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How do formalization, centralization and integration impact dynamic knowledge-based capability?

Rodrigo Valio Dominguez Gonzalez*

School of Applied Science, University of Campinas, Limeira, Brazil

Dynamic capability is a fundamental concept for firms to achieve competitive advantage. In the past two decades, researcher have studied the impact of dynamic capability on the business, financial, and innovative performance of organizations; however, it is clear that the results achieved by some companies are superior in terms of the development and application of dynamic capability. This difference in terms of the results achieved can be explained by factors related to the organizational structure and, therefore, this research analyses the impacts of the organizational structure on knowledge-based dynamic capability. Partial Least Squares (PLS) was applied to a sample of 192 Brazilian manufacturing companies to analyze our theoretical premises. Our research contributes to the literature by showing how the components of the organizational structure (formalization, centralization, and integration) affect the two elements of knowledge-based dynamic capability (knowledge absorptive and transformative capacity). Previous studies indicate that less mechanical structures, that is, structures with lower levels of centralization and formalization, are favorable for the development of dynamic capability. In a different way, our results indicate that formalization and centralization act differently in relation to the absorptive capacity transformative capacity.

Keywords: Knowledge-based dynamic capability; Organizational structure; Absorptive capacity; Transformative capacity; Manufacturing companies

1. Introduction

The companies' need to innovate, generating competitive advantage and differentiation, is a consolidated fact among researchers and organizational managers (Gupta, 2021; Kanchanabha & Badir, 2021; Lin et al., 2020; Mahmud et al., 2020; Grant, 1996). Many studies highlight the development of the dynamic capability of firms as an essential factor to achieve sustained innovation (Ali et al., 2020; Zotoo et al., 2020; Gupta et al., 2020; Teece et al., 2016; Teece et al., 1997). The theory about dynamic capability originates from the resource-based view (RBV), being defined by Teece et al. (1997) as the company's ability to integrate, build, and reconfigure internal and external competencies to quickly respond to external changes. Subsequently, from the knowledge-based view (KBV), Zahra and George (2002) proposed the knowledge-based dynamic capability. The main evolution in the concept resides in the value given to knowledge and, based on this new approach, dynamic capability is defined as the organizational competence to create, make available, and protect intangible assets that support superior performances (Teece et al., 2016). In this new proposal, the role of knowledge as a structural element of dynamic capability is evidenced.

*Email: rodrigo.gonzalez@fca.unicamp.br

Dynamic capability is defined as a high-level competence that determines the firm's ability to integrate, build, and reconfigure its resources and capabilities to adapt to environmental changes (Teece, 2007; Teece et al., 1997). This study is based on the vision of knowledge-based dynamic capability, whi combines perspectives on dynamic capability and knowledge management (Denford, 2013; Zheng et al., 2011; Gonzalez & Melo, 2019; Gonzalez & Melo, 2021). Based on this view and in line with the knowledge-based theory (Teece et al., 1997), dynamic capability is seen as a first-level capability that defines the performance of routines and other competencies of the organization (Hitt et al., 2016).

While dynamic capability has become an important and emerging theme in the literature (Eisenhardt & Martin, 2000; Teece et al., 1997; Zollo & Winter, 2002), this theme has only been explored in greater depth today, looking for relationships with other antecedent variables, evaluating the factors that promote it, as is the case of organizational structure (Liu et al., 2019; Calabuig et al., 2018; Jones & Knoppen, 2018). Organizational structure refers to the way work and tasks are divided or distributed, as well as the mechanisms for integrating and controlling these activities (Robbins, 1990). This study focuses on the three main aspects that define organizational structure: formalization, centralization, and integration (Robbins, 1990; Zheng et al., 2010).

As evidenced in a literature review conducted by Ali et al. (2019) and also by Gao et al. (2017), few studies have analyzed the antecedents of dynamic capability, highlighting how organizational characteristics affect this first-level competency. According to the authors, most studies have positioned dynamic capability and absorptive capacity as an independent, mediating, or moderating variable. Much of the research is focused on assessing how dynamic capability influences organizational success, such as the impact of dynamic capability on organizational performance (Babaei & Aghdassi, 2020; Jones & Knoppen, 2018; Gutierrez et al., 2018; Hung et al., 2007), innovative performance (Zotoo et al., 2020; Ali et al., 2020; Hsiao & Hsu, 2018), and product development performance (Gupta, 2021; Walheiser et al., 2021; Szymanski et al., 2007). Thus, this research aims to analyze how the organizational structure impacts the development of dynamic capability.

2. Theoretical background and research hypothesis

2.1 *Dynamic capability*

The past two decades have witnessed the emergence and evolution of dynamic capability as one of the most important concepts in management (Teece et al., 2016). Although it is a topic that refers to an extension of the resource-based view, which explains that companies can gain an advantage over competitors based on their resources and capabilities, dynamic capability explains how firms sustain competitive advantage in dynamic environments (Gupta et al., 2020; Zollo & Winter, 2002). Dynamic capability allows the organization to integrate, create, and reconfigure its resources in constantly evolving markets (Teece et al., 1997). Although there are variations in definitions, the literature converges in the sense that dynamic capabilities consist of a set of identifiable and specific routines (Eisenhardt & Martin, 2000).

