Business analytics leveraging resilience in organizational processes

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Abstract

Purpose – The survival and growth of organizations presently depend on managing processes and capabilities to effectively use large volumes of data from different sources to assist organizations' strategic and operational goals. This paper aims to test the relationship between organizational analytical capabilities (OAC), the performance results in organizational resilience (OR) and the business process management maturity (BPMM).

Design/methodology/approach – Based on a survey of companies operating in the state of Espírito Santo, Brazil, a conceptual model was proposed and tested using the partial least squares algorithm.

Findings – The results confirm the proposed theoretical hypotheses that OAC and BPMM positively impact OR. In addition, the results show that OAC exert a moderating effect on the relationship between BPMM and OR.

Practical implications – It is understood that stimulating the practice of data and information analysis in the organizational routine translates into a relevant managerial behavior, as this attitude leverages the knowledge development and understanding about how to manage unexpected risk events, enabling companies to assess their ability to react to disruptions, even in terms of operational failures.

Keywords Business analytics, Organizational resilience, Analytical capabilities, Business process management maturity

Paper type Research paper

1. Introduction

With the evolution of communication methods and the consolidation of the use of information technology systems by companies, increasingly more data and information are generated, captured and stored. In this context, the survival and growth of these organizations are linked to their ability to effectively use these large volumes of data from different sources to assist with strategic and operational goals, and this ability frequently becomes a critical success factor. This phenomenon is demonstrated by the fact that many

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organizations, from all over the world and from various industrial sectors, have adopted the analytical approach as a competitive advantage in their operations.

Organizations such as the Boston Red Sox, Netflix, Amazon.com, CEMEX, Capital One, Harrah's Entertainment, Procter & Gamble and Best Buy use business analytics to build their competitive strategies, guide their decision-making and beat the competition. By applying their analytical capabilities to the data, these organizations identify the most profitable customers, accelerate product innovation, optimize supply chains and manage to work with more competitive prices (Davenport and Harris, 2007).

Business analytics[1] is a comprehensive industry term that refers to the application of a wide range of data-driven analytical techniques and methods to different business domains (Chae *et al.*, 2014). It is an emerging theme focused on the improvement of organizational performance through a decision-making process based on facts and data (Cosic *et al.*, 2015; Davenport and Harris, 2007; Doumpos and Zopounidis, 2016; Mortenson *et al.*, 2015; Troilo *et al.*, 2015; Wagner *et al.*, 2016).

This work explores, as one of its constructs, organizational analytical capabilities (OAC), referred to as one of the five formative dimensions of business analytics (analytical capabilities, information quality, analytical technology, leadership commitment and analytical strategy) (Davenport *et al.*, 2005). Analytical capabilities, according to Delen and Demirkan (2013), refer to the inherent skills of the individual – the decision-maker – that is, one's ability to be able to understand the needs of the business, interpret the analyses conducted in large databases and provide meaning to them for making decisions about problems and opportunities that emerge in an organization. However, the interpretation of such data and information is supported by a portfolio of analytical methods and tools, including those that support traditional *ad hoc* queries, inferential statistics, predictive analytics, simulation and optimization, with the aim of assisting inquisitive, descriptive, predictive and prescriptive diagnoses at the managerial level (Acito and Khatri, 2014).

Furthermore, it is understood that OAC, once present in the organizational structure, can impact and interact with different resources, variables and capabilities (Barney and Clark, 2007) and, consequently, influence organizational performance. Therefore, based on the study of OAC, it becomes relevant to analyze how such capabilities relate to business process management maturity (BPMM) (Dijkman *et al.*, 2015) and organizational resilience (OR) (Pettit *et al.*, 2013, 2010).

The choice of these variables – BPMM and OR – is justified by the importance that they demonstrate for ensuring the continuity and good performance of organizational operations, which implies the constant need of articulating and prioritizing them within managerial actions. In addition, they represent two widely studied concepts in the field of operations management, with complementary approaches and proposals, because they are positively associated with better organizational performance results.

Dijkman *et al.* (2015) state that BPMM refers to the stage of evolution of the practices of process management undertaken by companies when executing their operations. These practices, in turn, are allocated in dimensions of maturity, which result in informing the organization's ability to manage its business processes. In addition, they emphasize that the greater the management and monitoring developed by the organization, the more mature its processes and the greater the chances of positively influencing performance results.

OR, in turn, considered here to be a performance outcome, relates to how organizations can recover and survive in the face of turbulent changes and unexpected events (Pettit *et al.*, 2013). In other words, it refers to the conditions of preparing for unexpected events, responding to disturbances and recovering from them (Fiksel *et al.*, 2015; Pettit *et al.*, 2013, 2010). Thus, when

considering that BPMM has conditions to positively influence performance and its subsequent results, it is understood that it may be previously related to OR.

Therefore, based on this argument, this study seeks to answer the following question: *can OAC influence the relationship between a company's BPMM and OR?* Thus, these relationships are studied using a sample of micro, small, medium, medium-large and large companies in the state of Espírito Santo, Brazil, operating in different segments of industry, commerce and service. In addition, the specific objectives include the evaluation of the impact of independent constructs on the dependent variable (OR) and the measurement of the moderating effect of OAC through the application of structural equation modeling (SEM) to test the proposed model, as presented in the next section.

