



## Integration efforts in radical and incremental projects of new product development based on biodiversity: case study in a biotechnology company

***Esforços de integração em projetos radicais e incrementais de desenvolvimento de novos produtos baseados na biodiversidade: estudo de caso em empresa do setor de biotecnologia***

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**Abstract:** Recent research on new product development (NPD) has presented divergent results on the need for interfunctional integration efforts. Studies have shown that contingent aspects and the level of innovation incorporated into product projects are elements that should be considered in these integration efforts. This study aimed to analyze how integration efforts occur in incremental and radical NPD projects. A case study was conducted in a company that continuously develops technologies and products based on Brazilian biodiversity. Among the main results, we noted that due to their greater technological complexity, the radical innovation projects require more intense integration. The physical distance from the R&D department was also shown to be a situation that generates positive results for the development of these types of projects. On the other hand, we observed that co-location is beneficial for interaction between the teams in the case of incremental innovation projects. The application of information technologies, such as Customer Relationship Management Systems as formal support mechanisms for integration in radical and incremental innovation projects was also observed.

**Keywords:** Innovation management; New product development; Inter-departmental integration; Innovation; Case study; Biotechnology company.

**Resumo:** Pesquisas recentes em gestão do processo de desenvolvimento de produtos têm apresentado resultados divergentes sobre a necessidade de esforços de integração interfuncional. Estudos demonstram que aspectos contingenciais e o grau de inovação incorporado aos projetos de produtos são elementos que devem ser considerados nesses esforços de integração. O objetivo deste trabalho foi analisar como ocorrem os esforços de integração em projetos de inovação incremental e radical no desenvolvimento de novos produtos. Realizou-se estudo de caso único em empresa que desenvolve continuamente tecnologias e produtos baseados na biodiversidade brasileira. Dentre os principais resultados, notou-se que, devido a sua maior complexidade tecnológica, os projetos de inovação radical demandam intensa integração interfuncional, e que a distância física do departamento de P&D também demonstrou ser prática que gera resultados positivos para o desenvolvimento desse tipo de projeto. Por outro lado, observou-se que a colocalização é benéfica à interação entre as equipes no caso dos projetos de inovação incremental. Outro resultado observado foi a aplicação de tecnologias de informação, tais como o sistema Customer Relationship Management, como mecanismos formais de auxílio à integração interfuncional em projetos de inovação radical e incremental.

**Palavras-chave:** Gestão da inovação; Desenvolvimento de produtos; Integração interdepartamental; Inovação; Estudo de caso; Empresa de biotecnologia.

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## 1 Introduction

Although the issue of integration has been studied often in the NPD field (Griffin, 1997; Olson et al., 2001), recent research has indicated that depending on the degree of product innovation to be developed, cross-functional integration may not be necessary, or it may even be detrimental to this process (Rubera et al., 2012). The studies of Brettel et al. (2011) and Stock et al. (2013) observed that the benefits of the integration of departments, such as among R&D, marketing and production in the NPD, depends on contingent factors such as the degree of innovation required for the new product and the business environment of the company.

Moreover, it is unclear whether the management of integration practices associated with incremental product projects should be applied in a manner similar to that of radical integration practices (Veryzer, 1998; Brettel et al., 2011). As suggested by Bessant et al. (2010) and Holahan et al. (2014), radical and incremental innovation projects require different organizational skills and competencies and may therefore require different kinds of processes.

Thus, there is a gap in the research in relation to integration efforts in new product development projects with different types of innovations (incremental and radical). Although many studies defend integration as contributing to the improvement of NPD performance (Griffin et al., 1996; Kahn, 1996; Rozenfeld et al., 2006; García et al., 2008; Jugend & Silva, 2014; Araújo & Jugend, 2015), there is some doubt regarding the optimization of these efforts with regard to integration specifically in radical innovation projects (Bessant et al., 2010; Calantone & Rubera, 2012; Rubera et al., 2012). For example, Rubera et al. (2012) suggest that excessive integration could result in negative effects for the NPD, such as overloading personnel with too many meetings and stress, agreeing about a group decision regardless of its correctness, and generating early decisions.

