in the hiring of a specialized company for the performance of the Emergency Plan of the port, representing a relevant action in the process of environmental management. Considering the port as being a service provider, the hiring of a specialized company to attend the Emergency Plan represents a product innovation, to be considered both for the interaction with clients and to new partners.

Another important point in this study is the marketing innovations. They are related to the issue of "strengthening environmental awareness," which means to take the perception of the importance of the environmental issues in port activities to all the sectors. The Port of Rio Grande was the first national port to implement the Program of Environmental Education through transformative and innovative actions, contributing to the effectiveness of the environmental management.

As a contribution of the study, it should be highlighted what Kitzmann et al. (2014) exposed, that the incorporation of innovations in the port processes has become urgent. In this sense, this study shows that these innovations are occurring in the port sector, especially in the port analyzed and thus, bringing new concepts about environmental management in the port area.

In relation to the limitations of this study, it is important to highlight that this is a case study, consequently, the conclusions refer to this case, and it cannot necessarily be determined as a

general rule. However, there were no limitations in relation to the information collection in the Port of Rio Grande.

As an opportunity for further studies, it is observed that there is the need to apply this same study in the main Brazilian ports with the intention of elaborating a general view about the innovations in port environmental management in Brazil. This further study can serve as a parameter for comparison with international studies related to the more developed ports in environmental issue.

Conflicts of interest

The authors declare no conflicts of interest.

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