The article is structured into five main sections. After this introduction, in Section 2, the conceptual model, the research hypotheses and the theoretical relationship between the variables are presented. In Section 3, the methodological path is explained based on the study design, data source and collection and data treatment. In Section 4, the results are shown and the discussion developed in light of the theory studied. In Section 5, the final considerations of the work are described, summarizing the study's findings, indicating its limitations and proposing questions that will guide future new research possibilities.

2. Conceptual model, research hypotheses and theoretical relationships between variables

2.1 Impact of organizational analytical capabilities on organizational resilience

The company's resource-based view provides an important basis for understanding how competitive advantage is created and sustained over time, given that firms gain competitive advantage through the accumulation of internal resources and capabilities that are rare, valuable and difficult to imitate (Barney, 1991). These capabilities consist of attributes, skills, organizational processes, knowledge and capabilities that enable an organization to achieve superior performance and sustainable competitive advantage over its competitors (Teece *et al.*, 1997).

In formulating the perspective of dynamic capabilities, Teece *et al.* (1997) argue that the capabilities of an organization can be renewed and developed to achieve congruence with the changing environment, making it possible to adapt, integrate and reconfigure resources, organizational capacities and functional competencies to respond to the challenges of the external environment. These dynamic capabilities, when approached in contexts of reaction to unforeseen situations, become important bases for the achievement of good OR performance results, because they enable organizations to respond to the challenges imposed by the environment through the reconfiguration of their organizational resources.

Thus, when considering that the data and information generated by the organization also constitute resources (Chae *et al.*, 2014; Cosic *et al.*, 2015), it is assumed that when they are reconfigured based on the application of analytical capabilities, particularly to help the organization cope with turbulence and uncertainty, such resources become rare, valuable and difficult to imitate. Thus, the cross-referencing of data and information enabled by OAC allows the production of knowledge and insights to aid decision-making, project future scenarios, capture opportunities and identify problems and other possibilities that help the organization perform satisfactory reconfigurations of resources to better respond to environmental challenges and therefore possibly collaborate for better resilience outcomes.

Some of the crucial aspects of resilience are anticipation, adaptability and recovery (Pettit *et al.*, 2013, 2010), and it is interesting that these dimensions go together. According to Wieland and Wallenburg (2013), resilience can be improved by investing in the routine of sharing knowledge about relevant changes in the environment, in advance or when they occur. In this manner, to anticipate, it is necessary to acquire knowledge about possible changes that may occur in the future (Zsidisin and Wagner, 2010). To adapt to changes, which may or may not be predicted, it is necessary to reconfigure organizational resources, and to recover, it is pertinent to control and evaluate the results of the implemented actions.

Therefore, the development of skills in anticipation, adaptability and recovery can be positively supported in organizations that maintain an approach to the use and sharing of their data and information among different working groups to be used in the most diverse applications and business needs.

Finally, following these considerations, it is assumed that when OAC (composed of statistical capabilities, business capabilities and information technology capabilities) act in an integrated and coordinated manner, they can have a significant impact on the formation of OR. It is therefore argued that the better the integration between OAC, the greater the possibility of positively influencing OR. This assumption results in the first proposition of the study:

H1. OAC positively impact OR.

2.2 Impact of business process management maturity on organizational resilience

Davenport *et al.* (2005) emphasize that most of the competitive organizational strategies presently used involve the optimization and innovation of business processes. In addition, Davenport and Harris (2007) note that companies interested in standing out from their competitors must compete by differentiating their business processes, that is, in the manner in which their processes are executed and managed.

Clearly, the ability to collect, analyze and act on organizational data is one of the methods of helping the organization cope with the competitive and predominantly vulnerable environment (Davenport *et al.*, 2005; Davenport and Harris, 2007). However, scholars also recommend that organizations should strive to make the management of their business processes mature and symmetrically aligned with their organizational characteristics and properties (Dijkman *et al.*, 2015). The respective recommendation is based on research that provides evidence that BPMM positively influences the performance of processes and the organization as a whole (Batenburg and Versendaal, 2008; Dijkman *et al.*, 2015; Hammer, 2007; Hofmann and Reiner, 2006; Lee *et al.*, 2007; Lockamy and McCormack, 2004; Raschke and Ingraham, 2010; Rohloff, 2009).

Based on these assertions, it is inferred that if BPMM impacts the performance of the organization, then it can be considered that the same maturity is related to OR because when measured, it represents one of the types of performance results.

Additionally, Pettit *et al.* (2013, 2010) emphasize that within the scope of strategies to improve resilience is the prior adoption of certain measures and procedures, such as the focus on business process management, because it is recognized that such an initiative allows us to improve the resilience of an entire chain and an organization. In addition, the authors note that managing business processes can contribute to making both organizations and supply chains less fragile and more adaptable to change.

Thus, based on the respective logical chain, the second theoretical hypothesis of the study is proposed:

H2. BPMM positively impacts OR.