Regarding the development of dynamic capability, this research is supported by the concept of knowledge-based dynamic capability. When studying knowledge absorptive capacity, Zahra and George (2002) concluded that it was a concept inherent to the firm's dynamic capability, and, from this, proposed the knowledge-based dynamic capability. Based on this view and in line with the knowledge-based theory (Teece et al.,

1997), dynamic capability is seen as a first-level capability that defines the performance of routines and other competencies of the organization (Hitt et al., 2016).

Previous studies have sought to conceptualize dynamic capability from factors. The first study that addresses the topic is by Eisenhardt and Martin (2000), who suggest three categories: (i) capability to integrate resources; (ii) capability to reconfigure resources; and (iii) capability to earn resources. Subsequently, Teece (2007) identifies, in a conceptual way, three factors related to dynamic capability: (i) capability to sense and shape opportunities and threats; (ii) capability to seize these opportunities; and (iii) capability to remain competitive by the reconfiguration of tangible and intangible assets. More recently, some studies have sought to operationalize these factors in empirical research, such as Pandza and Holt (2007) and Mahmud et al. (2020), proposing two dimensions of dynamic capability, called absorptive capacity and transformative capacity. Absorptive capacity refers to the firm's ability to recognize the value of new external information, assimilate them, and apply them to obtain competitive advantage (Cohen & Levinthal, 1990). This involves the process of assimilating external knowledge from the internal primary knowledge base (Wang et al., 2015). Transformative capacity, in turn, refers to the firm's ability to constantly redefine its portfolio of products and services (Pandza & Holt, 2007). More broadly, absorptive capacity refers to the firm's ability to identify and absorb external knowledge that is not part of its primary knowledge base, or simply complements it (Wang et al., 2015), while transformative capacity is complementary to absorption capacity, since transformative capacity uses the knowledge absorbed in new applications that result in product portfolio innovation or process improvements (Mahmud et al. (2020); Pandza & Holt, 2007). Wang and Ahmed (2007) propose a model similar to that of Pandza and Holt, adding the innovation capability factor to the other two factors (absorptive capacity and transformative capacity). Innovation capability refers to the firm's innovative behavior, that is, its ability to create new products and services, new production methods, and new ways of doing things (Wang & Ahmed, 2007). Since this study is an empirical research, according to Pandza and Holt (2007), Wang and Ahmed (2007), Wang et al. (2015), and Mahmud et al. (2020), we deal with dynamic capability based on two factors: absorptive capacity and transformative capacity. In line with Mahmud et al. (2020), we did not add the innovative capability factor proposed by Wang et al. (2015) because we understand that innovation capability is a consequence of the absorptive and transformative capacities, that is, innovation is an end and not a means of achieving dynamic capability.

Absorption and transformation are internal capabilities for organizations, although absorptive capacity presents a look outside the organization, and transformative capacity is oriented inside the firm. These two dimensions of dynamic capability are interdependent, since internal transformation depends on the ability of organizations to absorb and assimilate new knowledge from external sources, combining them with the primary knowledge base (Gonzalez & Melo, 2021; Cohen & Levinthal, 1990). In addition, the capability for internal transformation and updating of primary knowledge also support absorptive capacity (Lowik et al., 2016; Wang & Ahmed, 2007; Martínez-Román et al., 2020). Pandza and Holt (2007) point out that transformative capacity allows a firm to use its primary knowledge in new applications, improvements, or innovations, promoting the creation of new knowledge. Thus, although absorptive and transformative capacities are different concepts, we verify that these are mutually dependent components, which allows the firm to renew its routines and competencies (Martínez-Román et al., 2020; Mahmud et al., 2020).

2.2 *Organizational structure and dynamic capability*

Organizational structure refers to the formal division and distribution of work and serves as a means to coordinate and integrate activities (Chen et al., 2010). The central aspects of the organizational structure consist of the distribution of authority; the presence of rules; the way in which rules and procedures are codified; and communication and relationship mechanisms between activities, functions, processes, and people (Monteiro et al., 2020; Lee et al., 2015). In addition, the authors point out that the organizational structure acts as a formal control mechanism that shapes the behavior of individuals to achieve organizational goals. Thus, considering the aspects that the organizational structure defines within the firm, this is a construct that interferes with the development of dynamic capability.

Bearing in mind that the organizational structure imposes the way in which individuals and processes are integrated, and also the degree of autonomy for individuals to make decisions, we verify that this is a characteristic that interferes with the development of dynamic capability (Walheiser et al., 2021; Gonzalez & Melo, 2019; Ali et al., 2018). Organizational structure acts as a moderator in the relationship between organizational knowledge and innovation (Acharya & Mishra, 2017; Chen et al., 2010). Authors such as Chen et al. (2010), Zheng et al. (2010), Gonzalez and Melo (2021), and Zotoo et al. (2020) address organizational structure based on three elements: formalization, centralization, and integration.

Formalization refers to the degree to which activities within the organization are standardized, and also the degree to which individual behavior is driven by rules and procedures (Chen et al., 2010). In organizations with a high degree of formalization, there are explicit rules and procedures that prevent spontaneity and flexibility on the part of the team members, negatively impacting the dynamic capability of the firm. When activities are more standardized, there is less need for team members to discuss the content of the work and alternatives for the reconstruction of competencies. In contrast, in organizations with teams that operate with less standardized routines, the conduction of activities and the behavior of team members are relatively unstructured, stimulating the process of creation and innovation (Kanchanabha & Badir, 2021; Gonzalez & Melo, 2019; Monteiro et al., 2020).

