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Management Journal



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## The peer-review process: doing good and doing well

In one of our past year's editorials, we discussed the (critical) role played by reviewers in the publication process. At the time, we provided some guidance for inexperienced reviewers to perform good evaluations. We highlighted two main rules for them to perform a good job. First, they should clearly and objectively indicate the criteria for considering the article's contribution to the literature, the quality and adequacy of the chosen methods, the quality of the logical arguments and the clarity of the language. Second, they should make recommendations or suggestions in a constructive and well-organized way (Saes & Hourneaux, 2018)[1].

This time we would like to go further into this topic. We will discuss who should be the reviewers who would perform a helpful review, not only for the authors to have their feedback but also for the editors to make better decisions. Beyond, of course, being experts in the manuscript's subject, which criteria should editors consider when choosing reviewers?

First of all, it is worthy to notice that there are two particular types of (good) reviewers. We nominate the first as the *meticulous reviewer*. This type of reviewer makes thorough comments, topic by topic, paragraph by paragraph, from the beginning to the end of the manuscript, drawing attention to each particular issue to be corrected and discussing it exhaustively. It will not be a surprise if his/her review is as lengthy as the article itself.

The other one is the *generalist reviewer*. She/he skims the manuscript to focus on the key points that need to be addressed, such as the relevance of the theme and the research questions, the coherence of the hypotheses, the adhesion of the methodology and the importance of the findings and conclusions. In this case, this reviewer raises some comprehensive problems of the manuscript, as well as makes recommendations. In general, we are talking about a senior researcher who can give fruitful suggestions and appraisal, if the paper presents actual innovative ideas.

Both approaches can convey good aspects. The meticulous reviewer enormously helps authors improve their paper. On the other hand, the generalist reviewer also makes a significant contribution for the editors to better decide on publishing or not the paper.

However, according to Romanelli (1996), both approaches fail, and they also are not quite as "efficient" as it seems. A meticulous reviewer would provide a long list of specific comments that may not allow the authors to understand what the key issues to be addressed are. The generalist review approach is good for evaluating the manuscript as a whole, by



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highlighting the key points, but sometimes not providing constructive and practical advice to authors (Frost & Taylor, 1996; Leblebici, 1996).

Of course, up to this point, we can say that an efficient reviewer should have the double competence of helping the editor decide and the authors improve their article. A halfway solution to combine both would be to recommend that reviewers present some general remarks at the beginning of their assessment (including answers to the questions proposed in the evaluation forms) and then go into some more specific questions.

Nevertheless, our experience shows that both types of reviewers can be more (or less) “efficient”, according to the nature of the manuscript: whether it is a conceptual-based or an empirical-based paper. In the first case, conceptual studies, the reviewer is supposed to prioritize the search for the main theoretical contributions in the paper. In general, a conceptual manuscript is good if it brings theoretical advances and, commonly, it should have at least one good and new idea to present to the academic community. Hence, a good guideline for the reviewer is to begin the assessment with a short statement discussing this new theoretical contribution. In some cases, there is a good contribution in the manuscript, but the reviewer can reject the article for other reasons (e.g. poor writing or communication of these ideas). If the idea is worthy (and the generalist reviewer can identify it), a recommendation for revision may solve those problems. Therefore, a generalist reviewer (a more experienced researcher), would be more suitable to do a good review in theoretical papers than a meticulous reviewer.

In opposition, for empirical studies, editors look for a thorough and detailed review. In general, these papers are standardized (introduction, literature review, methodology, results, discussion and conclusions) with each section having its characteristics and importance[2]. However, the “empirical” parts, i.e. methods, analyses and results, need special attention with a specific recommendation, considering: the technical merit (internal and external validity, craftsmanship (clarity in presenting the model and results) and significance (testing a theory in a non-trivial and redundant way, improves the literature and leads to public or private policy implications) (Schwab, 1985). In short, in empirical manuscripts, reviewers need to pay more attention to the techniques and methodology details, thus being better suited for meticulous reviewers.

Finally, we would like to emphasize two comments. First, as editors, we must choose reviewers who fit best with the manuscript (depending on the theme, methodology or any other technical criteria) in order to not lead them to an uncomfortable situation, risking their immediate refusal to review it. And, of course, editors should try to balance and mix the nature of manuscripts and the characteristics of reviewers, making it possible to define sets of reviewers with different characteristics and perspectives.

Finally, the authors wish to immensely thank the reviewers for their good work, as they have help improve this and other journals, and their knowledge on management science itself.

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## Notes

1. To read more about the criteria for evaluating a paper, see also Mendes-Da-Silva (2018).
2. Even empirical-oriented papers should have a solid literature review, around 30 per cent of the paper extension (Sun & Linton, 2014).

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# Financial indicators, informational environment of emerging markets and stock returns

Emerging  
markets and  
stock returns

253

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## Abstract

**Purpose** – The purpose of this paper is to evaluate the influence of the informational environment on the relevance of accounting information in companies traded in stock exchanges of emerging markets.

**Design/methodology/approach** – For this purpose, the authors calculated indicators based on figures derived from the financial statements and variables that sought to capture the influence of the economic and institutional environment. The sample consisted of publicly traded companies from 20 countries classified as emerging by Standard & Poors. Macroeconomic information was obtained through the International Country Risk Guide database. The analysis period ranged from 2004 to 2013, excluding missing data, variables considered as outliers, besides the exclusion of data from companies that presented negative equity.

**Findings** – It was observed that the financial variables presented signs consistent with the literature, except for the price-to-book variable and the asset change variable. The inclusion of variables related to the accounting informational environment offered evidence that the more opaque the accounting environment in the country, the lesser the ability of the profits to portray the variations of stock returns. The variable that captured the adoption of international standards was consistent with expectations, i.e. the adoption of international standards would increase the quality of accounting information, showing a positive signal. Moreover, the variable aggressiveness of the earnings was statistically significant and negative, consistent with the literature.

**Research limitations/implications** – The variables earnings smoothing and aversion to losses did not show the expected behaviour though, highlighting the possible limitations of these proxies used to capture the opacity of the earnings.

**Originality/value** – When institutional moderators were included, it was observed that the adoption of the IFRS standards positively affected the relationship, which is more relevant when the accounting figures were under its aegis. Recently, countless nations' transition to international accounting standards has been justified by the need to use high-quality reporting standards. The research sought to contribute to strengthen this dimension, presenting evidence that the dummy variable included to capture the adoption of international standards had a positive effect on the relationship.

**Keyword** Emerging markets

**Paper type** Research paper



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## 1. Introduction

The financial statements are intended to provide their users with relevant information about the entity which is being reported. Such information should be useful to existing and potential investors, creditors and other stakeholders when making a decision regarding the provision of funds (Accounting Pronouncements Committee, 2012).

Generally speaking, this decision is based on the premise that financial information is used to estimate profits, cash flows and stock returns. Thus, it is implicitly assumed that accounting assists the projections of future events and evaluations regarding the firm's risk, performance and value (Lewellen, 2010). The financial literature, based on the Capital Asset Pricing Model (CAPM), began to evaluate which factors are able to explain the return of the assets traded in the capital market. In addition to the traditional market beta, which measures the sensitivity of stock returns to market fluctuations, other additional variables were included to explain asset price changes. The most recurrent variables in the literature in this respect include factors based on firm characteristics, such as profitability, size and investment levels (Fama & French, 2016).

In addition to issues inherent to firms, Bhattacharya, Daouk, and Welker (2003) point out the differences in equity markets among countries because of peculiar characteristics related to economic, political and legal infrastructure. Such phenomena influence how accounting figures are used and interpreted by users of accounting in the capital market. Given this context, a body of consistent research has come to appreciate how the peculiarities of each country and its capital markets generate differences in the content and timing of financial statements.

Foster, Kasznik, and Sidhu (2012) point out that previous literature is robust in describing which country-specific variables are responsible for delineating variations among countries. Despite the growth of empirical research on the influence of country-level variables at the enterprise level, a substantial part of the specialised literature is directed to developed capital markets (Dong & Stettler, 2011). Kearney (2012) points out that the nuances and financial, economic, cultural, social and institutional characteristics are useful to provide knowledge about emerging economies and also about the entire world. This fact opens up space for discoveries and knowledge that can help the development not only of emerging countries but also of those with fewer resources or even those considered developed.

Given the context presented, the main goal of this research is to evaluate the influence of the countries' informational environment on accounting information, considering controlled economic factors. Specific objectives of the research are:

- to detect the characteristics of the companies that explain the behaviour of the stock returns of firms that trade their securities in emerging markets;
- explain how the adoption of international standards interferes in the relations analysed; and
- indicate how the level of information opacity of the companies in the sample affects the explanatory capacity of accounting information in explaining the variations in the stock returns in emerging countries.

The study integrates the growing international accounting literature that examines the association between economic profit, measured by stock returns and financial information, such as accounting profitability. From this perspective, a model with a long window of stock returns at the contemporary level and changes in the accounting variables was estimated. Through this procedure, we tried to show which aspects of the capital market entail an active implication to generate differences in the usefulness of the financial statements.

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## 2. Theoretical framework

### 2.1 Market efficiency and expected returns

The efficient market hypothesis defines a market as being informationally efficient if prices are, on average, “correct” given the information available and presents a rapid reaction to new events, correctly incorporating new information. The presence of three conditions is observed, which are sufficient but not necessary to verify the market efficiency hypothesis:

- (1) absence of transaction costs;
- (2) information free of charge and fully available to all market participants; and
- (3) homogeneous expectations of all agents operating in the capital market (Fama, 1970).

Fama (1970) segregated the empirical tests for price adjustment into three groups, based on the nature of the relevant information. In the weak form of efficiency, historical asset prices would be reflected in the stock price. The semi-strong form, in addition to historical prices, covers all information publicly available in period  $t$ . Finally, the strong form of market efficiency considers that all available information would be reflected at time  $t$ , including private information not yet published.

Capital market research generally takes the form of semi-strong efficiency, which assumes that competition among investors makes stock prices reflect all publicly available information in a rapid, complete and unbiased manner. Kearney (2012) emphasises that, specifically concerning the behaviour of emerging markets, they tend to present a smaller development of their capital markets, a characteristic that has a direct influence on empirical evidence related to market efficiency.

The theory of market efficiency assumes that the expected return on any asset is compatible with the level of the risk assumed. In this context, there is a need for a model that estimates returns compatible with the level of risk of each company, highlighting the need for an asset-pricing model. In this context, the CAPM gained emphasis, which establishes the expected return of a stock as a function of a risk-free return and a risk premium. Among the assumptions of the model, it was highlighted that investors have the same expectations for the distribution of future returns, unlimited resources exist to borrow and lend at a risk-free rate and that investors can engage in unlimited short-term sale transactions among risky assets. Despite unrealistic assumptions, this is a limitation of the theoretical models, as this is the only alternative for the simplification and feasibility of a model (Burger, 2012).

With the development of this field, it was detected that the beta was not able to fully explain the cross-sectional variations in the average returns of the assets traded in stock markets all over the globe. Thus, other factors began to be identified, significant in explaining the average returns that the companies achieved. Among these factors, we can highlight size, price/earnings, leverage, profit (Novy-Marx, 2013), level of investments (Titman, Wei, & Xie, 2004), accruals (Sloan, 1996) and book-to-market ratio.

Later, Fama and French (2016) demonstrated the superiority in predicting the expected returns of a five-factor model, including variables related to size, book-to-market, profitability and investments of companies. Thus, the financial literature demonstrated the robustness of including more risk factors, capturing the effect of both company-specific variables and variables at the macroeconomic level.

### 2.2 Institutional factors that interfere in the relevance of financial information

The corporate finance literature shows that the portfolio developed by investors largely depends on the information available in the capital market. In general terms, comparative

empirical studies among companies from different countries have shown considerable differences in legal structure, enforcement mechanisms and corporate governance (Li & Sullivan, 2015).

This literature includes the work of Ali and Hwang (2000), which has been impacted by national factors of relevance regarding accounting information (measured by the capacity of profits and equity values to explain returns). Among the factors that stood out, the author highlighted the fact that the economy is either bank-oriented or capital-market driven. The authors also identified as relevant factors the possible private involvement with the establishment of norms, legal regime and amount spent on the audit.

The level of opacity of the countries' accounting environment was taken into account by Bhattacharya et al. (2003). In a survey based on a sample of 34 countries between 1985 and 1998, the authors assessed measures of "earnings opacity". The opacity of the profits was captured by three proxies, namely, earnings smoothing, earnings aggressiveness or the practice of avoiding loss reporting. The authors found that the increase in the opacity of the earnings resulted in an increase in the cost of capital and a reduction in the number of transactions in the market, demonstrating that the opacity actually interferes in the characteristics of the stock markets in the countries analysed.

Focusing on the cost of capital, Hail and Leuz (2006) examined the international differences of firms in 40 countries. The results indicated that the stronger the enforcement mechanisms and the disclosure requirement, the lower the cost of capital. Complementary to these findings, Papaioannou (2009) examined the determinants of banks' international financial flow in 50 countries. The author found the significance of the institutional quality, the protection of owners' rights and risk of expropriation as explanatory factors of the growth of foreign capital in banks.

Lang, Lins, and Maffett (2012) examined the relationship among transparency, stock valuation and market liquidity, analysing how this interconnection varied according to firm characteristics and the economic environment. The results showed that the incidence of lower transaction costs and greater liquidity for firms with a higher level of transparency was linked to the institutional environment of the countries.

Regarding accounting standards, Clarkson, Hanna, Richardson, and Thompson (2011) investigated the impact of the adoption of international standards in Europe and Australia and the relevance of equity value and profits for asset valuation. The results indicated that there were changes in the relevance of accounting, regardless of the legal origin. Thus, the assumption is made that the accounting data may be more informative if the firm follows international standards, particularly if the firm is from a country with low quality local accounting standards. Daske, Hail, Leuz, and Verdi (2013), however, point out that it is relatively simple for companies to adopt an IFRS label, without substantive changes, with no real economic effect.

The research presented showed how differences in the relationship between financial information and capital markets could be consistently influenced by factors peculiar to each country, specifically, in what concerns transparency, governance, legal enforcement and accounting standards adopted.

### **3. Method**

#### *3.1 Delimitation of the research sample*

The sample consisted of companies trading their securities in the capital market classified as "emerging" according to Standard and Poor's (2013) criteria. The period of analysis covered the years 2004 to 2013. Countries that had recent reclassifications and were included in the emerging group according to Standard & Poor's criteria were not considered.

Firms with missing data, outliers and those with negative equity were excluded. To identify sample components that could distort a characteristic behaviour of the analysed population, two detection techniques were used. For the detection of outliers in the dependent variable, the Box plot was used. For the detection of outliers in the independent variable, we used the bacon algorithm, described by Weber (2010) and Fávero and Belfiore (2017). The research sample consisted of 60,121 observations, as presented in Table I.

Company-level data were extracted from the S & P Capital IQ database. Country-level information was obtained from the International Country Risk Guide, which compiles countries' macroeconomic information.

### 3.2 *Company-level variables*

To assess how the economic and institutional environment affects the relationship between information and stock return in emerging countries, some preliminary indicators were calculated based on financial statement figures. Among the variables that explain the return, size and price-to-book (Fama & French, 2016), capital investment (Titman et al., 2004), accruals (Sloan, 1996), gross profit (Novy-Marx, 2013) and sales growth (Chan, Karceski, Lakonishok & Sougiannis, 2008) stand out (Table II).

The beta variable, one of the most traditional in the financial literature, derived from the CAPM and used to measure the sensitivity of stock returns against variations at market rates. Given the limitations related to stock liquidity and the operational difficulties of the variable, however, an alternative was the inclusion of the average performance indicator of the stocks traded according to the respective stock exchanges. Based on this indicator, it was possible to capture how the stock returns of the analysed companies behaved in the face of market variations.

### 3.3 *Country-level variables*

In addition to the measures estimated at the company level, information was also estimated at the country level, calculated on the basis of the same financial statements, in addition to information extracted from the International Country Risk Guide. The systematic calculation of each of the three variables is described in Table III.

There are possibilities to use alternative metrics to analyse accounting quality, such as quality perceived accounting, which measures the strength of audit standards and financial reports, through an executive opinion survey used by authors such as Knack and Xu (2017) and Malagueño, Albrecht, Ainge, and Stephens (2010). However, in our study, we used the earnings properties to analyse accounting quality, predominant in the literature and independent of the subjective opinions of its users.

Pais	Final sample	Country	Final sample	Country	Final sample	Country	Final sample
Brazil	1,419	Egypt	492	Mexico	619	Russia	293
Chile	963	Hungary	110	Morocco	364	South Africa	1,406
China	12,693	India	16,889	Peru	486	Taiwan	9,719
Colombia	220	Indonesia	2,074	Philippines	1,107	Thailand	3,227
Czech Republic	49	Malaysia	5,360	Poland	1,115	Turkey	1,516
Total							60,121

**Table I.**  
Sample composition

Variable	Description	Formula
Return (dependent variable)	The returns were calculated for an annual period. In stocks not quoted on the day analysed, the quotes of the immediately subsequent day were used	$ret_{it} = \frac{p_t - p_{t-1}}{p_{t-1}}$
Size	The Proxy used for this size is given by the natural logarithm of total assets	$Tam = \ln(AT_t)$
Price-to-book	The ratio between the market value and the book value is commonly called price-to-book in the literature. Where: NE – net equity value of the company MV – market value, calculated by the multiplication of the number of stocks traded in the capital market by the respective price of each of the stock modalities	$PBV = \frac{MV}{NE}$
Capital investment	The past capital investments for end June of each calendar year $t$ are measured by the change in PPE (plant, property and equipment) between the end of year $t - 2$ and $t - 1$ , divided by the firm's total assets at the end of year $t - 1$	$Inv_t = \frac{VLPPE_t - VLPPE_{t-1}}{TA_{t-1}}$
Accruals	The accruals were calculated based on information from the balance sheet and the income statement. $\Delta CA$ = Variation current assets; $\Delta Cx$ = Variation in cash and cash equivalents $\Delta CL$ = Variation current liabilities; $\Delta Deb$ = Variation short-term debts; $\Delta Tax$ = Variation taxes payable; $Dep$ = Variation depreciation and amortisation expenses; $TA_{t-1}$ = Total lagged assets; $TA_t$ = Total current assets	$Acc = \frac{\begin{pmatrix} \Delta CA_{t-(t-1)} \\ -\Delta Cx_{t-(t-1)} \\ \Delta CL_{t-(t-1)} \\ -\Delta Deb_{t-(t-1)} \\ -\Delta Tax_{t-(t-1)} \\ -Dep \end{pmatrix}}{\frac{1}{2}X(TA_{t-1} + TA_t)}$
Gross profitability	Gross profitability was selected to assess the company's current profitability level	$Prof_t = \frac{Gross\ Profit}{\frac{1}{2}X(TA_{t-1} + TA_t)}$
Sales growth	Sales growth was selected as an alternative measure to capture the company growth. $Sales_t$ corresponds to the total gross revenue in period $t$ , $Sales_{t-1}$ to the total gross revenue in the lagged period and $TA_{t-1}$ to the Total Assets in the lagged period	$SaleGrow_t = \frac{Sales_t - Sales_{t-1}}{TA_{t-1}}$

**Table II.**  
Company-level  
variables

A variable was included to capture the effect of the use of international standards in countries. The variable “Use of International Accounting Standards” consists of a variable equal to 0 if the country does not fully adopt the international accounting standards. Otherwise, the indicator is equal to 1. As an assumption, the proposition is accepted that the accounting data can be more informative if the firm follows the international standards (Clarkson et al., 2011).

