JPB REVIEW
INTERNATIONAL JOURNAL OF PROFESSIONAL BUSINESS REVIEW
ISSN: 2525-3654
OPEN ACCESS

RELATIONAL CAPABILITY: A PROSPECTIVE STUDY AT BRAZILIAN TECHNOLOGICAL-BASE ENTERPRISES IN BIOTECH INDUSTRY

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ARTICLE INFO

Article history:

Received 24 May 2021

Accepted 18 October 2021

Keywords:

Relational Capabilities, Strategic Alliances,
New Products Development,
Technology-Based Enterprises,
Biotechnology.

ABSTRACT

Purpose: R&D activities, as well as its knowledge multidisciplinary fostered contribute to technology-based enterprises (TBE) seek innovation of products in continuous and collaborative ways. Enterprise capability to dealing with diversity, inimitable values, emotional and social links among individuals involved in changing is crucial for P&D succeed. Considering context, we follow to answer research question: How do TBE articulate relational capability to new products development (NPD)?

Design/methodology/approach: Thereunto, a multiple cases study in four TBE is performed into biotech industry.

Findings: Outcomes led to design a descriptive relational capability model associated with NPD which identify interactions and synergies that contribute to deeper knowledge in strategic alliances management in TBE for NPD.

Research, Practical & Social implications: There are clear contributions to advance knowledge through this research in respect of deep analysis of relational capabilities into biotech TBE since they operate in a collaborative R&D system and partnership with outsiders to hunt opportunities, resources, and technologies. So, we have a social phenomenon to understand relational capabilities applied in NPD under a dynamic market influence.

Doi: https://doi.org/10.26668/businessreview/2022.v7i1.233

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CAPACIDADE RELACIONAL: UM ESTUDO PROSPECTIVO NAS EMPRESAS DE BASE TECNOLÓGICA BRASILEIRAS NA INDÚSTRIA DE BIOTECH

Objetivo: As atividades de P&D, assim como o seu conhecimento multidisciplinar fomentado contribuem para que as empresas de base tecnológica (TBE) busquem a inovação de produtos de forma contínua e colaborativa. A capacidade da empresa de lidar com a diversidade, os valores inimitáveis, os vínculos emocionais e sociais entre os indivíduos envolvidos na mudança é crucial para o sucesso da P&D. Considerando o contexto, seguimos para responder à questão de pesquisa: Verificar como a TBE articula a capacidade relacional para o desenvolvimento de novos produtos (NPD).

Método: Para isso, um estudo de casos múltiplos em quatro TBE é realizado na indústria de biotecnologia.

Resultados: Os resultados levaram ao desenho de um modelo descritivo de capacidade relacional associado ao NPD que identifica interações e sinergias que contribuem para um conhecimento mais profundo na gestão de alianças estratégicas em TBE para NPD.

Contribuições teóricas/metodológicas: Existem contribuições claras para o avanço do conhecimento por meio desta pesquisa no que diz respeito à análise profunda das capacidades relacionais em TBE biotecnológica, uma vez que operam em um sistema de P&D colaborativo e parceria com pessoas de fora para buscar oportunidades, recursos e tecnologias. Portanto, temos um fenômeno social para compreender as capacidades relacionais aplicadas no NPD sob uma influência dinâmica de mercado.

Palavras-chave: Capacidades Relacionais, Alianças Estratégicas, Desenvolvimento de Novos Produtos, Empresas de Base Tecnológica, Biotecnologia.

CAPACIDAD RELACIONAL: UN ESTUDIO PROSPECTIVO EN EMPRESAS BRASILEÑAS DE BASE TECNOLÓGICA EN LA INDUSTRIA BIOTECNICA

Objetivo (obligatorio): Las actividades de I + D + i fomentadas, así como su conocimiento multidisciplinar, contribuyen a que las empresas de base tecnológica (TBE) busquen la innovación continua y colaborativa de productos. La capacidad de la empresa para lidiar con la diversidad, los valores inimitables, los lazos emocionales y sociales entre las personas involucradas en el cambio es crucial para el éxito de la I + D. Considerando el contexto, pasamos a responder la pregunta de investigación: Verificar cómo TBE articula la capacidad relacional para el desarrollo de nuevos productos (NPD).

Método (obligatorio): Para ello, se realiza un estudio de caso múltiple en cuatro TBE en la industria biotecnológica.
Resultados: Los resultados llevaron al diseño de un modelo descriptivo de capacidad relacional asociado a NPD que identifica interacciones y sinergias que contribuyen a un conocimiento más profundo en la gestión de alianzas estratégicas en TBE para NPD.

Contribuciones teóricas / metodológicas: Existen claras contribuciones al avance del conocimiento a través de esta investigación con respecto al análisis en profundidad de las capacidades relacionales en TBE biotecnológicos, ya que operan en un sistema colaborativo de I + D y asociación con forasteros para buscar oportunidades, recursos y tecnologías. Por lo tanto, tenemos un fenómeno social para comprender las capacidades relacionales aplicadas en NPD bajo una influencia dinámica de mercado.

Palabras clave: Capacidades relacionales, Alianzas estratégicas, Desarrollo de nuevos productos, Empresas de base tecnológica, Biotecnología.

INTRODUCTION

Technology-based enterprises (TBE) are strong scientific technological basis organizations with established proposals to explore innovation (Ramdani et al., 2013). They must develop competitive edges with sights to make sure a distinct position in turbulent scenarios in constant

changes. Thereby, relation capability (RC), i.e., ability to relate with other organizations beyond boundaries, is where TBE search likelihood to expand existing competences and obtain new ones (Fernandes et al., 2016; Ngugi et al., 2010). One way to apply relational capabilities are strategic alliances which consist in contractual arrangements on behalf of organization's needs and cooperate with outsiders to find or expand resources-base to thrive in new products development (NPD) and value generation (Ortiz-de-Urbina-Criado et al., 2014).

Thus, strategic alliances are a governance path that aims to overcome lack of resources through sharing capabilities with partners for NPD (Pisano, 1991; Lin and Darnall, 2015; Walsh et al., 2016). Into innovation scenario, contractual management for strategic alliances has its central base in dynamic capabilities theory, i.e., organization capacity to create, expand or transform resource-base to reach and sustain competitive advantage in changing settings.

