GESTÃO & PRODUÇÃO

ISSN 0104-530X (Print)
ISSN 1806-9649 (Online)

ORIGINAL ARTICLE

From enthusiasts to systematic innovation: the journey of building the innovation function in a large industrial organization

De entusiastas à inovação sistematizada: uma jornada da construção da função inovação em uma organização industrial de grande porte

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How to cite: Melo, J. C. F., Bagno, R. B., Rio, B. C. P., Salerno, M. S., Dias, A. V. C., & Freitas, J. S. (2021). From enthusiasts to systematic innovation: the journey of building the innovation function in a large industrial organization. *Gestão & Produção*, 28(2), e5197. https://doi.org/10.1590/1806-9649-2020v28e5197

Abstract: The creation of a management system to systematically promote innovation is a great challenge for large companies. Some authors argue for the creation of a dedicated organizational function (the Innovation Function – IF) to guide this system. This paper aims to understand how a large company builds an Innovation Function from a longitudinal and retrospective case study. Some aspects regarding the emergence of the IF, its organizational structure evolution, and changes on its team's scope of action are discussed. The main results highlight the importance of key actors for IF's recognition by the organization, serving as connecting mediators to other functions and external agents. Besides that, specific competence accumulation, gradual legitimacy acquisition, and project intermediary results enabled the team to deal with radical innovation projects over time.

Keywords: Innovation; Innovation Management; Innovation Management System; Innovation Function.

Resumo: A criação de um sistema de gestão para a geração de inovações de forma recorrente ainda é um desafio para as grandes empresas. Alguns autores defendem a constituição de uma função organizacional dedicada (i.e. Função Inovação – FI) para efetivar esse sistema. Este trabalho busca compreender como se dá a construção da Função Inovação em organizações de grande porte a partir de um Estudo de Caso longitudinal e retrospectivo. Discutem-se aspectos relacionados ao surgimento da FI, destacando a evolução de sua estrutura organizacional e as

Received Feb. 3, 2019 - Accepted July 26, 2019
Financial support: (i) Grant 2015/26662-5, São Paulo Research Foundation (FAPESP); (ii) Grant PRPq/UFMG 11/2017 - "Programa Institucional de Auxílio à Pesquisa de Docentes Recém-Contratados of Universidade Federal de Minas Gerais (UFMG)"; (iii) Grant 420126/2018-0, National Council for Scientific and Technological Development – CNPq; (iv) Grant 23072.057271/2018-26, from IEBT.

alterações em seu escopo de trabalho. Dentre os principais resultados, demonstra-se que a atuação de indivíduos-chave como pontos de conexão com outras instâncias organizacionais e a colaboração com agentes externos foram determinantes para o reconhecimento da FI pela organização. Além disso, o acúmulo de competências específicas, o ganho progressivo de legitimidade e a entrega de resultados intermediários habilitam esse time para lidar com projetos de inovação radical.

Palavras-chave: Inovação; Gestão da Inovação; Sistema de Gestão; Função Inovação.

1 Introduction

There is no single way for industries to organize to innovate given that the sources of opportunities are distinct, even for those belonging to the same industry or sector (Pavitt, 1984). Figueiredo (2002) highlights the cumulative paths of technology in which firms move from routine capabilities (*i.e.* to use or operate certain technologies and production systems) to innovative ones (*i.e.* to adapt and / or develop technological innovations). Bagno et al. (2017a) emphasize the contribution of management models to achieve this goal, especially those considered "capability-focused", in which the focus is on radical innovations. Systems for the management of radical innovations would count on a set of underlying managerial elements (*e.g.* people and responsibilities, leadership, culture) that, if well concatenated, support the occurrence of radical innovations in a regular and systematic way (*i.e.* generation of ideas, development, launch) - (Goffin & Mitchell, 2010; O'Connor et al., 2008).

Despite the advances in the literature on the innovation management theme, some gaps stand out. First, relevant part of the studies presents what would be the constituent elements of an innovation management system, but they do not emphasize how to build such capability, in a processual way (Bagno et al., 2017b). Second, studies considered to be more procedural (similar to this paper), such as Börjesson et al. (2014), normally focus on a different level of analysis (*e.g.* the creation of new business units or R&D Centers) and pay little attention to the actions performed by individuals, from a micro perspective. Chiaroni et al. (2011) report a process of organizational change in an Italian cement industry from dispersed efforts till institutionalized open innovation practices, but the study is strictly focused on open innovation. O'Connor et al. (2008) argue that building a system for managing radical innovations relies on three major stages: stage preparation, initiation, and maturation. However, this study offers few prescriptive guidelines for the implementation process. Bagno et al. (2017b), in turn, discuss the concept of the "Innovation Function" from the experience of 15 Brazilian companies, but do not present details about the construction process of IF in these companies. Finally, from a methodological point of view, Kouamé & Langley (2018) call for process-oriented research that explores the connections between organizations' macro (*e.g.* strategic aspects, organizational changes) and micro (*e.g.* individuals, projects) levels.

For O'Connor (2012), these radical innovation management systems in large companies should be driven by a recognized group in the organization, whose mission is to create new business platforms for the company - the "Innovation Function" (FI). Bagno et al. (2017b) point out that, in large Brazilian industrial companies, innovation management activities suffer from the lack of legitimacy within the organization and there is a constant dispute for resources against the current operational activities. In this sense, the central question of this research is: "How do large industrial organizations build a dedicated function to the management of innovations?".

In order to answer the research question, a single Case Study was carried out in a large electro-electronic company, based on a procedural and retrospective approach. We present the history of this organization over six years in the construction of a dedicated function to the management of innovations, from the designation of a collaborator to assume such mission until the formalization of a department with more than 10 employees, responsible for a portfolio, at the end of the period, of 12 projects (total amount of approximately R$15 million). The study supports the advancement of theory by evidencing the relationship between the role of key individuals and their gradual accumulation of skills (micro level) for the creation of a new organizational structure dedicated to innovation management (macro level). In addition, it is discussed how the gain of legitimacy from intermediary /marginal outcomes in the execution of innovation projects helps to reshape the management team's scope of work (*i.e.* from incremental innovations to more radical innovations).

2 Theoretical framework

2.1 The Innovation Function (IF)

O'Connor et al. (2008) define an innovation management system through the following constituent elements: (i) Mandate and responsibilities - objectives and mission of the system; (ii) Structure and processes - (Report to whom?; location; Hierarchical or flat organization?; Rigid or flexible?"); (iii) Resources and knowledge - ability to attract and develop staff with appropriate knowledge and skills; (iv) Leadership and governance (*e.g.* "How are decisions made?"; "Who takes them?"); (v) Metrics and reward systems. To conduct this management system, O'Connor et al. (2018) propose the constitution of a specific team, with well-defined roles (*e.g.* from platform leaders to independent boards) - the Innovation Function (IF).

Lawrence & Lorsch (1967) argue that to be recognized in the organizational environment, an organizational function must differentiate itself from the others, but at the same time, it must be integrated with the mainstream to support the organization's central objective. Supported by this concept, Salerno & Gomes (2018) define an organizational function as a perennial entity, formally recognized in the company, with responsibility for a specific assignment or mandate related to the company's mission, which implies having a core base of knowledge.