To capture differences between the economic environments of each country, macroeconomic variables were taken into account. Given the excess of variables, however, which generates problems related to multicollinearity, the principal component factor analysis was used, as recommended by Narayan, Narayan and Thuraisamy (2014). Based on the literature on macroeconomic variables (Chang, 2008; Gay, 2008; Muradoglu, Taskin & Bigan, 2000), the following macroeconomic variables were used (Table IV) to capture the macroeconomic factors of each country.

**Table III.**  
Opacity variables

Variable	Description
Earnings aggressiveness	The measure was calculated by the median quotient between the total accruals and total lagged assets of country $i$ in year $t$ (the use of the median minimises the influence of extreme values). The higher the median accruals, the higher the earnings aggressiveness
Loss aversion	Loss aversion was calculated as follows: Firms with a low earnings level were defined as firms that exhibited a net profit per total assets between 0 and 1%. Similarly, firms with a low level of losses were defined as firms that exhibited a loss per total assets between 0 and -1%. Thus, the ratio is calculated by the difference between the number of firms with small positive profits and the number of companies making losses in the total number of companies. The higher the ratio in country $c$ and year $t$ , the greater the companies' trend towards earnings management to avoid reporting losses
Earnings smoothing	Earnings smoothing is calculated by the cross-sectional correlation between changes in accruals and changes in cash flows, divided by the total lagged assets. The more negative this correlation, the higher the level of earnings smoothing in country $c$ in year $t$

Source: Bhattacharya et al. (2003)

### 3.4 Estimated model

The study was based on the panel data analysis technique, allowing the estimation of cross-sectional regressions between 2004 and 2013 (time series). The dependent variable ( $y$ ) considered was the annual return of the firms. Firm-level variables extracted from the accounting and market information were selected to test the hypothesis considered herein. If they are used in studies on the forecast of returns, they are capable of holding some economic-financial information identified, measured and systematised in the financial statements from they are originated. Thus, if these indicators do not have this informational property, neither will the accounting information represented by the statements themselves. To test this relationship, the variables presented in Sections 3.2 and 3.3 were included in the model.

In this regression model, the  $\beta$  coefficients measure the predictive ability of the variables analysed. When  $\beta$  is not statistically different from zero, there are indications that these variables are not able to explain the variation of returns among firms over time:

$$\begin{aligned}
 R_{it} = & \beta_0 + \beta_1 Price/Book_{it} + \beta_2 r_{i,t-1} + \beta_3 Accruals_{it} + \beta_4 Inv_{it} + \beta_5 Siz_{it} + \beta_6 GrossProf_{it} \\
 & + \beta_7 SaleGrow_{i,t-1} + \beta_8 MarketRatio_{it} + \beta_9 IFRS_{it} + \beta_{10} EarnSmoot_{it} \\
 & + \beta_{11} EarnAggress_{it} + \beta_{12} AvLosses_{it} + \sum_{13}^J MacroFactors + \varepsilon_{it} \quad (1)
 \end{aligned}$$

where  $R$  = Return,  $Price\text{-}to\text{-}Book$  = relation between market value and book value,  $Accruals$  = Adjustments resulting from competence regime,  $Inv$  = Capital investment,  $Siz$  = Size,  $Gross\ Prof$  = Gross Profitability,  $SaleGrow_{(t-1)}$  = Sales Growth (t-1),  $Market\ Ratio$  = Mean performance indicator of stock quotes traded in the countries' respective exchanges,  $EarnSmoot$  = Earnings smoothing,  $EarnAggress$  = Earnings

Name of the variable	Definition
Budget expenses	Non-repayable and non-repaying payments by governments, plus government acquisition of claims on others (loans and equities), fewer repayments of lending and sales of equities previously purchased
Budget revenues	Non-repayable and non-repaying government receipts, plus grants received from other governments (domestic or foreign) and international institutions
Capital investment	The annual value of gross fixed capital formation
Budget Balance as % of GDP	Central government budget balance for a given year expressed as a percentage of GDP
Exports	Year's value of merchandise exports, measured free-on-board (modality in which the exporter is responsible for freight and insurance costs only until the merchandise has been loaded onto the ship)
Foreign direct investment	One year's investment by foreign entities or citizens in domestic business
GDP (nominal)	The nominal value of the total final output of goods and services produced within a country's territorial jurisdiction, regardless of the foreign or domestic ownership of the source of the production
Imports	Year's value of merchandise exports, measured free-on-board (modality in which the exporter is responsible from the freight and insurance costs only until the merchandise has been loaded onto the ship)
Money supply (M1)	The year-end stock of money in the economy. Components of M1 include currency in circulation, commercial bank deposits, cash deposits, credit union share drafts, and nonbank traveler's checks
Real GDP growth (%)	Annual change in estimated GDP at constant prices
Inflation (%)	Annual average percentage changes in the consumer price index
Foreign debt as % of GDP	18-month risk variable that takes into account the country's borrowing practices need for borrowing, attitudes toward borrowing and the willingness of public and private international sources to provide funds
Exchange rate (local)	Average currency value in relation to the USD on the applicable date
Exchange rate stability	Annual percentage change in the exchange rate of the national currency against the USD
Interest rate	Annual nominal interest rate of government bonds in each sample country
Capital market size	A number of companies publicly traded in the stock market of the countries analysed

**Table IV.**  
Macroeconomic  
variables

**Source:** Adapted from PRS Group – <http://epub.prsgroup.com/list-of-all-variable-definitions>

aggressiveness, *AvLosses* = Aversion to losses and Factors 1 to 4 represent the extracted factors based on the principal component factor analysis.

## 4. Results

### 4.1 Factor analysis

A large number of variables, which were observed in the literature, are capable of controlling macroeconomic risks, besides being responsible for a very high correlation among the macroeconomic variables. In this sense, initially, the principal component factor analysis was executed, reducing the number of variables analysed and avoiding multicollinearity problems. KMO and Bartlett's sphericity test indicate the suitability of our data for structure reduction. With a KMO value of 0.8 and a Bartlett statistic of 0.0000, factor analysis was adequate for the analysed case.

Based on the principal components method, establishing the eigenvalue higher than 1 as a selection criterion, it can be observed that four principal components were obtained. Four

main factors were identified. Table V shows the correlation between variables and factors (commonalities).

From Table V, it can be noted that the first factor is strongly related to the financial volume traded and the economic activity level, including nominal GDP, means of payment, investments, exports and imports. It is observed that an increase in the level of financial movement in the economy can generate an excess of available resources, which can interfere in the stock prices and returns.

The agglutination of the interest rate and the inflation rate is best understood by how they interfere in the valuation of assets. This is because the firm's value is related to two main factors: future cash flows; and the rate of return required to discount flows at their present value (Burger, 2012). Changes in inflation may alter stock returns through the discount rate. If cash flows do not adjust in the same direction, the increase in inflation will negatively affect the company value.

The third factor reflects real income growth, considering the percentage changes in the activity level of the economy and the current account of the balance of payments. It is also observed that the external debt, in percentage terms, despite having a strong influence on the formation of the third factor, also shows a strong connection with the fourth factor, related to the foreign exchange market. These variables may impact projected cash flows in the future. The fourth factor makes explicit the exchange market and its stability, interfering in the volume of exports and imports, in the capital flows of the companies and their cash flows.

#### 4.2 Descriptive statistics and initial considerations

The general descriptive statistics of the sample are presented in Table VI. It is noteworthy that, even with the exclusion of the outliers, a minimum stock return value of  $-0.99$  was obtained. This demonstrates a drop in the stock market value of almost every company of the sample.

It is observed that the price-to-book variable has a minimum value of 0, the behaviour based on the selection criterion of the sample, which excluded companies that had negative equity. It is also noted that, in general, as several companies present total assets (sales

Variable	Factor 1	Factor 2	Factor 3	Factor 4
Budget expenses	0.8984	0.2285	-0.2282	0.0118
Budget revenues	0.8868	0.2271	-0.22	0.0485
Capital investment	0.9745	0.0058	-0.1024	0.0212
Current account	0.7278	-0.3525	0.2277	0.2438
Exports	0.9791	-0.0999	-0.0521	0.052
Foreign direct investment	0.9736	0.0363	-0.0657	0.0335
GDP (nominal)	0.9829	0.0901	-0.1215	0.0067
Imports	0.973	-0.0464	-0.0755	-0.0361
Money supply (M1)	0.9555	-0.0945	-0.1	0.0264
Capital market size	0.6739	-0.0836	0.2988	-0.2575
Inflation (%)	0.0088	0.7832	0.2091	0.1748
Interest rate	0.1044	0.8113	0.0573	0.2285
Current account as % of GDP	0.2798	-0.5197	0.5091	0.2503
Real GDP growth (%)	0.3779	0.1639	0.6789	-0.2283
Foreign debt as % of GDP	-0.3349	-0.1118	-0.4668	0.4123
Exchange rate (local)	-0.076	0.2951	0.3633	0.5521
Exchange rate stability	0.0275	-0.4809	0.0277	0.4508

**Table V.**  
Factors extracted in  
factor analysis

Variable	Mean	SD	Minimum	Maximum	Variable	Mean	SD	Minimum	Maximum
Return	0.254	0.927	-0.999	11.426	Market ratio	0.067	0.386	-1.115	0.987
Price-to-book	2.061	2.626	0	33.58	<i>EarnSmoot</i>	0.007	0.026	-0.103	0.082
Accruals (t-1)	0.002	0.136	-1.575	1.6	<i>AvLosses</i>	0.572	0.208	-1	1
Capital investment	0.032	0.12	-0.831	1.549	<i>EarnAgress</i>	0.509	0.404	-0.942	1
Size	5.066	2.16	-5.98	14.955	Factor 1	1.024	1.879	-0.727	5.935
Gross prof	0.195	0.171	-1.032	2.203	Factor 2	-0.145	1.115	-2.177	2.84
Sales growth	0.189	0.549	-6.399	7.288	Factor 3	0.34	1.08	-3.146	2.355
Sales growth					Factor 4	-0.449	1.038	-2.467	3.277

**Notes:** Where: *R* = Return, *Price-to-Book* = relation between market value and book value, *Accruals* = Adjustments resulting from competence regime, *Inv* = Capital investment, *Siz* = Size, *Gross Prof* = Gross Profitability, *SaleGrow<sub>(t-1)</sub>* = Sales Growth (t-1), *Market Ratio* = Mean performance indicator of stock quotes traded in the countries' respective exchanges, *EarnSmoot* = Earnings smoothing, *EarnAgress* = Earnings aggressiveness, *AvLosses* = Aversion to losses and Factors 1 to 4 represent the extracted factors based on the principal component factor analysis

**Table VI.**  
General descriptive  
statistics of the  
sample

growth, accruals, investments and gross profit) as a common quotient, the variables presented an average inferior to 1. This standardisation was aimed at improving the comparison of the elements in the sample, despite considering the absence of uniformity in relation to the size of the companies analysed.

The earnings opacity measures and the return of the market index did not present very evident behaviour regarding the variability. It should be mentioned that the measures of earnings smoothing, aversion to losses and earnings aggressiveness were calculated by country and by year.

The measure of loss aversion showed a positive value. This trait indicates that companies tend to report smaller profits more often than they would with small losses. It is observed that the means and standard deviations of the variable earnings aggressiveness reached considerably lower levels, mainly because of the division of total accruals by total assets, permitting a comparison among countries.

#### 4.3 Inferential analysis and estimated regressions

The Chow test was used to evaluate the adequacy of the use of panel data models in relation to the model with stacked data. The rejection of the null hypothesis indicates that the fixed effects model would be the most appropriate one. Intuitively, one could expect that the random effects model would not be the most appropriate, given the inherent characteristics of the data, in a sample in which a series of explanatory variables was constant for the companies included in the same period (year) and in the same country as the data analysis. The Hausman test confirmed this intuitive appeal. The regression results are presented in Table VII.

The estimated results showed that the size of the company, in which the logarithm of the total assets was used as a proxy, was inversely related to the return, while the price-to-book indicator was positively related. According to the literature, specifically the model of Fama and French (2016), it could be expected that smaller companies with low price-to-book indicators would exhibit returns that are systematically higher than that of large firms with a high price-to-book ratio. This phenomenon is in line with authors such as Girard and Omran (2007), Lyn and Zychowicz (2004) and Ramcharan (2004), who indicate that regulations and tax regimes create an environment in which investors can behave differently in emerging markets.

Variable	Full model	Stepwise model
Price-to-book	0.100*** 0.001	0.100*** 0.001
Return (t - 1)	-0.116*** 0.003	-0.116*** 0.003
Accruals (t - 1)	0.018 0.016	
<i>Inv</i>	-0.092*** 0.019	-0.095*** 0.019
<i>Siz</i>	-0.02*** 0.006	-0.018*** 0.006
<i>Gross Prof</i>	0.349*** 0.028	0.353*** 0.028
SaleGrow (t - 1)	-0.025*** 0.004	-0.026*** 0.004
Market ratio	0.784*** 0.007	0.782*** 0.006
<i>EarnSmoot</i>	0.011 0.007	0 0
<i>EarnAgress</i>	-0.983 0.107	-0.944*** 0.105
<i>EarnAgress</i>	0.138 0.017	0.141*** 0.017
IFRS	0.019** 0.009	0.02*** 0.009
Factor 1	-0.065*** 0.007	-0.066** 0.007
Factor 2	-0.138*** 0.006	-0.137*** 0.006
Factor 3	0.015*** 0.004	0.015*** 0.004
Factor 4	0.037*** 0.005	0.038*** 0.005
Intercept	-0.072** 0.033	-0.078** 0.033
Observations	59890	59890
r2_w	0.556	0.556
r2_b	0.066	0.066
r2_o	0.411	0.41
<i>F</i>	3832.16***	4379.16***
Companies' number	10994	10994

**Notes:** Where: \* $p < 0.10$ , \*\* $p < 0.05$  and \*\*\* $p < 0.01$ ; *R* = Return, *Price-to-Book* = relation between market value and book value, *Accruals* = Adjustments resulting from competence regime, *Inv* = Capital investment, *Siz* = Size, *Gross Prof* = Gross Profitability, *SaleGrow*<sub>(t-1)</sub> = Sales Growth (t - 1), Market Ratio = Mean performance indicator of stock quotes traded in the countries' respective exchanges, *EarnSmoot* = Earnings smoothing, *EarnAgress* = Earnings aggressiveness, *EarnAgress* = Aversion to losses, IFRS = international accounting standards adoption and Factors 1 to 4 represent the extracted factors based on the principal component factor analysis

**Table VII.**  
Regression models  
for returns with  
country and  
company-level  
variables

The level of investment and the level of accruals was inversely related to the return of the companies analysed, but not significant. Regarding the sales growth, the result was compatible with the literature, which argues that a higher level of investment would reduce the intrinsic risk of the firm, with a significant coefficient in the complete model. It was also

observed that the higher the profitability, the greater the stock return of the analysed companies.

About macroeconomic factors, the first factor is related to the financial volume traded and the level of activities, showing the number of resources available in the economy, which may interfere in prices and stock returns. A closer look at the factor shows, however, that it is constituted primarily of macroeconomic variables at their nominal values. Thus, it can be assumed that the variable is capturing the effect of the size of the economy and the larger and more solid the economy of a country, the smaller the risk attributed to its capital market (and the lower, consequently, the required return).

The relationship between the second factor and stock returns is in line with the expectations. This is so because the interest rate and inflation rate interfere with the discount rate of the projected cash flows of the sample firms (Chang, 2008). If the cash flows do not adjust in the same direction as the discount rate, the increase in inflation will negatively affect the company value, generating negative returns.

The third factor is also consistent with the literature. Some percentage growth in the activity level of the economy should result in an increase in the capital market resources, generating positive abnormal returns (Muradoglu, Taskin & Bigan, 2000), and this direction is confirmed by the regression results. Finally, the fourth factor is explicitly related to the exchange market and its stability, which interferes in the volume of exports and imports, in the capital flows of the companies and their cash flows. In other words, it is positively related to the returns (Gay, 2008).

The variables related to the aggressiveness of profits, smoothing of profits and aversion to losses were inserted into the model specifically to understand how the level of opacity of profits in the country interferes in the ability to explain returns through indicators that were based on the use of numbers for their calculation. Given this scenario, it was evaluated how the inherent properties of the accounting numbers among countries and periods interfere in their informational capacity about the companies in the sample countries.

Concerning the profit opacity measures, at first, a negative and statistically significant coefficient was obtained for the variable earnings aggressiveness. This result means that this negatively affects the ability of accounting indicators to explain the variations in the returns of emerging market equities. Thus, the estimated model partially supported the hypothesis that the level of earnings opacity negatively affects the capacity of the accounting indicators to explain the variations in stock market returns in emerging markets.

The variable aversion to losses showed an opposite signal in comparison to what was expected. Rescuing the concept of loss aversion, the indicator is calculated to capture the country's pattern of having a high number of firms with small positive profits, but not with small losses. The motivations towards earnings management, however, according to DeGeorge, Patel, and Zeckhauser (1999), go beyond avoiding negative profits, reporting an increase in quarterly profits or dimming analysts' forecasts of profits. Therefore, it can be interpreted that this variable does not capture these other types of behaviour, causing the proxy not to behave as desired.

Regarding the absence of statistical significance of the "Earnings smoothing" coefficient, Ronen and Yaari (2008) argument that Income Smoothing can be used to "filter" the noises and fluctuations of profits in the short-term, providing firm's long-term trend of profits, in the long run, supports. As a metric of results regarding opacity, it was expected a negative relationship between the estimated coefficient and the dependent variable of return. However, we did not observe the relationship initially delineated, which highlights the adequacy of the alternative argument that, in fact, this type of practice does not necessarily reduce the transparency of the accounting numbers reported.