Schilke and Goerzen (2015) and Dyer and Kale (2007) describe relational capabilities (RC) as an organizational dynamic capability (DC) composed by assets, routines and individual abilities composing a set of activities which allow enterprises create, expand, and transform its resource-based arising from partners interactions. Considering that each institution has specific knowledge and resources the alliance could complement what they do not have as their own (Preusler et al., 2020). In respect to sectors potentially adherent and relevant to perform empirical studies about relational capabilities (RC), biotech ones stand out. Estrella and Bataglia (2013) emphasizes biotech enterprises develop over the years a complex contractual alliances system with various partners embracing their action field: universities, research institutes, investment funds, government agencies, pharmaceutical laboratories, and other biotech enterprises. They act in network and sustainable way to dedicate their resources to biotech industry. Biotech enterprises, according to Pisano (2006), differ from others high-tech industries because of limiting knowledge field in complex biological systems where uncertainty prevails and R&D role is a fundamental process, but higher risk. Therefore, we might not dismember R&D into parts which means its activities and processes must be performed in an integrated way. In addition, a majority knowledge is multidisciplinary, interdependent, and tacit making integration task many-sided and challenging (Traoré, 2004).

Scientific and technological diversity, R&D activities integration and multidisciplinary knowledge fostered contribute to biotech TBE reach out a continuous and collaborative way to innovate products contributing directly to corporate performance (Pastuszak et al., 2012). Thus,

relational capability maturity for biotech TBE is a mandatory path into strategic alliances management and might be relevant in its competitive edges. It also becomes potential for enhancements in innovation process and improvements in NPD, as well (Mitze and Strotebeck, 2019; Vlaisavljevic et al., 2020; Senior, 2021). Therefore, we reinforce research question about how do biotech TBE articulate relational capabilities for NPD? Hence, we aim to analyze relational capabilities influence in NPD. And, specifically, we seek (a) to verify how NPD occurs into biotech TBE; (b) to identify relational capabilities elements into biotech TBE for NPD.

Biotechnology integrates biological systems, living organisms or genetic engineering to promote technological development in different fields, such as health, food, the environment, plant agribusiness and manufacturing (Kang and Park, 2012; Hazir and Autant-Bernard, 2014; Pereira et al., 2021). Biotechnological research, development and application activities originated in the United States and immediately spread to Canada, Japan and Western Europe, finally reaching less developed countries (Niosi et al., 2013). The global biotechnology market is expected to be worth US$727.1 billion by 2025 (Grand View Research Inc, 2017). The sector has undergone unprecedented progress as a result of significant investments in R&D, the intense protection of intellectual property rights and the establishment of technological cooperation (Pereira et al., 2021).

Brazilian government supports biotech industry in three different ways: (a) state purchase power (public procurement); (b) regulatory framework (regulations) and (c) financial support through projects funding (National Economic and Social Development Bank - BNDES, 2014; Pereira et al., 2021). In 2012, biotech procurement reached out 5,5 billion (BRL), about 43% of Ministry Health (MS) budget. Regulatory frameworks are under National Health Surveillance Agency (ANVISA) accountability, it is an agency connected with MS. They applied compatible global sanitary standards without losing Brazilian security sight criteria. And projects funding is composed by public policies acting in structured projects promotion in biotech (BNDES, 2014; Pereira et al., 2021) Organization for Economic Cooperation and Development (OCDE) estimates biotech businesses in 27 trillion (USD) a year in the world (BNDES, 2014). Thence, Brazilian biotech industry must be a strategic sector to foster alliances in scientific, technologic, and economic boundaries of this industry generating value chain soon. It also may leverage exportations and new patents grants enhancing local wealth.

There are clear contributions to advance knowledge through this research in respect of deep analysis of relational capabilities into biotech TBE since they operate in a collaborative R&D

system and partnership with outsiders to hunt opportunities, resources, and technologies. So, we have a social phenomenon to understand relational capabilities applied in NPD under a dynamic market influence.

THEORETICAL FRAMEWORK

Entreprises' capabilities are demanded from competitive advantage needs above competitors (Camargo and Meirelles, 2012; Wang et al., 2015; Alves, 2015). Zollo and Winter (2002) describe two sets of activities which have relationship with capabilities' concepts, namely: (1) operational practices arising from operational activities and (2) dynamic capabilities that changing operational practices (DC).

Relational Capabilities (RC) are inserted into CD concept and can be visualized when two or more firms are wondering to cooperate for seeking new resources and competences that, at the beginning, they do not possess in their organizational boundaries (Wang and Rajagopalan, 2015; Delbufalo and Cerruti, 2012; Costa et al., 2017; Donada et al., 2015; Alves, 2015).

Lorenzoni and Lipparini (1999), Dyer and Kale (2007), Schilke and Goerzen (2010) and Niesten and Jolink (2015) highlight RC as dynamic capacity and it contributes to develop enterprises' resources base through formal and intentional partnerships. Hence, this capacity is hunted for many reasons, either to reach market diversification, resources synergy or tech resource acquisition. In certain situations, it can still be the best way to enter maturer into protected market. Relational capabilities (RC) can also promote enterprises to leverage and activate other resources embedded in networks to gain a competitive advantage and promote effectiveness project progress. Specifically, relational capabilities effectiveness leveraging is vital for firms to be able to uncover network's power. On the other hand, openness and transparent communication between cooperative enterprises may lead to knowledge leakage or deter cooperative projects progress (Guo, Yang and Zhang, 2020). Organization efforts should also be attentive to individual aspirations that can influence collaboration preferences and own relational capability. (Schillebeeckx et al, 2016).