In this research, we argue that dynamic capability, characterized by the absorptive and transformative capacities, is influenced by the firm's level of formalization. While organizations use formalization to coordinate and align the behavior of employees working in their processes, this simultaneously limits the firm's ability to adapt to changes required by customers and the market (Lowik et al., 2016; Acharya & Mishra, 2017; Damanpour & Gopalakrishnan, 1998). In short, formalization restricts the repertoire of actions by members of the organization. Companies that operate in dynamic environments are required to constantly renew or adapt their competencies over time, and formalized rules may not support this context of intense change (Walheiser et al., 2021).

Dynamic capabilities usually result in improvement or innovation in what an organization offers its customers or in the way it processes its product (Wang et al., 2015), and the degree of innovation of the product or process is impacted by the level of formalization. Thus, employees working in functional processes tend to have a limited sense of responsibility for the success of innovations when standardized procedures and rules and strictly outlined functions limit their opportunities to get involved in these innovations (Chen et al., 2010). This feeling of limited responsibility is reflected in the way the employee takes part in the processes of absorption, combination, and transformation of knowledge, negatively interfering in the dynamic capability, since formalization reduces experimentation and

inhibits members of the organization from modifying standardized procedures and behaviors (Jansen et al., 2006). According to Jansen et al. (2005), the excess of rules and procedures previously prescribed can hinder the establishment of informal relationships between individuals, as well as with external partners, reducing the ability to generate new knowledge internally.

On the other hand, low formalization promotes the openness and behavioral initiative of individuals to experimentation, a necessary condition especially for the process of knowledge transformation (Jansen et al., 2006). Therefore, less formalization allows employees to invest knowledge and time in developing or reconfiguring the routines and competencies of their functional processes (Walheiser et al., 2021). Consequently, a lower level of formalization suggests an increase in employee responsibility and a decrease in internal resistance to changes or re-adaptation of competencies (Jansen et al., 2005). From these arguments, we enunciate the following hypotheses that relate formalization and the elements that make up dynamic capability:

H1a. Formalization negatively impacts absorptive capacity.
H1b. Formalization negatively impacts transformative capacity.

Companies that operate in dynamic markets, which demand constant changes in their products and processes, are constantly challenged to create or reconfigure their competencies (Walheiser et al., 2021; Zheng et al., 2010). Nevertheless, centralization limits the ability of lower-level employees to use their specific knowledge to participate in the process of creating and renewing organizational skills, since centralization restricts decision-making to the upper echelons of the organization (Jansen et al., 2006). This restriction becomes problematic, since higher level managers do not always have detailed and specific knowledge about a routine or functional competency. The most in-depth knowledge of the various conditions and characteristics of routines tends to reside in employees who work within the functional processes. Access to this knowledge is reduced in centralized structures due to restricted information flows (Mihalache et al., 2014). Therefore, we argue that more centralized structures have less potential to leverage specialized functional knowledge to its fullest extent, reducing the company's ability to renew its internal competencies.

The extent of changes in routines and competencies at the functional level also changes with the level of centralization (Walheiser et al., 2021). Employees working in functional processes can create internal resistance and a limited sense of responsibility for the imposed changes (Burns & Stalker, 1961; Zheng et al., 2010). The literature on dynamic capability and innovation proposes that decentralization can promote commitment and acceptance of a routine reconfiguration. Since centralization restricts participation in decision making, the perceived control of employees over their work is reduced (Jansen et al., 2006). Therefore, employees have a restricted capacity to exercise control over changes in routines (Liao et al., 2011). In contrast, with lower levels of centralization, authority is assigned to the lower echelons, increasing in employees the feeling of property about their processes and routines, thus reducing potential sources of internal resistance (Liao et al., 2011).

The study by Zheng et al. (2010) points out that less centralized structures encourage communication and increase satisfaction and motivation, since, in these structures, a flow of horizontal and vertical communication is encouraged. In addition, motivation is increased by the decentralization of decision making, allowing individuals with a certain level of knowledge to have authority and responsibility over their processes (Mihalache et al., 2014; Damanpour, 1991). In more centralized structures, the decision-making

process implies a greater number of channels through which the communication of new ideas and learning must pass.

Jansen et al. (2006) argue that centralization reduces the firm's dynamic capability, since knowledge-centered activities, such as activities such as new projects and product development, require a process of innovation and non-routine problem solving, proposing the transformation of existing primary knowledge. Gonzalez and Melo (2018) argue that centralized structures have a more stable behavior of knowledge, that is, the primary knowledge base is conserved to solve specific problems. In contrast, the authors consider that more centralized structures may impair the processes of knowledge generation and combination by restricting decision-making and the experimental process. Thus, we enunciate the following hypotheses that relate centralization to the elements of dynamic capability:

H2a. Centralization negatively impacts absorptive capacity.

H2b. Centralization negatively impacts transformative capacity.

Integration describes the degree to which activities of different actors in the organization can be coordinated by formal mechanisms to achieve common goals and objectives (Liao et al., 2011; Kim, 1980). Ali et al. (2018) suggest that, in times of increased competitiveness and dynamic environments, the organization's performance depends on high levels of differentiation and integration of activities. Diversity of occupations, specialization in individual tasks, and horizontal departmentalization are essential for organizational dynamic capability (Gonzalez & Melo, 2021).