The adoption of international accounting standards was expected to positively affect the ability of accounting indicators to explain the variations in stock returns in emerging markets. This impression is supported by the expectation that the adoption of these standards is closely related to greater standardisation and comparability between information and information quality. Thus, it was expected that the adoption of international standards would enhance the quality of accounting information, acting as a moderating factor in the ability of accounting indicators to explain variations in stock returns (Barth, Landsman, & Lang, 2008).

On the other hand, it could also be argued that high quality accounting standards would make pricing more informative only in countries with strong legal environments. Thus, it can be assumed that the predictive capacity of the indicators would be more related to the legal environment than to the adoption of a higher quality standard, in line with Daske et al. (2013), for whom the legal environment of the country dominates the corporate governance mechanisms at the country level.

In the sample, we have the participation of countries like China and India, which have not yet fully adopted the international accounting standards. Their accounting standards have already substantially converged into IFRS or permit their use. Situations like this cause the IFRS proxy to exhibit some limitations. Nevertheless, the IFRS variable presented a signal that was consistent with the expectations.

## 5. Final considerations and recommendations

The aim of this study was to evaluate the effect of institutional and country factors on the interaction between financial variables and stock returns of companies located in emerging countries. The basis for this concern emerged from the analysis of the level of opacity of the country's reported earnings, which are measures based on the study developed by Bhattacharya et al. (2003), and of the use of international accounting standards.

The estimated results showed that the size of the company, calculated by the logarithm of the company's total assets, was inversely related to the return, while the price-to-book indicator was positively related to it. It was expected that smaller firms with low price-to-book indicators would exhibit systematically larger returns than large firms with high price-to-book indicators (Fama & French, 2016). In addition, this result is in accordance with authors who have identified that regulations and tax regimes create an environment in which investors can behave differently in emerging markets (Girard & Omran, 2007; Lyn & Zychowicz, 2004; Ramcharran, 2004).

It was also observed that the higher the profitability, the greater the stock return of the companies analysed. In turn, the higher the sales growth, the lower the intrinsic risk attributed to the firm, which is compatible with the literature in the field.

When institutional moderators were included, it was observed that the adoption of the IFRS standards positively affected the relationship, which is more relevant when the accounting figures were under its aegis. Recently, countless nations' transition to international accounting standards has been justified by the need to use high-quality reporting standards. The research sought to contribute to strengthening this dimension, presenting evidence that the dummy variable included capturing the adoption of international standards had a positive effect on the relationship.

Concerning the opacity measures, at first, a negative and statistically significant coefficient was obtained for the variable earnings aggressiveness. This result means that this negatively affects the ability of the accounting indicators to explain the variations in the stock returns of emerging markets. Nevertheless, the variables earnings smoothing and aversion to losses showed, respectively, signs that were not significant and opposite to the

expectation. One possible justification for this result is that the motivations for managing the outcome go beyond the concern with avoiding negative earnings, but also with reporting increased earnings or reaching analysts' forecasted earnings. Because the proxy was not able to capture these limitations, it may have performed differently than expected. Therefore, only one measure of earnings opacity was statistically significant and showed an expected signal. Therefore, the limitations of this study include the possibility of measuring errors in the proxies used, which may affect the analysis.

As another limitation in this study, it is emphasised that the grouping of the risk classification agency Standard and Poor's (2013) was used as a criterion to select countries. A heterogeneous group of countries, geographically dispersed and with different levels of development (such as Chile, China, Poland and Taiwan), were considered "emerging", in any case. Finally, when using the panel data approach, instead of the construction of portfolios, this paper focussed on the ability to explain the accounting variables, without an analysis of the possibility to obtain abnormal returns based on this information.

The results obtained suggest that the risk related to the informational environment is associated with the returns the firms displayed. The possibilities for expanding the research include the insertion of variables that capture the companies' level of disclosure in the countries, in addition to the opacity measures of the accounting information. Also, the influence of the legal origin, governance structure and the number of auditors on the relationship between accounting indicators and company returns are highlighted. In addition, the use of different analysis methods is suggested, such as the application of hierarchical linear models to assess the characteristics of countries that do not vary over time, such as the legal origin.

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268

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# Conceptualizing and qualifying disruptive business models

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Disruptive  
business  
models

269

## Abstract

**Purpose** – This paper aims to elaborate a set of characteristics that conceptualize and qualify a disruptive business model.

**Design/methodology/approach** – The literature on disruptive business models will be analyzed using the latent semantic analysis (LSA) technique, complemented by content analysis, to obtain a more precise qualification and conceptualization regarding disruptive business models.

**Findings** – The results found described concepts already described in the theory. However, such findings, highlighted by the LSA, bring new perspectives to the analysis of the disruptive business models, little discussed in the literature and which reveal important considerations to be made on this subject.

**Research limitations/implications** – It should be noted, about the technique used, a limitation on the choice of the number of singular values. For this to be a problem in the open literature, the authors tried to work not just with the cost-benefit ratio given the addition of each new dimension in the analysis, as well as a criterion of saturation of the terms presented.

**Practical implications** – The presentation of this set of characteristics can be used as a validation tool to identify if a business is or is not a disruptive business model by managers.

**Originality/value** – The originality of this paper is the achievement of a consolidated set of characteristics that conceptualize and qualify the disruptive business models by conducting an in-depth analysis of the literature on disruptive business models through the LSA technique, considering the difficulty of obtaining precise concepts on this subject in the literature.

**Keywords** Disruptive business model, Innovation, Technology

**Paper type** Research paper

## 1. Introduction

Reflecting the constant changes in the market and the needs of consumers, in addition to innovation in products and services, managers from different areas have focused their attention on innovation in business models (Pereira, Imbrizi, Freitas, & Alvarenga, 2015). This occurs because alternative means of management and value creation allow the redefinition of the business performance in a specific field, as well as the acquisition of competitive advantage (Christensen, 1997; Johnson, Christensen, & Kagermann, 2008; Rodrigues, Silveira, Kono, & Lenzi, 2013; Simmons, Palmer, & Truong, 2013). In this sense, there has been a market competition not only in terms of innovation in products and services

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(Pacheco, Klein, & Righi, 2016) but also about business models (Gassmann, Frankenberger, & Csik, 2013).

In this context, disruptive business models (DBMs) are presented, which arise to replace the existing business models, aiming to adapt the organizational structures to the products and services offered, emphasizing the proposition of a unique value to the market served (Hwang & Christensen, 2008; Markides, 2006; Mitchell & Coles, 2004; Osiyevskyy & Dewald, 2015; Santos, Spector, & Van der Heyden, 2009; Wu, Ma, & Shi, 2010). Despite these understandings about DBM, their exact meaning and conceptual boundary, about the aspects of the innovation process in business models, are still imprecise in the literature (Wu et al., 2010). Foss and Saebi (2017) corroborate this discussion by stating that the literature on the innovation process of business models is emerging, and address an important phenomenon in the market that lacks the theoretical basis and empirical research to sustain it.

The existence of these conceptual limitations ends up influencing the adoption of innovation in business models, especially regarding managers' understanding on when and how to innovate in existing business models (Chesbrough, 2010; Gilbert, 2005; Johnson et al., 2008). In the face of this need to conceptualize innovative DBMs, this article aims to elaborate a set of characteristics that conceptualize and qualify DBM.

To do so, the literature on DBM will be analyzed through the latent semantic analysis (LSA) technique, complemented by content analysis, to obtain a more precise qualification and conceptualization regarding DBM. The LSA is a text mining method for content analysis that combines quantitative techniques with the researcher's judgment to extract and decipher the main latent (hidden and/or implied) factors of a set of texts (Kulkarni, Apte, & Evangelopoulos, 2014).

## **2. Theoretical framework**

### *2.1 Disruptive business model*

The management of innovation is an essential factor to be considered in the business strategies of companies that constantly seek to gain prominence in the market and to ensure competitive advantage (Freitas, Martens, Boissin, & Behr, 2012; Pereira et al., 2015). It is noted that the innovation process does not only deal with traditional prescriptions of strategies related to low cost, better management and control but also are concerned with the way of creation and delivery of value to the consumers, which affects business in all its forms and activities (Rodrigues et al., 2013; Sainio, 2004). Based on this context, it is possible to see that, in addition to innovation in products and services, the innovation in the business model has stood out in the search for new ways of creating a business, emphasizing the unique value proposition, which raises consumers' awareness and differentiates the company in the market (Pereira et al., 2015; Rodrigues et al., 2013).

For Markides (2006), innovations in business models are not about discovering new products or services but simply redefining what an existing product or service is and how it is delivered to customers. Thus, in the innovation of business models, the attention is focused on the consumers (Magretta, 2002), seeking new ways of proposing value to them, through a new structuring of business, rather than simply delivering a new product or service (Bashir, Yousaf, & Verma, 2016). In this regard, Santos, Spector and Van der Heyden (2009) establish that the innovation of business models focus on the reconfiguration of the activities belonging to the business model of a specific

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company, which are related to new products or services that will be provided in the market in which the company competes.

In view of these highlighted aspects, DBMs present themselves as an alternative to replace traditional business models, either by restructuring current models or by creating new ones, aiming to adapt the organizational structures to the products and services offered and to take advantage of the opportunities arising from this process of reorganization, focusing on proposing a single value to the new market served (Amshoff, Dülme, Echterfeld, & Gausemeier, 2015; Habtay, 2012; Hwang & Christensen, 2008; Markides, 2006; Mitchell & Coles, 2004; Santos et al., 2009; Wu et al., 2010; Yovanof & Hazapis, 2008). This is possible because these new business models emphasize other attributes in the products or services offered, different from those highlighted by the existing business models of established competitors (Christensen & Raynor, 2003).

Moore (2004) points out that the disruption of business models arises at a stage in which emerging technologies and innovations become impractical in a traditional business model, as the commercialization of a new technology or an innovation process requires companies and managers to understand the cognitive role of business models, especially when the opportunities presented by them do not fit into existing business models (Chesbrough & Rosenbloom, 2002). Khanagha, Volberda and Oshri (2014) complement that the disruptive forces that require organizations to develop a new business model are usually driven by external changes in technologies and market needs, which cannot be followed nor taken advantage of by existing activities in the current business models.

## 2.2 Latent semantic analysis

The LSA model is one of the techniques developed in response to the different needs of the information retrieval area that more recently supports the text mining activity (Visinescu & Evangelopoulos, 2014). When proposed by Deerwester, Dumais, Furnas, Landauer and Harshman, in 1990, their main objective was to approach the problem of synonymy (use of different words with the same meaning) and polysemy (use of expressions that have more than one meaning) related to working with unstructured texts. The purpose was to address the fact that it is not possible to consider the words used in a search in a crude way since there are different ways of communicating the same concept.

The LSA model was proposed as a solution for those issues (Deerwester, Dumais, Furnas, Landauer, & Harshman, 1990). The main idea was the use of singular value decomposition (SVD) to discover a latent semantic structure hidden between the terms in a set of documents, also called *corpus*. The SVD is a decomposition solution to deal with non-symmetric matrices, that is, with a larger number of rows than columns, or vice versa. Matrices used in text mining, known as term-document matrices, fit this profile because there will hardly be the same amount of terms and documents.

This decomposition is based on models of vector spaces, an application of linear algebra. The LSA model works with a particular application to create a semantic space. The input for creating this space is the term-document matrix. Thus, a *corpus* containing  $n$  documents and  $m$  terms can be represented by an  $\mathbf{X}$  matrix, of order  $m$ -by- $n$ . After the creation of the  $\mathbf{X}$  matrix, it is possible to represent its terms and documents in a vector space, through orthogonal decomposition. Orthogonal transformations can maintain the properties of the original matrix, including norms (the length and distance of the vectors) of the rows and columns of  $\mathbf{X}$  (Martin & Berry, 2011). An orthogonal matrix, resulting from decomposition, has the fundamental property  $\mathbf{Q}^t\mathbf{Q} = \mathbf{I}$ , where  $\mathbf{Q}$  is the orthogonal matrix,  $\mathbf{Q}^t$  is its transpose, and  $\mathbf{I}$  is the identity matrix:

$$Q^t Q = \begin{bmatrix} 1 & 0 & \dots & 0 & 0 \\ 0 & 1 & \dots & 0 & 0 \\ \vdots & \vdots & 1 & \vdots & \vdots \\ 0 & 0 & 0 & \ddots & 0 \\ 0 & 0 & \dots & 0 & 1 \end{bmatrix}$$

Thus, the  $n$  vectors that form  $\mathbf{Q}$ , and which can be represented by  $[q_1, q_2, \dots, q_n]$ , are orthogonal, as for any pair  $(q_i, q_j)$ , we have:

$$\begin{cases} q_i^T q_j = 0, & i \neq j \\ q_i^T q_j \neq 0, & i = j \end{cases}$$

In addition, the  $\mathbf{Q}$  matrix is also orthonormal, as the length of each vector is 1, which can be denoted by  $\|q_i\| = 1$ . Being orthonormal, these vectors (i.e. the columns of the  $\mathbf{Q}$  matrix) are positioned in different directions and form a 90° angle to each other. Thus, the vectors  $[q_1, q_2, \dots, q_n]$  form a linearly independent set, serve as a basis for a vector space and can form any other vector, in this same space, from the linear combination of their terms.

Therefore, the objective is to obtain, from the term-document  $\mathbf{X}$  matrix, the set of linearly independent vectors, which form the basis of that set. This way, it is possible to discover the latent semantic structure, hidden between the documents and the terms that compose the *corpus*.

The SVD process results from a mathematical decomposition of an  $\mathbf{X}$  matrix into three other matrices,  $\mathbf{U}$ ,  $\mathbf{S}$  and  $\mathbf{V}^t$ , as shown in Figure 1. In addition to the SVD, there is more than one way to perform this decomposition, such as the QR factorization or the semi-discrete decomposition, but for LSA application, SVD decomposition is the most popular (Martin & Berry, 2011). One of the main reasons is the ability to decompose the  $\mathbf{X}$  matrix into orthogonal factors that have representation both in the terms and in the documents (matrices  $\mathbf{U}$  and  $\mathbf{V}^t$  in Figure 1). Besides connecting these two components mathematically through the vectors, it is possible, with the same operation, to achieve the vector representation for both. Also, dimensionality issues can be dealt with in this same operation.

The SVD has extensive application, as it works with the eigenvalues and eigenvectors, which carry much information about the matrices (Becker, 2016). In the context of the LSA model, as proposed by its authors, this decomposition, when applied to a term-document matrix, allows the identification of terms that are similar to each other and, thus, the correspondent similarity among the documents.

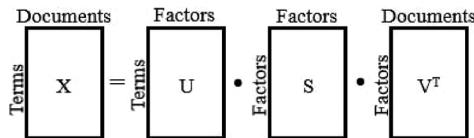


Figure 1.  
SVD in the context of  
the LSA model

Source: Ashton, Evangelopoulos and Prybutok  
(2014)

As shown in Figure 1,  $\mathbf{U}$  is an orthogonal matrix  $\mathbf{U}^t\mathbf{U} = \mathbf{I}$ ,  $\mathbf{V}^t$  is also an orthogonal matrix  $\mathbf{V}^t\mathbf{V} = \mathbf{I}$  and  $\mathbf{S}$  (also denoted by  $\Sigma$ ) is a diagonal matrix containing the singular values of  $\mathbf{X}$ , represented by:

$$\Sigma = \begin{bmatrix} \lambda_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \lambda_n \end{bmatrix}$$

Through this decomposition, we have the  $r$  columns of  $\mathbf{U}$  containing the  $r$  orthonormal eigenvectors associated with the nonzero eigenvalues of  $\mathbf{X}\mathbf{X}^t$ , and likewise the  $r$  columns of  $\mathbf{V}$  (lines of  $\mathbf{V}^t$ ) containing the  $r$  orthonormal eigenvectors associated with  $r$  nonzero eigenvalues of  $\mathbf{X}^t\mathbf{X}$ . In addition,  $\{\lambda_1, \dots, \lambda_n\}$  represent the singular values of the  $\mathbf{X}$  matrix, originated from the *corpus*. Without loss of generality, it is possible to assume that the singular values are ordered in ascending order, being  $\lambda_1 > \dots > \lambda_n$  (Crain, Zhou, Yang, & Zha, 2012).

From this process, it is possible to obtain the *factors* that are distributed throughout the documents and presented in the terms. Thus, different words with similar meanings will be approximate given their distribution in the documents. Likewise, similar words with distinct meanings will appear in different factors, as they are present in separate documents.

Despite the authors' main objective, the LSA model enables researchers to go beyond solving the problems of synonymy and polysemy. By identifying the factors (which form the latent structure behind the terms and documents), it is possible to extract the key *topics* from a given set of documents. These topics can summarize the information of a large volume of text by approximating words using the singular values of the term-document  $\mathbf{X}$  matrix. Thus, it is possible to analyze many documents at a conceptual level, besides the pure analysis of term-document counting (Crain, Zhou, Yang, & Zha, 2012). Hence, the possibility of creating a semantic space has expanded LSA applications.

LSA has been previously used to uncover the intellectual structure from a research discipline. Kulkarni, Apte and Evangelopoulos (2014) applied LSA to uncover the main Operations Management research topics from 1980 to 2012. Also, Evangelopoulos (2011) also applied LSA to understand the influence of Taylor's ideas among scholarly work. Although there is not a single way to select the optimal number of latent dimensions, which can be pointed out as a limitation, LSA can address some shortcomings from other text analysis methods, as it does not rely on previously notion, limiting any subjective bias in the analysis (Evangelopoulos, 2011; Kulkarni, Apte & Evangelopoulos, 2014). For a detailed discussion about dimensionality reduction, see Wild, Stahl, Stermsek, Neumann and Penya (2005).

### 3. Methodology

Aiming to contribute to the existing literature on DBM, this research, essentially quantitative and descriptive, proposed a review of the literature on this topic under debate, using the LSA technique to consolidate the concepts presented on DBM in the literature, elaborating a set of characteristics that conceptualize and qualify DBM.

LSA can be conceptualized as a method for extracting and representing the meaning of a set of documents, i.e. a *corpus* because it combines local occurrence (one document) with global co-occurrence (all documents), making the association value between words greater if both appear together in two different documents than if each of them appears twice in single

documents. This can also be seen as an inverse entropy measure: the larger the entropy, the less information the word transmits about where it has appeared, and conversely, the less the meaning of a particular context is determined by that word (Landauer & Dumais, 1997; McNamara, Kintsch, Dennis & Landauer, 2011).