Enterprises' cooperation norms, practices, and goals should be a key priority and consistent with cooperative objectives, which will build trust, increase deep cooperation, and reduce transaction costs (Mitze and Strotebeck, 2019; Senior, 2021). Through knowledge resource

coordination and integration, relational capability (RC) is regarded as the capability to interact with other companies and to foster, develop and manage cooperative relationships (De Silva and Rossi, 2018). Therefore, relational capability plays a critical role in gaining a competitive advantage. When partners conduct R&D activities, relational capability allows heterogeneous knowledge acquisition and technology by cooperative partners and facilitates information flow and integration. During R&D project, the enterprise with core technological capability can strengthen cooperative relationships and to be able to provide additional resources and advanced technology to meet with cooperative requirements and, at the same time, to fulfill R&D targets. Relational capability generated by interacting with cooperative enterprises can promote knowledge transfer and can also reduce transaction costs in R&D projects (Guo, Yang and Zhang, 2020).

Thence, contractual strategic alliance should performance in a way to protect the cooperative relationship. Also, R&D pattern requires strategic alliances to keep competitiveness for both sides (Guo, Yang and Zhang, 2020). Gibbons and Henderson (2012) say that competitive capability attainment may depend on management practices supported by relational contracts and their formalization whose may contribute to solve issues related to organizational partnerships in requirement of credibility and transparency. A well-defined strategic alliance scope contributes to determine accountability for interested parts avoiding information leakage (Cui and O'Connor, 2012; Feller et al., 2013; Costa and Porto, 2016).

Although contractual strategic alliances create credibility and transparency, they cannot cover all demands and contingencies in the moment of their establishment (Feller et al., 2013). Thus, the practice and experience during the process contribute to organizational processes development enhancing RC. (Anderson et al., 2011). According to Heimeriks and Duysters (2003), previous experiences in alliances cause enhancement in alliances performance and affect its success rate (Kale and Singh, 2007).

About RC scientific discussion, it should be highlighted McGrath (2008), Schilke and Goerzen (2010) and Alves (2015) patterns that support this study (Table 1).

Table 1. Theoretical construct of the RC that supported the study.

Schilke e Goerzen (2010)	McGrath (2008)	Alves (2015)
Alliance experience: previous experiences accumulated and a such influence on routines creation and support new alliances management.	Knowledge access dimension: allow to generate, integrate, and use knowledge	Coordination dimension: management capability to handle partnership resources, make them effective, profitable, and productive. It´s essential to identify correlations, duplication actions avoidance and produce synergies among individual alliances.
Alliance structured: organizational units constructed for this function, what involves a dedicated and specialized group to strategic alliances management.	Evaluation dimension: is defined as enterprises' capability of managing proactively their partnerships strengthening value link and, consequently expanding alliances	Cultural dimension: enterprise capability to dealing with diversity, inimitable values, emotional and social links among individuals involved in changing.
Interorganizational Coordination ensures individual coordination effectiveness and reinforcement of transactions legitimacy among partnerships.	Co-adaptation dimension is a way to expand technological innovations once it helps in efforts concentration and learning degree increases.	Knowledge dimension: capability of creating, using, and controlling knowledge generated in the partnership, it also addresses learning, routines and processes to facilitate knowledge transfer and abilities translated into employees, suppliers or costumers' knowledge, assets and technologies.
Portfolio Coordination: is about correlation existence among alliances, being necessary to identify to avoid duplicity of actions and produce synergy among them.	Co-innovation dimension: ability to explore tech opportunities, as well as human resources from partnerships, having as objective to obtain an innovation together (co-innovation).	Technological Dimension: are rules and procedures for technological improvement, such as systems integration and necessary technical procedures, expanded vision of technical systems and technological innovation, collaboration with new technologies and technological lessons absorption from the partners.
Interorganizational learning: learning potential transferred to enterprises, resulting from knowledge acquisition from their organizational boundaries, is considered the key to obtain competitive advantage by alliances.	Opportunity dimension: as regards new ways of resources usage, by changing or combining, to make them more effective and profitable.	Co-adaptation dimension: resources adjustment capability or ways of working to increase partnership benefits, this means that mutual investments and partners' adjustment may generate new products, more effective solutions, or relationship improvements.
Proactiveness: is effort to identify new alliances opportunities.	Accomplishment: enterprises capability of perceiving they are inserted in a network to improve their efforts.	
Transformation: in addition to flexibility that enterprises must have to operate their alliances, they need to remain open and prepared for transformations that may arise, as of contract changes, changes in people involved or changes in administration structure.		

Source: Adapted from Schilke and Goerzen (2010), McGrath (2008) and Alves (2015).

RC is completely involved in dynamic markets, as biotech industry, where enterprises need to react quickly and be prepared to strategic alliance establishment to gain competitive edges (Donada et al., 2015; Wang and Rajagopalan, 2015). Thus, there is a tendency in biotech industry about innovation locus dispersion in interorganizational networks for aiming NPD. Rozenfeld et al. (2006) observe that a sequential product development system has been prevailing in enterprises for a long time. Product creation activities and information has been following a logical sequence, specialized and segmented, therefore, there has not been greater interaction among functional areas involved.

Currently, we observe a collaborative approach in NPD (Bueno and Balestrin, 2012), in network perspective when enterprises open themself for external scenarios placing their R&D capabilities in synergy with collective consumers intelligence supported by universities and suppliers' resources. It´s been evident a transition from close pattern, focused on internal resources development, to open pattern where external interactions are mandatory to find out new ways of doing things in R&D (Vlaisavljevic et al., 2020; Pereira et al., 2021). NPD construct is summarized in Table 2.

Table 2. Theoretical Construct of NPD which based the study.