Added to this is the fact that there are few studies on NPD integration in companies operating in Brazil, and such analyses are even scarcer when comparing radical and incremental innovation efforts. It is important to note that when investigating aspects related to innovation, the environment in which companies operate deserves to be observed (Garrett et al., 2006). As suggested by some studies (e.g., Souder et al., 1997; Perks et al., 2009) each country's culture, economy and policies reflect different practices in innovation management and even in NPD. This fact can be seen in the study of Perks et al. (2009), which demonstrated that the

integration practices among Chinese managers of R&D and marketing differ from the practices of Western managers, particularly in relation to trust in informal social systems, which may influence integration in the NPD process.

Therefore, this article aims to analyze how integration efforts occur in incremental and radical NPD projects by identifying management practices for each of these situations. For this, was conducted qualitative research operationalized through a case study in one of the largest biodiversity companies in Brazil. This company has a consolidated area of R&D and develops radical and incremental innovation projects in their NPD activities. This firm was chosen because it is Brazilian, it belongs to the biotechnology sector and it uses nanotechnology in its technology development—that is, it is an innovative company that develops and incorporates new technologies in its product portfolio. Furthermore, it has a large insertion in the international market, exporting the products it develops and produces to more than seventy countries.

After this introduction, the paper is organized in the following way. The next section of this article presents a brief theoretical framework. The following section presents the research method employed. In the fourth section, the case study is presented and analyzed. Lastly, final considerations, the limitations of the research, and suggestions for future research are presented.

## 2 Integration in new product development

The theme of integration in the management area has been studied for a few decades, especially by contingency theorists (Burns & Stalker, 1961; Lawrence & Lorsch, 1973). According to Lawrence & Lorsch (1973), integration depends on the collaboration between different departments of a company. Studies on management innovation often analyze the internal and external integration for driving innovative projects through the organizational ambidexterity (Duncan, 1976; Jansen et al., 2009; O'Reilly & Tushman, 2013), and they recommend a balance between actions of exploration and exploitation. By analyzing NPD management, Clark & Wheelwright (1993) suggested organizational structures for the integration of different functions involved in new product development projects.

There are several studies that have discussed integration in terms of interaction and collaboration (e.g., Griffin et al., 1996; Perks et al., 2009; Calantone & Rubera, 2012; Rubera et al., 2012; Jugend & Silva, 2014). Interaction corresponds to information

exchange activities through formal and informal mechanisms (Kahn & Mentzer, 1998). Collaboration includes the development of collective goals and resource sharing (Kahn, 1996). Kahn & Mentzer (1998) stated that collaboration requires a unity of effort to achieve common goals in the company.

There are different opinions on how companies should focus their integration efforts for NPD. While some researchers have suggested that greater integration is related to improved performance, such as innovative and NPD (Kahn, 1996, 2001; Leenders & Wierenga, 2002), others have suggested the implementation of a contingency approach to integration efforts in NPD in which not all new projects would require intense levels of integration to achieve good performance (Olson et al., 2001; Rubera et al., 2012; Tsai & Hsu, 2013). Brettel et al. (2011) and Rubera et al. (2012) question whether functional integration is also important in radical and incremental innovation efforts. Radical product innovation can be defined as projects intending to develop highly innovative products with significant improvements in performance and capable of generating new markets; however, they also involve

a higher level of uncertainty and risk. On the other hand, incremental product innovation entails small improvements in existing products and processes, using knowledge already consolidated and involving lower risks and uncertainties (Brettel et al., 2011; Slater et al., 2014).

In order to suggest mechanisms for the improvement of integration in NPD, some researchers have proposed “frameworks” (Kahn, 2001; Perks et al., 2009; Barczak et al., 2009; Kahn et al., 2012; Jugend et al., 2015). Studies by Griffin et al. (1996) and Leenders & Wierenga (2002), which are widely cited in the international literature (as shown by Scopus databases and Web of Science), proposed seven mechanisms to analyze the integration of NPD: relocation and physical facilities design, personnel movement, informal social systems, organizational structure, informal social systems, incentives and rewards, and formal integrative management processes. Leenders & Wierenga (2002) and Dietrich et al. (2010) added information technology as a mechanisms that also can improve integration. Chart 1 presents a summary of these mechanisms.