Organizational integration is essential for the processes of exploration via the absorption of new knowledge and exploration of knowledge by the generation and combination of retained knowledge, as integrated environments allow individuals or groups to collect all solutions previously applied to specific problems and use this knowledge in new applications, transforming it (Burcharth et al., 2015). Dynamic capability requires people trained in specialized tasks, as well as people who build the links between these employees or specialized departments. Usually, this integration effort is carried out by the area managers (Liao et al., 2011). Thus, the third set of hypotheses is stated:

H3a. Integration positively impacts absorptive capacity.

H3b. Integration positively impacts transformative capacity.

Figure 1 summarizes the theoretical research model.

3. Research method

3.1 *Sample and data collection*

The empirical research was conducted based on a survey of Brazilian manufacturing companies. The primary sample of this study consists of 7,012 industrial companies registered in the catalog of the Industrial Register of the State of São Paulo of the Center for Industries of the State of São Paulo (CIESP), available from http://ebgebrasil.com.br/industrias/sp. The first criterion for choosing the companies included in the study was the presence of a manufacturing area, that is, companies in the catalog that only provide services were excluded. From this first filter, 4,831 companies remained under analysis. Then, the research team filtered out companies that had up-to-date contact details, reaching a total of 1,400 companies. The procedure for data collection consisted of sending an email to directors, managers, and coordinators in the areas of design, product development, research and development, and engineering to explain the purpose of the research and

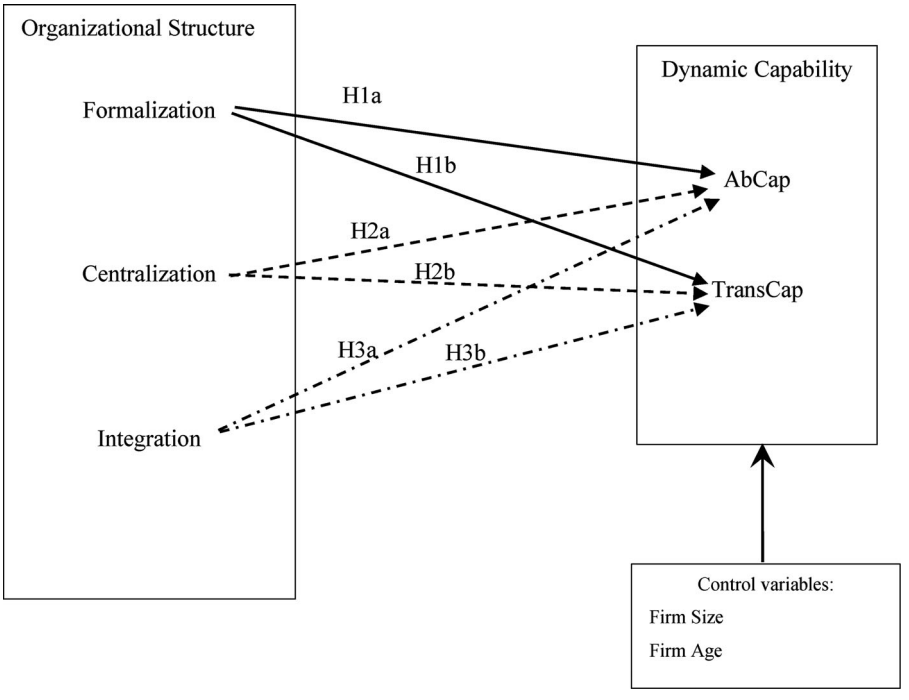

Figure 1. Theoretical research model and hypotheses

formalize the invitation to participate, including a link to the online questionnaire, from January 2021 to March 2021. By clicking on the link, the respondent could access the questionnaire, complete it online, and then send it automatically, saving it in the research database. The research reached a total of 192 questionnaires answered, with a response rate of 13.71%. The online questionnaire did not allow the submission of questionnaires answered incompletely. The response rate achieved by the research can be considered good and is in line with other surveys in the area (Gonzalez & Melo, 2018; Jones & Knoppen, 2018; Mahmud et al., 2020; Ali et al., 2020). Table 1 summarizes the demographic data of the companies and respondents surveyed.

The questionnaire developed for this study was preliminarily subjected to a pilot test based on interviews involving 10 participants, including researchers and professionals in the project area. This step aimed to verify the respondent's understanding of the questions and the scale. Thus, the pilot test respondent was encouraged to read the questions and the possible answer based on a 5-point Likert scale, with 1 being 'strongly disagree' to 5 'strongly agree'. This stage was developed with the presence of the researcher in order to resolve doubts and collect the interviewee's perceptions regarding the understanding of the items and the scale. From the pilot test, the research items had their wording improved to promote a better understanding to the research participants. In questions AC1, AC2 and AC3, the term 'Our company has the attributes necessary … ' was replaced by 'Our company has the necessary competencies … '. Also, two items of the dynamic capability construct were unified because they deal with similar aspects. The items 'Our company has a clear division of tasks to acquire new knowledge' and 'Our company has a clear division of responsibilities to acquire new knowledge' were unified in item AC4 (annex).