The Innovation Function (IF) is considered to be in its early days, but it has been recognized in some organizations, especially through the increasing formalization of positions and roles for the management of innovation in mature companies (O'Connor, 2012; O'Connor et al., 2018, 2008). For O'Connor (2012), IF is responsible for creating new growth platforms in companies and for fostering completely new benefits for the market. Salerno & Gomes (2018, p. 87) argue that functional arrangement is adequate for systematizing the generation of radical innovations because it is the "[...] best organizational mechanism for the accumulation of explicit and tacit knowledge regarding a theme." The function consolidates knowledge, since it has a specific mandate on which it articulates its own resources, independent from specific orders or clients - it is a reference for subjects related to its field of knowledge.

For O'Connor et al. (2008), a specific person should take over the leadership role of the IF: the "Orchestrator". This agent would be responsible for monitoring the mandate, in order to guarantee that the system does not tend, under pressure, to gravitate towards

opportunities that are more aligned to the current business or to short-term demands (*i.e.* incremental innovations). In addition, it would lead the projects transition during the development process so that, for example, initiatives with acceptable commercial results are not launched without proper preparation. In addition, the orchestrator should be responsible for managing the necessary interfaces within the organization as a whole (senior management, other corporate functions, project teams) in order to gain legitimacy and to ensure that resources are available for the IF core activities.

O'Connor et al. (2018) argues that the Orchestrator and the Chief Innovation Officer (CIO/CNO) work together to nurture and manage the company's innovation portfolio, but that other roles are critical to the Innovation Function (*e.g.* Opportunity Generator, Functional Manager, New Business Platforms Leader, Directors of Incubation and Acceleration, Innovation Council). Salerno & Gomes (2018) argue that the FI does not have all the resources needed to comply with its mission (*i.e.* to identify, structure, nurture and manage a radical innovation portfolio). In this sense, the IF should act in a network (*i.e.* "networked-function"), in that part of their activities come to be done by other people in the company (*e.g.* acceleration with the process engineering sector, experimentation together with the R&D team).

Bagno et al. (2017b) investigated 15 Brazilian industries with a typical IF arrangement where a central team was in charge of certain assignments (*e.g.* finding tax and other funding opportunities, portfolio and project management, partnership building, knowledge development, among others) that characterizes the IF and make it identifiable in the organizational environment. Three instances would be associated with this team, supporting the work guidance, catalyzing internal connections or even assuming complementary responsibilities: (i) the strategic committee; (ii) focal points - people formally allocated in other functions, but working part-time as extensions of IF core team; (iii) and project teams - temporary structures working directly on the innovation projects. Specifically, de Melo & Bagno (2017) discuss how the development of the IF core team's assignments impacts the consolidation of IF in the organizational environment.

2.2 The process of building an innovative capability

Companies begin employing their efforts in creating a capability to generate innovations systematically for diverse reasons. However, in the view of O'Connor et al. (2008), there is always a central motivation or a trigger event (*e.g.* strategic growth, financial return, technology strategy, need for skill development, product/business diversification and defense current business). In the case of Brazilian companies, Bagno et al. (2017b) suggest that IF origins from: previous projects or other initiatives related to innovation; facts around political and economic contexts (public policies, funding opportunities or existing infrastructure of Science and Technology); avoidance of commoditization and obsolescence; and business diversification to take advantage of the available technological assets.

At the beginning of the process of implementing an innovation management system, the company tends to seek for opportunities in close proximity to the current businesses, in order to apply available knowledge or to bring noble technologies to the current markets (O'Connor et al., 2008). This situation happened at Renault, where an "Innovation Logic" research department was created in 2004, involving academia to adapt governance rules, processes and innovation management tools. This initiative was carried out to optimize the range of existing products (Börjesson et al., 2014). These activities corresponded to what O'Connor et al. (2008) set as the first step of the

process, the “stage preparation”. At this stage, the mandate, scope and objectives of the new organizational function are clarified. Initially, groups start small and their perpetuity depends on top management support, even if the groups were not designed by them (Börjesson et al., 2014; O’Connor et al., 2008).

The challenge of building a capability for innovation is strongly related to change management and, therefore, to overcoming organizational resistance and the predominant mentality of some impacted individuals (Eisenhardt & Martin, 2000). Chiaroni et al. (2011) associate the first phase as an “unfreezing” exercise in which a sense of urgency for change is created. At this moment, in the case these authors discuss, social networks between the actors were created, the commitment of the top management was sought to support the change, and a committee of external experts was established to evaluate the innovation projects. Both companies studied by Börjesson et al. (2014) can be described as “restricted” in O’Connor et al. (2008)’ perspective as they were under constant pressure for short-term results with economic outcomes.

Companies don’t need to start by developing all their innovation competences at the same time (O’Connor et al., 2008). This choice should be based on specific organizational gaps. If there are no projects, the focus should be on discovery activities. But for example, if small businesses with some potential are already in place, more effort should be devoted to business acceleration. The successes in the management of innovation projects and their subsequent activities end up leading to a cultural change. Thus, they give legitimacy to the “need to work differently” (Börjesson et al., 2014).

Chiaroni et al. (2011) highlight that, after the initial stage, companies undergo a “moving” phase. In their specific case in a Cement company, external networks at the firm level were built to explore new ideas, and a dedicated department was set up to coordinate collaborative research projects. The studied company adopted formal procedures for the identification of external sources of knowledge as well as technical solutions developed by universities for projects. In O’Connor et al. (2008)’s point of view, after the “preparation of the terrain”, an “initiation” phase is started, focusing on the construction of a capability (and not just a process) where the whole management system is put into practice. It focuses on the creation of an innovation-based culture, either by promoting workshops of ideation, by defining vocabulary for innovation and by seeking the people (leaders and staff) who will be involved in the new mission. Another point highlighted by the authors is that, at this moment, an internal infrastructure is defined (*i.e.* to whom the group reports, where it is physically located) and the group starts the search for an initial subset of projects, especially those in that the team already has some kind of experience.

Bagno et al. (2017b) point out that short-term results carried by the IF minimize internal friction as well as the diffusion of the IF’s efforts to other areas of the company. In Börjesson et al. (2014)’s study, while projects were useful to evidence results, it was difficult to persuade the organization to adopt new ways of working. The study demonstrated that the direct operation of the portfolio has become a tool to achieve a second goal of the managers (*i.e.* to build the capability to innovate systemically).

The innovation management system only reaches maturity after the systematization of some processes like initiation, support and reward for its activities. For O’Connor et al. (2008), this maturity is achieved through the consolidation of the new organizational function (the Innovation Function), in a company. IF must be identifiable and measurable, in a way that it may be testified by rich interfaces and/or strong networks both internal and external, defined governance in project and portfolio levels, availability of appropriate metrics, and the rising of a culture / leadership that values innovation. In an analogous way, the changes in the organization as those presented by Chiaroni et al. (2011) get consolidated (*i.e.* the “institutionalization” phase) when:

the company establishes formal long-term collaborations with universities and research centers; formal roles are created (*e.g.* gatekeeper, innovation champions for the main research areas); performance metrics are in place for project managers as well as a defined policy for Intellectual Property (IP) is implemented.