**Chart 1.** Framework for the analysis of integration in NPD.

<b>Mechanisms</b>	<b>Definition</b>	<b>Potential Benefits</b>	<b>Source</b>
Relocation and physical facilities design	Allocation of teams from different departments in the same place.	<ul style="list-style-type: none"> <li>- Supports interaction and promotes the exchange of ideas among the teams.</li> <li>- Increases face-to-face interaction.</li> <li>- Intensifies interaction among different specialists.</li> </ul>	Pinto et al. (1993), Griffin et al. (1996), Kahn & McDonough (1997), Maltz et al. (2001), Leenders & Wierenga (2002), Jugend & Silva (2014).
Personnel movement	Movement of employees among different departments.	<ul style="list-style-type: none"> <li>- Intensifies the sharing of information among specialists.</li> <li>- Disseminates skills among different specialty areas or departments.</li> <li>- Reduces the probability of department isolation.</li> <li>- Allows for a common understanding about customer needs and for NPD characteristics.</li> </ul>	Griffin et al. (1996), Leenders & Wierenga (2002), Brem & Voigt (2009), Brettel et al. (2011).
Informal social systems	Informal meetings with the objective to strengthen the interpersonal relationships among employees in different departments or areas.	<ul style="list-style-type: none"> <li>- Increases the friendship between employees</li> <li>- Increases face-to-face interaction.</li> <li>- Intensifies interaction among different specialists.</li> </ul>	Leenders & Wierenga (2002), Jugend & Silva (2014).

Chart 1. Continued...

Mechanisms	Definition	Potential Benefits	Source
Organizational structure	Use of the cross-functional teams and adequate organizational structures, for example, for project and matrix.	- Institutionalizes the joint work between different functions and specialties.	Leenders & Wierenga (2002), Dietrich et al. (2010), Slater et al. (2014).
Formal integrative management processes	Application of formal methods with a logical sequence of activities and resources to achieve certain organizational objectives (e.g. Quality Function Deployment, Stages, and T-Plan for technology roadmap).	- Institutionalizes formalization for integration. - Facilitates communication among the areas involved in NPD. - Allows for a common understanding about customer needs and for NPD characteristics.	Drejer (2002), Phaal et al. (2001), Leenders & Wierenga (2002), Cooper (2007), Laugen & Boer (2008), Jugend & Silva (2013, 2014).
Incentives and rewards	Adoption of rewards practices (career plan and salary) to encourage greater collaboration and interaction among teams and departments.	- Stimulates collaborative behavior.	Leenders & Wierenga (2002), Stock et al. (2013).
Information technology	Use of computer tools to facilitate the exchange of information and interaction among departments and teams (e.g. e-mail, video conferencing, intranet, etc.).	- Facilitates the communication among the areas involved in the NPD. - Facilitates the flow of knowledge and information.	Leenders & Wierenga (2002), Dietrich et al. (2010).

### 3 Research method

With the objective to analyze how integration efforts occur in incremental and radical innovation projects, we used a qualitative research procedure operationalized by a case study. For Yin (2005), the case study is an appropriate method when the researcher requires a greater understanding of the facts being researched. Yin (2005) states that a case study allows for a deeper analysis of a number of relatively small situations as it emphasizes a broader understanding of the phenomenon in question.

As explained in the introduction of this article, the choice of the company was made intentionally. This company was chosen because it has a well-established R&D department and develops new product projects containing both incremental and radical innovations. The innovations of the firm are mainly related to biotechnology and nanotechnology. In addition, the company uses scientific knowledge from chemistry, which suggests that it belongs to the sector with the greatest propensity for innovation Pavitt (1984). Additionally, this firm is representative of an important sector of the Brazilian economy

and, at the same time, this sector is poorly studied in relation to its management aspects.

The questionnaire was predominantly constructed with open questions and had the main intention of understanding the implementation of integration practices in product projects containing incremental and radical innovation. As much of the recent research about integration in NPD has taken a quantitative approach, which employs research questions that are closed and use preset scales, the authors of this study developed a research questionnaire that was based on concepts presented in studies by Griffin et al. (1996), Kahn (1996), Leenders & Wierenga (2002), Kahn & McDonough (1997), Dietrich et al. (2010), Brettel et al. (2011), Jugend & Silva (2013), Stock et al. (2013), Jugend & Silva (2014) and Slater et al. (2014). An overview of the questionnaire can be found in the Appendix A.

After first contact by phone, the questionnaire was sent by email to the director of R&D. Then the company was visited to conduct the interviews over a whole day. A formal interview was held with the director of the R&D company, who is responsible

for driving product development projects containing both radical and incremental innovation. Information was also obtained from the chief executive officer (CEO), who provides specific technology development services exclusively for the studied company. After the transcription of the case study, the director of the R&D company examined and confirmed the information presented.