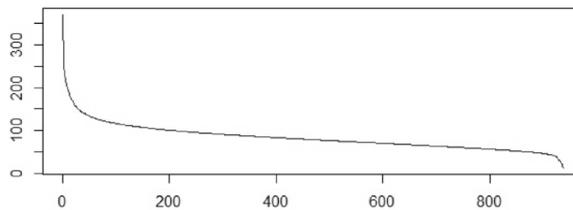
The articles selected for this analysis deal with DBM, most of which were developed in the form of empirical research. This set of articles was obtained from systematic searches conducted in scientific databases, which are *CAPES/MEC Journal Portal*, *EBSCO*, *SCOPUS* and *Web of Science*. The searches in the databases were performed at the beginning of the second semester of 2016. They were chosen due to their influence in the academic area, considering the access to several periodicals and magazines of all knowledge areas, as well as those related to business management, which include studies related to DBM.

Four searches were carried out, one in each database, by the term *disruptive business model* (without quotes) only in titles of peer-reviewed scientific articles, with no period limitation, in order to obtain studies that approach this subject in depth. Excluding duplicate articles among the databases, 19 articles were obtained for analysis. Initially, each of the articles resulting from the searches was thoroughly verified, to ensure its relevance for this research, as well as to confirm that the topic was being explored in depth.

The data were organized in electronic spreadsheets to carry out the analysis of the research. A spreadsheet was prepared in Excel with the full text of the articles, considering the form required for *RStudio*, the platform used to work with the R software. The organization of this worksheet sought a matrix representation in which each column was composed of one article (totaling 19 columns), and each row was represented by one of the 490 paragraphs of the article set, the first line being represented by the title of the article. For the preparation of this worksheet, the presentation texts of authors and journals, references, captions and sources of figures, tables or charts and preprocessing (with citation) were not taken into consideration. The data preprocessing phases followed the research of Marcolin and Becker (2016): removing special characters, such as @, #, among others, unifying the article's language, as one article was published in Spanish, and filtering stop words, such as *a*, *the*, *that*, *with*, and *to*, for example.

Thus, the term-document X matrix was generated from this set of documents, resulting in a matrix of 7,904 by 490, containing 7,904 unique terms distributed throughout the 490 paragraphs. In this matrix, the SVD decomposition was applied from the LSA package implemented in R. From this decomposition, three matrices were produced, as shown in Figure 1. For this article, the U matrix, which relates the terms to the 490 dimensions analyzed, was explored. Using the paragraphs, rather than the documents, as dimensions, we sought alignment with the literature regarding the potential for finding better latent relations when working with document expansion (Damais & Nielsen, 1992; Zelikowitz & Hirsh, 2001).

The decomposition performed considered all the dimensions, resulting in the distribution of singular values. In Figure 2, it is possible to perceive that there is a marked decrease in the



**Figure 2.**  
Singular values of the  
decomposed matrix

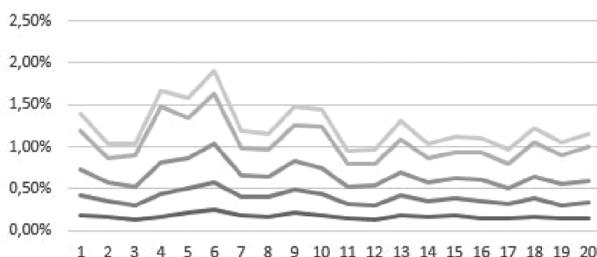
first dimensions about the singular value. This happens because the decomposition occurs in descending order, seeking to accumulate in the first dimensions the maximum amount of information that allows the reconstruction of the original  $\mathbf{X}$  matrix. The chosen cut-off point, therefore, took into account the dimensions that proportionally have greater explanatory power and that coincides with the point of greatest decrease in the curve, so that adding new dimensions to the analysis would represent more effort than explanation possibilities (Kulkarni, Apte, & Evangelopoulos, 2014; Wild et al., 2005).

From the obtained dimensions, we proceeded with the analysis of the data found. In the process of decomposition used by LSA, the singular values respect the order of the eigenvalues to the left and right of the  $\mathbf{X}$  matrix. Therefore, it is possible to state that, without loss of generality, the most significant dimensions are associated with the higher singular values, that is, the first dimensions. Thus, the first 20 dimensions were analyzed (cut-off point), composing a representative and relevant group that exhausted the criterion of quantity of dimensions for the construction of the set of characteristics that conceptualize and qualify DBM, as the later dimensions ended up bringing repeated aspects already analyzed in the previous dimensions and did not bring new relevant points for analysis (generic terms unrelated to the subject being discussed).

For the data analysis, each term had its relative frequency calculated about the absolute total loads of all the terms present in the same dimension. This process was performed for all terms of the 20 dimensions analyzed. After obtaining this relative frequency, we looked for a common cut-off point for all dimensions to define the number of terms to be analyzed by each dimension. To do so, we plotted the relative participation of the top- $N$  first terms. We tested the values of  $N$  from 5 to 25, seeking in the 20 dimensions which  $N$  would be more balanced. The results of the tests are presented in Figure 3, showing the choice for the top-24 terms by dimensions that will be analyzed later.

After defining the cut-off point for terms to be analyzed, a new calculation of the relative frequency was performed for each of the 24 terms of each of the 20 dimensions. The new relative frequency was calculated about the absolute total of the loads of the 24 terms that compose each dimension. This process was performed in all 20 dimensions analyzed. The accomplishment of this step allows the verification of the frequency of the terms in each dimension, to generate, later, a tag cloud for each dimension analyzed using the *Nvivo* software.

From the tag clouds obtained, the final analysis of this research was carried out by estimating the meaning of the most relevant terms highlighted by LSA, evidenced in these tag clouds, along with the content analysis to emphasize the meaning of the messages analyzed in the literature. This is because text mining techniques are closely related to content analysis, which extracts data-driven categories for analysis, allowing one technique to complement the other in the process (Yu, Jannasch-Pennell, & Digangi, 2011). Four data-



**Figure 3.**  
Top- $N$  test terms for  
analysis, with the  
lighter shade  
indicating the lowest  
value ( $N = 5$ ) and the  
darker shade  
indicating the highest  
value ( $N = 24$ )

driven categories were identified in our analysis: Disruptive technology and innovation; value proposition to consumers; maintenance of existing business models; and pattern within DBM.

Some of the data-driven categories were presented in more than one dimension because of the similarity between the main terms emphasized by LSA and tag clouds. Therefore, these data-driven categories consolidate the concepts and characteristics of DBM presented in the literature and highlight new insights on this topic, which are highlighted in bold. Such findings pointed out by the LSA and illustrated by the tag clouds are combined with content analysis, by cross-checking these data with the theory.

#### 4. Analysis

For the results of this research, the first 20 dimensions were used, as they were of greater weight and relevance for the intended analysis, exhausting the number of analyzed dimensions from the total. Out of these 20 dimensions, three were discarded in this research. The first discarded dimension was the seventh, as it deals with a dimension focused on an article dealing with DBM in the Latin American beef industry, presenting insignificant terms for this research, such as *exports, beef, Mexican, market, meat and cattle*.

The second and third discarded dimensions were the 13th and 14th because they were also exclusively about one of the articles of the analyzed set. This article is a seminal work referring to DBM in health and is frequently quoted in other studies, so it is presented in two dimensions. However, the most evidenced terms in these dimensions were considered as insignificant for this study: *care, health, study, research, service, delivery, businessmodel, hospitals and innovation*.

##### 4.1 Disruptive technology and innovation

In this subsection, we present the first group of concepts analyzed, which were driven mainly by the first dimension extracted from LSA. The first dimension, which is very representative for the research, as it reveals the most important terms among the set of articles examined, presented a compilation of the main subjects related to DBM in the literature, being highlighted by the following most frequent words in this dimension: *technology, model, innovation, disruptive and business*. Figure 4 illustrates the first dimension, showing an overview of DBM in theory.

This result reflects the initial literature on market disruption, which focused on a disruptive technology (Bower & Christensen, 1995) and disruptive innovation (Christensen, 1997). Following the presentation of these subjects in the literature, there is the emergence of DBM, representing a *link between business models and technological and innovation ruptures*



Figure 4.  
The 1st dimension

(Christensen & Raynor, 2003), uniting creative ideas in the exploration of technologies and innovation processes with their respective economic implementations in business (Yovanof & Hazapis, 2008).

It is important to highlight the theoretical findings which affirm that *disruptive technology and innovation are better used when combined with the innovation of business models* (Chesbrough & Rosenbloom, 2002; Christensen & Raynor, 2003; Johnson et al., 2008). This is because *the exploration of a new technology or an innovation process requires an evaluation and re-adaptation of the business models*, especially when they do not fit into the existing business models (Chesbrough & Rosenbloom, 2002). This phenomenon leads to a *conflict between the established business model and the new models required for disruptive technology or innovation* (Christensen & Raynor, 2003), a fact that may be related to the presence of the words *existing*, *established* and *incumbents* in the tag cloud from the first dimension.

From this initial dimension, which illustrates a broad picture of DBM, encompassing business models and disruptive technologies and innovations in their concept, other dimensions were analyzed with the emphasis on the variables technology and innovation (Figure 5). Initially, the third dimension is highlighted, which focuses on the influence of technology on the DBM. Analysis of this dimension is complemented by the findings of the sixth dimension.

In the third dimension, it is possible to verify *the influence of the new technologies on the business model* (Bashir et al., 2016), *which simultaneously create opportunities and challenges for organizations* (Sainio, 2004). This situation originates from the fact that the anticipated recognition of these possibilities and threats allows a reaction on the part of the companies, through the *reconfiguration of the business structures and the services or products offered* (Sainio, 2004). These results are presented based on interpretations of the emphasis given to the terms *technology*, *emerging*, *disruptive*, *businessmodel* and *service*.

The association between *technology* and *emerging (latecomer) economy firms* is another important interpretation to be made in the third dimension, as it is shown in the tag cloud. According to the research developed by Wu et al. (2010), *emerging-market firms*, while at a disadvantage in technological capabilities and some other resources, *can successfully introduce emerging technologies and innovations from more advanced economies through secondary innovations, into business models*. In these circumstances, the authors highlight the case of Taobao, a Chinese organization, which took there the new consumer-to-consumer



Figure 5.  
The 3rd and 6th  
dimensions

business model for the eCommerce of US-based eBay, adapting this type of business model for the characteristics of their market.

These results are in line with the sixth dimension, which points out this issue by highlighting the terms *latecomer* and *economies*. This way, the importance of innovative business models, even secondary ones, is verified in companies from emerging economies to obtain competitive *advantages* by articulating unique and attractive value propositions for their local consumers. It is also emphasized that this is possible by introducing not only new technologies coming from more advanced economies but also from innovation processes. The issue of innovation can be perceived in the sixth dimension by the prominence of the terms *explorative* and *exploitative*, which compose concepts related to organizational ambidexterity, linked to innovation.

Following the question of *innovation*, the fourth dimension (Figure 6) highlighted this variable, relating its potential for *disruption when market-oriented (marketdriven) or technology-driven (technologydriven) with the disruption of business models*.

This relationship reveals the findings of Habtay (2012), indicating that, in the short term, the potential for technology-driven innovation disruption is limited by several uncertainties related to the chosen technologies and the market; on the other hand, market disruptive innovations grow relatively rapidly and disrupt a significant part of the established market. However, this scenario changes significantly over the long term, revealing that if technology-driven disruptive innovation manages to reduce early uncertainties, it will likely have positive effects on its potential for disruption in the future; on the other hand, market-driven disruptive innovation will be moderated in the long term by the initial choice of the market, customers, necessary expertise and costs.

Another important dimension of our research is related to *Christensen* (Figure 7), one of the leading authors of research on DBM. Linking the seminal works by Christensen with the most evidenced words in the tag cloud, it is perceived that this dimension brings elements that show the influence of *technologies* and *disruptive innovations* on the business environment.

This is due to the fact that disruption does influence not only the business models of the companies that propose to be disruptive but also the competitors in their *search to reach new markets*, generating a *great competitive advantage* over the *failure of the companies that until then were dominant (established, incumbent) in the market* (Bower & Christensen, 1995; Christensen, 1997; Christensen & Raynor, 2003; Hwang & Christensen, 2008).



Figure 6.  
The 4th dimension

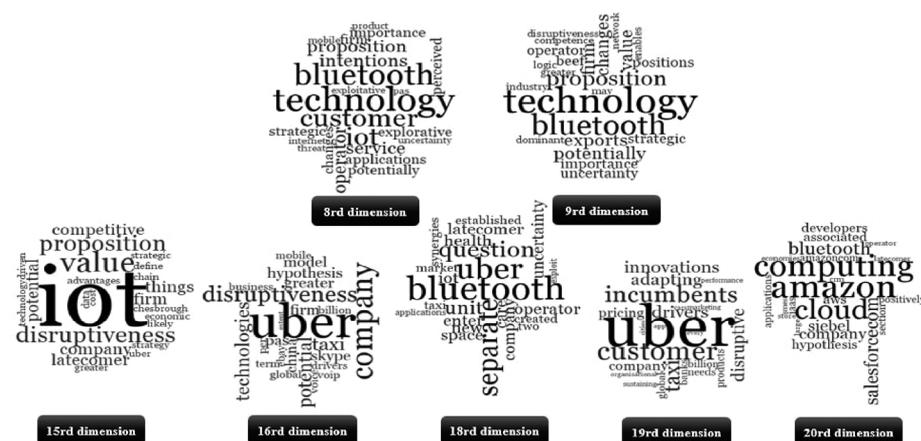


**Figure 7.**  
The 12th dimension

Finally, a considerable number of dimensions indicated examples of *disruptive technologies and innovations* (IoT, cloud computing, bluetooth) as well as organizations with *business models* that benefit from new technologies and innovation (Uber, Amazon). Figure 8 compiles the different tag clouds formed from the seven dimensions analyzed herein.

It should be noted that disruptive technologies and innovations, in their essence, bring a *very different value proposition to the market* (Bower & Christensen, 1995; Christensen, 1997; Christensen & Raynor, 2003; Sainio, 2004; Yovanof & Hazapis, 2008), when compared to the other available options. This is due to the fact that, considering the result of the new products and services offered, some unique benefits from disruptive technologies and innovations such as *greater simplicity, convenience, accessibility and lower cost* significantly influence and sensitize consumers (Christensen, 1997; Christensen & Raynor, 2003; Hwang & Christensen, 2008; Pereira et al., 2015; Sainio, 2004).

These aspects differentiate new business models from traditional business models in terms of new ways of value proposition, market segment and revenue sources (Pacheco et al., 2016). These aspects can be confirmed by the emphasis given to the new business model launched by



**Figure 8.**  
The 8th, 9th, 15th,  
16th, 18th, 19th and  
20th dimensions

the company Uber in dimensions 16, 18 and 19. The Uber business quickly revolutionized the taxi industry by providing consumers with a differentiated transportation service, by the intensive use of technology in transport activities, something that had been stagnated until then. This search for new business models, through emerging technologies or the introduction of innovations in traditional industries of the market, has had an expressive expansion in different sectors; using the last example, it is recognized worldwide as *Uberization*.

To maintain the benefits related to the development and commercialization of disruptive products and services, new skills and business reorganizations are required from the new business models, mainly in strategic terms (Christensen, 1997; Christensen & Raynor, 2003; Sainio, 2004; Yovanof & Hazapis, 2008).

#### 4.2 Value proposition to consumers

The second group of concepts analyzed was based on the second dimension extracted from the LSA. This second dimension concerns a feature strongly reported in the literature on DBM: the *value proposition to consumers*. This is because it is possible to identify in the research that *DBM emerges to replace existing business models by redefining what an existing product or service is and how it is delivered to customers through new technologies and processes of innovation, as well as by aiming at a unique proposition of value to the market* (Hwang & Christensen, 2008; Markides, 2006; Mitchell & Coles, 2004; Wu et al., 2010).

In this dimension, the terms *networks* and *marketing* are also highlighted. They emphasize the importance of *marketing* activities as a way to promote the creation and capture of value between new business models and customers, which constitute a dynamic business network (Simmons et al., 2013).

This dimension is complemented by the 11th dimension, which highlights the figure of the customer and its relevance to the structuring of new business models. This dimension clearly illustrates the *great concern and attention of DBM with the selected market segment* (Magretta, 2002), *seeking new forms of value creation that sensitize consumers, rather than simply delivering a new product or service* (Bashir et al., 2016). Figure 9 highlights the tag clouds formed from the 2nd and 11th dimensions.

Figure 9 also brings the tag cloud of the 17th dimension, which once again centralizes the consumer, as well as highlights the terms *project* and *Uber*. By making an association among these elements and complementing the analysis already carried out, it is possible to *make an association between the development of the new organizational models and business projects with defined objectives, based on the delivery of value to a determined market*



Figure 9.  
The 2nd, 11th and  
17th dimensions

segment, through the definition of a structure, resources and specific activities in order to achieve this goal (Magretta, 2002; Simmons et al., 2013; Bashir et al., 2016).

#### 4.3 Maintenance of existing business models

Another group of concepts from the fifth dimension (Figure 10) was analyzed, which brought terms such as *logic, model, intentions, dominant* and *threat*. Aligned with these subjects, it is possible to associate the issue of maintaining the dominant logic of existing business models, even when *new models emerge on the market, which represents direct and severe threats to the maintenance of traditional and stabilized models*.

This is because these existing models tend to ignore new technologies and innovation potentials because they do not fit into the current business model (Chesbrough, 2010; Christensen, 1997; Gilbert, 2005). Consequently, the emergence of *innovative business models causes radical changes in the market, disrupting leading and stabilized companies, making their existing business models obsolete* (Gassmann et al., 2013; Johnson et al., 2008; Osiyevskyy & Dewald, 2015; Yovanof & Hazapis, 2008).

It is highlighted that DBM, combining technologies and innovation with the offer of products and services with *unique value* to the market, are important tools to *gain competitive advantage* (Bashir et al., 2016). Thus, *it is fundamental for managers to assume an entrepreneurial behavior, with the purpose of analyzing the market as well as the business, seeking new ways of delivering value to the consumer, to seize the opportunities and evade the threats that come with new business models* (Bashir et al., 2016; Chesbrough & Rosenbloom, 2002).

#### 4.4 Pattern within disruptive business models

The last group of concepts analyzed herein relates with terms such as *pattern, model, options, elements, business, firm* and *framework*, present in the 10th dimension, which focuses on the matter of pattern within business models (Figure 11).

As highlighted in the analysis of the other dimensions, the emergence of new technologies and innovation processes provide opportunities and threats for business models (Amshoff et al., 2015; Sainio, 2004). This situation is due to the singular characteristics related to emerging technologies and innovations, which, through new business models and new forms of value creation, made it possible to offer products and services that sensitize consumers, exploring new markets.