Figure 1 tries to articulate the concepts of the presented theoretical approaches in a framework that represents the macroprocess for the creation of a systematic innovation capability. It is organized in three main phases: the beginning; intermediary phase; and maturity. This framework will support the evaluation of the case in the "Discussions" topic.

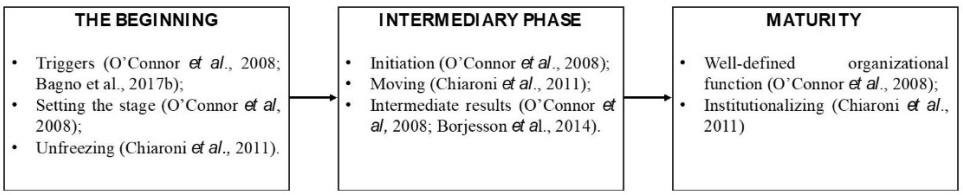

Figure 1. Theoretical Framework. Source: The authors.

3 Methodology

We conducted a single case study, based on a process approach - *i.e.* taking seriously the temporal sequence between events (Langley, 1999). Events can be defined as actions of a given agent on a given object at a specific moment in time (Heise & Durig, 1997), and may include decisions, meetings, conversations, or even a simple handshake (Langley, 1999). The case selected for the study was considered a rare one (Yin, 2017) due the scarcity, in the Brazilian context, of large organizations adopting the IF perspective (Bagno et al., 2017b). An in-depth intra-case analysis is considered to be more adequate when the object of the research refers to a processual phenomenon (Mahoney, 2000).

The case under analysis was an organization of the energy and automation systems sector - hereafter, the "ORT". During the period of the study, this company had 3,000 direct employees and revenues of R$ 1bi / year. Its field of activity covered Energy, Refining and Sanitation, Metals and Cogeneration, Mining and Oil & Gas markets. The list of ORT's business units is presented in Table 1.

Table 1. ORT business units' presentation.

BUSINESS UNIT	DESCRIPTION
OES	Turn-key solutions in power and automation systems, and electrical and electromechanical equipment manufacturing.
BLT	Current transformers, potential transformers and manufacturing of measuring sets.
MCT	Manufacturing of power transformers.
SPE	EPC (Engineering, Procurement and Construction): design, electromechanical assembly, civil works, commissioning, start-up and assisted operation.
MPN	Multidisciplinary engineering project design.
OAC	High-technology robots for the oil and gas sector.
ENR	Generation and transmission of renewable energy.
CNP	Oil and gas exploration and production.

Source: The authors.

Data were initially collected by one of the authors from a longitudinal participant observation (Langley et al., 2013) of approximately four years. In that period, supporting documents were collected to serve as a supplementary data source, including e-mails, administrative documents - *e.g.* proposals, reports, internal documents and meeting minutes, studies and evaluations, media publications, tables and budgets and personal records (journal entries and schedules). In order to understand the phenomenon before and after the participant observation, eight semi-structured interviews were conducted with ORT employees who were involved in the process of building the new organizational function. Table 2 shows the interviewed employees and the duration of their respective interviews.

Table 2. Duration of interviews and identification of interviewees.

INTERVIEWER	DURATION	ROLE	BELONGS TO IF? (Y/N)
ENTR-1	68’ 24”	R&D Project Analyst	Y
ENTR-2	34’ 57”	Member - Vice-President of the Group	N
ENTR-3	38’14”	R&D Coordinator	Y
ENTR-4	72’ 34”	Quality, Safety and Environment Manager	N
ENTR-5	39’ 47”	Production Coordinator (Electric Panel Factory)	N
ENTR-6	56’57”	R&D Manager	Y
ENTR-7	35’ 55”	Operations Manager	N
ENTR-8	52’ 07”	Engineering Director	N

Source: The authors.

The interviews were recorded, and the audios were transcribed. As a first step of analysis, researchers constructed, from data gathered during the participant observation, an ordered list of events associated to the process of IF consolidation. In order to justify both the occurrence and the timeframe of each happening, a specific supporting document was related to each event. At this stage, 121 events were identified, ordered by month and year. Subsequently, lists of events were elaborated from the discourse of each interviewee, by at least 2 collaborators, in isolation, as a way to allow for inter-coder cross-validation. In sum, 284 possible events were identified at this stage. After peer validation (*i.e.* between two researchers), a list was reached for each interviewee, with a sum of 185 events. During validation, researchers discussed: (i) the inclusion of an event identified by only one party; (i) the exclusion of a supposed event - when in fact it was a contextual or routine aspect, and not a specific event (*i.e.* no specific timeframe); (iii) and the granularity of events - merging (*i.e.* multiple events into one) or unlinking (*i.e.* one event into two or more of them).

In the possession of all supporting documents and chronologically ordered lists of events, a detailed narrative of the case was prepared, through cross-validation of all the collected evidence, expressing them in a meaningful way (from the point of view of a theoretically-informed reading), without losing their adherence to the particular case and language settings. Throughout the narrative (Section “4 Narrative of the Case”), patches of the transcriptions were used to enrich the story’s presentation. Fictitious names (*e.g.* Luiz, Amanda, Marcos) were given to actors considered central for the narrative, to preserve anonymity.

During textual elaboration, the authors faced several doubts about the dynamics of the case and had to seek for additional clarifications with some interviewees in order to make sense of the story. The narrative allows the presentation of circumstances not initially pointed out during the interviews and the preparation of events' lists, mainly in what regards the participation of relevant actors and the sequences of actions. In addition, during this writing exercise, the research team inductively coded some entities that are recurrent and relevant to the case (*e.g.* internal employees, external personal agents, funding agencies, science and technology institutes - STIs). One of these entities are the "innovation projects" developed by ORT during the period (149 instances in total, presented in Appendix A), which were used at the end of the article to foster the discussion of the evolution of the IF in order to manage more radical projects over time.

4 Case narrative

4.1 Antecedents

The history of ORT begins with the creation of a unit (OES) for electrical panels manufacturing in 1977. Throughout the 1980s, the association of this company with a French engineering firm, specialist in supplying energy installations, transformed its business model. After all, the company started to provide complete solutions, ranging from products of their own manufacture to the installation in field, commissioning and assisted operation (*i.e.* turn-key systems).

The Brazilian National Electric Energy Agency (ANEEL), in order to encourage innovations in the electric sector, regulated the "P&D-ANEEL" Program. Electric power generation, transmission and distribution companies should invest at least a minimum percentage of their revenues in this program. Annually, these companies started to launch "Public Calls (or Calls)", releasing their priority lines of research, in order to hire interested companies, STIs or partnerships involving both of them.

Following this trend, in 2004, the Brazilian Federal Government issued a general innovation Law (10,973), which provided incentives for innovation and technological research in the productive environment, and regulated some entities of the National Innovation System, such as funding agencies, STIs (Institute of Science and Technology), innovation nuclei, support institutions, among others.

From this moment, Luiz, then Vice-President of ORT, started to encourage ORT employees to take part in these programs jointly promoted by local and federal government entities. In 2006, the Commercial Department of OES pointed to a demand for the development of a "Microprocessor Rectifier". An Operations Manager, due to his expertise in electronics, proposed a solution and sought the Minas Gerais Energy Company (CEMIG) for the presentation of his idea. Subsequently, he submitted the project to CEMIG's "P&D-ANEEL" call in that year.