Cooper (1990)	Koen et al (2001)	Bueno e Balestrin (2012)
Stage 1: It begins with an idea that originate product. Gate 1: called initial screen, it decides about resources source; (Stage 1: previous evaluation to determine technological and market merits; Gate 2: repeat previous phase (Gate 1), however it is reevaluated with information from Gate 1 Stage 2: product is clearly defined.	Transformation opportunity to an idea of a product: phase in which ideas are suggested, combined, reworded, changed, and updated, until obtain an idea that meets potentially with client needs.	Idea concepts: it is constituted by ideas generation for a product, which may be created by digital platforms, for example, in a way people send their ideas using sites and might comment other ideas.
Gate 3: the last point in which project can be addressed, being fundamental to review previous phases so that there is no question, making sure that expected results so far are positive so we can advance to the next steps); Stage 3: product development and detailed test evaluation, operation plans and marketing.	Idea selection: after ideas elaboration phase, we select one or some ideas for concept development we are looking for. Usually, a criterion for decision-making is determined based on technological risks, investment level, competitive analysis, productive and organizational capability, as well as expected financial return.	Design Concept: divided into two parts. First, an open design aiming generated ideas interpretation, being collective creation among enterprises and consumers a participative and creative process. Second, is about enterprise development and created concept interpretation which will give rise to a prototype.
Gate 4: it is post-development review in which are checked product and process advances, verifying if their technical and commercial attractiveness remain. Stage 4: project viability is tested as a whole, since product, production processes, costumer acceptance and project economic viability.	Concept: it develops a business plan based on some factor's analysis, such as Market potential, costumers need; technologies potential development; investments demands; as competitor actuation and global risk.	Open Branding: product launch decision-making and brand, product name and communication, launch campaign, consumer integration once again to marketing decision-making, dissemination, and full launching.
Gate 5: commercialization, inconsistence verification. It is the last step where still possible any abortion. Focused on quality activities and validation results. Financial forecasts are considered as a key of continuing. Finally,		

operation and marketing plans are reviewed and approved.	
Stage 5: operation and marketing plans implementation, as well as product release for trading	

Source: Adapted from Cooper (1990), Bueno and Balestrin (2012) and Koen et al. (2001).

From theorical constructs analysis synthesized in Figure 1 and 2, we can infer contractual strategic alliances objectives (Schilke and Goerzen, 2010; McGrath, 2008; Alves, 2015) must substantiate new products technologically or significantly improved (Cooper, 1990; Koen et al., 2001; Bueno and Balestrin, 2012), as well as internal and external investments in R&D and qualified professionals allocation. Therefore, we proposed:

(P1) NPD opportunities prospection, on national and international level, precede grounds of strategic alliances objectives stablished with external partners.

(P2) New technological product development or significantly improved is fundamental goals of strategic alliances established with external partners.

(P3) Internal R&D investment is relevant for achieving strategic alliances objectives established for NPD.

(P4) Resource's allocation in research institutions or universities is relevant for achieving strategic alliances objectives established for NPD.

(P5) Qualified professionals' performances (graduates, masters, and doctors) in engineering activities and R&D are relevant to achieve strategic alliances objectives established for NPD.

In NPD phase, it can be inferred that contractual strategic alliances structures (Schilke and Goerzen, 2010; McGrath, 2008; Alves, 2015) need specialized departments and dedicated people which will perform management activities. We emphasize, contracts contribution for alliances formalization and collaboration for management in potential conflicts. Thus, we propose (P6 to P8):

(P6) External partners are prospected as a fundamental part of NPD.

(P7) To formalize NPD with external partner we must establish contractual strategic alliances.

(P8) To conduct NPD strategic alliances we must systematize a formal management team.

Even in NPD phase (Cooper, 1990; Koen et al., 2001; Bueno and Balestrin, 2012), it can be inferred that interorganizational alliance coordination, alliance portfolio, as well as activities synchronization involved in contractual strategic alliances (Schilke and Goerzen, 2010; McGrath,

2008; Alves, 2015) need a governance structure that gives support to activities among partners so that knowledge acquisition is transferred in a continuous and interactive way, avoiding or minimizing potential conflicts (Mitze and Strotebeck, 2019; Pereira et al., 2021). As such, it is possible to establish the following propositions (P9 to P12):

(P9) Knowledge acquisition from interorganizational NDP strategic alliances must be disseminated throughout TBE areas.

(P10) NPD' strategic alliances portfolio coordination must establish an interactive and continuous knowledge among the company and its external partners.

(P11) Knowledge acquisition from previous strategic alliances generate future innovation projects of products.

(P12) In NPD' strategic alliances we must synchronize decision-making among TBE and its external partners.

Regarding to post-development, it can be inferred that, when alliances configure themself in a collaborative and open ways, including developed products protected by registrations or trademarks in co-ownership with partners, contributions are latent, including income obtained by marketing of new products and adoption of a business model based on open innovation (OI) (Chesbrough, 2003; Senior, 2021; Pereira et al., 2021., Borges et al., 2021). It also highlights that experience derived from continuous practice in alliances management is a contribution that can optimize RC into organization (Schilke and Goerzen, 2010; McGrath, 2008; Alves, 2015). Thus, it is possible to establish the following propositions (P13 to P15):

(P13) income obtained from products protected by patents or software registration, or in process of protection acquisition, is a fundamental contribution in contractual strategic alliances established for NPD.

(P14) Collaborative business model adoption contributes to RC development into TBE.

(P15) Continuous strategic alliances practices for NPD contributes to RC development into TBE.

Finally, it should be highlighted that opportunities prospection must permeate the entire NPD cycle and RC performs as a fundamental role in value creation to a business model based on OI (Schilke and Goerzen, 2010; McGrath, 2008; Alves, 2015).

RESEARCH METHODOLOGY

A descriptive research is sketched (Barros and Lehfeld, 2007) in qualitative nature (Biklen and Bogdan, 1994; Richardson, 1999) and multiple case study method (Yin, 2010) in four Brazilian biotech enterprises (small size), private capital and partnerships in universities, research institutes, commercial agents and/or national and international clients, which strategic focus is innovation (Figures 3 and 4). It is noteworthy that an analysis unit was represented by the EBTs from the biotechnology sector, as they are companies that seek, through external partnerships, to obtain new resources or resources that complement the development of innovative products (Figures 3 and 4).

Primary data are collected from structured interviews (Gil, 2005) and secondary data are obtained in organizational documents, including NPD contracts, projects, and reports. (Richardson, 1999). Questions from data collection are guided by dynamic capabilities theory, outlined to achieve relational capabilities outcomes (Schilke and Goerzen, 2010; McGrath, 2008; Alves, 2015), as well as NPD direction (Cooper, 1990; Koen et al., 2001; Bueno and Balestrin, 2012). Interview script preview is approved by active researchers, professors and managers in innovation and NPD area. In the end, four interviews are performed in TBE's research direct to NPD directors.