Figure 10.  
The 5th dimension

**Figure 11.**  
The 10th dimension

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Nevertheless, anticipating the necessary ways of doing business within this context is a challenge for managers (Amshoff et al., 2015). Hence, establishing *business model patterns* can be a way to address this challenge through the knowledge of the elements related to DBM, which can reveal valuable information about how to do the desired business (Amshoff et al., 2015).

#### 4.5 Consolidation of concepts on disruptive business models

It is verified that the results found herein represent many of the aspects already described in theory. However, such findings, highlighted by LSA, bring new perspectives to the analysis of DBM, still little discussed in the literature and which reveals important considerations to be made on this subject. These concepts were consolidated, as systematized in Table I, into a set of characteristics that conceptualize and qualify DBM.

Analyzing Table I, it is possible to see the breadth of the concept of DBM, which encompasses aspects related to the influence of disruptive technologies and innovation on the organization's existing business models. This is because DBM focuses on replacing business models, either by reconfiguring existing models or by creating new ones, when disruptive technologies and innovation are not adequately leveraged in current models, requiring new forms of organization of business. Thus, the delivery of unique value to consumers, the opening of new markets, the obsolescence of existing business models and the competitive advantage, by offering products and services with greater simplicity, convenience, accessibility and lower costs, are important aspects observed in DBM.

Figure 12 illustrates the characteristics of DBM presented in Table I. This figure consolidates the concepts that are similar, revealing the main features of a DBM.

### 5. Final considerations

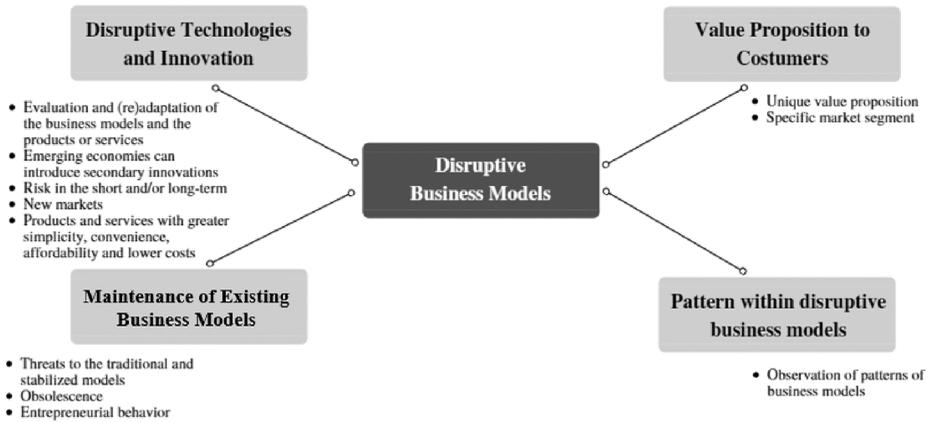
This article aims to consolidate the concepts presented on DBM in the literature, elaborating a set of characteristics that conceptualize and qualify a DBM. This is because, despite the existence of research and understanding about DBM, such findings do not accurately reveal the conceptual limit of this subject, which is imprecise in the literature (Foss & Saebi, 2017; Wu et al., 2010). Therefore, the literature on this subject was analyzed using the LSA technique, complemented by content analysis, to obtain a more precise qualification and conceptualization regarding DBM.

Although it is possible to verify a growth in the number of researches that deal with the innovation process in the business models, it is still necessary to further theorize and

Data-driven categories	Characteristics of DBM
Disruptive technologies and innovation	<p>DBM represents a link between business models and breakthroughs in technology and innovation (Christensen &amp; Raynor, 2003)</p> <p>Disruptive technologies and innovations are best seized when combined with the innovation of business models (Chesbrough &amp; Rosenbloom, 2002; Christensen &amp; Raynor, 2003; Johnson <i>et al.</i>, 2008)</p> <p>The exploration of a new technology or an innovation process requires an evaluation and a re-adaptation of the business models and the products or services offered (Chesbrough &amp; Rosenbloom, 2002)</p> <p>Conflict between established business models and the new models required for disruptive technology or innovation (Christensen &amp; Raynor, 2003)</p> <p>New technologies influence business models while creating opportunities and challenges for organizations (Bashir <i>et al.</i>, 2016; Sainio, 2004)</p> <p>Emerging economies can introduce emerging technologies and innovations originated from more advanced economies through secondary innovations into business models (Wu <i>et al.</i>, 2010)</p> <p>The disruption of disruptive innovations in business models varies, in the short and long term, when technology-driven or market-driven (Habtay, 2012)</p> <p>The exploration of emerging technologies and innovations within DBM provides the offering of products and services that reach new markets, making it possible to obtain competitive advantage and bring the failure of the companies (Bower &amp; Christensen, 1995; Christensen, 1997; Christensen &amp; Raynor, 2003; Hwang &amp; Christensen, 2008)</p> <p>Disruptive technologies and innovations bring a very different value proposition to the market and deliver products and services with greater simplicity, convenience, affordability and lower costs (Bower &amp; Christensen, 1995; Christensen, 1997; Christensen &amp; Raynor, 2003; Hwang &amp; Christensen, 2008; Pereira <i>et al.</i>, 2015; Sainio, 2004; Yovanof &amp; Hazapis, 2008)</p>
Value proposition to costumers	<p>DBM arises to replace existing business models, redefining what an existing product or service is and how it is delivered to customers, through new technologies and innovation processes (Hwang &amp; Christensen, 2008; Markides, 2006; Mitchell &amp; Coles, 2004; Wu <i>et al.</i>, 2010)</p> <p>Great concern and attention of DBM with the selected market segment, seeking new forms of value creation that sensitize consumers (Magretta, 2002; Bashir <i>et al.</i>, 2016)</p> <p>The formation of the new organizational models can be associated with business projects with defined objectives, based on the delivery of value to a specific market segment, through the definition of a structure, resources and specific activities (Bashir <i>et al.</i>, 2016; Magretta, 2002; Simmons <i>et al.</i>, 2013)</p>
Maintenance of existing business models	<p>New business models in the market pose direct and severe threats to the maintenance of traditional and stabilized models (Chesbrough, 2010; Christensen, 1997; Gilbert, 2005)</p> <p>DBM bring about radical changes in the market, disrupting leading and stabilized companies, making their existing business models obsolete (Gassmann <i>et al.</i>, 2013; Johnson <i>et al.</i>, 2008; Osiyevskyy &amp; Dewald, 2015; Yovanof &amp; Hazapis, 2008)</p> <p>It is fundamental for managers to have an entrepreneurial behavior, with the purpose of analyzing the market as well as the business, seeking new ways of delivering value to consumers, to seize the opportunities and escape the threats that come with new business models (Bashir <i>et al.</i>, 2016; Chesbrough &amp; Rosenbloom, 2002)</p>
Pattern within DBM	<p>Patterns of business models can be used to interpret the environment and anticipate how to perform the intended business through the knowledge of the elements related to DBM (Amshoff <i>et al.</i>, 2015)</p>

**Table I.**  
Consolidation of  
concepts on DBM

**Figure 12.**  
Characteristics of  
disruptive business  
models



conceptualize this theme (Foss & Saebi, 2017). Therefore, this article contributes to the theory by conducting an in-depth analysis of the literature on DBM using the LSA technique, raising and consolidating concepts presented on DBM in the literature. From this, it was possible to present a set of characteristics about DBM, as presented in Table I.

Also, the presentation of this set of characteristics aims to help managers understand this theme and later translate these understandings into their business with greater confidence. The arguments presented in Table I and illustrated in Figure 12 contribute to the practice as these concepts and characteristics can be used as a validation tool to identify if a business is a DBM. Besides, considering the explanation of each concept and characteristic, managers of different sectors can identify opportunities to reach the disruptive characteristics of their businesses or change what is necessary to achieve this position.

It should be noted, about the technique used, a limitation on the choice of the number of singular values. This limitation is a problem still discussed in the literature (Visinescu & Evangelopoulos, 2014); for this reason, we tried to work not just with the cost-benefit ratio given the addition of each new dimension in the analysis, as well as a criterion of saturation of the terms presented. Thus, the fast decline of the singular values is in agreement with the studies suggested by Wild et al. (2005). For future research, it is suggested the application of this set of characteristics in empirical research, to verify such theoretical findings in the field and to add empirical aspects to this set of DBM characteristics.

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# Adoption of health information technology in the mobile emergency care service

Mobile  
emergency

287

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## Abstract

**Purpose** – Health is at the center of society concerns, being characterized by the dilemma of contributing to the population well-being, while demanding high financial investments at the same time. In this sense, information technology (IT) becomes essential for the progress of the sector, directly impacting on how care practices are performed. This study aims to analyze the adoption of mobile devices in the mobile emergency care service (MECS) of the state of Rio Grande do Sul, Brazil.

**Design/methodology/approach** – The authors carried out a multi-method study with an initial qualitative exploration through a focal group, followed by a survey. Potential determinants and impacts of mobile device use on the work context of the MECS teams were identified. Following, we tested the proposed conceptual model applying a questionnaire to 350 professionals from a total of 160 bases throughout the State. Partial least squares structural equation modeling was used to test the hypotheses herein.

**Findings** – The authors found that Satisfaction with the Use of Mobile PHC (PHC – Primary Health Care) is determined by the application compatibility with MECS work, followed by the performance expectancy with the use of the technology and the technical support provided to the users – acting as important facilitators of this process; while the technological complexity inherent in the use of the technology appears as the main barrier to the success of this technology. Besides, the authors found that both intensity of Use and Satisfaction with the Use of the technology provide different benefits to those involved (teams, patients and the organization).

**Research limitations/implications** – As limitations of the study, the authors point out to the fact that the data are from a single Brazilian State, and therefore, its results cannot be generalized. Another limitation is that the study considered only the use of a specific mobile technology, which requires caution when using this information in contexts where the health information technology is different, besides the fact that the findings may not be compatible in environments where IT adoption is voluntary.

**Practical implications** – The study can help managers of public and private organizations in the planning and implementation of different technologies, whether mobile or applied to the health context, as well as in the expansion of their use in their respective institutions.

**Social implications** – The research contributes to other studies that realize that the adoption of IT can cause relevant changes to health being associated to productivity gains and improvement of the quality of service provided to society through different forms and solutions.



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**Originality/value** – The adoption and use of IT – such as mobile devices – impacts on how care practices are performed in the MECS, providing different benefits to those involved (teams, patients and the organization).

**Keywords** Technology adoption, Information systems, Mobile technologies, Health information technologies, Mobile emergency care service

**Paper type** Research paper

## 1. Introduction

Society has been constantly concerned with health-related issues, especially considering they demand high financial investments while being paramount for the well-being of the population at the same time. In a context marked by budget cuts and growth in demand for health services – heavily influenced by the ageing population with a corresponding rise in chronic diseases (Ingebrigtsen et al., 2014) – the adoption of different information technologies (ITs) has emerged as an alternative to achieve greater efficiency and effectiveness in health-care activities (Silva, Rodrigues, de la Torre Diez, Lopez–Coronado, & Sallem, 2015).

Among the main examples of IT applied to health, some of them already present in Brazil, Electronic Health Record (Gagnon, Ghandour, Talla, Simonyan, & Godin, 2014; Perez & Zwicker, 2010), health information exchange systems (Ingebrigtsen et al., 2014; Vest, 2010), telemedicine (Wen, 2008), computerized physician order entry (CPOE) and decision support systems (Buntin, Burke, Hoaglin, & Blumenthal, 2011), as well as mobile devices such as the personal digital assistant – PDA) (Tan, Siah, Ooi, Hew, & Chong, 2014), smartphones and tablets (Barra & Sasso, 2010; Silva et al., 2015) have been highlighted in the literature. The present study adds to current literature that examines the use of applications installed in smartphones; more specifically, in emergency calls made outside the hospital base.

Recently, there has been a greater presence of applications using mobile devices, especially the smartphone, both by the public in general and health professionals (Silva et al., 2015), mainly because it is a new technology that combines communication and mobile computing through a portable device. In an increasingly mobile society, wireless IT infrastructure supports numerous applications, whether linked to mobile commerce, supply chain management or more recently to health care (Wu, Li, & Fu, 2011). Similarly, the advance of mobile devices powered by 3G, 4G and wireless technology has enabled the creation of a wide variety of service applications to perform mobile health care easily and conveniently, such as medical consultations, hospital records and location-based services (Silva et al., 2015).

One of these recently implemented applications occurred in the mobile emergency care service (MECS) of the state of Rio Grande do Sul, Brazil. To automate the communication between the teams and the Regulation Center, freeing the 192 line and making the service more agile, the State Health Department of Rio Grande do Sul initiated, between 2013 and 2014, the implementation of a Mobile PHC system (PHC – primary health care). The application, which works through the use of a smartphone made available to each service team, automates a good part of the activities performed by the teams when receiving a call. However, the adoption of this system by the different MECS's units scattered throughout the state has been done in a systematic way, replacing the exclusive use of telephony as a form of communication between the teams and their respective regulation center (Secretaria Estadual Da Saúde Do Rs, 2016), with occurrence of units where acceptance and use of Mobile PHC are more successful than others.

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The information systems (IS) literature has suggested different facilitators and inhibitors of the adoption of technologies in the organizational environment and in health-related areas; however, there is a lack of studies addressing the use of IT in mobile emergency care services. Studies of this nature may interfere with the decision whether to adopt new technology and to identify and measure its potential benefits to users, patients and the health system as a whole. Toward a better understanding of this context, we propose the following research question: How can the acceptance of mobile applications by users and their impact on service performance be explained by facilitating or inhibiting factors in the mobile emergency care service? We intend to answer this question by proposing a model that explains and predicts the factors that facilitate and hinder the acceptance of the use of Mobile PHC and its impact on the performance of the teams.

## 2. Theoretical framework

In general, health information technologies (HITs) have drastically changed the way health professionals work (be they doctors, nurses, psychologists, among others), as well as the experiences of patients receiving care (Krist et al., 2015). Such technologies have the potential to improve health care, as well as the performance of the providers of this service, enabling improvements in the quality of care, cost reduction, better access to medical information and greater patient interaction with their own care (Blumenthal, 2010).

Regarding the scientific research developed on the subject, especially in Brazil, a limited number of studies that identify and measure the factors that influence the adoption and use of mobile technologies in the health area is observed, highlighting the studies developed by Perez and Zwicker (2010) and Barra and Sasso (2010). When we search for international publications, the reality is quite different. However, scholars still emphasize the need for further studies on the motives that lead health professionals to adopt mobile devices to effectively promote their diffusion in health-care settings (Ingebrigtsen et al., 2014; Wu et al., 2011), as well as researches that analyze the potential and challenges of using mobile technologies in health care (Kumar et al., 2013). Considering the investments that have been made in HIT, quantifying the impacts of their use on performance should continue to be an important focus of research (Agarwal, Gao, & Des Roches, 2010).

Identifying factors that influence the adoption of these technologies can provide insights to managers in the development of more effective strategies that, in turn, would allow health units to create new opportunities to increase the efficiency and effectiveness of their professionals (Chau & Hu, 2001). Regarding the use of mobile technologies, it has been shown to be beneficial in supporting professional work practices and patient care, through the possibility of rapid response, prevention of medication errors and data management and accessibility (PROGOMET et al., 2009). In emergency medical services, for example, it is of fundamental importance that the technology allows the medical staff to process the necessary information about the patients quickly and accurately (Rippen, Pan, Russel, Byrne, & Swift, 2013), which will directly affect the care provided, decrease sequelae or even save lives.

A review of the literature on the subject made it possible to identify 28 motivating and inhibiting factors of the adoption of HIT. The high number of constructs would make the proposed model extremely exhaustive and complex. Thus, it was considered appropriate to develop multi-method research, starting with a qualitative phase, followed by a quantitative one.

### 3. Methodology

The research is characterized as an exploratory-descriptive study, being operationalized through a survey. The quantitative approach had the initial support of a focus group to better understand the use of the Mobile PHC system and its impacts on MECS performance. In this sense, this research is classified as a mixed-method study, because it combines qualitative and quantitative research. Regarding ethical issues, the study was submitted to the Ethics Committee of the Federal University of Rio Grande (FURG), receiving the approval and registered in the Brazilian Platform under the number CAAE 57048316.3.0000.5324. Next, we detail how we propose the research model, followed by the construction of the hypotheses and the methodological procedures used in the survey.

#### 3.1 Proposition of the research model

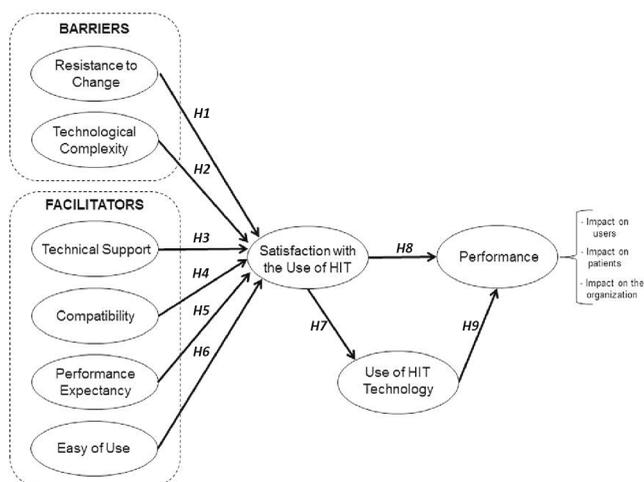
To identify the different determinants of mobile device use and its impacts on the working context of the Mobile Emergency Care Service (MECS) teams, we carried out a literature review followed by qualitative exploratory research. Therefore, a focus group was chosen from a MECS team, consisting of members who have been using the mobile PHC application for more than two years and have received formal training to use the technology.

The focal group was mediated by one of the authors, in the figure of the moderator, being guided by a semi-structured interview script. The activity occurred at the MECS unit of the professional team, corresponding to the place where the team awaits the calls from the Regulation Center. Six professionals participated in the focal group, two drivers, two nurses, one nurse technician and one physician. The activity lasted about 1 h, and the reports were recorded and later transcribed to enable the adequate analysis of the data, which was performed by the content analysis technique. The analysis obtained in the focus group showed that the use of the mobile device in the MECS is influenced by two sets of determinants, one formed by barriers: *resistance to change* and *technological complexity*; and the other by facilitators: *technical support*, *compatibility*, *performance expectancy* and *ease of use*. Concerning the benefits, these were identified and grouped according to the impact of the use of the mobile PHC system on each stakeholder group: users, patients and the organization.