2.3 Moderating effect of organizational analytical capabilities on the relationship between business process management maturity and organizational resilience

Considering the business scenario characterized by great dynamism, complexity and intense global competition, the search for ever smarter solutions – to improve the operation of business processes and achieve expected results – becomes an important strategic weapon for companies. According to Davenport and Harris (2007), when companies adopt analytical tools, they are benefiting from solutions to their business problems. Among these benefits is the possibility of managing the risks arising from possible ruptures and changes in the business environment (Fahimnia *et al.*, 2015).

OAC, when applied to the approach of process management, can, for example, through their family of analytical methods and tools (Acito and Khatri, 2014; Delen and Demirkan, 2013; Muehlen and Shapiro, 2010), support decision-making in organizations. They enable an organization to evaluate what has occurred in the past to understand what is occurring at the moment, or to develop an understanding of what may occur in the future in terms of process execution and management.

Thus, one of the intentions of the application of analytical capabilities in processes is to shorten the reaction time of decision-makers to events that may affect changes in process performance and to allow a more immediate assessment of the impact of process management decisions in process metrics. In addition, analytical capabilities favor the management in establishing adherence to process implementation with established rules and regulations, and they corroborate that contractual obligations and the quality of service agreements are met (Muehlen and Shapiro, 2010).

Frequently, analytical methods and tools include a simulation component that allows the exploration of implementation scenarios of alternative processes. In these scenarios, obtaining resources, processes and/or the workload are changed to discover methods to improve the overall performance of a business process (Muehlen and Shapiro, 2010). This mainly contributes to helping the organization in the continuity of its operations even in contexts of turbulence or in the occurrence of ruptures, because previous simulations prepare organizations to adapt and recover more easily from a new reality imposed by changes in the business environment.

In addition, another basic proposal to suspect the existence of the moderating role exercised by analytical capabilities in the relationship between maturity and resilience consists of the assumptions of Galbraith (1974) that the greater the uncertainty inherent in the market (due to the dynamism, turbulence and external variables that are not under the organization's control), the greater the complexity related to process implementation, consequently requiring more information processing by the decision-makers to achieve a given level of performance. In this manner, the knowledge acquired by the processed information will contribute to the identification of possible needs for changes in the allocation of resources, schedules and priorities, thus favoring the results of process performance.

However, the author notes that as uncertainty increases and the amount of information to be addressed increases, it is recommended that the organization should adopt integration mechanisms that amplify its data processing and analysis capabilities (analytical capabilities). These mechanisms, in turn, can be based on the construction of technological infrastructure, the use of tools and analytical models, professionals/work teams trained in data management and the establishment of analytical strategies.

Bronzo *et al.* (2013) corroborate Galbraith (1974) in a complementary manner, stating that the intensive use of data and information in business processes – through the integration of analytical capabilities of individuals/work teams and analytical technologies – can provide the extraction of knowledge from stored data, enabling the redesign of routines and forms of execution, the elimination of obsolete and inefficient procedures and the adoption of behaviors aligned with organizational objectives and strategies. As a result, it is assumed that analytical capabilities increase the results of process outputs because of the benefits that they present to improve the feedback of these processes, culminating in generating process performance results and, ultimately, impacting organizational performance (Chae *et al.*, 2014; Klatt *et al.*, 2011; Ladeira *et al.*, 2012; Oliveira *et al.*, 2012; Souza, 2014; Trkman *et al.*, 2010).

Therefore, it is possible to assume that the application of OAC enables an improvement of the relationship between BPMM and the performance of process resilience. The reason is that the analytical information resulting from data about the processes can be used for historical analysis, real-time control, predictive intelligence, process simulation and the exploration of alternative process execution scenarios (Muehlen and Shapiro, 2010), which contribute to better resilience results and the generation of positive performance results (Pettit *et al.*, 2013, 2010). This confers the possibility of taking actions to intelligibly reprogram the organization's strategies.

Therefore, based on these assumptions, we seek to evaluate whether the use of OAC is significant to enhance the possible relationship between BPMM and OR. That said, the third hypothesis of the study is formulated:

H3. OAC moderate the relationship between BPMM and OR.

2.4 Presentation of the research model

The hypothetical model of this study contemplates constructs related to the conceptual domains of OAC, BPMM and OR. As shown in Figure 1, the conceptual model of this study presents OAC and BPMM as predictors of OR and OR as a dependent variable (the operational definition of each of the first- and second-order constructs of the model is presented in detailed fashion in Appendix 1 of the article).

3. Research method

The data used in this study were collected from a questionnaire distributed to managers of companies tied to the Federation of Industries of the State of Espírito Santo (FINDES). The questionnaire was based on an extensive literature, which served as a theoretical basis for the formulation of 49 assertions – 4 on the profile of the respondent/company and 45 on the constructs studied. The questionnaire used a Likert scale ranging from 1 to 5 points.

The construction of the OAC scale was based on a compilation of several articles about the topic. With regard to the BPMM construct, its measurement was entirely based on the scale developed by Dijkman *et al.* (2015), who were inspired by the Business Process Maturity Model proposed by the Object Management Group (OMG) (2008). The measurement of the OR construct was partly inspired by the scale developed by Pettit *et al.* (2013), titled Supply Chain Resilience Assessment and Management (SCRAM), validated with data from seven global organizations in the industry and services sector.