In parallel, in 2007, OES won a competition to supply electric panels to PETROBRAS, which would increase its production capacity to about 100 electric panels per month. A production bottleneck was identified at that moment. The final inspection of these products was manually performed in the factory environment by employees (*i.e.* (individual measurement of various variables

product interest), with customer follow-ups. There was a need for an automated equipment to systematize these tests, the so-called “Test Gigas” - developed over four years.

Management of innovation projects at that time was basically based on: (i) drawing up a preliminary project budget; (ii) approval by the board of executives; and (iii) registration in a corporate system to monitor purchases. As they were normally associated with a specific demand, previously identified by the Commercial Department, the amortization of these investments in innovations was allocated to the demanding business units.

> *The first [prospection] is carried out by the Commercial Department itself, which often, due to the biddings that exist* [related] *to the quotation processes, maps, together with Product Engineering, the products that are not being provided* [by the company]. *Often, we are reactive because we are going to develop only when we have declined a proposal: “We are declining this proposal because we have no product”.* (Production Coordinator of the Electric Panel Factory).

At the end of 2007, due to the Brazilian context (*i.e.* incentive to innovative activities) and the incipient innovation activities at ORT, the need to formally allocate a collaborator for this task was perceived by the top management team.

4.2 Cycle 1 – Setting the stage

When asked about “what event marks the beginning of innovation management activities in ORT?”, the interviewees were emphatic: “The hiring of Amanda.” However, it should be noted that she was hired initially to work on other OES projects and later allocated to this mission by Luiz. The beginning of this work is registered by a partnership with the Euvaldo Lodi Institute (IEL) for the implementation of an “Innovation Management Methodology”, creating the so-called “Innovation Management Center” or simply NGI.

> *We did a job, which I remember, together with the IEL, which was bringing to Brazil a methodology for innovation management... And we implemented at the time the* “NGI [Innovation Management Center]”. (Luiz, Vice-President of ORT).

> *This nucleus started with one person. This person tried to restructure and was adding, let’s say, knowledge and expertise. At the beginning, it worked with a very small core of people* [...]. (Operations Manager).

It is clear by this last interview extract that this Center was created to be an instance to support R&D (*c.f.* Bagno et al., 2017b), creating external connections to support R&D activities, rather than directly executing them. At the outset, cultural barriers hampered the progression of Amanda’s work, as people were focused on their daily tasks and short-term results. Those who ventured into innovation initiatives made it out of their usual work schedule, with no expectation of recognition.

> *You must imagine that this would lead to some problems. Why? Because those people who are so attached here to a particular department, they have their tasks,*

> *their obligations, and the development and innovation activities became an exception to their work*. (Operations Manager).

At that moment, the attempt to frame projects in external funding calls began. An Engineering Director had been contacted by a former co-worker - at this time a professor at the Federal Center for Technological Education (CEFET-MG) - to discuss possible synergies between the institutions. OES was renovating the turbines of the Três Marias - MG hydroelectric power plant and a proposal was presented to CEMIG in the "P&D-ANEEL" for a software to increase hydroelectric generation efficiency based on computational intelligence techniques.

In this cycle, two initiatives involving the payment of scholarships for OES employees were also approved. Amanda complained about not getting internal support to promote innovation initiatives. A "Suggestions Box" was also implemented to collect ideas from internal collaborators. Some opportunities were identified, but the feeling was that this process would not work satisfactorily.

> *We had a program of suggestions for improvements [...] we did not participate, but a world of information arrived. Some made sense, some less so*. (Engineering Director).

At the end of this period, after approval, the "Microprocessor Rectifier" was started, in partnership with CEMIG. Amanda was approved in a public contest of a federal educational institution to become a full professor. She established an agreement with Luiz to transfer the activities and projects developed to the new person to be hired in order to assume the "Innovation Management Center", the NGI.

4.3 Cycle 2 - A new leadership

With the departure of Amanda, Luiz hired a trainee, Marcos, to take over the post of the NGI Orchestrator. The mission was clear, and the support of top management would also come deliberately and unrestrictedly. For Marcos, this mission should be converted into the creation of a portfolio of innovation projects so that these activities could be recognized and valued in the organization.

> *It started, until Marcos came* [...] *there, yes, he started to have open innovation projects*. (R&D Coordinator).

> *Let's grow the cake and then adjust it, show that it* [innovation] *exists here. Let's make some noise*!". (Innovation Analyst, repeating Marcos' speech at this time).

At the beginning of this Cycle, there was a restructuration of ORT through a corporate governance process - see Figure 2. "We made an internal change in the company, and it was redesigned in terms of high-level management practices" (Luiz, ORT's Vice-President). The shareholders left their executive positions and would occupy the level of advisers (one president and two vice-presidents). Five permanent committees were set up for strategic matters and a new Direction (Shared Corporate Services) was created to serve all ORT's business units.

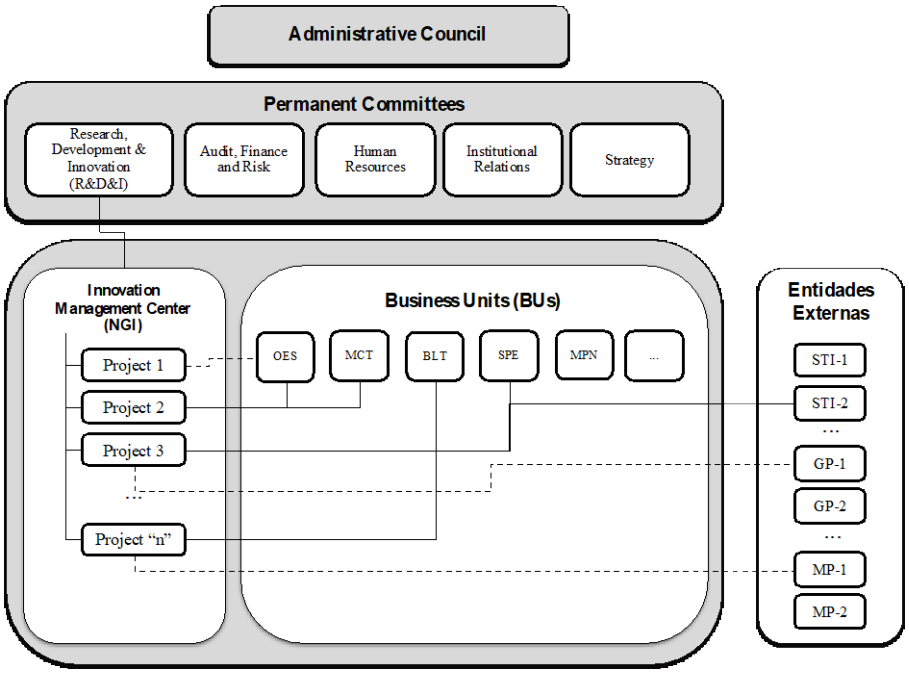

Figure 2. The Innovation Management Center (NGI) in the organizational structure. Source: The authors.

Luiz (Vice-President) was appointed to lead the "Research, Development & Innovation Committee" – R&D&I. Permanent members were appointed and, depending on the staff, other participants were also invited to attend the meetings.