Data content interpretation adopt theoretical propositions as an analytical strategy leding intracase discussions (Bardin, 1979; Chizzotti, 2010). In addition, Iramuteq software covers textual corpus (Camargo and Justo, 2013) to build a semantic network. During cases transcription activities to validate and complement data a new contact with participants are done by phone and Shype to final analysis (Table 3).

Table 3. Methodological Design.

Methodological Design	
Research nature	Qualitative (Biklen and Bogdan, 1994; Richardson, 1999).
Methodological approach	Descriptive (Barros and Lehfeld, 2007).
Method	Multiple case study (Yin, 2010).
Analysis unit	Biotech TBE
Data collection techniques	Structure interview conduction (Gil, 2005).
	Documents revision (Richardson, 1999).
Data collection instruments	Structured interviews script
	Structured document analysis
Data analysis	Analytical strategy and content analysis based on theoretical propositions (Bardin, 1979) Iramuteq software usage to recover textual corpus and words (Camargo and Justo, 2013).
Main research questions that guided the interview script and the script for document analysis	How are objectives defined in contractual strategic alliances established for NPD? How are contractual strategic alliances based on NPD structured? How are contractual strategic alliances based on NPD coordination? How are contractual strategic alliances established for NPD in TBEs?
Participants	

	Shareholder and Business Development Director at Biotika; Business and Product Development Director at Gentros; Shareholder and Businesses Development at Itatijuca; and Shareholder and Products and Businesses Development Director at Rheabiotech.
Analysed documents	NPD contracts, projects, and reports

Source: Elaborated by the authors.

RESULTS

Organizations researched recognize themselves as technology-based enterprises - TBE (104 incidences in Iramuteq) and their main strategic goal is new product development. TBE works on products intermediation and prospection which can compose final products, i.e., make feasible entirely products development that clients, in principle, are not able to build scientifically or technologically. Albeit Biotika deliverables for some clients are product pieces, however for Biotech it is its final product (Table 4).

Gentros business model consists of to identify technologies developed by tech institutions (STI) which have NPD's potential. Enterprises develop technology and other enterprises perform trading and production. Technology transferring occurs by partnership agreement or product licensing.

Itatijuca business model is highlighted by products and biotech supplies developments, as well as bioleaching (kind of unique outsourcing service). They have a strategic alliance with Pöyry, a Finnish consulting and engineering services company, to provide their services but bioleaching methodology was developed by them. Furthermore, Itatijuca is responsible for performing proof concepts till bioleaching operation. On the other hand, Pöyry operates on engineering fields, future industrial plants, and bioleaching pilots' projects.

Rheabiotech business model follows (a) supplies production to R&D (polyclonal and monoclonal primary and secondary antibodies, conjugated antibodies, and recombinant proteins); (b) agriculture, veterinary and human health's diagnostic kits development; and (c) third-party in immunochemical services area.

Table 4. Main NPD characteristics in TBE

NPD	Biotika	Gentros	Itatijuca	Rheabiotech
NPD steps	Supplies searching development, Project adequacy, confidentiality, and trading agreements.	Confidentiality agreements and contract for development and trading.	Uses methodology developed by company itself, based on "Stage Gate" with nine decision steps	Three steps: confidentiality agreement, development agreement and trading agreement.
Main products or services offered	ADN/ARN products representation, proteins and molecules, bioengineering cells, and tissues cultivation; in addition, provides services in technology transfer.	Molecular Diagnostic, vaccines, and genome sequencing.	Mineral, residues, and difficult effluents management processing; residues processing in paper and cellulose sector; recovery of electronic waste; biological control in agroindustry, and others.	Primary and secondary antibodies, recombinant proteins, and diagnostic kits.
Main commercial partners and representations	Foreign companies, including USA, Germany, France, United Kingdom, Denmark, and Israel.	Sector companies.	Pöyry (Finnish company) and Esalqtec (Technological Incubator).	Brazilian Universities, research institutes. private and state companies.
Textual corpus Recovery and words from the Iramuteq software	'Product' 47 events; 'enterprise' (36); 'market' (2); 'patent' (22); 'knowledge' (21); 'client' (18); 'project' (15).	'Enterprise' and 'product', 27 events; 'develop', (24); 'knowledge', (22); 'development', (19); 'patent', (18).	'Development', 26 events; 'project', (23); 'enterprise', (22); 'develop', (15); 'partnership' and 'product', 12 events each one.	'work', 31 events; 'product', (24); 'project', (21); 'enterprise', (19); 'development', (18); 'partnership', (17); 'market', (15); 'patent', 14 events.

Source: Elaborated by the authors.

DISCUSSIONS

Discussions ahead, it is established technical-empirical approach considering throughout researched cases and theoretical concepts about relational capabilities (RC) and NPD. Thus, we analyzed RC alignment faced with cyclical NPD phases, defined in following way from textual corpus recovery in Iramuteq software as: (1) pre-development; (2) development divided in (2.1) NPD structuring and (2.2) NPD's knowledge coordination and (3) post-development (Figures 5, 6, 7, 8 and 9).

Pre-development phase, we identify RC elements in biotech TBE as of textual corpus recovery by Iramuteq software point out by opportunities prospection, objective grounds, human resources allocation, investments prioritization, internal and collaborative R&D in STI (Mitze and Strotebeck, 2019; Vlaisavljevic et al., 2020; Senior, 2021; Pereira et al., 2021) (Table 5).