Another point observed with the accomplishment of the focal group was that the use of Mobile PHC system in MECS is not voluntary, but mandatory. Given this reality, Brown, Massey, Montoya-Weiss, and Burkman (2002) provide evidence that a change in the dependent variable is appropriate when examining the acceptance of technologies in this context, contrary to a reality of voluntary use. Thus, along with *Use*, *Satisfaction* has been considered as more appropriate to evaluate the success of a technology when the use of an IS is mandatory (Brown et al., 2002; Sykes, 2015; Maillet, Mathieu, & Sicotte, 2015). Figure 1 presents the proposed model, elaborated from different antecedents and consequences of the use of HIT, considering the peculiarities of the context of mandatory use. It should be noted that after the proposal of the conceptual model, we returned to the MECS team, with which the focus group had been carried out. Through an interview with the team leader, we confirmed the coherence of the obtained reports along with the pertinence of the conceptual model, which portrays the context of acceptance and use of the mobile PHC application and the perceived impact of its implementation on the performance of users, patients and MECS itself.

#### 3.2 Hypothesis construction

Studies that address Satisfaction as the main dependent variable are rare, using mostly the traditional *IS Success Model* provided by Delone and McLean (1992). Innovatively,



**Figure 1.**  
Conceptual model

Maillet et al. (2015) proposed an adapted model in which Satisfaction and Use are presented as the main focal variables, using, however, different antecedents to those traditionally proposed by DeLone and McLean (1992). Maillet et al. (2015) found it difficult to find research to support their hypotheses that contained the variable Satisfaction, thus opting for the use of studies that tested the same antecedents as the constructs Use or Intention of Use, in contexts where the use of the system is mandatory. The same difficulty was faced in the present study, opting to follow the same strategy. Next, the theoretical construction that underlies the conceptual model of the research is presented.

Resistance to change is characterized as a personality trait of people who believe it is difficult to change their routines, thus becoming emotionally stressed in the smallest signs that changes might occur. It is understood as any conduct that aims to maintain the *status quo* in the face of pressures that seek to change it (Keen, 1981). Some studies such as Lapointe and Rivard (2005) have highlighted this issue, providing support for the negative effect of resistance on the use of HIT. Thus, we propose the following hypothesis:

*H1.* The degree of Resistance to Change will be negatively associated with the degree of Satisfaction with the use of a mobile application.

Technological complexity, on the other hand, refers to an individual's degree of perception of the difficulty in understanding and using a specific type of technology (Thompson, Higgins, & Howell, 1991). Any aspect of a particular technology may have an impact on the user's intention to accept it or not (Lu et al., 2003). It is emphasized that users will have difficulty meeting their needs when the complexity of the technology use increases. Literature presents some studies that prove this relationship (Au & Kauffman, 2008). Thus, we propose the following hypothesis:

*H2.* The degree of Technological Complexity of the system will be negatively associated with the degree of Satisfaction with the use of a mobile application.

In the IT context, technical support can be defined as the assistance provided to users of computer products by people with IT skills and knowledge. It comprises the technical aspects of users' needs such as specialized instructions, guidance, training and

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consultation on the use of technologies (Pijpers, Bemelmans, Heemstra, & Van Montfort, 2001). Considering that the nature of health professionals' work is characterized by the scarcity of time and the intense flow of activities, technical support becomes fundamental to the success of a technology (Lu et al., 2003). Thus, the higher the level of technical support, the greater the probability of adoption is successful. When considering the relationship between technical support and satisfaction, two studies confirm this connection: Chatterjee, Chakraborty, Sarker, and Lau (2009) and Sykes (2015). Based on this discussion, we propose the following hypothesis:

- H3.* The degree of Technical Support offered to users will be positively associated with the degree of Satisfaction with the use of a mobile application.

Compatibility is the extent to which the user believes the technology is consistent with his/her values, needs and past experiences (Payton, Pare, LeRouge, & Reddy, 2011), i.e. the degree to which new technology applies to a job. Compatibility has been shown to be relevant and significant in studies in the context of the adoption of HIT, examples being the studies of Chau and Hu (2001); Lu et al. (2003) and Maillet et al. (2015). Therefore, if health professionals consider that technology in question is compatible with their work style and all aspects of their profession, they will be willing to use this technology (Hsieh, 2015). On the other hand, if an individual perceives the new technology as irrelevant to his/her work, he/she will be less likely to accept it (Son, Park, Kim, & Chou, 2012). Thus, we propose the following hypothesis:

- H4.* The degree of Compatibility of the system with the activities performed will be positively associated with the degree of Satisfaction with the use of a mobile application.

Performance Expectancy can be defined as the degree to which an individual believes that the use of technology will help him or her to obtain gains in performance at work (Venkatesh, Morris, Davis, & Davis, 2003). The impact of this construct was observed in other health studies (Adamson & Shine, 2003), standing out as the strongest factor in the prediction of use. Users value the usefulness of technology as a support to their work practices and, consequently, to improve their performance and quality of care (Maillet et al., 2015). Based on these settings, we propose the following hypothesis:

- H5.* The degree of Performance Expectancy of a system will be positively associated with the degree of Satisfaction with the use of a mobile application.

Ease of Use is understood to be the degree to which a person believes that the use of a particular technology is effortless. Thus, technologies that the individual perceives as being easier or less complex to use are more likely to be adopted and accepted by these individuals (Davis, 1989). Several studies have established ease of use as an important determinant of the intention and use of IT in the health-care context, especially the study presented by Gagnon et al. (2014), in which the ease of use proved to be the most relevant determinant of doctors' intention to adopt the electronic medical record, and Tan et al. (2014), who emphasized that health professionals were reluctant to adopt the PDA when they perceived its interface as unfriendly or difficult to operate. Research developed by Adamson and Shine (2003) confirmed the relevance of user-friendliness as a strong catalyst and is indispensable in promoting the use of IT applied to health. Therefore, we propose the following hypothesis:

- H6.* The degree of Ease of Use of the system will be positively associated with the degree of Satisfaction with the use of a mobile application.

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Satisfaction with the use of technology refers to the extent to which the user is satisfied with his/her interaction with technology (DeLone & McLean, 2003). It measures aspects of the user's perception of his/her experiences of using the technology, verifying that it has been psychologically accepted. Even though the use is mandatory, satisfaction is not, as it is a personal feeling (Hsieh, Rai, Petter, & Zhang, 2012). In their research, Chatterjee et al. (2009) and Petter, DeLone, and Mclean (2008) suggest that the more satisfied an individual is with a determined technology, the more likely he/she is to use it again. Thus, we propose the following hypothesis:

*H7.* The degree of Satisfaction with the Use of a system will be positively associated with the Intensity of Use of a mobile application.

In general, satisfaction has been recognized as a key metric for the success of any IS (Brown et al., 2002; DeLone & McLean, 1992). In the health-care field, some studies have presented sufficient empirical results to guarantee support and coherence in the relationship of satisfaction with obtaining benefits in a network (Lapointe, Mignerat, & Vedel, 2011). It is also important to assess the impacts of HIT through measures that include aspects focused on different stakeholder groups (Wu et al., 2012). In this sense, it is understood that satisfaction with the use of technology can have positive impacts on the performance of the individual, as well as the group or team, and the organization itself. Thus, we propose the following hypothesis:

*H8.* The degree of Satisfaction with the use of a mobile application will have a positive effect on the performance of different stakeholder groups.

When we consider the influence of the use of technology on performance, its variability portrays a significant impact on the achievement of benefits, even if use is mandatory. As a result of use and user satisfaction, certain network benefits will occur (DeLone & McLean, 2003). This relationship has been tested and supported by studies presented by Chatterjee et al. (2009) and Petter et al. (2008). As for the different actors involved in health-care delivery, they may be affected differently by HIT, and may be impacted to a greater or lesser extent depending on the beneficiary. Therefore, considering this discussion, we propose the following hypothesis:

*H9.* The degree of Use of a mobile application will have a positive effect on the performance of different stakeholder groups.

### *3.3 Survey procedures*

For the elaboration of the questionnaire used in this research, the questions referring to each one of the constructs were, for the most part, adapted from studies already validated and tested empirically. The only exception was the *Performance* construct, which had its items based on the results obtained in the qualitative stage of this research because we found no studies regarding the proposition of indicators that evaluate the impact of the use of HIT in the different stakeholder groups, such as the ones (users, patients and MECS) proposed herein. Furthermore, for the analysis, we decided to transform the 12 first-order items proposed in 3 second-order items, represented by the average of the items corresponding to each of the three groups of beneficiaries: patients, teams and the organization. The instrument underwent a process of refinement and validation, initially receiving the evaluation of a specialist in languages, a health professional working at the MECS and three specialists with theoretical and practical knowledge of IT. This procedure guarantees both

face and content validity of the questionnaire, which was composed by 44 questions, operationalized in a five-point Likert scale, varying from (1) totally disagree to (5) totally agree. Before the application, a pretest was carried out in one of the MECS's units, totaling 15 respondents, and no problem was pointed out or identified in the instrument. The questionnaire, presenting the references from where the constructs originated, is available in Appendix.

The study population was composed by 2,106 health professionals (nurses, doctors, nursing technicians and drivers) who work in 160 units that form the MECS service in the state of Rio Grande do Sul. Based on this information and using the criterion of sample size selection proposed by Hill and Hill (2002), we determined a total of 329 respondents as the minimum number of members needed to compose the sample in a representative manner. From a list provided by the State Coordination of MECS, containing information on all units, we identified the respondents of the study. All 160 units were contacted – initially, through a telephone call with made by the technical head of the unit and later by sending an e-mail with the attached questionnaire. By the end of the data collection, 360 questionnaires were answered, of which 350 were considered valid, composing the final sample of the study. The majority of the individuals surveyed were men (55.4 per cent), between 31 and 40 years of age (52 per cent) and with a high school education (35.4 per cent). Most of them are nurse technicians (40.3 per cent), followed by nurses (27.7 per cent), drivers (24 per cent) and doctors (6 per cent). On average, the respondents have been working for MECS for five years, and have been using Mobile PHC in their work routine for an average of two years.

Since the data were collected, we took some precautions to identify potential sources of method bias – a rather common problem in the conduction of behavioral research (common method bias) (Podsakoff, Mackenzie, Lee, & Podsakoff, 2003) but still little explored in Administration studies published in Brazil. To do this, we performed Harman's single factor test and tested the correlation between all the constructs of the proposed model finding no evidence of common method bias. Afterwards, we analyzed the proposed model through structural equation modeling using the statistical software SmartPLS 3.0 (partial least squares).

## 4. Results and discussion

### 4.1 Measurement model

Through the measurement model, we seek to analyze the relationship between the constructs and their items. It is recommended that the factor loadings of all items are higher than 0.70 in their respective constructs, indicating a well-defined structure. Thus, we excluded five items, which presented factor loadings lower than the minimum recommended. After these exclusions, all factor loadings confirmed the validity and reliability of items and constructs (Table I).

The Composite Reliability (CR) of the instrument was then verified. As can be seen in (Table II), the CR value of all the constructs exceeded the minimum value of 0.80, suggested by Fornell and Larcker (1981), confirming the reliability of the scales. For convergent validity evaluation, the criterion of the average expected variance (AVE) was used. The value of the AVE for each construct must exceed the established minimum value of 0.50, which means that more than half of the variances observed in the items are accounted for by their hypothetical constructs (Fornell & Larcker, 1981). This result is reinforced by the factor loadings of the items being higher in their respective constructs.

Discriminant validity was tested through the criterion of cross loadings, in which it is expected that the factor loading of each indicator is greater than all its cross loadings, as well as by the criterion that the square root of the AVE of each construct is greater than all

Items	COM	TEC	PER	EXP	EOU	RES	SAT	SUP	USE
COM1	0.792	-0.207	0.479	0.465	0.486	0.281	0.423	0.285	0.293
COM2	0.880	-0.191	0.479	0.538	0.586	0.341	0.509	0.473	0.319
COM3	0.842	-0.205	0.447	0.569	0.479	0.320	0.462	0.468	0.326
TEC1	-0.126	0.809	-0.130	-0.040	-0.092	0.032	-0.171	-0.040	-0.051
TEC2	-0.264	0.874	-0.213	-0.182	-0.172	-0.010	-0.207	-0.218	-0.080
IMO	0.509	-0.225	0.943	0.632	0.462	0.278	0.575	0.402	0.353
IMP	0.518	-0.182	0.953	0.692	0.522	0.280	0.589	0.402	0.367
IMU	0.565	-0.188	0.960	0.726	0.551	0.318	0.571	0.407	0.381
EXP1	0.498	-0.116	0.614	0.888	0.507	0.377	0.482	0.438	0.242
EXP2	0.565	-0.097	0.629	0.918	0.560	0.325	0.437	0.502	0.331
EXP3	0.638	-0.163	0.706	0.917	0.624	0.315	0.500	0.542	0.359
EOU1	0.530	-0.171	0.526	0.542	0.833	0.310	0.433	0.453	0.242
EOU2	0.431	-0.104	0.245	0.372	0.729	0.283	0.273	0.337	0.276
EOU3	0.464	-0.079	0.427	0.510	0.752	0.315	0.293	0.334	0.359
RES1	0.305	-0.019	0.248	0.315	0.295	0.827	0.239	0.196	0.173
RES2	0.294	-0.006	0.239	0.287	0.315	0.866	0.279	0.204	0.203
RES3	0.344	0.054	0.284	0.340	0.367	0.810	0.248	0.237	0.266
SAT1	0.572	-0.231	0.580	0.533	0.432	0.319	0.917	0.464	0.375
SAT2	0.450	-0.186	0.511	0.449	0.381	0.228	0.901	0.382	0.389
SAT3	0.474	-0.192	0.548	0.426	0.389	0.277	0.886	0.413	0.394
SUP1	0.417	-0.130	0.311	0.423	0.384	0.155	0.364	0.826	0.272
SUP2	0.391	-0.172	0.346	0.454	0.386	0.149	0.357	0.832	0.207
SUP3	0.462	-0.155	0.431	0.524	0.484	0.291	0.434	0.841	0.283
SUP4	0.364	-0.085	0.310	0.401	0.381	0.231	0.393	0.826	0.309
USE2	0.273	-0.087	0.394	0.322	0.314	0.137	0.330	0.259	0.790
USE3	0.313	-0.037	0.261	0.264	0.262	0.221	0.356	0.279	0.819
USE4	0.306	-0.060	0.242	0.234	0.289	0.266	0.331	0.230	0.767

**Table I.**  
Factor loadings of  
the items in the  
constructs

**Notes:** COM = Compatibility; TEC = Technological Complexity; PER = Performance; EXP = Performance Expectancy; EOU = Easy of Use; RES = Resistance to Change; SAT = Satisfaction; SUP = Technical Support; USE = Use

	Mean	CR	AVE	COM	TEC	PER	EXP	EOU	RES	SAT	SUP	USE
COM	4.13	0.88	0.70	0.84								
TEC	3.25	0.83	0.71	-0.24	0.84							
PER	3.44	0.97	0.91	0.56	-0.21	0.95						
EXP	3.97	0.93	0.82	0.63	-0.13	0.72	0.91					
EOU	4.25	0.82	0.60	0.62	-0.16	0.54	0.62	0.77				
RES	4.08	0.87	0.70	0.38	0.01	0.31	0.37	0.39	0.84			
SAT	3.57	0.93	0.81	0.56	-0.23	0.68	0.52	0.45	0.31	0.90		
SUP	3.71	0.90	0.69	0.49	-0.16	0.42	0.55	0.50	0.25	0.47	0.83	
USE	3.85	0.84	0.63	0.37	-0.08	0.39	0.34	0.37	0.26	0.43	0.32	0.79

**Table II.**  
Correlation matrix  
and average  
extracted principal  
constructs variance

**Notes:** COM = Compatibility; TEC = Technological Complexity; PER = Performance; EXP = Performance Expectancy; EOU = Easy of Use; RES = Resistance to Change; SAT = Satisfaction; SUP = Technical Support; USE = Use

the correlation coefficients in the corresponding column (Fornell & Larcker, 1981). To meet this criterion, it was necessary to exclude two more items. When analyzing Table II, it is possible to verify that the values meet the predefined criterion.

4.2 Structural model

Through the structural model, it is possible to evaluate the predictive and causal relationship among the constructs. Thus, the path coefficients ( $\beta$ ) and their statistical significance ( $t$ ) are estimated to test the hypotheses; the coefficients of determination ( $R^2$ ) of the endogenous variables are also calculated to evaluate the predictive capacity of the model. To verify the consistency of the model and the statistical significance of the established connections, the bootstrapping technique was adopted with 500 random simulations. The results obtained are  $t$  values for each connection and to be considered significant, this value should be higher than 1.96 ( $p < 0.05$ ), which represents a 95 per cent confidence interval. As shown in Figure 2, only two connections did not reach this value (Resistance to Change => Satisfaction, and Ease of Use => Satisfaction), which represents the non-confirmation of  $H1$  and  $H6$ . All the other hypotheses had empirical support.

The  $R^2$  values, in turn, evaluate the portion of the variance of the dependent constructs that is explained by the structural model. According to the results, it can be stated that

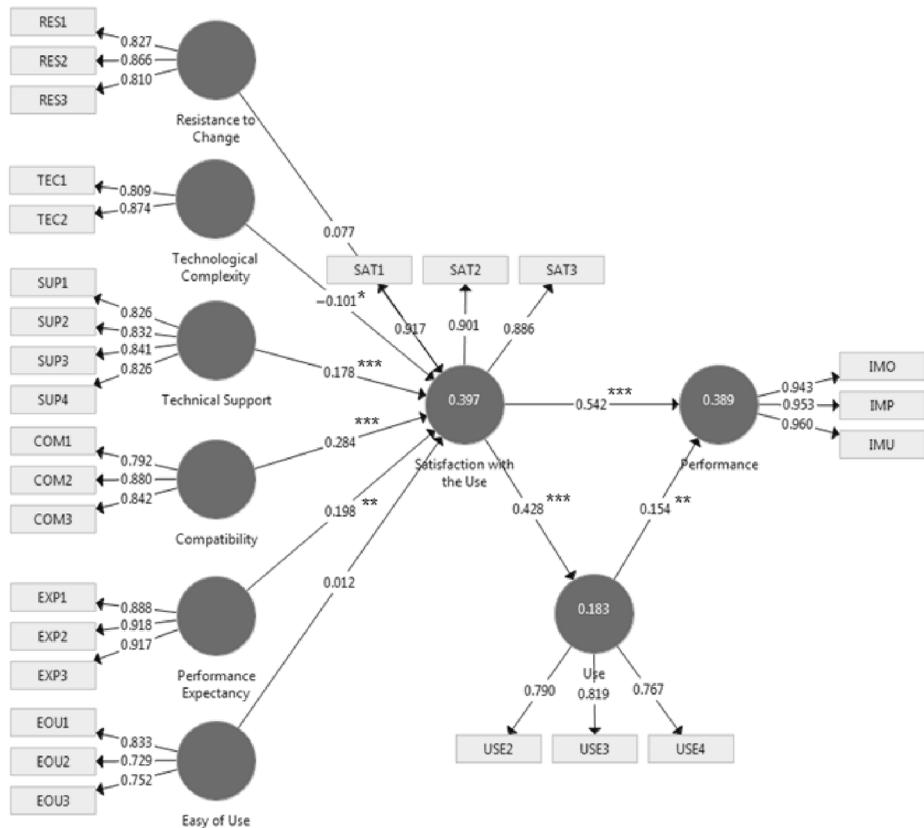


Figure 2.  
Research model  
results

Technological Complexity, Technical Support, Compatibility and Performance Expectancy explain jointly 39.7 per cent of the variance present in the Satisfaction with the Mobile PHC. On the other hand, Satisfaction of Use of the Mobile PHC explains, alone, 18.3 per cent of the variance of the Use of the application. Finally, Satisfaction of Use with Mobile PHC and Use of Mobile PHC accounts for 38.9 per cent of the existing variance of the Performance construct. Given these values, it can be considered that the model has an explanatory power varying from medium to large effect size.