In order to triangulate the data, information from other representatives of the development team and members of the supply, planning and production control departments was also obtained. This information was obtained mainly through informal conversations during the visit to the company. Following other recommended procedures for conducting case studies, interviews were accompanied by visits to different departments and also to the “factory floor” of the company. Informal conversations were also conducted to obtain new information and different perceptions about the research field (Gibbert & Ruigrok, 2010; Miguel, 2007, 2012). In addition, the company also offered the researchers the product manual, which allowed for a greater understanding of the research object.

## 4 Case study

In this section, we discuss the case study. The first part aims to present the company. Next, the management practices for the integration of radical and incremental product innovation projects are presented.

### 4.1 Characterization of the company and the projects presented

The company chosen for this case study is from the biotechnology sector and operates in botanical extracts. The company exports its products to more than seventy countries. It has four industrial units, two commercial offices, an agricultural unit and an innovation unit—the center of R&D—and has about 350 employees. From plant extracts, dehydrated pulps, essential oils and active ingredients, the company develops and manufactures products to meet consumer health sectors, pharmaceutical and personal care products (cosmetics).

In 2012, the group that controls the company acquired quotas in a joint venture that has been maintained since 2004 with two other companies, one in the cosmetics sector and another in the agricultural sector. Furthermore, an independent unit of innovation focused on research, development and innovation was created whose focus is the development and commercialization of technologies based on Brazilian biodiversity through research,

intellectual property licensing, regulatory support and innovation management.

The development of new products in the company is also supported by a cross-functional team that operates in this innovation unit. This unit plays a supporting role to ensure compliance with regulatory issues, approvals and certifications of their products and to manage the company’s innovation process.

### 4.2 Management practices for integration in new product development

New product development projects that have radical type of innovation begin with trends in therapeutic and marketing research, especially considering medium and long-term perspectives. From these inputs, the company tries to identify new species of plants and molecules with developments in medicaments, aromas and flavors, which make up the portfolio of radical innovation projects. In radical innovation projects, the company emphasizes the recent development of antiperspirant deodorant that uses menthol as an alternative mechanism to replace aluminum chloride, since the safety of aluminum chloride for human health has been questioned. The unit has developed menthol as an alternative mechanism for this active element; it activates the cold receptors in the brain and to inhibit sweating. The company’s radical innovation efforts are usually generated through research projects that are referred to support agencies such as the São Paulo Research Foundation (FAPESP) and the National Council of Technological and Scientific Development (CNPq) among others that can obtain the funds for investments despite the high risks associated with these types of projects.

By contrast, incremental innovation projects usually begin from customer requests and the identification of opportunities and difficulties by the company. An estimate of the costs and demands are then made. These estimates are sent to an internal committee for approval. Once approved, the project is sent to R&D and, later, to the industrial sector, which includes the following departments: supplies, production, quality and processes. These projects are restricted to making improvements to existing products, such as changing a component of an herbal medicine. The company highlights the following incremental innovation project: the development of an isolated active anti-inflammatory drug that has a 5% concentration of Arpadol. This new product made it possible to manufacture smaller capsules (in this case, 250 mg), improving the production process and allowing for the reduction of the size of the drug. It also enabled the drug to meet the needs of the pharmaceutical industry.

The departments involved in both radical and incremental projects are marketing, project management and R&D. They work in an integrated manner with the innovation unit with the purpose of developing new products. The participation of these departments within the NPD process was reported as democratic for both projects; all of them have space for suggestions, and they report the common use of brainstorming, especially in the pre-development phase of NPD.

Departmental differences in product development projects containing radical and incremental innovations are presented briefly in Chart 2.

The results presented in Chart 2 indicate the presence of different integration practices in NPD projects with radical and incremental innovations. In order to detail these results, the following observations are obtained, and quotes are presented throughout the case study.

In the case of radical product innovation, the innovation unit has greater involvement in the NPD project, from the earliest stages to the delivery of the product. This unit functions independently of the operations of the plant. *“We deliver the product developed for the factory, and for this reason we have an independent structure.”* In the incremental NPD project, the innovation unit adopt a supporting role but focused on its interaction with the R&D plant. *“The company gets the radical innovation that was developed, and from that it generates incremental innovations.”*

The innovation unit leads and coordinates radical innovations for the company. The advantage of this strategy is that it externalizes the determination of deadlines and requirements for cost and quality.