Table 5. Propositions in predevelopment phase

Propositions in predevelopment phase	Proposition's adherence			
	Biotika	**Gentros**	**Itatijuca**	**Rheabiotech**
(P1) NPD opportunities prospection, on national and international level, precede grounds of strategic alliances objectives stablished with external partners	**ADHERENT** Prospection occurs on national and international level	**ADHERENT** Prospection occurs on national and international level	**NOT ADHERENT** Prospection occurs on national level	**ADHERENT** Prospection occurs on national and international level
(P2) New technological product development or significantly improved is fundamental goals of strategic alliances established with external partners	**NOT ADHERENT** Fundamental objective is to meet demands for supplies and specialized technical services already flagged by the technological and commercial partners	**ADHERENT** (Fundamental objective is to product development and technologically innovative processes	**ADHERENT** Fundamental objective is providing technological solutions based on green biotechnology and chemistry	**NOT ADHERENT** Depends on partner competence and its respective demands for immunochemical solutions in research and diagnostic)
(P3) Internal R&D investment is relevant for achieving strategic alliances objectives established for NPD	**ADHERENT** (15% of enterprise income is to internal R&D)	**ADHERENT** Income is almost completely directed to internal R&D	**ADHERENT** (10% of enterprise income are directed to internal R&D)	**NOT ADHERENT** (Internal R&D uses subvention exercise in projects approved by Fapesp or Finep)
(P4) Resource's allocation in research institutions or universities is relevant for achieving strategic alliances objectives established for NPD	**NOT ADHERENT** 0% of enterprise income is directed to the STIs)	**NOT ADHERENT** 0% of enterprise income is directed to the STIs)	**ADHERENT** 30% of enterprise income are directed to STIs to collaborative development of new products)	**NOT ADHERENT** 0% of enterprise income is directed to the STIs
(P5) Qualified professionals' performances (graduates, masters, and doctors) in engineering activities and R&D are relevant to achieve strategic alliances objectives established for NPD	**ADHERENT** All professionals who act in NPD are qualified, one is graduated and three have master's degree and/or doctorate	**ADHERENT** All professionals who act in NPD are qualified, one is graduated and three have master's degree and/or doctorate	**ADHERENT** All professionals who act in NPD are qualified, ten are graduated and seven have master's degree and/or doctorate	**ADHERENT** All professionals who act in NPD are qualified, two are graduated and two have master's degree and/or doctorate

Source: Data from interviews, contracts, projects, and NPD reports

Biotika, Gentros and Rheabiotech, in predevelopment phase, prospect NPD opportunities in national and international level (Bueno and Balestrini, 2012). After that, contractual objectives in strategic alliances are defined as suggested by Alves (2015), specially at Gentros and Itatijuca. They work based on technological new products or significant improvements. Biotika and Rheabiotech, create their foundations in alliances to meet supplies demands, services and tech solutions already known and disseminated into national or international market.

Rheabiotech's exception, in predevelopment phase, internal R&D income is relevant to achieve strategic alliances objectives in researched Biotika, Gentros and Itatijuca's TBE. Additionally, qualified professionals' performances (graduates, masters, and doctors) in engineering and R&D activities are shown as relevant as well. Finally, allocation resources in Institutions or Universities obtain relevance only at Itatijuca.

At development phase itself divided in NDP' structuring and NDP's Knowledge coordination gathered by Iramuteq software in textual corpus recovery, we identify in NDP' structuring some RC's elements such as external partners' prospection, contractual strategic alliances formalization and team systematization for alliances shared management (Mitze and Strotebeck, 2019; Vlaisavljevic et al., 2020; Senior, 2021; Pereira et al., 2021) (Table 6).

Table 6. Propositions linked to NPD structuring phase.

Propositions linked to sub phase of NPD structuring	**Proposition's adherence**			
	Biotika	**Gentros**	**Itatijuca**	**Rheabiotech**
(P6) *External partners are prospected as a fundamental part of NPD*	**ADHERENT** (Technological platform Webinar, commercial representations network, professionals and academic managers' contacts managers are fundamental for partners prospection	**ADHERENT** (Manager's network and virtual platform called Research Gate are fundamental for partners' prospection)	**ADHERENT** (Technological platform (Itec) is fundamental for partners' prospection)	**NOT ADHERENT** Marketplace and events participation, but work mainly on demand
(P7) To formalize NPD with external partner we must establish contractual strategic alliances.	**ADHERENT** Confidential agreements and contracts' establishment	**ADHERENT** Confidential agreements and contracts' establishment	**ADHERENT** Confidential agreements and contracts' establishment	**ADHERENT** Confidential and commercial agreements and contracts' establishment
(P8) To conduct NPD strategic alliances we must systematize a formal management team	**ADHERENT** Systematized NPD's involvement and business board, commercial board, and sales team	**NOT ADHERENT** Focused on business and product development board	**NOT ADHERENT** Focused on business and product development board	**NOT ADHERENT** Focused on markets and NPD's board

Source: Data from interviews, web sites, contracts, projects, and NPD reports

External partners are fundamental for NPD structuring at Biotika, Gentros and Itatijuca confirming McGrath (2008) discussions, however Rheabiotech is an exception. We highlighted as external partners prospection mechanism a commercial representation network, professional and academic managers' contacts, and digital platforms such as Webinar, ResearchGate and Itec.

NPD structuring is also identified as much relevant in all TBE to formalize contractual strategic alliances with external partners as postulate by Schilke and Goerzen (2010). Alliance's mechanisms formalization is pointed out emphasizing: (a) confidentiality agreements and R&D contracts; and (b) supplies provision or specialized technical service delivery. At Biotika, strategic alliances for NPD are systematized and shared-manage by a formal management team as Alves (2015) highlighted, adding new business, NPD and commercial board and sales team. In fact, it is not perceived in others TBE.

In development phase yet we identify RC elements in NPD's knowledge coordination as of textual corpus from Iramuteq software highlighted by knowledge dissemination among internal TBE areas, Knowledge replication in subsequent NPD, decision-making synchronization, alliances' portfolio synchronization sharing (Mitze and Strotebeck, 2019; Vlaisavljevic et al., 2020; Senior, 2021; Pereira et al., 2021) (Table 7).

Table 7. Propositions linked to NPD knowledge coordination.