Table 1. Demographic characteristics of companies, teams, and respondents

Measurement	Items	Frequency	Percentage
Sector of researched companies			
Industry type	Metallurgy	40	20.83
	Chemistry	35	18.23
	Machinery and Equipment	35	18.23
	Automotive	30	15.63
	Food	19	9.90
	Electrical and Electronic	15	7.81
	Pharmaceutical and Cosmetic	13	6.77
	Paper And Cellulose	3	1.56
	Textile	2	1.04
Number of employees	50 or less	41	21.35
	51-100	63	32.81
	101-500	47	24.48
	501-1000	25	13.02
	1001 or above	16	8.33
Firm Age	Less than 10 years	33	17.19
	11-25 years	64	33.33
	26-50 years	75	39.06
	51-100 years	20	10.42
Annual Sales	Less than U$1 million	9	4.69
	U$1 million-U$5 million	44	22.92
	U$5 million-U$10 million	82	42.71
	Above U$ 10 million	57	29.69
Respondents			
Gender	Male	119	61.98
	Female	73	38.02
Educational level	Undergraduate	18	9.38
	Graduate	109	56.77
	Master or above	65	33.85
Position	Coordination/Supervision	53	27.60
	Manager	91	47.40
	Senior Manager/CEO	48	25.00
Age range	18-25	30	15.63
	26-35	60	31.25
	36-45	65	33.85
	46 or above	37	19.27

To determine whether respondents were suitable for our study, at the end of the questionnaire, we included the item 'I am confident that my answers reflect the company's situation,' measured on a five-point Likert scale, with 1 for strongly disagree and 5 for strongly agree. The average obtained among the interviewees was 4.46, indicating that our respondents are highly qualified and appropriate to the study.

Common method bias is a potential threat resulting from the use of data from questionnaires completed by the interviewees themselves (Podsakoff et al., 2003). The authors suggest that the common method bias may represent about 25% of the measurement variation. To minimize bias, Podsakoff et al. (2003) indicate the adoption of measures regarding the process of applying the questionnaire and statistical tests. Concerning the questionnaire application method, we ensured confidentiality and anonymity to reduce apprehension (Podsakoff et al., 2003). Statistically, we conducted the Harman's one-factor test. All variables of the dynamic capability and organizational structure constructs

were inserted into an exploratory factor analysis model. The results showed that no factors emerged, and that there is no general factor that explains most of the variance of these variables. The first factor was responsible for only 12.8% of the total variance, indicating that common method bias was not a problem.

3.2 *Measurements*

The questionnaire was developed from validated measurement items present in the literature. A seven-point Likert scale, from 1 (strongly disagree) to 7 (strongly agree), was used to measure the items in the questionnaire. The measurement items of the study constructs are detailed below.

Organizational structure is measured from three constructs. The first, formalization, is measured by three items; centralization is assessed using three items; and the third construct, integration, is measured by two items. The items of the three constructs referring to the organizational structure were extracted from the studies by Andrews and Kacmar (2001) and Germain (1996) and assess the degree to which knowledge is codified in rules and procedures (formalization), the degree of autonomy for decision-making (centralization), and the level of integration between employees of different hierarchical levels and departments.

Dynamic capability was conceptualized according to Pandza and Holt (2007) and Wang and Ahmed (2007) by two components: absorptive capacity and transformative capacity. Regarding the absorptive capacity, we used a four-item scale, based on García-Morales et al. (2008), which comes from the definition of absorptive capacity by Cohen and Levinthal (1990). By these research items, respondents were asked about their firms' ability to recognize new opportunities and external knowledge. Transformative capacity, in turn, we measured using the five-item scale by Gibson and Birkinshaw (2004) and Schilke (2014). These items address the firm's ability to strategically adapt and reconfigure opportunities and knowledge within its environment.

And finally, we control the effects of these variables, including control variables. Based on previous studies on dynamic capability, we control the potential effects by firm size and firm age (Ali et al., 2020; Mahmud et al., 2020; Walheiser et al., 2021; Wang et al., 2015). The choice of these variables is due to the fact that larger companies have more resources that allow greater investments in research and innovation activities, and because younger companies tend to be more innovative because of their flexibility. We measured the firm's size and age as a logarithm of the number of employees and the number of years of foundation, respectively.

4. Results

This study uses the Partial Least Square – Structural Equation Modeling (PLS-SEM) technique for data analysis, by the Smart-PLS software (version 3.0). PLS-SEM is a technique widely used in management studies, including several studies on dynamic capability, teamwork, and organizational structure (Gonzalez & Melo, 2019; Gonzalez & Melo, 2021; Ali et al., 2020; Chión et al., 2019). Hair et al. (2013) highlight PLS-SEM because it is a technique with less restrictions in terms of data normality, and it is also applied to smaller samples compared to structural equation modeling (SEM). In addition, PLS is also recommended for models with complex relationships (Fornell & Larcker, 1981) and for studies dealing with theoretical development based on constructs (Hair et al., 2013), as

is the case with this study, which aims to analyze the relationship between two constructs (organizational structure and dynamic capability).

4.1. *Estimation of the measurement model*

First, to assess the reliability and validity of the research model, the confirmatory factor analysis (CFA) technique was conducted. The reliability measures of the constructs, according to Hair et al. (2013), used in this study are Composite Reliability (CR), Cronbach's α, and Dijkstra–Henseler Rho_A. The minimum value for these three measures is 0.70 (Hair et al., 2013). Table 2 shows that all constructs have an adequate level of reliability.