After structuring the questionnaire, the 49 assertions were validated by a group of experts (professors and managers of strategic areas of the FINDES system) experienced in the conduction and application of research surveys. The respective validation by these professionals contributed to the objectivity, clarity and coherence of the instrument,

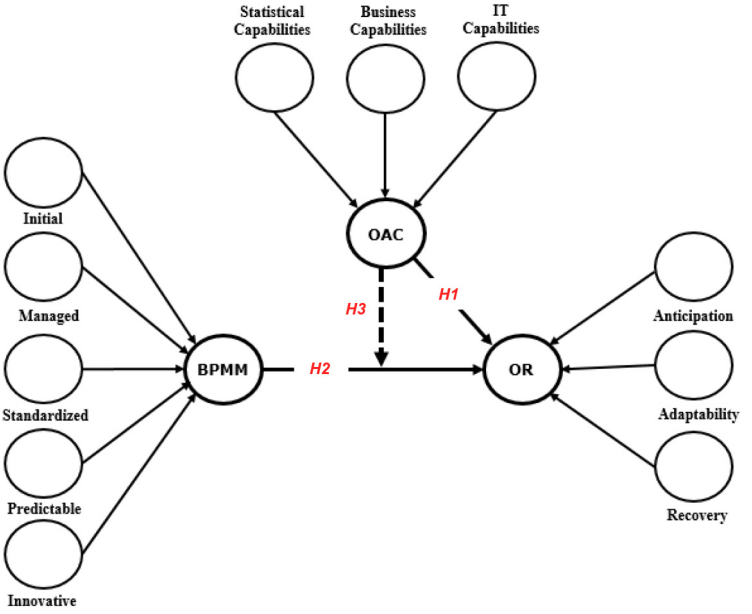

Figure 1.
Research model and hypotheses

eliminating redundancies, ambiguities and overlaps of contents and allowing the common variance bias of the research instrument to be reduced. At the end of this validation process, the 49 original questions remained.

Espírito Santo is one of the states located in the south-east region of Brazil. The state's economy is essentially based on traditional activities such as construction, extraction and processing of marble and granite, coffee agriculture, the garment industry and tourism. In addition, the state has a solid position in the steel, furniture, mining, pulp and fruit growing sectors, also emerging in new economic sectors such as oil and gas production and agro-tourism (Ferrari and Arthmar, 2011).

However, with the end of the Port Activities Fund and with the change in the division of oil royalties for producing states, the Espírito Santo economy stopped collecting a significant volume of revenues that would be invested in priority and strategic areas for the state's growth. In addition, with the worsening of the current economic crisis in the country, the state has been forced to rethink alternatives for the readjustment of its development model.

Undoubtedly, the changes imposed by the current political and economic situation generate turbulence and mark the trajectory of the sectors of industry, commerce and service of Espírito Santo, compelling these sectors to incorporate into their operations and strategies technological and managerial innovations that are able to cope with the modifications that have been occurring in the internal and external markets. This context provides the study with information about how the use of data and information by companies in Espírito Santo has been reflected in their performances, based on the evaluation of their OAC and their supposed impact on important organizational variables. Therefore, through the data collected in this scenario, it becomes possible to identify viable paths to generate a competitive advantage sustained through informational resources and the application of analytical capabilities.

According to Anderson *et al.* (2007), when the population's standard deviation is not known, one of the alternatives is to replace it with a standard deviation of the sample of a pilot study by means of a preliminary sample. However, because this pre-test was not performed, the determination of the sample size occurred with the use of another criterion, which, in turn, was a sufficient and necessary condition to enable the use of the technique and the Smart PLS-SEM 3.0 software (Ringle *et al.*, 2014) selected for the study's data analysis.

That said, the criteria used to calculate the sample were recommended by Hair *et al.* (2014) for the use of SEM, based on the partial least squares (PLS) algorithm, which consisted of the following conditions:

- The value of the sample should be ten times greater than the number of indicators of the construct that has the highest number of formative indicators of the measurement model.
- The sample value should be ten times greater than the number of the greatest number of paths directed to a particular construct of the structural model.

Therefore, based on the respective criteria, a minimum sample size of 50 respondents was identified. After performing a preliminary analysis to identify and treat possible problems with the data collected, the final sample consisted of 82 valid cases.

When evaluating the sample composition, considering the respondent's position in the company, we identified presidents (1 per cent), directors (22 per cent), managers (35 per cent), analysts (15 per cent), assistants (9 per cent) and others (18 per cent – owner, partner, coordinator, supervisor, overseer, etc.). In aggregate terms, this result informs us that more than half of the respondents belong to strategic positions (58 per cent – the sum of the functions of president, director, and manager), which is beneficial for the study because it denotes greater knowledge about fundamental questions of the study, as these respondents capture a greater understanding of the organizational functioning due to their positions in areas related to operations.

In addition, when analyzing the variable related to the business sector, it was possible to observe that 65.85 per cent of the sample cases came from the service sector, followed by companies from the commercial (17 per cent) and industrial (17 per cent) areas. Regarding the time of existence of companies variable, the respondents predominantly reported that the companies in which they perform their professional activities have more than 20 years of existence (56.10 per cent) in the market, followed by 5-10-year old companies (14.60 per cent).