*When the department that develops is internal, they are often consumed by hours for operating adjustments, which ultimately stop the development. The independent unit does not have this problem, because its core business is not the production of the product on a commercial scale, but rather the development of the product concept. It also generates better communication, because the external partner is the one who controls the project schedule. Aside from all of this, it also assists in the formalization of the whole process.*

In incremental NPD projects, the innovation unit assumes the responsibility for providing support for the internal R&D. According to the respondent, *“[...] there were many conflicts when was is all over in R&D. With the support of the innovation unit, the know-how is shared and allows for the resolution of conflict and a balance of activities”*.

Two integration mechanisms adopted by the company were highlighted: informal social systems and physical facilities design. As reported by the R&D director, in the case of the radical project, the co-location is mainly for driving the innovation of small teams innovation drive has size and small teams, highlighting the intimacy generated in the teams.

*In a small team where everyone knows each other and knows how each other works, it is not difficult to maintain motivation to achieve the desired performance. But the excess of intimacy can also be harmful, so the team should look for good communication, cooperation and collaboration, but not allow the human factor (intimacy/friendship) to interfere with the performance due to the fact that the company is small.*

However, the fact that the innovation unit is physically separate from the plant was also identified as beneficial, as it avoids undesirable stops of the R&D team to solve everyday problems not related to NPD. The company's incremental project involves co-localization between the R&D and industrial (production, supplies, etc.) units. This need was identified in the SWOT and 5W2H diagnosis and was a measure taken to improve communication between the departments.

*The same place was adopted to decrease the noise and discrepancies of communication. When they were separated like in a stadium-like Palmeiras and Corinthians—one cries to another; but they did not understand each other. The use of a common area improved communication.*

An informal social system was adopted by the company that involves themed lunches in the restaurant, hiking and other programs in which all employees of the company participate. *“When people meet outside the workplace helps in improving communication between them.”* In the specific case of the innovation unit, *“as the team is smaller and everyone knows each other, it becomes easier to keep engaged and motivated people to work together.”* On the other hand, the study highlighted the need to use formal tools to inhibit excessive informality that can be harmful to project performance.

*Too much informality hinders, because people can lose focus of the desired results. So in these cases, management tools such as the “TO DO” list help, because they indicate the responsibilities of each of the teams working on the project and require them to meet these responsibilities.*

**Chart 2.** Integration practices.

<b>Analyzed Items</b>	<b>Radical Innovation</b>	<b>Incremental Innovation</b>
<b>Departments</b>	Innovation Unit (external R&D).	Internal R&D.
<b>Size of the teams</b>	Independent team with high cooperation of employees.	Each analyst is responsible for one project only.
<b>Department that coordinates the NPD project</b>	Innovation Unit (external R&D).	Internal R&D with support of external R&D.
<b>R&amp;D involvement in the development of the project</b>	Intense involvement of external R&D with little interaction with the company (independent structure).	Internal R&D with support of external R&D.
<b>Formal integrative management processes</b>	Cross-functional teams, stages, quality function deployment (QFD) and customer relationship management.	Cross-functional teams, stages, quality function deployment (QFD) and customer relationship management.
<b>Job rotation</b>	Not applicable.	Not applicable.
<b>Informal social systems</b>	External relations to the company as a guideline and orientation (e.g. research groups at universities).	Team meetings, thematic lunches and walks.
<b>Relocation and physical facilities design</b>	External R&D is a small factory where everyone knows each other and shares information, but it is separated from the manufacturing plant.	The R&D and industrial departments are neighbors.
<b>Incentives and rewards</b>	Participation in profits and results. Performance goals for each product development project increases the value of the reward.	Participation in profits and results. Performance goals for each product development project increases the value of the reward.
<b>Tools of information communication technology</b>	Whatsapp (commonly used), Skype, customer relationship management (CRM), internal chat and shared database.	Whatsapp (commonly used), Skype, CRM, internal chat and shared database.
<b>Conflict mediation</b>	Focus on meeting the costs of products. There are meetings to resolve conflicts.	Focus on meeting the costs of products. There are meetings to resolve conflicts.
<b>Financing source</b>	Financing search in government agencies.	From the company itself or a client.
<b>Methods for integration of teams</b>	Informal processes and small teams assist to keep everyone engaged.	Integration needs diagnosed with methods such as SWOT and 5W2H.
<b>Sharing of performance objectives</b>	External R&D reports to the company board.	Management Group (supervisors, managers, and directors) and Internal Project Commission.