The evaluation of formative measurement models requires the multicollinearity test between the items that make up the constructs, as well as the analysis of the factor loads between the items and constructs to validate them (Hair et al., 2013). The amount of multicollinearity was measured by the variance inflation factor (VIF) and by the tolerance value of the independent constructs. The tolerance values for all constructs are less than 0.10, as recommended by Hair et al. (2013), and the VIF values of the items ranged between 1.58 and 2.72 (Table 2), indicating no multicollinearity between the items. All of them resulted statistically significant at $p = 0.05$ level.

Convergent validity is assessed by estimating the average variance extracted (AVE), which indicates the amount of variance that is shared by the items that make up the constructs. The AVE values of all constructs are higher than the minimum acceptable value of 0.50, as recommended by Hair et al. (2013). In addition, the CFA measures the factor load, which points out the contribution of each item regarding the variance of the latent construct, to complement the convergent validity assessment. As shown in Table 2, all

Table 2. Reliability, multicollinearity, and convergent validity

Characteristic	Items	Loading	α	CR	AVE	ρA	VIF[a]
Organizational structure							
Formalization	Form1	0.873	0.823	0.798	0.725	0.811	1.77
	Form2	0.861					1.58
	Form3	0.772					1.63
Centralization	Cent1	0.820	0.840	0.776	0.788	0.785	1.91
	Cent2	0.788					2.28
	Cent3	0.775					2.54
Integration	Int1	0.833	0.792	0.784	0.815	0.768	1.80
	Int2	0.781					2.27
Dynamic Capability							
Absorptive Capacity	AC1	0.887	0.775	0.816	0.744	0.736	1.72
	AC2	0.830					1.84
	AC3	0.862					2.28
	AC4	0.788					2.72
Transformative Capacity	TC1	0.802	0.786	0.804	0.806	0.828	1.75
	TC2	0.834					2.48
	TC3	0.855					2.27
	TC4	0.776					1.96
	TC5	0.792					1.84

Notes: a: Cronbach's ; CR: composite reliability; ρA: Dijstra–Henseler's rho; AVE: average variance extracted; [a] percentage of variance of item explained by the latent variable

Table 3. Discriminant validity – correction matrix and Heterotrait-Monotrait (HTMT) ratio

Construct	Form	Cent	Int	AC	TC
Form	*0.851*	0.247	0.255	−0.188	0.213
Cent	0.224	*0.888*	0.333	−0.257	−0.284
Int	0.231	0.326	*0.903*	0.277	0.265
AC	−0.165	−0.234	0.248	*0.863*	0.378
TC	0.190	−0.108	0.257	0.347	*0.898*

Notes: The values of diagonal cells (italics) refer to the square root values of AVE; below diagonal elements are the correlations between constructs; above diagonal elements are the HTMT ratio values

items have a factor load greater than 0.70, indicating that they are relevant for the formation of constructs (Hair et al., 2013).

The discriminating validity of the measurement model, in turn, is used to assess how distinct a latent construct is from other constructs (Hair et al., 2013). To fulfill the condition of discriminant validity, the square root of the AVE values of each construct must be higher than the other correlations (Fornell & Larcker, 1981). Table 3 points out that all constructs are statistically distinct from the others, as they have an AVE square root superior to the correlations. In addition, to complement the discriminant analysis test, Table 3 also presents the Heterotrait-Monotrait (HTMT) values. All values above the diagonal are less than 0.85, indicating discriminant validity (Henseler et al., 2015).

4.2 *Structural model and hypothesis testing*

The results of the structural model (Table 4) show that formalization has a significant negative relationship with absorptive capacity, and a positive relationship with transformative capacity, $\beta=-0.264$, $p<0.001$ and $\beta=-0.212$, $p<0.01$, respectively. Centralization presented a significant negative relationship with transformative capacity ($\beta=-0.386$, $p<0.001$) and did not present a significant relationship with absorptive capacity. Integration, in turn, was positively related to absorptive capacity and transformative capacity, presenting a greater impact in transformative capacity ($\beta=0.437$, $p<0.001$) than in absorptive capacity ($\beta=0.143$, $p<0.05$). The two control variables, firm size and firm age, had a negligible effect on dynamic capability.

Table 4. Structural model analysis

Hypothesis	Relationship	Path coefficient	t-statistics	p-value	Sig. level	Results	f^2
H1a	Form → AC(-)	−0.264	−2.755	0.000	***	Supported	0.238
H1b	Form → TC(-)	0.212	2.112	0.006	**	Not Supported	0.202
H2a	Cent → AC(-)	−0.088	−0.744	0.068	NS	Not Supported	0.068
H2b	Cent → TC(-)	−0.386	−3.876	0.000	***	Supported	0.262
H3a	Int → AC(+)	0.143	1.592	0.003	*	Supported	0.155
H3b	Int → TC(+)	0.437	4.638	0.000	***	Supported	0.293
Control variables	SF → TP	0.072	0.610	0.059	NS	Not Supported	0.040
	AF → TP	0.086	0.856	0.077	NS	Not Supported	0.061