For the operation of the size of companies variable, we used the definition given by the National Bank for Economic and Social Development (Banco Nacional de Desenvolvimento Econômico e Social – BNDES), which is widely used as a reference in several studies in Brazil. The BNDES classifies companies as micro, small, medium, medium-large and large based on annual revenues or the number of employees that they have. Therefore, based on the research data, it was inferred that 44 per cent of the state's companies participating in the study are small, followed by medium-sized companies (24 per cent), and the minority, represented by 4 per cent, refer to large companies. The criteria selected for the classification of the company's size were based on the amount of annual turnover for the year 2014.

4. Evaluation of the proposed model

Next, the SEM analysis technique was used to validate the proposed conceptual model (Figure 1) and to verify the hypothesized relationships. Initially, tests were conducted to validate the formative measurement models (convergent validity test, collinearity test and significance and relevance test – Appendix 2) to identify whether quality indexes of the

model would be adequate. Thus, after removing the q6, q7 and q27 indicators, once they presented high collinearity in the set of indicators to which they belonged, the new results showed that all relationships between the indicators and the constructs were considered valid within the quality criteria explained by Hair *et al.* (2014).

With the validated measurement models, we proceeded to validate the structural model of the study (the direct and indirect relationships between the constructs of the model), which presented the results discussed below.

The *t*-test, with 81 degrees of freedom and a 5 per cent significance level through the data extracted from bootstrapping, demonstrated that *H1* (OAC positively impact OR) and *H2* (BPMM positively impacts OR) are significant for the structural model (Table I).

H1 was confirmed by the significance and relevance test for the structural model, demonstrating that the relationship between the exogenous OAC construct and the endogenous OR construct has significance at a level of 0.014, with a path coefficient of 0.253. Although the value of the path coefficient was not high, it proved to be significant for the relationship between OAC and OR. This result means that when present in an organization, OAC act as an antecedent of OR, positively influencing the behavior that resilience, as a type of process performance result, can assume in the organization.

In the field of the relationships between OAC and OR, one of the explanations for this result is that when the company develops its analytical capabilities, it improves its predictive capacity, and that by improving its predictive capacity, it can satisfactorily prepare itself for the risks of the environment, which culminates in strengthening its resilience capabilities.

Additionally, through the *t*-test, we can emphasize that only the path coefficient (0.626) of business capabilities has been shown to maintain significance and statistical relevance (p-value = 0.011) in relation to the OAC construct, thus revealing that this first-order construct contributes the most to indirectly impacting the behavior of OR. This conclusion therefore reinforces the assumptions of Wieland and Wallenburg (2013) that resilience can be improved through investments in the routine of sharing knowledge about relevant changes in the business environment in advance or when change occurs.

The respective information points to the importance of business capabilities because their presence in the business structure indicates that the organization is able to understand its business needs and interpret the context for decision-making in relation to problems and opportunities that emerge in the routine, with the potential to communicate and share them

Direction of the path coefficient	Value of the path coefficient	p-value*
Statistical capabilities → OAC	0.077	0.648
Business capabilities → OAC	0.626	0.011
Information technology capabilities → OAC	0.332	0.194
Initial → BPMM	0.117	0.331
Managed → BPMM	0.192	0.182
Standardized → BPMM	−0.040	0.791
Predictable → BPMM	0.096	0.558
Innovative → BPMM	0.684	0.000
OAC → OR	0.253	0.014
BPMM → OR	0.675	0.000

Notes: *Significance of the path coefficients of the first- and second-order constructs at p-value < 0.05 when subjected to the *t*-test with the bootstrapping technique
Source: Prepared by the authors based on research data

Table I.
Total effects of the structural equation – path coefficients

whenever necessary (Acito and Khatri, 2014; Bayrak, 2015; Cosic *et al.*, 2015; Cybulski *et al.*, 2013; Delen and Demirkan, 2013; McClure and Sircar, 2008; Mortenson *et al.*, 2015; Ranyard *et al.*, 2015; Rasmussen and Ulrich, 2015; Troilo *et al.*, 2015; Wilder and Ozgur, 2015).

Nevertheless, another explanation for this outcome may be in the reality of the organizations surveyed. Because the organizations do not have all of the dimensions of OAC to fuel the decision-making process, most decisions are based on subjective knowledge of the business and are not actually based on facts and data. In addition, this result may also mean that although companies direct constant investments in technology platforms, enterprise resource planning systems, and corporate management solutions, they are, it seems, used only to store data without effective contribution to the managerial process. Additionally, companies may not be familiar with quantitative data extraction and use because of the lack of ability of working with descriptive, predictive and prescriptive analyses.

Therefore, the set of such assumptions helps explain why information technology capabilities and statistical capabilities have not been shown to be significant as antecedents of OR for the companies participating in the sample. Finally, unlike the other explanations, it is assumed that information technology capabilities and statistical capabilities can be configured as antecedents to business capabilities, thus considering a different association and order of precedence among the OAC constructs studied.

With respect to *H2*, confirmation occurred because the significance and relevance test noted that the relationship between the exogenous construct of BPMM and the endogenous construct of OR has high significance, presenting a considerable path coefficient (0.675) at a significance level of 0.000. This result reflects that companies that handle and operate their business processes on a daily basis using some type of management – regardless of the level of complexity of this management – will culminate in generating some type of satisfactory result in terms of resilience for the organization, thereby demonstrating it is an antecedent of OR.