## 5 Results analysis

Chart 3 presents the integration practices for the types of projects analyzed—radical and incremental. To assist in the analysis of these practices, they have been grouped according to the type of product innovation that was identified and classified according to the themes presented in the literature.

The practices presented by the company and highlighted in Chart 3 reinforce recent studies in this field (e.g., Brettel et al., 2011; Rubera et al., 2012) which suggest that integration efforts can provide better performance in NPD projects since analyzed by the theory of contingency. The observation of the early stages of NPD require an increase in face-to-face contact between the departments, which is consistent with the results observed by Olson et al. (2001). The differences observed in this study between

radical and incremental NPD innovation projects with respect to organizational structure and practices such as leadership, coordination and training teams is also aligned with the study by Brettel et al. (2011), whose results show that the type innovation used influences the practices and the need for integration.

Rubera et al. (2012) highlighted the negative effects of excess integration in NPD. In relation the physical facilities design, it is noted from Chart 3 that while in the case of incremental innovation proximity between departments generates improved communication between the departments involved in NPD, in the case of radical innovation the separation of R&D and other departments improves communication during the NPD process. The case study also verified the use of integration mechanisms such as physical proximity and information technologies as facilitators

of integration, which aligns with the observations of Leenders & Wierenga (2002) and Dietrich et al. (2010). Moreover, it was possible to identify a very productive process for the participation of departments in NPD using tools such as brainstorming, in which departments demonstrate the freedom of their members to participate in generating ideas and proposals.

Because of the greater complexity of NPD in radical projects, which are carried out by an autonomous structure of R&D, there is more freedom and creativity for the project to be developed without interference from routine situations from the manufacturing department. On the other hand, this autonomous structure also allows for greater control by the company; it usually behaves as a kind of external supplier that has to meet goals, objectives and company specifications. In the case of incremental projects,

this autonomous unit assumes a position of support for R&D and industrial departments, functioning as a type of consultancy for these departments to develop these projects.

It was also found that a greater effort of integration was needed, especially in the radical project where there are different areas and specialties involved. Aside from the cross-functional teams, other practices have also been adopted: the intensification of face-to-face contact among the teams, visits to different departments, the intensive use of information technology tools to improve communication and so on. This need for more integration linked to the radical project has ensured that all areas analyze the NPD from the perspective of their specialty, but without losing the holistic view of the process. This tends to strengthen the reach of the common organizational

**Chart 3.** Management practices in the company for the integration of NPD projects with radical and incremental innovations.

<b>Management practices for integration (radical and incremental)</b>			
<b>Type of Innovation</b>	<b>Management practices for integration and NPD</b>	<b>Literature classification (integration and NPD)</b>	<b>Case study</b>
<b>Radical</b>	Radical projects unit (independent of the production area)	Relocation and physical facilities design	- Improvement upon the planned deadlines.
			- Elimination of R&D hours spent on trivial activities.
			- Improvement of the communication during the NPD process.
			- Demand for results is external (R&D is characterized as a company supplier).
			- The company performs incremental innovations from radicals developed by the external unit, reducing the effort required for NPD.
	Stages	Formal integrative management processes	- It permits all departments involved to make evaluations in order to solve problems. - More frequent face-to-face contact among the teams.
	Greater involvement of the technical departments (R&D and engineering)	Organizational structure	- It allows commercial areas to be invited to interact only at specific points, which avoids overloading these teams with unnecessary meetings.
	Project coordination under the R&D responsibility		- Better design of teams, preventing teams from getting overloaded by projects that require more employees.
	Uses larger teams for NPD		- Allows the R&D team to focus its efforts on projects that require more attention.
	R&D supervises and operates the entire NPD process		
Use management tools like spreadsheets “to do” lists outlining the tasks and responsibilities of each team and team member	Formal integrative management processes	- It inhibits excessive informality that can lead to a lack of focus on the objectives and consequent low team performance.	

Chart 3. Continued...