Notes: * $p<0.05$; ** $p<0.01$; *** $p<0.001$; NS – Not significant

The results of the PLS analysis indicated a strong explanatory power of the model concerning dynamic capability, with a coefficient of determination (R^2) of 0.53. The overall quality of the model was assessed by the goodness-of-fit index (GoF), which is calculated from the geometric mean of the AVE of the latent variables and the average of the R^2 of the endogenous variables (Tenenhaus et al., 2005). The calculated GoF was 0.405, exceeding the cut-off value of 0.36 (Wetzels et al., 2009). In addition, the measure of predictive quality of the proposed model was assessed using the Stone-Geisser (Q^2). A Q^2 value above zero suggests that the model has acceptable predictive validity (Geisser, 1975). In the model of this study, Q^2 is 0.42 for dynamic capability, supporting the hypotheses of this study. The effect size values (f^2) were calculated to measure the level of importance of an independent variable over a variable dependent on the structural model. The low, medium, and high effect threshold values are 0.02, 0.15, and 0.35, respectively (Chin, 2010). As indicated in Table 3, except for hypothesis H2a and the control variables Team Size and Team Tenure (refuted by the level of significance), which have low values of f^2, the other hypotheses have values of f^2 at medium or high level.

5. Discussion and conclusion

5.1 *Theoretical contributions*

This research contributes and theoretically advances the concept of knowledge-based dynamic capability by relating it to a relevant background: organizational structure. While previous research is aimed at analyzing the benefits that dynamic capability brings to business performance (Walheiser et al., 2021; Chión et al., 2019; Burcharth et al., 2015; Chen et al., 2010; Damanpour, 1991) and innovative performance (Ali et al., 2018; Zotoo et al., 2020; Gonzalez & Melo, 2019), there is a gap in the literature to relate constructs that interfere in the development of dynamic capability, that is, antecedent constructs, as is the case with organizational structure. Another important aspect that this research presents is the relationship covering simultaneously the three elements that characterize organizational structure (formalization, centralization, and integration) and the two aspects that constitute dynamic capability (absorptive and transformative capacity). This study is conducted in the context of companies in the industrial sector, which is characterized by intense demand for innovation due to customer demands and strong competition, requiring the development of dynamic capabilities that enable the constant renewal of competencies that result in innovation of products and processes.

In line with previous research, such as Damanpour (1991); Thompson (1965); Chen et al. (2010); Chión et al. (2019); and Walheiser et al. (2021), our study pointed out that formalization acts in a negative way in terms of knowledge absorptive capacity. Formalization implies that employees follow rules and procedures, preventing them from seeking new ways of doing things, and, in addition, it can promote a block in individual and collective awareness of possible performance gaps between what the organization is doing and what employees perceive they should be doing (Kim, 1980; Ali et al., 2018). On the other hand, formalization was positively related to transformative capacity, pointing out different results from the research by Walheiser et al. (2021) and Boso et al. (2012). Our main argument for this positive effect is the fact that formalization allows knowledge to be more accessible for application and implementation (Jansen et al., 2005), eliminating the need for communication and coordination between functional areas of the organization, and also creating an organizational memory that encourages the exploration of knowledge (Van den Bosch et al., 1999). This result is in line with findings that relate formalization to a two-stage model of initiation and implementation (Kim, 1980; Damanpour &

Gopalakrishnan, 1998; Ali et al., 2018). In these models, low formalization can be considered more appropriate for the initiation stage, and a high degree of formalization becomes appropriate for the implementation stage. Making a parallel between the two-stage model and the two elements of dynamic capability, we found that in the initiation phase, as well as in the absorptive capacity, the organization needs to be more flexible and open to the acquisition of knowledge from different external sources. Otherwise, in the implementation process, as with transformative capacity, the organization assumes a role of stability of primary knowledge, executing the exploration of this retained knowledge (Kim, 1980; Damanpour & Gopalakrishnan, 1998).

Regarding the effects of centralization on dynamic capability, the current literature is not conclusive. For example, Liao et al. (2011); Burcharth et al. (2015); and Evanschitzky et al. (2012) point to a positive relationship between centralization and dynamic capability or knowledge-based processes, proposing that the centralization of decision making is important for the process of recognition of external knowledge. In contrast, Jansen et al. (2006); Walheiser et al. (2021); and Gonzalez and Melo (2019) present studies with negative relationships between dynamic capability or knowledge-based processes and centralization. In our study, centralization was negatively related to transformative capacity and did not have a significant effect on absorptive capacity. We advocate that centralization reduces the interest and motivation of employees at lower hierarchical levels in carrying out learning processes by trial-and-error processes. Thus, lower-level employees, who have specialized functional knowledge and are closer to problems or possibilities for improvement, are not encouraged to develop activities that involve the combination or transformation of knowledge. Another aspect that supports this negative relationship is related to the fact that centralization reduces or eliminates decision-making by employees who work in functional processes. Considering the context of manufacturing companies, we find that there is usually a well-defined hierarchy that inserts technical-level employees, as is the case with technicians, operators, and production planners, in a position of little autonomy, obfuscating a possible contribution to problem solving and improvement activities, which would imply knowledge transformation. A possible explanation for the insignificant relationship between centralization and absorptive capacity may be the context of our research. In manufacturing companies, the process of recognizing and acquiring external knowledge is usually carried out by higher-level employees with specialized knowledge, such as engineering, product development, and research & development personnel (Jansen et al., 2006).