Thus, it is concluded that the BPMM construct has a substantial impact on the endogenous construct evaluated, revealing that it is an important predictor to explain the variation that occurs in the behavior of the endogenous construct in question. Thus, companies interested in improving their levels of resilience should invest in the method by which their business processes are managed because this is where much of the measure is to change the results in resilience. In the case of PepsiCo, for example, warning signals sent in advance, the use of buffers, the reconfiguration of the supply chain and the search for improvement in the frequency and quality of the transacted data are reflections of investments made in process management to improve resilience (Banker, 2016).

By also analyzing the significance and relevance tests of the first-order constructs, it was concluded that only the innovative level had a significant and relevant (p-value 0.000) path coefficient (0.684) in relation to the BPMM construct, indicating that this is the level that significantly contributes to impact variation in the endogenous OR construct.

Accordingly, it can be observed that a company that keeps process management aligned with the innovative level seeks to continuously improve its processes by resorting to the understanding of problems and critical areas of business, using the feedback of performance measures, establishing improvement goals to dynamically reorganize processes whenever the need is perceived and constantly using new ideas and new technologies to improve its processes [Dijkman *et al.*, 2015; Object Management Group (OMG), 2008]. Therefore, it is in these companies that the inherent characteristics of the respective level of maturity collaborate to strengthen the organization's resilience capabilities, particularly with regard to its ability to anticipate, adapt and recover. Thus, when organizations experience some

disturbing event or have their operations interrupted, they are better able to return to their original state or even reach a more desirable state of their operations (Christopher, 2005).

Therefore, it is understood that a company that maintains a mature management of its business processes will be better able to positively influence OR, because management of business processes can contribute to making both the organizations and the supply chains less fragile and more adaptable to change, as noted by Pettit (2008) and Pettit *et al.* (2013, 2010).

However, based on the evaluation of the coefficient of determination (R^2), it was verified that a 1 per cent variation in the OAC and BPMM constructs is responsible for causing a variation of 80.4 per cent in the endogenous construct of OR. It follows that if a manager wants to develop the analytical capabilities in a company and therefore matures the management of the business processes, then the manager should use efforts to improve capabilities, particularly in business (inherent in the capacity to identify problems, formulate and implement solutions, perform the decision-making process based on data and facts and develop expression and communication that are compatible with the business environment), maturing their processes towards more innovative management practices in which business processes are more flexible and continuously improved – in this case, the innovative level – because the continuous reformulation of routines and lagged procedures results in developed activities more efficiently. As a result, the OAC and BPMM can act as medium- and long-term performance drivers, helping companies design and develop new process capabilities and, over time, improve competencies and competitiveness standards.

In a managerial decision, for example, the relevance of these data is that the company can choose to invest in the promotion of OAC in its professional routine and in the development of more mature business processes in the organizational structure because they will benefit the company's performance, particularly its ability to respond to stakeholders in situations of challenges and uncertainties, thereby helping deliver satisfactory results to both customers and shareholders.

In addition, to evaluate the size of the change in the value of the R^2 in the endogenous OR construct, it was possible to identify using the *calculation of effect* f^2 – which evaluates how much each construct is "useful" for the model's fit – that the second-order exogenous constructs of OAC and BPMM have a small (0.097) and large effect (0.642), respectively, on the size of the R^2 for OR when excluded from the structural model. This result particularly shows that the exogenous construct of BPMM functions as an important principle to explain the level of resilience present in the organization.

It follows that an organization that is more oriented towards managing its business processes will have a method to determine the degree of resilience in its operations because these processes have a significant effect in explaining the behavior and variation in the level of resilience in the business structure whenever this process management undergoes some variation and/or change. The respective information is consonant with what is indicated by Pettit *et al.* (2013, 2010) that within the scope of strategies to improve resilience is the prior adoption of certain measures and procedures, such as the focus on business process management, because it is recognized that such an initiative allows the improvement of an entire organization's resilience capabilities.

4.1 The moderating effect

Finally, after performing the tests required by the PLS-SEM software in the measurement models and structural model, the tests were developed to obtain the significance of the moderating effect exerted by the OAC construct. The approach adopted consisted of the two-stage procedure (Hair *et al.*, 2014) in which the scores of the BPMM and OR latent

variables were multiplied by the scores of the OAC moderator variable to create a single-item measure so as to allow the measurement of the interaction term and thus allow the identification of the moderation result.

Therefore, based on the values obtained from the PLS algorithm and bootstrapping, it can be inferred that the moderating effect of the OAC construct is significant and relevant (path coefficient is 0.129 and p-value is 0.003) when inserted into the relationship between the BPMM and OR constructs. Accordingly, *H3* (OAC moderate the relationship between BPMM and OR) is confirmed (Table II), revealing that whenever the mean value of OAC varies by one standard deviation, the relationship between BPMM and OR will improve by 0.129 (by 12.9 per cent).