Propositions linked to NPD's knowledge coordination	Proposition's adherence			
	Biotika	**Gentros**	**Itatijuca**	**Rheabiotech**
(P9) Knowledge acquisition from interorganizational NDP strategic alliances must be disseminated throughout TBE areas	**ADHERENT** Knowledge acquisition is disseminated in internal meetings every two months and are stored electronically)	**ADHERENT** Knowledge acquisition is disseminated in internal meetings)	**ADHERENT** Responsibilities and deadlines for deliverables are documented by meeting minutes	**ADHERENT** (Knowledge acquisition is disseminated in internal meetings)
(P10) NPD' strategic alliances portfolio coordination must establish an interactive and continuous knowledge among the company and its external partners	**NOT ADHERENT** NPD board centralize alliances portfolio coordination that only handle internal technical teamwork schedule	**NOT ADHERENT** It is not performed by enterprise activities	**NOT ADHERENT** (The Business and products development board centralized alliances portfolio coordination	**NOT ADHERENT** There is no alliances portfolio
(P11) Knowledge acquisition from previous strategic alliances generate future innovation projects of products.	**ADHERENT** Knowledge acquisition from previous alliances were used in NPD in partnership with Embrapa and Fiocruz	**ADHERENT** Knowledge acquisition from previous alliances were used in vaccines development projects	**ADHERENT** Knowledge acquisition from previous alliances were used in paper and cellulose development projects in	**ADHERENT** Knowledge acquisition from previous alliances about biosensors were used in recent development projects
(P12) In NPD' strategic alliances we must synchronize decision-making among TBE and its external partners	**NOT ADHERENT** Decision-making synchronization involve only internal NPD, commercial board, and team	**ADHERENT** Meetings are held to monitor progress, redirect activities involving TBE and its partners in a weekly and fortnightly basis.	**NOT ADHERENT** Decision-making synchronization is provided by internal weekly meeting and formalized in meeting-minutes to make easier internal communication	**ADHERENT** Work schedule among TBE and partners support decision-making synchronization and outcomes monitoring

Source: Data from interviews, websites, contracts, projects, and NPD reports

Knowledge acquisition is disseminated in TBE internal areas as pronounced by Alves (2015) through scheduled meeting in continuous frequencies basis and documented in electronic records to promote knowledge sharing.

Knowledge acquisition from previous alliances is an important asset for TBE. It is always used in subsequent NPD projects corroborating with Schilke and Goerzen (2010) findings. However, only Gentros and Itatijuca perform in a good manner decision-making sharing with their external partners using NPD strategic alliance discussed by Bueno and Balestrini (2012). Biotika and Rheabiotech's decision-making occurs only internally, at all. Despite of concerning mentioned by participants about alliances integrated management maturity, we verify that NPD portfolio is not used for interactive knowledge sharing in a continuous way by TBE. Biotika and Itatijuca coordinate their portfolio with a great centralization. Yet, Gentros and Rheabiotech do not perform any activity of portfolio coordination.

In post development phase, we also identify RC elements as of textual corpus from Iramuteq software bespeaking by industrial property income, collaborative business model adoption and continuous strategic alliance practice for NPD (Mitze and Strotebeck, 2019; Vlaisavljevic et al., 2020; Senior, 2021; Pereira et al., 2021) (Figure 8).

Table 8. Propositions linked to predevelopment phase.

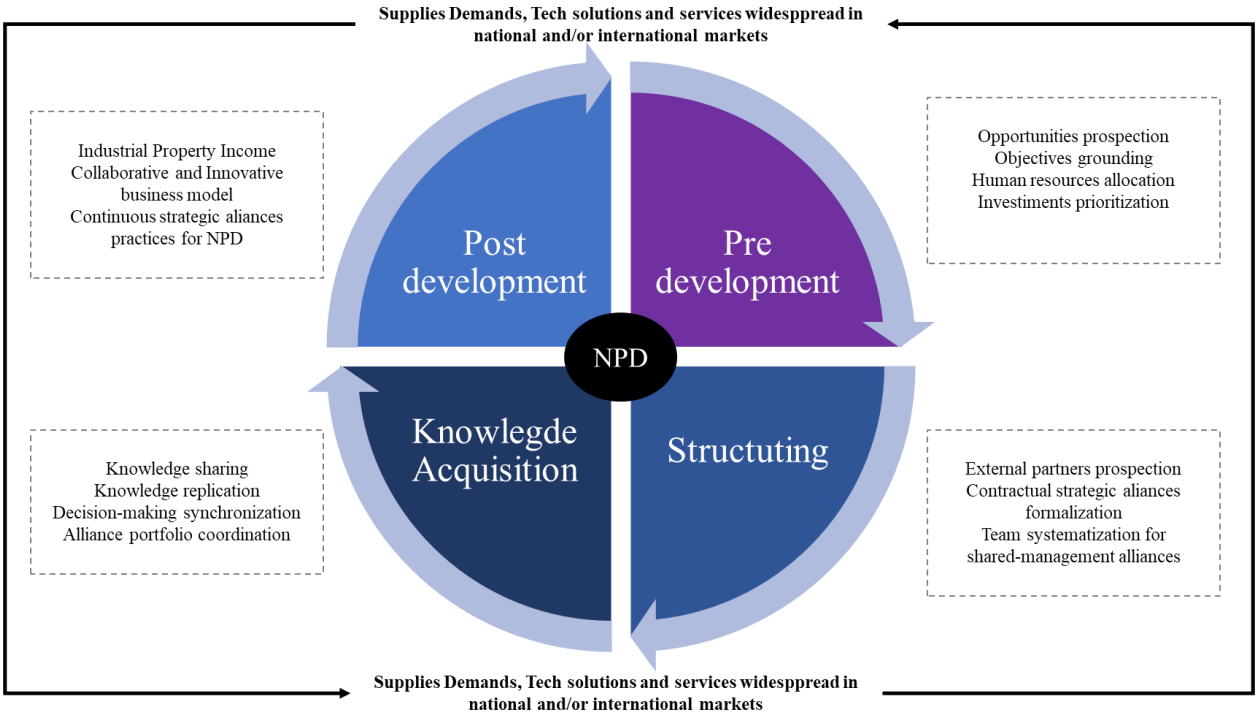
Propositions linked post development	Proposition's adherence			
	Biotika	**Gentros**	**Itatijuca**	**Rheabiotech**
(P13) income obtained from products protected by patents or software registration, or in process of protection acquisition, is a fundamental contribution in contractual strategic alliances established for NPD	**NOT ADHERENT** 0% enterprise income is obtained from non-protected products by patent, software registration or products in registration process	**NOT ADHERENT** 0% enterprise income is obtained from non-protected products by patent, software registration or products in registration process	**NOT ADHERENT** 0% enterprise income is obtained from non-protected products by patent, software registration or products in registration process	**NOT ADHERENT** 0% enterprise income is obtained from non-protected products by patent, software registration or products in registration process
(P14) Collaborative business model adoption contributes to RC development into TBEs	**ADHERENT** Enterprise business model is supported by knowledge acquisition	**ADHERENT** External partnership is used to tech competences searching and standardize research protocols	**ADHERENT** Popularization and disclosure technology development is shown as collaborative business model	**ADHERENT** Taskforces (association and complementariness) with partners demonstrate capacity to handle biotech dynamic market
(P15) Continuous strategic alliances practices for NPD contributes to RC development into TBE	**ADHERENT** Work routines and organizational process involve strategic management alliances for NPD	**ADHERENT** Enterprise empowerment to engage partners in a good manner way.	**ADHERENT** Provide new knowledge and generate competences for new partnerships establishment	**ADHERENT** successes and mistakes reinforce learning, empowering enterprise, and its partners for future alliances management