Considering the established and tested connections between the constructs, the disconfirmation of *H1* means that even the health professional who does not want the Mobile PHC to change the way they make their decisions, how they interact with their workforce, or how they work, does not influence their satisfaction with the use of the technology. The probable non-confirmation of this construct as a barrier can be explained by the fact that the technology in question has already been used in the vast majority of the units investigated for at least two years and has become a mature technology. That is, the resistance occurred at the beginning of the deployment. What may also have contributed to this overcoming of resistance is the high compatibility (average = 4.13, Table II) of the technology with the work routine of MECS teams, not significantly altering the way the activities are performed with or without the presence of the mobile device.

Regarding the direct relationship between Technological Complexity and Satisfaction with the Use of Mobile PHC, we found a negative and significant correlation ( $\beta = -0.101$ ;  $p < 0.05$ ), confirming *H2*. Some authors have suggested that Technological Complexity arises as one of the main obstacles in the acceptance of mobile computing devices (Son et al., 2012). It is critical that developers design the features and interface of the application with the quality, availability and speed of data transmission via the internet, available at different times and locations. It is worth noting that usually this part of the infrastructure is not included in the scope of services offered by the technical support provided by the development or maintenance team. To make the operation of these computational programs satisfactory, it is desirable that it reconfigures itself according to the availability of the signal strength of the connection so as to minimize the impact of this delay on user satisfaction. However, hardly all settings remain equally attractive, making the application less efficient under certain operating circumstances. In this sense, the complexity of information and communication technologies can negatively affect user's ability to meet their needs and, in the worst case, even result in the abandonment of the technology (Aldunate & Nussbaum, 2013).

Technical Support has a positive and significant impact on the Satisfaction with the use of Mobile PHC ( $\beta = 0.178$ ;  $p < 0.001$ ), confirming *H3*. The confirmation of technical support as a facilitator can be evidenced by the good evaluation that it received from users of the application (mean = 3.71, Table II). This result is in line with the evidence provided by Sykes (2015), who confirmed the relevance and importance of support structures (such as training, online support and help desk) on the satisfaction of users of an ERP, which is of mandatory usage. Chatterjee et al. (2009) also showed that the reliability of mobile devices and available organizational support are important indicators of usage and user satisfaction with this type of technology. The same authors point out that in the context of health care, where speed and accuracy are critical aspects, the performance of the technology is essential.

Compatibility of the system with professional activities was also found to be the main predictor of Satisfaction with the Use of Mobile PHC ( $\beta = 0.284$ ;  $p < 0.001$ ), supporting *H4*. It is identified that the greater the user's perception that the technology is compatible with most aspects of their work and that it fits their working style, the greater will be the satisfaction of this professional with the use of technology in the performance of their tasks.

An analogous result was found by Maillet et al. (2015) while investigating Electronic Patient Registration System usage. This means that the higher the perception of health professionals regarding the compatibility of HIT with their daily work routines, the greater the likelihood of the acceptance of these technologies.

Similarly, we verified that Performance Expectancy also affects positively and significantly the Satisfaction with the Use of Mobile PHC ( $\beta = 0.198; p < 0.01$ ), confirming *H5*. It is noticed that the greater the perception that the use of the application increases productivity and improves the performance and the quality of the work of the health professional, the greater will be the satisfaction with its use, regarding attendance and exceeding expectations. Studies that corroborate this finding, also performed in contexts in which the IT use was mandatory, are ones presented by Adamson and Shine (2003) and Maillet et al. (2015).

The Ease of Use, on the other hand, did not show a significant relationship with Satisfaction with the Use of Mobile PHC ( $p > 0.05$ ), rejecting *H6*. In this sense, the user realises that ease in the usage of this technology or becoming skilled in its use does not significantly affect the satisfaction of this professional with the technology. One explanation for this result would be that today, access and use of smartphones have become so common among people that their use in the workplace closely resembles how they use that technology in their private lives.

Regarding Satisfaction with the Use of Mobile PHC and its relation with the intensity of use, a strong positive and significant relationship was identified ( $\beta = 0.428, p < 0.001$ ), thus supporting *H7*. In this sense, the greater the satisfaction of the health professional with the use of the Mobile PHC, the more intense will be its use. Another possible finding is that even if the use is done in a mandatory way by the requirement of superiors, user satisfaction enhances its use. Other studies have also tested this relationship, concluding that high levels of satisfaction have a significant increase in use (Chatterjee et al., 2009; DeLone & McLean, 2003).

Considering the direct influence of Satisfaction with the Use of Mobile PHC on the performance of the different stakeholder groups, we verified a high positive and significant impact ( $\beta = 0.542, p < 0.001$ ), proving to be the main connection of the model, which supports *H8*. In other words, the greater the health professional's perception of their satisfaction with the use of Mobile PHC, the greater the impact on performance. Observing the averages obtained for the three groups of beneficiaries – IMU, IMP and IMO – presented in the Appendix, it is possible to perceive that the greatest beneficiaries of the use of this technology are the professionals who use it, confirming that the Mobile PHC promotes efficiency and effectiveness in carrying out their tasks (Buntin et al., 2011), as well as contributing to the better communication of the teams with their respective regulatory centers (Prgomet, Georgiou, & Westbrook, 2009). The second largest beneficiary of the Mobile PHC, according to the respondents' perspective, is the patients' group. The gains seen are also regarding higher efficiency and effectiveness in providing care. In emergency medical services, it is essential that the technology allows health teams to process relevant information about patients quickly and accurately (Rippen et al., 2013), as is the case with the mobile application under evaluation, which directly impacts the effectiveness of the service performed.

The impact of lesser intensity, but still important concerning benefits offered, occurs in the institution itself. According to the respondents, the greatest gain obtained with the use of the Mobile PHC for MECS is the possibility that the technology will serve the Central Regulation as support for better decision-making (Junglas, Abraham, & Ives, 2009; Prgomet et al., 2009). In addition, the application also helps to enable the Regulation Center to respond to calls in a fast and agile way, making it possible to attend patients faster, in addition to taking a larger number of calls per day. Results similar to the ones presented herein were also found by Chatterjee et al. (2009) and Petter et al. (2008) who, in their review of empirical

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research, have confirmed the existence of sufficient support to claim that satisfaction has a considerable impact on obtaining network benefits.

Finally, we identified that Use also affects positively and significantly the Performance ( $\beta = 0.154$ ;  $p < 0.01$ ), but with a lower intensity than Satisfaction, confirming *H9*. This result allows us to conclude that, even in contexts where the use of technology is mandatory, both use and satisfaction have a significant impact on the achievement of benefits, although user satisfaction with technology has an impact almost four times greater than the effect provided by the intensity of use. Therefore, it is not enough for organizations simply to require their employees to use a certain technology without being concerned with the satisfaction of these users with their use as well.

### 5. Final considerations

The present study brings important contributions to IS area and, more specifically, to the context of HIT. Notably, the health-care services offered to the population have faced numerous difficulties, with IT emerging as an important ally to improve the sector and overcome these barriers. Based on the literature review and the qualitative exploration, a model was proposed containing antecedents and consequences of the adoption and use of mobile devices in the Mobile Emergency Care Service of the state of Rio Grande do Sul, Brazil. We identified that Satisfaction with the Use of Mobile PHC is determined by the Application Compatibility with MECS work, standing out as its main predictor, followed by the Performance Expectancy with the use of the technology and the Technical Support provided to users – acting as important facilitators of this process; while the Technological Complexity inherent in the use of Mobile PHC appears as the main barrier to the success of this technology. Another finding was that even though the use of the mobile application is mandatory, it was perceived that the use of technology is significantly affected by the user's satisfaction with it. In this sense, both Use and Satisfaction with the Use of the Mobile PHC provide a series of benefits, measured herein through the perceived impacts on the different stakeholder groups (users, patients and organization), highlighting Satisfaction with the Use of the application as the main predictor of benefits.

Regarding the theoretical contributions of this study, we propose a model capable of explaining the main determinants of user satisfaction with the adoption of a health information technology and at the same time mobile, as well as the impacts of its use. In addition, it is observed that the Satisfaction with the Use of technology fits better than the intensity of Use as the main dependent variable in the investigation of IT acceptance in contexts of mandatory use, corroborating with the guidelines of Brown et al. (2002). About the managerial practice, the findings obtained herein may help managers of public and private organizations in planning and implementing different technologies, whether mobile or applied to the health context, as well as in the expansion of their use in their respective institutions. It is noteworthy that the system (in terms of compatibility and performance expectancy), the support structure required for its operation (measured here by available technical support) and the technology per se (measured by technological complexity) are essential for the success and acceptance of innovative mobile technologies such as the one approached in our research.

Among the main limitations of the study, we point out the fact that the data are from a single Brazilian state, and therefore, the results cannot be generalized. Another limitation is that the study considered only the use of a specific mobile technology, which requires caution when using this information in contexts where HIT is different, and may not be

compatible in environments where IT adoption is volitional. As for suggestions for future studies, we propose replicating the model developed and validated herein in other institutions, or with other HITs – whether mandatory or voluntary. Finally, we also suggest complementing the results of the present study by investigating the perception of managers and directors of institutions linked to health services regarding the potential benefits obtained with the deployment and expansion of the use of HIT as this theme has attracted attention from governments and organizations, making the field of study promising for scientific research.

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#### Appendix. Measurement items

- (1) Easy of Use (EOU) – Davis (1989)
  - EOU4. *Learning to use Mobile PHC is easy for me* .
  - EOU2. Mobile PHC is easy to use.
  - EOU3. It is easy for me to become skillful at using Mobile PHC.
  - EOU1. I find it easy to get Mobile PHC to do what I want it to do.
- (2) Compatibility (COM) – Chau and Hu (2001)
  - COM3. Using Mobile PHC fits into my work style.
  - COM1. Using Mobile PHC is compatible with most aspects of my work.
  - COM2. Using Mobile PHC fits well with the way I like to work.
  - COM4. *Mobile PHC is compatible with the way I generally work* .
- (3) Performance Expectancy (EXP) – Venkatesh et al. (2003)
  - EXP4. *I find Mobile PHC useful in my job* .
  - EXP5. *Using Mobile PHC enables me to accomplish tasks more quickly* .
  - EXP3. Using Mobile PHC enhances the quality of my work.

- EXP2. Using Mobile PHC enhances my performance.
  - EXP1. Using Mobile PHC increases my productivity.
- (4) Resistance to Change (RES) – Lapointe and Rivard (2005)
- RES2. I don't want Mobile PHC to change the way I interact with other people on my job.
  - RES3. Overall, I don't want Mobile PHC to change the way I work.
  - RES4. *I don't want Mobile PHC to change the manner that I interact with patients\**.
  - RES1. I don't want Mobile PHC to change the way I make my job decisions.
- (5) Technical Support (SUP) – Igbaria, Zinatelli, Cragg, & Cavaye (1997)
- SUP4. The Mobile PHC technical support provides useful and understandable instructions.
  - SUP2. The Mobile PHC technical support provides satisfying responses.
  - SUP1. The Mobile PHC technical support is easy to be reach.
  - SUP3. The Mobile PHC technical support solves my problems quickly.
- (6) Technological Complexity (TEC) – Son et al. (2012)
- TEC4. *I realize that Mobile PHC is a fragile device and can be easily damaged\**.
  - TEC1. I have difficulty in accessing or using Mobile PHC due to the Internet signal quality.
  - TEC2. I have difficulty in accessing or using Mobile PHC due to the application crash or slowness.
  - TEC3. *I have difficulty in navigating the menus or commands of Mobile PHC\**.
- (7) Use (USE) – Junglas et al. (2009) and Davis (1989)
- USE1. *I became very dependent on Mobile PHC\**.
  - USE4. I use Mobile PHC in my job as often as needed.
  - USE3. Whenever possible, I use Mobile PHC in my job.
  - USE2. I consider myself an intensive Mobile PHC user.
- (8) Satisfaction with the Use (SAT) – Fang et al. (2014)
- SAT1. Extremely satisfied.
  - SAT2. Extremely pleased.
  - SAT3. All my expectations were exceeded.

*Performance (PER) – developed by the authors, 2016*

- (1) IMU: Impact on users
- IMU1. Using Mobile PHC provides greater efficiency and effectiveness in accomplishing the team tasks.
  - IMU2. Using Mobile PHC improves the team communication with the Regulation Center.
  - IMU4. Using Mobile PHC reduces the time accomplishment of the team tasks.
  - IMU3. Using Mobile PHC reduces the occurrence of errors in accomplishing the team tasks.
- (2) IMP: Impact on patients
- IMP1. Using Mobile PHC provides greater efficiency and effectiveness in patient care.
  - IMP2. Using Mobile PHC improves the communication about the patient.

- IMP4. Using Mobile PHC reduces patient care time.
- IMP3. Using Mobile PHC reduces the occurrence of errors in patient care.
- (3) IMO: Impact on the organization
  - IMO4: Using Mobile PHC provides the Regulation Center support for a better decision-making.
  - IMO1. Using Mobile PHC allows the Regulation Center to answer calls faster.
  - IMO3. Using Mobile PHC reduces the costs of services provided by the mobile emergency care service.
  - IMO2. Using Mobile PHC provides greater user satisfaction (population) with the mobile emergency care service.

\*The items in *italic* were deleted during pretest analysis.

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# Operational competencies and relational resources: a multiple case study

Operational  
competencies

305

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## Abstract

**Purpose** – The purpose of this study was to use relational vision as a theoretical support for an investigation of how operational competencies are developed from the interaction of shared relational resources in the supply chain and to verify how these competencies allow the resources to be able to function, unity, integration and direction.

**Design/methodology/approach** – This multihull study was based on semi-structured interviews with 13 representatives of four dyads from companies in the steel, automotive and industrial applications, pulp processing and manufacturing and application of flexible tubes.

**Findings** – The results indicate that information, knowledge and learning are significant constructs to influence the development of operational skills in the supply chain because they represent the ability of the company to promote skills to efficiently use resources and create a barrier to imitation.

**Research limitations/implications** – There are limitations in the use of four companies from different industrial segments because it is possible to generalize the results. However, given the cross-sectional nature of the research, new studies may adopt a longitudinal approach to verify the evolution in the area of operations. Future studies may also expand the unit of analysis to understand the role of the relationship between the focus business and its strategic suppliers from the viewpoint of the suppliers.



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Thus, new research can be expanded to dyads, triads and business networks by investigating the various stages in the supply chain.

**Practical implications** – This study contributes to the literature and adds the dimension of relational operational skills, which is hitherto little explored in previous studies.

**Social implications** – This study contributes to the literature in the area of operations management, in collaborative relationships between buyers and sellers, focusing on the relational view of competitiveness.

**Originality/value** – The growing importance of organizations and the role of collaboration, based on mutual benefits and grouping of skills, tend to increase the competitive benefits of companies operating in this context. The management of this type of arrangement becomes a challenge for researchers, reinforcing the originality of this study.

**Keywords** Supply chain, Operational competencies, Operations management, Collaborative relationship, Resource-based view, Relational view

**Paper type** Research paper

## Introduction

In the field of operations management from the 1960s to the 1980s, operational strategy studies were developed with a focus on the development of skills and new technologies and the more efficient use of resources (Amit & Schoemaker, 1993; Barney, 1991; Barney & Clark, 2007; Barney & Hesterly, 2011; Barney, Ketchen, & Wright, 2011; Collis & Montgomery, 1995; Grant, 1991; Wernerfelt, 1984).

With the advancement of business competitiveness, an understanding of how internal resources can function effectively for organizational strategy began to be reached in the 1980s, with investigations that have broadened the field of studies on internal resources advocated by the shift from the resource-based view to the relational view of strategy, focusing on dyads, triads, strategic alliances and networks (Dal Bó, Milão, & Toni, 2018; Dyer & Singh, 1998; Lavie, 2006; Nyaga, Whipple, & Lynch, 2010).

In highly competitive markets, the intensification of competition over recent decades has led to the emergence of various theories, e.g. the relational view of strategy and the recognition of the value of collaborative relationships, to leverage resources and knowledge among partners as an important response strategy to changing environments (Cao & Zhang, 2011; Dyer & Singh, 1998; Narasimhan, Swink, & Kim, 2005; Voss, 1995) and to increase relational profits (Combs & Ketchen, 1999; Das & Teng, 2000; Dyer & Singh, 1998; Ingham & Thompson, 1994; Mesquita, Anand, & Brush, 2008).

In this context, the relational view enables one to affirm that relational resources promote the development of operational competencies and productivity gains (Asanuma, 1989; Dyer, 1996; Dyer & Singh, 1998). However, recent studies such as that by Wu, Melnyk, and Flynn (2010) bring together resources and competencies from the company's internal perspective, leaving gaps in the literature on relational resource sharing and the development of operational competencies, with strategic implications for the proper allocation of resources that can result in superior performance (Wu, Melnyk, and Flynn, 2010; Wu, Melnyk, & Swink, 2012).

Considering these shortcomings in literature, this paper intends to answer the following research question:

*RQ1.* Do relational resources promote the development of operational competencies?

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Thus, this study aims to identify and analyze how operational competencies are developed from the interaction with the relational resources shared in the supply chain, as operational competencies are the ones that give unity, integration and direction to the resources, determining how they can be used more efficiently to physically transform inputs into outputs (Wu et al., 2010).