Consequently, it can be concluded that the advantages obtained by an organization from the management of its business processes are enhanced by the presence of OAC in the organizational structure. In this manner, the continuous use of data and information that are successively generated and circulated in the organizational environment support business operations and decision-making processes, thus helping the company leverage its levels of resilience and achieve satisfactory and significant performance.

This finding corroborates Davenport *et al.* (2005) by stating that business process optimization strategies, above all, require the extensive use of data on the state of the business environment and the organization itself, with a view towards modeling this environment, predicting the consequences of alternative actions and guiding executive decision-making. Thus, organizations that understand the value of analytically orienting themselves through the development of their analytical capabilities better discern how to manage their business processes and strive for superior performance results.

Muehlen and Shapiro (2010), in agreement with Davenport *et al.* (2005), emphasize that the analytical information resulting from process execution data can be used to intelligently reprogram the organization's strategies when needed, particularly in situations of disruption and disturbing events (e.g. through the use of historical analysis, real-time control, predictive intelligence, process simulation and the exploration of alternative process execution scenarios), because they collaborate to improve the company's predictability and reaction capacity to possible changes in the market, providing an environment conducive to the development of resilience capabilities (OR), thus generating positive results in process performance.

In addition, the moderating role of OAC is also justified through the assumptions explained by Bronzo *et al.* (2013) and Galbraith (1974) by stating that the intensive use of data and information in processes – through the integration of statistical, business and information technology capabilities – provides the extraction of knowledge from stored data, allowing the redesign of routines and execution, the elimination of obsolete and

Table II.
Consolidated results for the study's hypothesis test

Hypothesis	Test
H1: OAC positively impact OR	Corroborated. Positive and significant correlations (p-value = 0.014) were found between the OAC and OR constructs
H2: BPMM positively impacts OR	Corroborated. Positive and significant correlations (p-value = 0.000) were found between the BPMM and OR constructs
H3: OAC moderate the relationship between BPMM and OR	Corroborated. A positive and significant correlation (p-value = 0.003) was found for OAC when inserted into the relationship between BPMM and OR

Source: Prepared by authors based on the study's data

inefficient procedures and the adoption of behaviors that are aligned with organizational objectives and strategies, resulting in a decrease in the uncertainty inherent in the execution of business. Therefore, it is understood that OAC potentiate the results of process outputs because the processed information improves the feedback system of these processes, thus promoting positive and significant impacts on organizational performance (Chae *et al.*, 2014; Klatt *et al.*, 2011; Ladeira *et al.*, 2012; Oliveira *et al.*, 2012; Souza, 2014; Trkman *et al.*, 2010), particularly in the results dimension in OR.

Therefore, the findings of this study are in line with other studies that affirm that resilience can be improved through a routine of sharing information and knowledge, generated through the extraction and analysis of data by different teams in the organization, to be used in the most diverse applications and business needs, including to better manage business processes (Wieland and Wallenburg, 2013; Zsidisin and Wagner, 2010).

5. Final considerations

The collection, storage and analysis of large amounts of data have been constant in several areas of knowledge, leading to what Acito and Khatri (2014) call an analytical revolution. When the analytical knowledge acquired through business analytics is used intensively by companies, business processes are affected by changes or innovations in an incremental manner, and consequently, the continuous reformulation of lagged routines and procedures results in activities developed in a more efficient manner, thereby helping improve performance.

The results of this research effort present relevant findings from the practical perspective of organizations and their academic relevance by showing that OAC and BPMM act as two critical elements and predictors to determine variation in OR. Thus, the findings of this study allow us to conclude that OAC, when undertaken in the business routine, mainly to support the management of business processes by obtaining relevant information about the processes themselves, can positively influence resilience.

In other words, the implication is that when OAC are effectively articulated in the organizational structure, they enable companies to discover what has occurred in the past, what is occurring in the present and what may emerge in the future through the use of their data and information, which is a rare, valuable and difficult-to-imitate resource (Barney and Clark, 2007; Chae *et al.*, 2014; Cosic *et al.*, 2015).

The Logistics Centre of Zaragoza, for example, is making efforts to develop a tool to predict the estimated arrival time of its shipments exported from China to Spain. Unexpected delays and a lack of information about the movement of orders between origins and destinations frequently raise suspicions about something wrong – a stop at an unauthorized place to load illegal cargo, for example. Accordingly, the use of business analytics for arrival times can prevent fraud and illegalities and prepare supply chains to react in advance if there are delays in freight, assessing recovery alternatives and minimizing the impacts of possible disruptions in operations (Urciuoli, 2017).

When collected, aggregated and synthesized information comes from the execution of processes, it is inferred that, specifically, the prediction and risk analysis capabilities – inherent to OAC (Acito and Khatri, 2014; Fahimnia *et al.*, 2015) – lead companies to better prepare for unexpected or disruptive situations by modifying their business processes to adjust to the changes imposed by the environment, thus ensuring full adaptation and recovery from disruptive events that have occurred and, ultimately, positive results in terms of OR.

In summary, meeting the specific objectives served to address the central question of this study about whether *OAC could influence the relationship between a company's BPMM and*

OR. The response obtained was that OAC play a moderating role in the relationship between BPMM and OR, in addition to informing that both OAC and BPMM act as antecedents to OR, as empirically demonstrated.