> *A stronger innovation committee was created, where we started to look* […] *more formally: external partnerships, partnerships with state and federal institutions through government calls, to participate in these calls, showing what was our innovative idea, to try to obtain resources that would enable the execution of these ideas*. (Product Engineering Coordinator).

At this moment, the mission of the Innovation Management Center (NGI), defined by Luiz, was the leadership of innovation initiatives in the ORT as a whole (Figure 2). The NGI was guided by the R&D&I Committee, but funded and accountable to OES (specifically to its CEO). For each innovation initiative approved to compose the project portfolio, a specific development team was formed. These teams had both internal and external members from Science and Technology Institutes (STIs), other Large Companies (GPs), and Micro and Small Enterprises or Startups (MPs).

Marcos, in his search for external funding for projects, attended an event at the Federal University of Minas Gerais (UFMG) regarding the Brazilian Law 11,196/05 ("Lei do Bem") which grants tax incentives to innovation projects, presented by an external consultant. After a first contact, Marcos and the Financial Manager met with the consultant at OES. This contact was motivated by a desire to return part of the investment on the "Test Gigas". The work was executed in cooperation between these agents, with a recovery of R$ 117,000 in taxes. At that time, the then CEO of OES stated: "Since we learned, next year we will do it by ourselves".

At the same time, Luiz sent a message to Marcos requesting the follow-up of a proposal to develop a panel with 36kV nominal capacity (thirty-six thousand volts),

already negotiated by the OES Commercial Department. At that moment, the “SENAI-SESI INNOVATION” call was launched, which promoted support through economic subsidy for projects in partnership with SENAI and / or SESI units. A few months after submission, the “36kV Panel” project was approved and the CEO of OES requested to use this project as a management model. As confirmed in the interviews, this project was, in fact, a “watershed” for the Group ORT:

> *The* “36kV Panel” *allowed us to fight with these people*. “*Do you have a product? I also have! Mine, national. You pay royalties*”. (R&D Coordinator).

At the same time, NGI approved a financing in the “PRÓ-INOVAÇÃO” Program with the Development Bank of Minas Gerais (BDMG) for the counterparts involved in the “Microprocessor Rectifier”, “36kV Panel” and the “Improvements in MCC columns of engines” projects. In addition, a new partnership with CEFET-MG was established for the development of the “System for management of distributed energy-network assets” in a public call for the electric sector involving CEMIG and the State of Minas Gerais Research Support Foundation (FAPEMIG). With the growing portfolio, Luiz, Marcos and the OES’s CEO established periodic meetings for project reporting. A channel was created, including for presentation and approval of projects by the Board of Directors.

ORT was in the process of implementing a new ERP (Enterprise Resource Planning). Based on the experience in the use of the tax incentives of “Lei do Bem”, ORT attempted to incorporate it into this planning system, with specific reports to subsidize accountability in innovation projects. After a few months working with the IT Department, an ERP procedure was created for the automatic extraction of individual, specific values for any employee in the organization.

In this period, BLT decided to develop a “High Voltage Transformer Platform” and build a new plant to produce such equipment. The top management of the main competitor in the market was hired by BLT for this mission. Marcos stayed impressed with the magnitude of this initiative, the financial amount involved and the potential market entrance of such products. After a visit to the BLT, he returned to ORT headquarters determined to support this project.

4.4 Cycle 3 - Towards maturity

In the beginning of the following year, there was an opening of NGI’s activities in relation to interaction with other ORT business units: (i) invitation from the Foundation for Technological Innovations (FITEC) to meet a demand from Companhia Paulista de Força and Luz (CPFL) in the development of an Unmanned Submersible Vehicle (VSNT), in a possible partnership with the OAC; and (ii) interaction with ENR, a company specialized in electricity generation and transmission, such as small hydropower plants and other renewable sources to seek for repayable financing for its innovation projects.

For the amount of financial resources in the “High Voltage Transformers Platform” development, Marcos engaged with BLT’s technical team to prepare a proposal for the Brazilian Funder of Studies and Projects (FINEP) and the National Bank for Economic and Social Development (BNDES), which offered superior financial conditions compared to BDMG, despite greater complexity in submitting a proposal and merit evaluation. Proposals were submitted both to FINEP and BNDES. However, while FINEP approved the complete project, BNDES had only made its initial evaluation. In

addition, the good relationship with an analyst recently hired by FINEP accelerated the process with this entity. Also, in that year, repayable financing was obtained for funding the counterparts of projects supported by economic subsidies (*e.g.* those supported by P&D-ANEEL) and were presented in the "Lei do Bem" report (*i.e.* three funding instruments were combined in one single project).

The "INOVA PETRO" was an unprecedented development program launched at that time by a cooperation between FINEP, BNDES and PETROBRAS. OAC had a track record in developing robotic solutions for the Oil & Gas market, in partnership with a French Business Group specialized in robotics and with the PETROBRAS Research Center (CENPES), but without commercial success. Marcos and the CEO of OAC structured a high-risk project proposal, including the development a new platform of tools for inspecting shells and submarine pipelines, with a total amount of R$ 96 million. All these tools would be developed by means of a France-Brazil technology transfer, with the commitment of 25% of local content.

Camila, then a NGI trainee, was hired as an R&D Analyst. At that moment, she and Marcos already divided the assignments of the NGI clearly, as put by Camila (one of the interviewees).

> *In a way, it was already well divided: I was in charge of the projects, the management itself, and this is fine to talk about. At first, until he* [Marcos] *was able to get things right, we did all together, like this: he* [Marcos] *had a lot to do. Then, when I started taking care of this management on my own, I performed the internal* [work], *which was timing, accountability, knocking on everybody's door, collecting signatures* [...]. (Camila - Innovation Analyst).

Marcos was invited to participate in discussions involving ORT's Strategic Planning. In a meeting of the R&D&I Committee and subsequent presentation to the Board of Directors, a portfolio of projects was approved for the "INOVA ENERGIA" (a program similar to "INOVA PETRO", focused on the electricity sector): "System for discarding loads"; "Sensors for high voltage transformers"; "Industry of photovoltaic modules"; and "Photovoltaic solar power plant and own inverter technology". Due to the volume of projects in the pipeline and portfolio, NGI pressured the top management for additional resources to format and submit proposals for "INOVA PETRO" and "INOVA ENERGIA". Two different consulting firms were hired, and task-forces with internal collaborators were built to support each initiative. There was not enough time for the formation of a new team at NGI dedicated to such demands. Some tensions emerged between Marcos and the OES' CEO for the distributed attention of the NGI (*i.e.* attendance to all ORT's business units while its costs were hold only by OES).

At the end of the Cycle, a change in the organizational structure of OES represented, for the first time, the creation of a formal department to deal with innovation activities. That department would be responsible for both the execution of the projects and their management. The NGI was incorporated into this structure. For the first time as well, OES recognized the unique dedication of some of its employees to R&D activities (*e.g.* Software, Electronics), which were incorporated into the new structure.

> *That was a milestone. We did not have an innovation structure, despite having a R&D sector*. [Until that] *This was not, let's talk like that, widespread among people and was not a reference* [for the company]. *Today, anyone who has an idea of product innovation will seek the new department to make this idea viable*. (Engineering Coordinator).