<b>Management practices for integration (radical and incremental)</b>			
<b>Type of Innovation</b>	<b>Management practices for integration and NPD</b>	<b>Literature classification (integration and NPD)</b>	<b>Case study</b>
<b>Incremental</b>	Departments of engineering, production, marketing and sales located in the same building	Relocation and physical facilities design	- Improvement in the communication among departments.
	Stages	Formal integrative management processes	- Allows for all areas involved to make evaluations for troubleshooting, but only in phases when it is necessary in order to avoid overloading the teams with unnecessary meetings.
			- Reduced need for face-to-face contact among the departments.
	Greater involvement in the commercial areas (marketing and sales)	Organizational structure	- Enables greater involvement of commercial areas in projects considered to be more straightforward, freeing up technical teams to develop projects that require radical technological development.
	Use of small teams in NPD		- Better design of the teams, preventing teams from being idle due to having too many members for projects that require fewer employees.
	R&D provides support for the other departments involved in NPD		- Allows R&D to focus its efforts on projects that require more attention.
- Assisted in conflict resolution. - Sharing of knowledge, technologies and skills from the radical projects with the incremental ones.			

objectives as well as the technical and commercial aspects of the products developed.

### 6 Final considerations

The presence of difficulties in communication, understanding and cooperation between different departments has been an area of analysis with regard to NPD management and innovation for more than a decade. Recent research has shown conflicting results on the necessity of larger or smaller integration efforts for this process, including the existence of cases where low integration can be beneficial to the performance. We understand that this publication contributes to the issue, presenting an analysis of integration in radical and incremental NPD projects through a unique case study in a Brazilian company that develops technologies and products based on biodiversity.

This research has aimed to understand how integration efforts occur for radical and incremental NPD projects. The results showed that firms can adopt different strategies for integration during the NPD process according to the type of innovation. This result is aligned with the contingency approach. On the one hand, radical innovation projects may require greater integration efforts, with the largest share of personnel working in technical and technological areas. On the other hand, incremental innovation projects may require lower integration efforts, which may even benefit the project’s development by making the process more flexible. Among these strategies are different strategies for locating the departments involved in the NPD (either nearer to or further away from each other) and the use of emerging and flexible information technology tools for communication such as instant messaging and CRM applications.

It was noted that radical innovation NPD projects may require the greater involvement of technical teams such as engineering and R&D as compared to incremental innovation projects. This is different because incremental projects use already-established and well-known knowledge and technologies and so they don't have a great need for the integration of technical teams. Instead, incremental innovation NPD projects need greater monitoring of commercial teams such as marketing, after-sales and sales, and these departments can be responsible for identifying the increments to be considered and added to the products undergoing redevelopment.

The results should be regarded based on the limitations of this research. Even considering that the company stands in relation to its efforts to develop technologies and products based on Brazilian biodiversity, due to the research method employed the results presented here cannot be generalized. Another limitation refers to the classification of innovation adopted in this research. The literature has several classifications for innovation (for example: exploration and exploitation), so the presented results cannot be generalized to other classifications presented in the literature. We suggest that future studies could examine integration from the perspective of these other types of innovation. In this way, future studies could also include integration in the theory of organizational ambidexterity.

Furthermore, this research has focused on internal integration, but it has not analyzed external integration, that is, integration between partners such as suppliers, customers, universities, research institutes and other stakeholders. It is understood that the integration of companies in the supply chain for the development of radical or incremental innovation projects also emerges as another opportunity for further studies. Finally, it is suggested that future studies identify quantitative relationships between practices for integration in radical and incremental innovation projects with strong performance in areas such as finance, innovation, operations and product development.

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**Appendix A.** Overview of questionnaire.

## Company and respondent identification (characteristics)

- 1) Please briefly describe one radical project of NPD.
- 2) Please briefly describe one incremental project of NPD.
- 3) Innovation and new product development in the company:
  - a) Please briefly describe the new product development in the company with regard to radical and incremental projects.
  - b) What are the tasks (or phases) and departments involved?
  - c) How are the teams for product development for radical / incremental projects created?
  - d) How does the leadership coordinate radical / incremental NPD projects?
  - e) Please briefly describe the performance goals (cost, quality, market, specifications, etc.) for radical / incremental NPD projects.
  - f) Please briefly describe the tools and methods used in radical / incremental NPD projects.
  - g) Please describe the autonomy of the departments involved with radical / incremental NPD projects.
- 4) Integration among departments for NPD. Please elaborate on each of these:
  - h) Integration strategy among departments involved with radical / incremental NPD projects.
  - i) Needs of integration (more or less) in the radical / incremental projects.
  - j) Integration mechanisms for radical / incremental projects.
  - k) Communication among departments in radical / incremental NPD projects.