Thus, the results of this study provide significant evidence of relevant associations between the constructs that constitute the research model. In addition, the development of the study followed the recommendations of the literature, aiming to rigorously fulfill the methodological steps, to respond to the research problem invoked and to meet the objectives proposed. However, limitations in the study were identified, such as the impossibility of generalizing the results in a broader manner. This factor, however, does not disqualify the sample, which, composed of 82 respondents, is a sufficient universe for the development of the statistical tests described in Section 4, but it limits the generalization of the results only to companies with characteristics similar to those studied. Quantitatively, the study also presented restrictions on a qualitative analysis of the queries surveyed. If such an analysis had been possible, more explanatory and detailed results would possibly be obtained.

Despite this set of restrictions, it should be noted that this study presents findings that are extremely relevant to the field of business analytics research. Only a few years ago, the effective discussion involving this subject within organizational studies and management science began and was rooted as a possibility of generating teaching and research because publications are progressively growing and becoming popular, contributing to the evolution of the analytical movement. Therefore, an approach that first emerged within the context of consulting and evolved over a short period of time within applied social sciences has received increasing attention from the scientific community interested in understanding its phenomenon and its impacts and configurations within organizations, thus justifying the validity of the study performed here.

Finally, as a suggestion for future work on the topic discussed, it is possible to evaluate in more detail the extent to which for each level of BPMM, the moderating effect of OAC would be significant. This would investigate at which stage an organization could capture high levels of OR and is considered one of the methods of representing its process performance. The results presented in this paper demonstrate that the last level of maturity (innovative) contains practices that are more in line with the development of resilience in organizations, mainly through the support of OAC. In addition, it is recommended that new studies should be developed using the same model used in this study but with the use of a qualitative approach. Thus, it is possible that new and useful information regarding the relationships between the constructs studied here may emerge, starting from, for example, comparative case studies, single case studies or even distinctive forms of action research, making possible, in particular, a better understanding of the theoretical interdependence of statistical capabilities, business capabilities and information technology capabilities.

Note

1. To standardize the language referring to the term business analytics (also translated in this work as analytical approach), it will be noted by means of the abbreviation BA.

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Appendix 1

Formative constructs: second-order	Formative constructs: first-order	Items/formative indicators*
OAC	Statistical capabilities	Inquisitive analysis; descriptive analysis; predictive analysis; prescriptive analysis; improving the decision-making process (reflexive indicator)
	Business capabilities	Communication of problems; data translation; interpretation of analyses; decision-making; improving the decision-making process (reflexive indicator).
	Information Technology Capabilities	data exploration; data hygiene; data integration; creation of environments; improving the decision-making process (reflexive indicator)
BPMM	Initial	Non-formal procedures; non-fulfilment of defined procedures; different forms of task execution
	Managed	Definition of methods and technologies; documentation of work methods; control of individual projects
	Standardized	Standardized procedures; documented procedures and objectives; definition of processes
	Predictable	Performance management; process management; correction of processes
	Innovative	Understanding of problems and critical areas; establishment of goals; constant use of new ideas and technologies
OR	Anticipation	Identification of risks; monitoring deviations; early recognition of disruptions; recognition of opportunities; good predictive capacity (reflexive indicator)
	Adaptability	Modification of processes; simulation of processes; development of technology; use of continuous improvement; good capacity for adaptation (reflexive indicator)
	Recovery	Organization of response teams; communication of information; managing public relations; mitigation of effects of interruption; good capacity for recovery (reflexive indicator)

Table AI.
Constructs and indicators of the study's structural model

Notes: *In the research instrument, there are a total of 45 indicators used to measure the second-order constructs of OAC, BPMM and OR. These indicators were derived from the items presented in this table. Thus, for each item present in the table, there is one corresponding question in the research questionnaire
Source: Prepared by authors based on research data

Appendix 2

Formative constructs	Reference Parameters (Hair *et al.*, 2014) Magnitude: 0.90 or, at least, 0.80 Convergent validity	Tol > 0.2 and VIF < 5 Collinearity	External weights $\leq 1/\sqrt{N}$ and external Loads ≥ 0.5 Significance	*p*-value ≤ 0.5 Relevance
Statistical capabilities (q5, q6, q7, q8, q9)	0.899	Removal of q6, q7, and q27. The other indicators were within the reference parameter	All indicators were within the reference parameter	Indicators with *p*-value > 0.5: q8, q11, q13, q17, q24, q31, q32, q38, q40, q42, and q48. All other indicators were within the reference parameter
Business capabilities (q10, q11, q12, q13, q14)	0.877			
Information and technology capabilities (q15, q16, q17, q18, q19)	0.707			
Initial (q20, q21, q22)	There is no reflexive indicator			
Managed (q23, q24, q25)	There is no reflexive indicator			
Standardized (q26, q27, q28)	There is no reflexive indicator			
Predictable (q29, q30, q31)	There is no reflexive indicator			
Innovative (q32, q33, q34)	There is no reflexive indicator			
Anticipation (q35, q36, q37, q38, q39)	0.861			
Adaptability (q40, q41, q42, q43, q44)	0.777			
Recovery (q45, q46, q47, q48, q49)	0.711			

Source: Prepared by authors based on research data

Table AII. Values of tests to validate the formative measurement models

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