5 Discussion

Figure 3 summarizes the IF's building process from the narrative analysis presented before. In the analyzed case, the IF gains legitimacy progressively from the individual action, the skills accumulated by the team (and consequent recognition of these skills by the organization), and the intermediate results obtained with the innovation projects. We also highlight the growth of the structure (i.e. number of members) as well as the portfolio of projects managed by the IF.

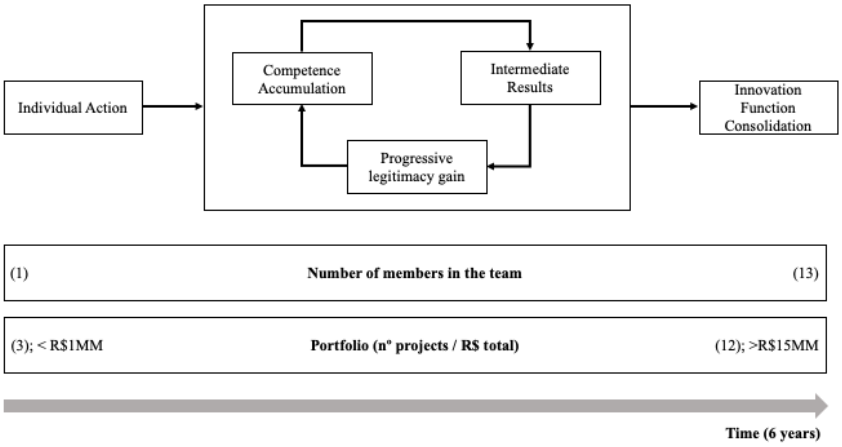

Figure 3. The IF's building process. Source: The authors.

5.1 Emergence and consolidation of the Innovation Function

From the Function concept proposed by Salerno & Gomes (2018), the narrative of the case presents in detail the creation of a distinctive organizational unit dedicated to innovation management. The case demonstrates the formalization of the team at ORT's at the business organization chart in the end of the investigated period with distinctive assignments when compared to other organizational instances, such as: the raising of resources from external Funding Agencies; the portfolio management; interface with external entities (*e.g.* Science and Technology Institutes, consultancies, among others) for issues involving innovation projects; and the accomplishment of R&D itself.

> *Before, a single person was the whole department, and today we have a department with ten people* [...]. *I have already hired three more trainees for software development*. (R&D Coordinator).

The convergence of events for the constitution of a dedicated organizational function to innovation management is evidenced from different perspectives. In the described period, new procedures were created for project management (from planning to approval and monitoring - by the R&D Committee and the Board of Directors). More than 50 new opportunities were articulated, and the team managed 12 innovation projects simultaneously at the end of the period. There was also an expansion in the team's activities regarding the establishment of formal partnerships (i.e. legal

agreements) with Federal Government Funding Agencies, public and private investment banks, suppliers, clients, and universities. In addition, during the process narrated, the NGI discussed and formulated proposals for new projects with all seven ORT business units.

5.2 The articulation of teamwork from the individual action of central actors

The case highlights the relevance of individual action (especially, Amanda and Marcos) for the construction of IF. Respondents recognize the key performance of these managers throughout the process, who initially act as hunters (i.e. seeking for opportunities) and centralizers (i.e. focal points for other agents) serving as connecting points to the various parts of the organization (*c.f.* Leifer et al., 2000).

At the beginning, the instances involved in an innovative project were basically: Commercial Department - in identifying opportunities (most of the times, those were new normative requirements for the products); Board of Directors - in project approval; Engineering - in the product development itself. The projects were generally of an incremental nature, involving technical improvements in existing products to meet specific legislation, almost as a condition to continue competing in the respective markets. With the involvement of the IF's dedicated team, the number of connections made with other agents (internal and external to the company) is increased and also the diversity in the nature of the projects.

The IF establishes a point of reference in the organization for the discussion of subjects involving the theme "innovation" - many opportunities may have been left aside over the years by the lack of a channel to direct them. Over time, external agents started to search NGI to prepare project proposals. This is an important milestone, as the effort to build the portfolio is no longer just "inside out" of ORT. The companies' innovation process becomes more open (Chesbrough et al., 2006) as the IF consolidates itself in the organizational environment.

The projects carried out in partnership require new interactions with other organizational functions (Bagno et al., 2017b). The Finance Department, for example, supports the financial resources management (*e.g.* project accountability) provided by external Funding Agencies. Partnering brings the discussion of intellectual property (IP) and, consequently, the involvement of the Legal Department. Another good example is the interaction of IF with the Information Technology (IT) Department for the creation of reports in the company's ERP as a way of searching for specific information (*e.g.* salaries and social charges incurred with employee "X" in month "Y") in order to be accountable for Funding Agencies and the Science, Technology and Innovation Ministry (MCTIC), in the context of the "Lei do Bem".

In addition, while the IF's performance is recognized in the organizational environment, new connections emerge, especially at the top management level. Throughout history, NGI has been invited to participate in meetings promoted by "Strategic Planning" and to discuss project proposals with the Board of Directors. Over time, ORT business units' boards seek Marcos' support for the identification and search of external partners, structuration of innovation projects (*e.g.* deliveries, milestones, activities), raising of external funds, proposal preparation and submission to the R&D&I Committee and to the Board of Directors.

5.3 The accumulation of competences in the core group of the IF, the gain in complexity of the IF network and the increase in the radicality of innovation projects

The central group's role in monitoring innovation projects throughout the period is notably flexible and non-linear. Although there was, for example, a R&D&I Committee, there were no rules for approval or continuity of a project, a planned annual budget for the initiatives, or even a clear guideline concerning the participation of employees from other departments in the actions promoted by the NGI. Even so, one can note that there was an effort to protect innovation projects, either by seeking for external resources to reduce the perception of risk associated with them or by articulating partnerships as a way to raise sponsors for such initiatives in the context of the ORT.

The work performed by the management team unfolded as the challenges emerged (recognized by the team) and were faced in a constant process of accumulation of skills to manage innovations. A good example is the use of the "Lei do Bem" incentives. After a first experience supported by an outside consultant, NGI built a series of routines together with other departments and internalizes that competence for subsequent demands. Another example concerns the evolution of the team's ability to manage financial resources of external agents by combining different types of instruments (*e.g.* repayable financing, economic subsidy and tax incentives) in a single project (*e.g*. "36kV Panel", "Microprocessor Rectifier").

Throughout history, NGI underwent a change in its way of acting. At the beginning, the team sought initiatives within the limits of the ORT (the use of tax incentives in the "Test Gigas" and the participation in the SENAI-SESI Program for the "36kV Panel" are some examples). Subsequently, there was a reversal in which other agents went for the NGI to contribute to their initiatives (*e.g.* invitation to Strategic Planning meetings). In addition, the team came to achieve greater budgetary autonomy (i.e. Camila's hiring, consultancy hiring to support the preparation of the proposals to "INOVA PETRO" and "INOVA ENERGIA", among others).