Integration presented a positive relationship with both elements of dynamic capability, in line with the results of Gonzalez and Melo (2021), Zheng et al. (2010), and Van den Bosch et al. (1999). The process of learning and generating knowledge, which includes the ability to absorb and transform knowledge, is usually not the result of an individual action, or even of a department or organizational function in isolation. Although integration had a positive impact regarding both elements of dynamic capability, we found that its relationship was stronger with transformative capacity. Again, we sought to analyze this effect by evaluating the context of manufacturing companies. In these companies, activities related to the exploration of knowledge, which imply knowledge transformation, as is the case with problem solving and improvement activities, usually involve the coordinated action of different functional areas, such as operation, maintenance, engineering processes, product engineering, or production planning. The organizational design of this type of company, characterized by the functional division of processes, makes knowledge more specific to each of the functional areas or departments. This implies less demand

for functional integration for the absorption and acquisition of knowledge, since knowledge is specialized in each functional area.

Thus, our study advances in the literature by pointing out the effects of three components of organizational structure on dynamic capability. Much of the literature establishes a negative relationship of formalization and centralization with dynamic capability or knowledge-based processes (Walheiser et al., 2021; Ali et al., 2018; Gonzalez & Melo, 2019; Jansen et al., 2006; and Zotoo et al., 2020) and a positive one between integration and dynamic capability (Jansen et al., 2006; Ali et al., 2018; Damanpour, 1991; and Damanpour & Gopalakrishnan, 1998), that is, these studies indicate that organic structures – lower level of formalization and centralization and a higher level of integration – are more beneficial for the development of dynamic capabilities. In a different way, the results of our research, carried out in the context of manufacturing companies, show that the two elements of dynamic capability have different requirements regarding the structural characteristics of the firm. While transformative capacity is sustained by a higher level of formalization and integration and a lower level of centralization, absorptive capacity, in turn, is negatively related to formalization, positively related to integration, and has no significant relationship with centralization.

5.2 *Practical implications*

Nowadays, many organizations recognize the importance of knowledge as the main resource capable of bringing differential and competitive advantage. However, the understanding on the part of managers about the impact of organizational characteristics on the construction of knowledge-based dynamic capability is very nebulous. This study contributes with managers of manufacturing companies by analyzing how the characteristics of the organizational structure affect dynamic capability.

This research shows the managers of manufacturing companies that dynamic capability has two main elements (absorptive and transformative capacity), and these, in turn, present different behaviors regarding the characteristics of the organizational structure. Thus, the results of this research show managers that formalization, characterized by the creation of procedures and rules and codification of knowledge, acts in a positive way for the transformation of knowledge and in a negative way in terms of absorption and acquisition of knowledge. Centralization, marked by the reduction of autonomy and decision-making power by employees of lower hierarchical levels, has a negative impact on the transformation of knowledge and does not interfere with absorptive capacity. Integration, on the other hand, has a positive impact regarding the two elements of dynamic capability, although it is more significant for transformative capacity.

5.3 *Limitations and potential research directions*

Like most empirical research, this study has a number of limitations that must be considered. First, we study the global impact of the organizational structure on knowledge-based dynamic capability in companies in the industrial sector. However, this approach limits the understanding of how each aspect of the organizational structure (formalization, centralization, and integration) interferes individually with dynamic capability. Therefore, future studies may consider the study of the individual effect of each characteristic of the organizational structure on dynamic capability.

Second, we used cross-sectional data in this study. However, the literature indicates that the characteristics of the organizational structure and the dimensions of dynamic

capability are developed over time (Zheng et al., 2011). Therefore, the effects of organizational structure on dynamic capability may differ depending on the company's management model. Thus, future works may consider longitudinal data to demonstrate more realistic results.

Third, this research shows the impact of formalization, centralization, and integration on dynamic capability (absorptive and transformative capacity). The degree to which company employees have a body of knowledge can interfere in this relationship. Moreover, future studies can consider the degree of mastery over the specialized knowledge retained by individuals, and also the degree of multidisciplinarity present in the firm. Fourth, although many studies show satisfactory results with small samples using PLS, we recognize the small sample size as a limitation of this study and hope that future studies will be based on our results, expanding the sample size. Finally, this research is conducted in the Brazilian industry and the results cannot be expanded to other organizations and cultures. Thus, we hope that, in the future, researchers will access the results of this research and verify whether they are compatible with other sectors, such as services, and different cultures.

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Appendix

Appendix Measurement items

Organizational Structure

Formalization
Form1. The firm has a large number of explicit work rules and policies
Form2. Employees follow the clearly defined task procedures made by the firm
Form3. The firm relies on strict supervision in controlling day-to-day operation

Centralization
Cent 1. Employees have autonomy to do their work
Cent 2. Employees participate in the decision-making process
Cent 3. Employees search for problem solutions from many channels

Integration
Int 1. The firm integrates vertically
Int 2. The firm integrates horizontally

Dynamic Capability

Absorptive Capacity (AC)
AC1. Our company has the necessary competencies to implement the newly acquired knowledge
AC2. Our company has the necessary competencies to transform the newly acquired knowledge
AC3. Our company has the necessary competencies to use the newly acquired knowledge
AC4.Our company has a clear division of roles and responsibilities to acquire new knowledge

Transformative Capacity (TC)
TC1. Our company encourages employees to change outdated practices
TC2. Our company evolves rapidly in response to changing business priorities
TC3. Our company is flexible enough to respond quickly to market changes
TC4. Our company has established its identity to be competitive in the open market
TC5. Our company seeks to determine areas of internal synergy