Source: Data from interviews, websites, contracts, projects, and NPD reports

Continuous practices in strategic alliance for NPD contribute to RC development and this capability is supported by a collaborative business model reinforcing what Bueno and Balestrini (2012) and Alves (2015) highlight. TBE have not obtain income commercializing protected products by patent or software registration (or through referred protections) given low intellectual property business culture into researched TBE. At this time, products nature offered do not require information from prior research or technique status verification (Mitze and Strotebeck, 2019; Vlaisavljevic et al., 2020; Senior, 2021; Pereira et al., 2021).

In sum, supplies demand, tech solutions and services already known in national and international market pass through entire NPD (Rosenfield et al., 2006; Bueno and Balestrini, 2012) present into researched TBE. RC perform a fundamental role for contractual strategic alliances whose aggregated value is vital for TBE business model (Schilke and Goerzen, 2010; McGrath, 2008; Alves, 2015). Therefore, we propose a framework for NPD phase and RC elements identification into TBE (Figure 9).

Figure 9. NPD phases into TBE and RC elements identification



Source: Data from interviews, contracts, projects, and NPD reports.

CONCLUSION

Research main issue, research question and propositions led this study to analyze on how biotech TBE manage RC for NPD purpose providing a clear path for descriptive model proposed whose research outcomes ratified. NPD phases demand strong RC management mainly during contractual strategic alliances preparation and after in linkage with partners for knowledge acquisition or sharing. As already mentioned, supplies demand, tech and service solutions disseminated in national or international market permeate whole NPD also leveraging RC elements to aggregate value for TBE business model (Schilke and Goerzen, 2010; McGrath, 2008; Alves, 2015; Mitze and Strotebeck, 2019; Vlaisavljevic et al., 2020; Senior, 2021; Pereira et al., 2021).

Itatijuca, Gentros, Rheabiotech and Biotika analysis booster conclusions binding the research propositions in how objectives are defined during contractual strategic alliances established for NPD. These practices permeate predevelopment phase evincing RC elements such as opportunities prospection, objectives grounding, human resources allocation, investments prioritization and internal collaborative R&D in STI.

All TBE researched have intense acting in searching and prospecting opportunities for NPD aiming to bring complementary resources-base. We also notify a meaningful proximity between strategic planning activities and NPD. These activities almost are developed simultaneously in all of them.

About how contractual strategic alliances for NPD are structured, we identified some practices in development phase, in which there are RC elements involved, such as team systematization for alliances share-management, branch structure organization and contractual strategic alliances formalization (Gibbons and Henderson, 2012).

Lean structure is identified in researched TBE considering they are small-size companies. Hence, NPD and new business' board are central in its structure so much in operational as management practices for contractual strategic alliances. Interaction practices in interorganizational coordination, portfolio coordination, activities and decision-making synchronization for each NPD alliance are identified in development phase whose sub phases elegy some RC elements as mandatory such as external partners prospection for NPD structuring, contractual strategic alliance formalization and team systematization for alliances shared management. (Schilke and Goerzen, 2010; McGrath, 2008; Alves, 2015). In knowledge acquisition

coordination (Guo, Yang and Zhang, 2020), we describe knowledge sharing, knowledge replication to subsequent NPD, decision-making shared synchronized during NPD process and alliance portfolio coordination as mandatory, as well (Mitze and Strotebeck, 2019; Vlaisavljevic et al., 2020; Senior, 2021; Pereira et al., 2021).

Upon how contractual strategic alliances configure its contribution (Pisano, 1991; Lin and Darnall, 2015; Walsh et al., 2016) we highlight that are connected in post-development phase supported by RC elements identified as gained industrial property income, collaborative business model adoption (Bueno and Balestrin, 2012), and continuous strategic alliance practices.

Finally, open innovation (Chesbrough, 2003) is a key factor for biotech TBE to keep competitiveness as empirical outcomes demonstrate in Itatijuca, Gentros, Rheabiotech and Biotika practices. They are technology-based enterprises (TBE) transforming scientific knowledge permanently through new techs available for innovative products and services. NPD represents to researched TBE a wide innovation gateway. However, as this science field is multidisciplinary (Traoré, 2004), these enterprises work in open system, searching partners that could complement their resources-base scientifically or technologically. Biotech industry (Pisano, 2006; Estrella and Bataglia, 2013) is fertile in its nature and incentive constant relationships therefore organizational interaction is fundamental for NPD successfulness.

As study limitation we do not offer generalized evidence to a representative Brazilian sample in biotech TBE industry. It is notorious relevance of thinking about quantitative future research in relational capability in TBE innovation performance that are potentially familiar with tech and commercial alliances for NPD.

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Contribution of authors

Every author should account for at least one component of the work. Paper approved for publication need to specify the contribution of every single author.

Contribution	[Author 1]	[Author 2]	[Author 3]	[Author 4]
1. Definition of research problem	√	√		
2. Development of hypotheses or research questions (empirical studies)	√	√		
3. Development of theoretical propositions (theoretical work)	√	√		
4. Theoretical foundation / Literature review	√	√		
5. Definition of methodological procedures	√	√		
6. Data collection	√	√		
7. Statistical analysis	√	√		
8. Analysis and interpretation of data	√	√		
9. Critical revision of the manuscript	√	√	√	√
10. Manuscript writing	√	√	√	√
11. Other (please specify)				