During the innovation management group maturation, the portfolio was raised with some projects with higher levels of uncertainty (i.e. cannot be foreseen during project planning) and complexity (i.e. number of parties with different specialties and amount of resources involved) - (Pich et al., 2002). The "Microprocessor Rectifier" (a variation of an existing product) was one of the first initiatives developed in partnership with external agents (CEMIG), involving an electronic engineer and two technicians of the company, with resources in the order of R$150.000,00. The "36kV Panel", which totalized R$1 million, was based on the development of a product for a new voltage class, not previously covered by OES. This project involved the Engineering and Quality Departments, external suppliers (in the development of some specific components of the new panel) and five SENAI professionals. At the end of the period presented, the NGI could already articulate opportunities involving unprecedented new business platforms for ORT, such as the OAC's robot platform for off-shore structures inspection and the development of photovoltaic solar energy solutions by OES, estimated at R$96 million and R$1 billion, respectively. The latter involved international partnerships for technology transfer as well as government arrangements for the discussion on regulatory issues and tax immunities.

As the team developed competencies, the ability to manage a larger number of projects and projects with higher levels of uncertainty was expanded. New routines were created (*e.g.* project accountability and presentation of advances in projects), streamlining the execution of several processes associated to the generation of

innovations. In addition, team members became able to find useful resources inside and outside of the organization more quickly, and relationships with other entities (i.e. people, groups, organizations) became stronger (i.e. through a successful shared experience) over time. In this sense, Figure 4 shows ORT's innovation portfolio evolution throughout history. It should be noted that in the two years preceding the consolidation of the IF (periods 6, 7, 8 and 9) there has been a large increase in companies' projects, especially those executed in partnership and considered more radical. Figure 4 was constructed from the list of innovative projects identified throughout the research, available in the Appendix A.

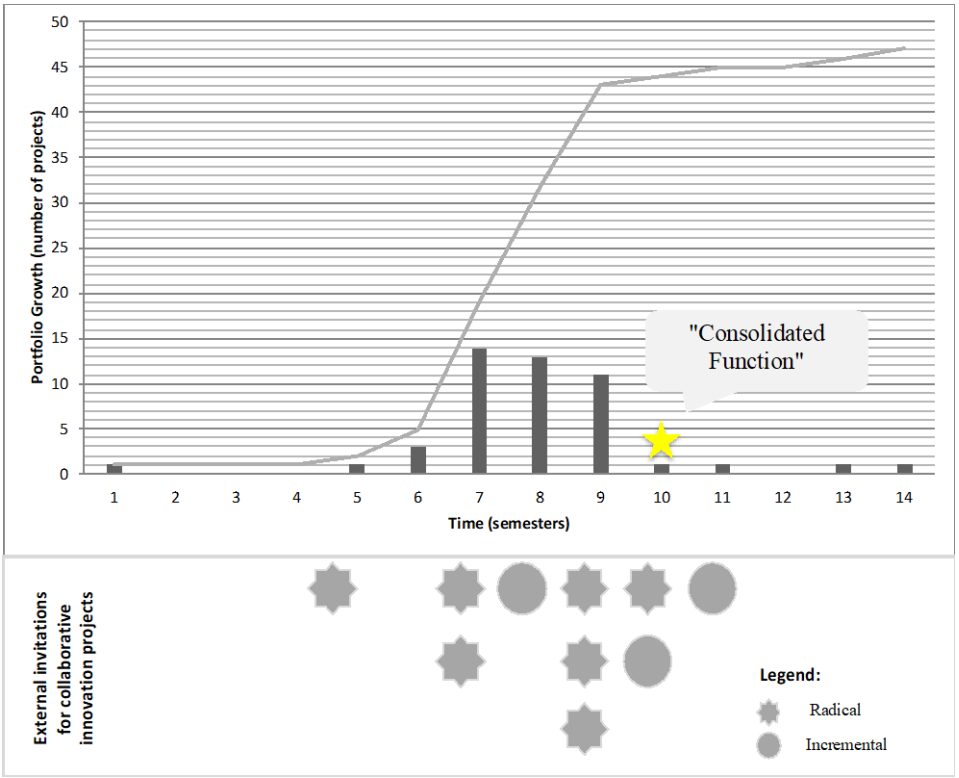

Figure 4. The evolution of the innovation portfolio. Source: The authors.

This last analysis, in particular, reinforces the perspective that the management of innovation by the constitution of a dedicated function makes sense when innovations are more radical (O'Connor, 2012, O'Connor et al., 2008, Salerno & Gomes, 2018). Although NGI's work has also catalyzed the occurrence of incremental innovations, the case analyzed does not show evidence that this organizational instance would have been essential for the occurrence of these projects (although they may have occurred in greater numbers or have been conducted with better fluency). Incremental innovation projects may have been important in order to generate faster results for the IF, but the contribution of a dedicated team is mainly to protect the most radical innovations, searching for external support, partners or sponsors, in order to mitigate the uncertainties perceived by the top management.

6 Conclusion

This study deepens the discussions about how to build a dedicated function to innovation management in large organizations. The main contributions to the literature are: (i) deepening the understanding of the emergence of the IF (O'Connor, 2012; O'Connor et al., 2018, 2008) in large organizations, from a micro-analysis perspective, in which central individuals (*e.g.* Orchestrators), build the company's capability for innovation from the accumulation of competencies and from the legitimacy built with top management; (ii) the study presents in detail the gradual process of creating a managerial system for radical innovations, unlike previous works that deal with this implementation in a static way, from the definition of a set of pre-established organizational elements (Bagno et al., 2017a; Goffin & Mitchell, 2010; O'Connor, 2008) – in sum, previous studies present a picture of the system and not the film to reach it; (iii) finally, this study presents how an organization starts from micro processes (i.e. individual interactions, team building and interpersonal relationship networks) to macro outputs (i.e. capability building from the constitution of a dedicated organizational entity) reinforcing Kouamé & Langley's (2018) clamor.

From a practical point of view, this study: (i) provides specific insights for companies that aims to create a capability to generate more radical innovations (*e.g.* allocation of dedicated employees to conduct the mission, search for external resources to support the execution of projects, beginning of the construction of innovation portfolio by acting in projects more adherent to the business as a way to obtain top management's visibility); (ii) shows that, for senior managers, the construction of an innovative capability is a long and gradual process (in the case presented, it lasted more than four years) - this point is relevant for leveling expectations and reducing pressure on the team for short-term results; (iii) reinforces the importance of governmental support (financial and tax incentives) for the leverage of innovative projects in companies as well as a mechanism for the approximation between large companies and Universities / Research Centers.

However, there are some limitations, especially from a methodological point of view. New interviews could strengthen the analysis of the case. The internal agent responsible for the IF during the first cycle of the narrative may have been the main gap in the interviewing stage. We chose not to listen to external agents within the scope of this work, based on the assumption that their visions would be restricted to projects that had been involved and because they were not mentioned directly during the interviews.

Suggestions for theoretical advances include: (i) how IF changes itself from interaction with startups, as observed in recent forms of open innovation programs in large companies; (ii) to study mature organizational functions, dedicated to radical innovation management, from a social network perspective (Granovetter, 1977; Scott, 1988; Wasserman & Faust, 1994) in order to understand how the IF articulates support from other functions to obtain necessary resources to fulfill its mission; and (iii) to expand the understanding of the IF's organizational structure with an emphasis on roles, hierarchy and forms of coordination, a debate initiated by O'Connor et al. (2018).

Acknowledgements

The research was partially funded by: (i) Grant 2015/26662-5, São Paulo Research Foundation (FAPESP); (ii) Grant PRPq/UFMG 11/2017 - "Programa Institucional de

Auxílio à Pesquisa de Docentes Recém-Contratados of Universidade Federal de Minas Gerais (UFMG)"; (iii) Grant 420126/2018-0, National Council for Scientific and Technological Development – CNPq; (iv) Grant 23072.057271/2018-26, from IEBT.

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Appendix A. ORT's List of Projects.

PROJECT	DESCRIPTION	YEAR	RADICAL ® / INCREMENTAL (I)	INTERNAL (IN) / EXTERNAL (EX)
1	Integrated supervision, protection and digital control system.	ANTECEDENTS	R	IN
2	Equipment for the final inspection of electrical panels (cubicles or columns) and engine control center (CCMs).	ANTECEDENTS	R	IN
3	High performance microprocessor rectifier prototype.	1	R	IN
4	Software for increasing the efficiency of hydroelectric generation based on computational intelligence techniques.	3	R	EX
5	Medium voltage panel (36kV) with reduced dimensions.	3	R	IN
6	Transformers with electrical and physical variables online monitoring.	3	I	IN
7	Study of modernization of transmission substations with emphasis on the full digital integration of the functionalities and the construction of an unprecedented predictive maintenance system for all the assets.	3	R	IN
8	Software for real time management of production process, from the integration of corporate (ERP) and operational systems (SCADA, CLP, DCS).	4	I	IN
9	Transfer of knowledge in the area of Energy Efficiency in "Hot Rolling" steel processes.	4	I	IN

PROJECT	DESCRIPTION	YEAR	RADICAL ® / INCREMENTAL (I)	INTERNAL (IN) / EXTERNAL (EX)
10	Platform of instrument transformers for high voltage (72.5 - 550kV).	4	R	IN
11	Stainless submersible transformer.	4	I	IN
12	Innovative computational system of load discharges capable of managing the distribution of power in the grid, by optimally and dynamically disconnecting parts of the system in an attempt to prevent failures due to overloads in the case of demand greater than capacity to a certain part of the power grid.	4	R	IN
13	Development, production and marketing of a 690V Engine Control Center (CCM).	4	R	IN
14	Prototype of Uninterruptible Power Supply (UPS), input and output three-phase, with power of 20kVA.	4	R	IN
15	Development of a methodology supported by computational tools for the choice of locations for the implementation of renewable energy generation plants (solar, wind, bioenergy and sources of cogeneration).	4	R	IN
16	Sharing of fiber optic networks for optical sensing (temperature, current and voltage) of transformers and data communication.	4	R	IN
17	Computational system for the management of medium and low voltage assets aiming at the optimal compromise between	4	R	IN

PROJECT	DESCRIPTION	YEAR	RADICAL ® / INCREMENTAL (I)	INTERNAL (IN) / EXTERNAL (EX)
	conflicting objectives of cost reduction, risk, performance increase and financial return.			
18	Optimization of heat exchange systems in power transformers.	4	R	EX
19	Planning and evaluation of the impact of distributed generation on electricity distribution systems.	4	R	EX
20	Incremental improvements in columns of CCMs and panels of low voltage (development of electric air deflectors, structural reinforcements in the duplication of shielding plates in strategic points of the structure, optimization of the ways for the expansion of gases, optimization of the flaps in the pressure level) .	4	I	IN
21	Intelligent system based on the smart grid concept for the measurement and estimation of technical and commercial losses in cross-network circuits of spot-type distribution with economic feasibility for telemetry of small grouped consumers.	4	R	IN
22	Projects, analysis and construction of portfolio of Small Hydroelectric Power Plants (SHPs).	4	I	IN
23	Creation of models and applications for inspection of hydropower reservoirs with support of Unmanned Submersible Vehicle (VSNT).	4	I	EX
24	New generation of I-tubes annular space inspection	4	I	IN

PROJECT	DESCRIPTION	YEAR	RADICAL ® / INCREMENTAL (I)	INTERNAL (IN) / EXTERNAL (EX)
	tool for Oil & Gas offshore platforms.			
25	New generation of navigator robot and submarine creeper designed to perform continuous measurement (equipped with ultrasonic system) of thicknesses of submerged metallic structures, ship hulls and offshore platforms.	4	I	IN
26	New generation of the tool for inspection of vertical sections of flexible ducts with external diameters ranging from 250 to 450mm, in depth up to 2000m.	4	I	IN
27	New robotic system and remotely controlled to clean flexible lines up to 200m.	4	I	IN
28	Development of robotized tool with high productivity and remotely controlled for repair of flexible lines up to 2000m.	4	R	IN
29	New self-propelled vehicle to perform inspection and evaluation services for submarine equipment and pipelines, using state-of-the-art sensors and submarine robotics equipment.	4	R	IN
30	Panel class 24kV - 1250A.	4	I	IN
31	Incremental improvements in 17.5kV-50kA electrical panel for certification in NBR IEC 62271-200 standard for 50kA / 13.8kV.	4	I	IN
32	Incremental improvements in engine control center and low voltage panel for certification according to NBRIEC 60439-.	4	I	IN

PROJECT	DESCRIPTION	YEAR	RADICAL ® / INCREMENTAL (I)	INTERNAL (IN) / EXTERNAL (EX)
33	New medium voltage grounding switch, genuinely national.	4	R	IN
34	Consists of promoting hardware and software changes in the previous object prototype.	4	I	IN
35	Waste processing plant via plasma technology, pyrolysis and gasification with the combined cycle electric power generation.	5	R	EX
36	Development of frequency inverters and measurement, control and supervision system for distributed generation.	5	R	IN
37	Development of product platforms standardized from the concept of Modularity.	5	I	IN
38	Manufacturing industry of photovoltaic panels, from the purification of Brazilian metallurgical silicon, through ingots, wafers, cells to complete modules.	5	R	IN
39	OES capacitation to provide turn-key solutions for isolated or grid-connected photovoltaic systems using its own inverter technology.	5	R	IN
40	Training to provide solutions for hydraulic, vertical and horizontal fracturing, as well as drilling of air drilling in “unconventional” natural gas basins.	5	R	IN
41	Development of new technologies with optical sensors in potential and current transformers - of measurement and protection - in the most diverse classes	5	R	EX

PROJECT	DESCRIPTION	YEAR	RADICAL ® / INCREMENTAL (I)	INTERNAL (IN) / EXTERNAL (EX)
	of voltage and current for detection of partial discharges and formation of gases in the oil.			
42	TCP / IP stack construction directly on the Remote Terminal Unit (RTU), thus enabling the emergence of IEEE 802.15.4 standard (typically telemetry) Wireless Sensor Network (WSN) capable of supporting in-band internet sharing wide by the same infrastructure that now serves the AMR (Automatic Metering Reading) services of power distributors.	5	R	EX
43	High power factor rectifier.	5	I	IN
44	Bus Rapid Transit (BRT) powered by electricity.	5	R	EX
45	Pilot installation of solar photovoltaic power plant.	5	I	EX
46	Medium voltage panel composed of 2 (two) circuit breakers per column.	5	R	IN
47	Underground camera project execution monitoring software.	6	I	EX
48	Feasibility study of hacks.	7	I	IN
49	Busbar temperature monitoring system.	7	I	IN

Source: The authors.