## Theoretical foundation

### *Resource-based view*

Competitive advantage is an important concept in the field of business strategy (Gohr, Santos, Burin, Marques, & Arai, 2011; Penrose, 1959). There is a consensus in the resource-based view theory that this advantage is obtained by companies from the possibility to accumulate tangible and intangible resources – brands, technological knowledge, machinery, plant, and personnel skills, etc. – and create additional economic value over their competitors (Amit & Schoemaker, 1993; Barney, 1991; Carvalho, Prévot, & Machado, 2014; Collis & Montgomery, 1995; Grant, 1991; Wernerfelt, 1984).

### *Relational view*

The relational view (Dyer & Singh, 1998), and the vision based on extended resources (Lavie, 2006; Mathews, 2003), complements the traditional resource-based view. The relational view argues that a company's internal resources can be combined beyond its borders, extending the unit of analysis to a network that creates additional relational revenues developed from the partners' unique qualities (Cao & Zhang, 2011; Dyer & Singh, 1998).

The relationship is, for the partners, a resource of competitive value, because it develops informational principles and a reputation for new collective actions (Balestrin & Zen, 2010; Cardeal & Antonio, 2012; Dyer & Singh, 1998; Gulati, 1999; Gupta, Tan, Lee, & Chen Phang, 2018; Balestrin, Verschoore & Perucia, 2014; Zacharia, Nix, & Lusch, 2011). Thus, the relational view is guided by the adoption of collaborative relationships and practices among members of the same network, resulting in the creation of value and superior performance for each party and the relationship as a whole. There are four sources of income in this sort of relationship: investments in specific relationship assets, knowledge sharing routines, resource complementarity, and governance (Combs & Ketchen, 1999; Dyer & Singh, 1998; Lavie, 2006; Mesquita, Anand, & Brush, 2008).

### *Operational competencies*

It is necessary to emphasize that resources alone only define the potential that an activity may have to lead to better performance as resources depend on operational competencies being used efficiently. Operational competencies represent the ability of the company to promote skill sets (Hayes & Wheelwright, 1984; Laugen, Boer, & Frick, 2005; Voss, 1995) and achieve a sustainable competitive advantage (Wu et al., 2010).

Operations management studies that have made important contributions in the theoretical field of competitiveness have focused on the concepts and practical applications of operational competency (Hayes, Pisano, Upton, & Wheelwright, 2008; Santos, Gohr, & Varvakis, 2011; Swink, Narasimhan, & Kim, 2005; Voss, 1995; Wu et al., 2010), as well as considering how operational competency acts as a strategic function for the improvement of processes (Tan, Kannan, & Narasimhan, 2007; Wu et al., 2010), creating primary income (Barney, 1991; Penrose, 1959; Peteraf, 1993; Wu et al., 2010).

Operational competencies are defined in the operations management literature as the ability to exploit resources efficiently (Bromiley & Rau, 2014; Flynn, Huo, & Zhao, 2010; Hayes et al., 2008; March, 1991; Nonaka, 1994; Wu et al., 2010), to carry out the basic functional activities of the company (Collis, 1994) and to troubleshoot and perform daily activities (Pavlou & Sawy, 2011; Winter, 2003). Operational competencies act through learning, process refinement, skills and incentives to repeat, leverage and sustain previous successful experiences (Martin, 2011; Wu et al., 2010) as a result of the use of resources and practices that enable the efficient performance of activities (Paiva, 2017).

Wu et al. (2010), based on the study by Swink and Hegarty (1998), developed a taxonomy of six operational competencies in the context of product differentiation. Their objective was to provide a theoretical framework to guide the operationalization of operational competencies:

- (1) *Operational improvements*: These include the incremental enhancement and reinforcement of current operational processes that can contribute to the organization's innovation (Peng, Schroeder, & Shah, 2008; Swink & Hegarty, 1998).
- (2) *Operational innovations*: These include radical improvements in existing operational processes or the creation of new unique processes (Peng et al., 2008; Swink & Hegarty, 1998).
- (3) *Operational customizations*: These include knowledge creation and the customization of operational processes (Schroeder, Bates, & Junttila, 2002; Wheelwright & Hayes, 1984).
- (4) *Operational cooperation*: This includes the skills to develop stable relationships with internal functional areas and supply chain partners (Droge, Jayaram, & Vickery, 2004; Escrig-Tena & Bou-Llusar, 2005; Swink & Hegarty, 1998).
- (5) *Operational response capability*: This is the rapid reaction and easy adaptation to internal and external changes (Swink & Hegarty, 1998; Upton, 1994).
- (6) *Operational reconfiguration*: This includes the skills to perform the transformations necessary to restore the operations strategy as a result of environmental contingencies (Pandža, Polajnar, Buchmeister, & Thorpe, 2003; Swink & Hegarty, 1998; Teece, Pisano, & Shuen, 1997).

#### *Collaborative supply chain relationships*

Changes in the dynamics of markets and organizations in recent years have motivated studies that advocate the need for inter-organizational collaborative relationships (Bronzo, 2004) that become increasingly deeper and are based on trust, deep social interactions, communication, information and knowledge for the appropriation of relational incomes (Combs & Ketchen, 1999; Dyer & Singh, 1998; Lavie, 2006; Wu et al., 2010; Zatta, Mauri, Freitas, Goncalves, & Mattos, 2018). These relationships are encouraged because the synergies that are developed generate benefits superior to those generated by a company on its own (Cao & Zhang, 2011; Dyer & Singh, 1998; Wu et al., 2010). In addition, ever-deepening relationships stem from the competitive environment (Wu et al., 2012), which increasingly requires companies to engage in value activities in each other's business processes (Cao & Zhang, 2011; Chen & Paulraj, 2004; Cooper, Lambert, & Pagh, 1997).

In the supply chain, the relevance of the relationship stems from the increasingly global processes with which companies are looking for more effective ways of coordinating the flow of materials (Zacharia et al., 2011) while improving their operational performance and competitive advantage. In this situation, there might be positive gains for the parties, enabling the competition with other chains (Cao & Zhang, 2011; Lummus & Vokurka, 1999; Rungtusanatham, Salvador, Forza, & Choi, 2003; Tan, 2002).

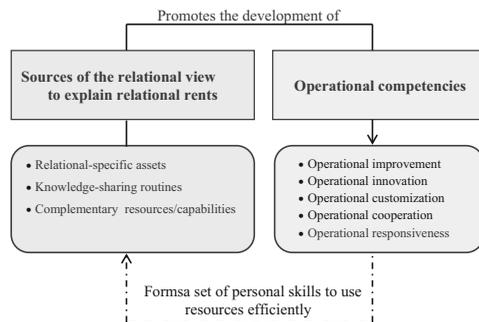
Collaboration involves the sharing of information, communications, risks, synchronized decisions, congruent objectives, the alignment of incentives, the creation of new knowledge, the reduction of costs and response times, effectiveness and the co-development of resources, skills and innovation (Bowersox & Closs, 2001; Burgess, Singh, & Koroglu, 2006; Cao & Zhang, 2011; Chen & Paulraj, 2004; David & Stewart, 2008; Dyer & Singh, 1998; Gulati, 1999; Hardy, Phillips, & Lawrence, 2003; Jap, 2001; Krause et al., 1998; Rao, Phillips & Johnson, 2006; Singh & Koroglu, 2006; Vangen & Huxham, 2003).

**Research framework**

To analyze the development of operational competencies, the proposed research model was anchored in the main constructs of the relational resource theory (Dyer & Singh, 1998) regarding the companies in the supply chain and in the constructs of operational competencies (Vasconcelos & Cyrino, 2000; Wu et al., 2010). The relational vision model was adopted to provide the basis for an analysis of how shared relational resources in dyads promote the development of operational competencies.

Considering the relationship between buyers and sellers, the dynamics of competitiveness refers to strategic actions undertaken to increase a competitive advantage, which is possible due to the shared resources, emphasizing that the resources alone define the potential to perform certain activities, and that the resource-based competitive advantage could be restricted to a small number of companies (Frega, Lemos, & Souza, 2007) (Figure 1).

Level of analysis	Unit of analysis	Purpose of the analysis
Interorganizational	Networks and dyads of firms as the unit of analysis to explain relational rents (in the supply chain)	To identify and analyze how the development of operational competencies occurs, focusing on the relational view and the interaction of shared resources in supply chains



**Figure 1.**  
Research framework

### **Research methodology**

With the objective of identifying and analyzing the relationship between relational resources and the development of operational competencies for the different members of supply chains, the present study adopted the methodology of a study of multiple interpretative cases (Miguel, 2010; Yin, 2010) and is characterized as descriptive and exploratory (Cervo & Bervian, 2002; Collis & Hussey, 2005; Gil, 2010). In Brazil, a case study is a research method commonly used in production engineering and operations management (Miguel, 2010; Nakano, 2010), with relevant results in the administration of production and operations (Meredith, 1998).

#### *Definition of the sample*

The qualitative empirical multiple case study consisted of in-depth interviews conducted with managers responsible for the relationships in the dyad of strategic buyers and suppliers, from the perspective of the buyers, but the theoretical constructs investigated herein evidenced the initiatives enabled by the link and the nature of the relationship (Chen & Paulraj, 2004).

Distinct sectors and companies were chosen with the aim of identifying particular issues in each case related to the phenomenon being investigated and making comparisons between cases (Eisenhardt, 1989; Meredith, 1998). The sectors and companies were defined according to their particular features, their strategic position in the Brazilian and international scenario, their competitiveness on a worldwide basis, employability and the income and taxes they generate. A total of four sectors were surveyed:

- (1) a company in the steel sector, present in 60 countries (Alpha);
- (2) a company in the automotive and industrial sector that is a global leader (Beta);
- (3) a cellulose processing company (Gamma); and
- (4) a global leader in the underwater technology sector (onshore, offshore and surface) (Delta).

#### *Data collection*

Data were collected using semi-structured interviews (Collis & Hussey, 2005; Grötsch et al., 2013; Lockstrom et al., 2011; Miguel, 2010), validated and pre-tested by academics and specialists in the areas of operations management and supply chains.

The first block, with six questions, characterized the profile of the company's strategic suppliers. The second block, again with six questions, concerned the collaborative relationship between the company and its strategic suppliers. The third block, with 17 questions, related to relational resources and operational competencies.

Responses were collected from 13 specialists: supply superintendents, supply chain managers and specialists in logistics, procurement, planning and control, process engineering, human resources, operation and quality (Collis & Hussey, 2005). The interviews lasted, on average, about 1 h 40 min, and the total duration of the interviews was 8 h 20 min. Two rounds of interviews were held for Alpha and three for Beta.

#### *Data analysis*

The data were analyzed, first, through individual analysis and, later, through cross-comparative and case analysis. The content analysis method was adopted (Bardin,

2007) for the treatment of the data collected in the research (Collis & Hussey, 2005). The analysis included the general analytical procedure with techniques of interpretation and codification to transform text into numerical variables. Operationally, the content analysis was performed in the pre-analysis, material exploration or coding stage and as part of the processing and interpretation of the results obtained (Minayo, 2007). The methodological quality of the research was established by looking at the criteria of reliability and the validity of the observations and points of attention (Miguel, 2010; Yin, 2010).

## Results and discussion

The qualitative evaluation of the value activities of the companies present in the sample, in which the strategic suppliers were involved, comprised an investigation of the characteristics of the suppliers and their collaborative relationship with the companies in the sample (Table I).

The activities with the greatest convergence value in the cases investigated were the development of new products and quality management. For Alpha and Gamma, other activities with high convergence value were the joint execution of production and inventory management, and for Beta and Gamma, such activities included the management of deadlines for the delivery of raw materials. It was evident that a collaborative relationship has significant explanatory capacity in relation to the sharing of information and knowledge.

One aspect of the characteristics of the relationships (Table II) was that, although the predominance of long-term relationships with a few suppliers can be seen, purchases of raw materials were made under formal contracts because the criticality and dependency of these resources were crucial for the business. For example, Alpha used mineral commodities to ensure lower price volatility, as in the international market purchases are anticipated up to two years before the delivery date. Delta formalized long-term contracts for multi-year periods (three years) through an advanced pricing policy. Gamma had formal contracts for the acquisition of standing eucalyptus forests in the national market.

It was also shown that collaborative activities were diversified, and that the supply structure was guided by mixed governance mechanisms. Relational mechanisms were present more often as they presume agreements based on processes and social norms, rather than a transactional mechanism structure for market governance that presumes formal contracts with clauses and obligations to be fulfilled (Poppo & Zenger, 2002).

Alpha	Beta	Gamma	Delta
<i>Value-based business activities in which strategic suppliers are involved</i>			
Steel industry	Automotive applications	Pulp processing	Flexible tubes
Product development and process improvement	Development of new products		
Planning and production		Joint production	
Storage processes	Order tracking	Inventory management	
Packaging processes	Management of lead-time of work-in-process in manufacturing	Management of lead-time of work-in-process in manufacturing	
Distribution logistics			
Quality systems			

**Table I.**  
Value-for-money  
business activities

**Table II.**  
Characteristics of  
collaborative inter-  
organizational  
relationships

	Alpha	Beta	Gamma	Delta
Companies/features	Steel industry	Automotive applications	Pulp processing	Flexible tubes
Supplier selection method	Proximity, financial strength, quality, term, cost, technology			
Transactional mechanism (Formal contract)	Purchase of raw materials			
Collaborative assumptions to share high levels of interaction and involvement	Predominantly long-term relationships			
	Reliable relationships			
	Collaboration			
	Collaborative communication			
	Joint learning			
	Interpersonal relationships and managers involved			
	Suppliers involved in value activities of the business			
	Transfer of personnel (unilateral)	Transfer of specialized personnel (bilateral)		
	Integration into the supply chain			
Relational resources	Investment in specific assets	–	Investment in specific assets	–
	Information exchange			
	Shared knowledge			
	Complementary resources			

The most commonly used shared relational resources were investments in specific assets made by strategic suppliers in Alpha and Gamma, the exchange of information and knowledge and complementary resources. In Alpha, the investments were made unilaterally by the suppliers. The results indicate that other relational mechanisms were more commonly present in the Alpha and Gamma companies, evidencing that in the steel and pulp sectors, the players are more likely to share resources. This can be linked to other aspects, such as the size of the companies, financial strength and the ability to interact with the international market. The main characteristics of the relationships identified:

- the method of selecting strategic suppliers;
- orientation regarding the term of the relationship;
- trust;
- interpersonal relationships;
- manager involvement;
- collaborative communication;
- sharing of tangible and intangible resources; and
- operational proximity.

The interviews revealed that the involvement and engagement of senior managers was the key success factor of the relationship, especially in informal negotiations.

We identified that operational proximity and a long duration of the relationship generate greater trust among partners, create knowledge and operational skills to support internal processes and external relations and develop relational operational competencies (Amit & Schoemaker, 1993; Dierickx & Cool, 1989; Wu et al., 2010).

*Relationships between the companies in the sample and their strategic suppliers*

In the supply chain, the relationship arises from the characteristics of the collaboration and the level of involvement of the partners: the relationship may be deep (having relational characteristics) or superficial (having transactional characteristics). The data presented herein showed relationships with mixed characteristics but indicated that the relational ones had stronger intensity. Transactional relationships were in place to avoid possible interruptions in the supply of raw material.

It was evident that the relationships between the companies of the sample and their strategic suppliers had deep levels of partnership in which the partners worked together to carry out common activities (Grant & Baden-Fuller, 1995).

*Characterization of the shared relational resources and operational competencies developed*

This section considers the value activities of the companies of the sample in which strategic suppliers were involved (Table I), the characteristics of the collaborative relationships (Table II) and the patterns of the relationship between the companies and their strategic suppliers, as discussed in the previous subsection. Two important categories are highlighted.

The relational resources between the sample companies and their strategic suppliers can be categorized into the following classes: investments in specific assets; substantial exchange of knowledge and learning; and complementary resources, skills and abilities; this was done for the joint creation of new or exclusive products, services or technologies.

Operational competencies comprise the following: operational improvement, operational innovation, operational customization, operational cooperation, rapid response to the market and operational reconfiguration. However, the last area was not investigated in this study.

The results point to shared relational resources in the supply chain that develop operational competencies:

- Investment in specific assets, made unilaterally by strategic suppliers, in infrastructure, industrial plants, facilities and equipment (Alpha) and joint investment with suppliers in infrastructure, industrial plants, equipment, technology, brands and patents and financial and human resources (Gamma);
- Exchange of information on purchases, consumption of raw materials, deadlines and value activities (Alpha); on supply chain performance, product improvement, cost and quality standards (Beta); on supply chain performance, production, planning, timing and value activities (Gamma); and on the performance of the supply chain, production, and value activities (Delta);
- Knowledge sharing about ways to use materials, operate equipment, improve processes and customize and develop new products (Alpha, Beta, Gamma and Delta); and
- Complementary resources for the development of transport and logistics systems, raw material delivery, technical assistance, research and development and inter-

organizational alignment to harmonize systems and processes (Alpha, Beta, Gamma and Delta).

The related operational competencies developed were as follows:

- *Operational improvement*: This involves continuous improvement, elimination of waste, recycling of waste, reduction of inventories and set-up, new working methods and technical knowledge (Alpha); control of process variability, technological improvements, standardization of processes, cost reduction, quality, flexibility and technical knowledge (Beta); reduction in inventories and setup, new working methods and technical knowledge (Gamma); and technical knowledge, new technologies, efficient utilization of raw materials and receipt term management (Delta). All the companies adopted continuous improvement processes, as well as Six Sigma, Just in Time and TQM tools.
- *Operational innovation*: This involves development of new processes and products for specific customers (Alpha); development and testing of new products, systems and processes and laboratory simulation methods (Beta); new technologies and product and process development (Gamma); and development of experiments, tests, error tolerance analysis and product qualification (Delta).
- *Operational customization*: This involves development of new equipment, adaptation of planning systems, modification of processes for specific customers (Alpha); development of products to meet the requirements of specific sectors and knowledge and learning (Beta); new manufacturing processes for production flexibility (Gamma); and product development according to customer specifications, product application testing and computer simulation (Delta).
- *Operational cooperation*: This involves having information to carry out operational activities, joint decision-making to solve supply chain problems, sharing information to deal with uncertainties and resolving inter-organizational and inter-organizational conflicts (Alpha, Beta, Gamma and Delta).
- *Rapid response to the market*: This involves having information to meet production orders, manage demand fluctuations, adjust production capacity, inputs, labor and equipment and change process flow paths (Alpha, Beta, Gamma); and sharing information to meet production orders, manage resources and stream production to volume flexibility (Delta).

It is possible to emphasize that the information and knowledge constructs already discussed herein generate learning from the joint performance of routines and operational practices as key factors in the development of experience and specific skills in the relationship. Information facilitates collaborative activities, creates organizational and operational knowledge and promotes the development of new skills. Knowledge develops innovation capacity, reduces the learning curve, and promotes higher innovation rates for companies that share learning information regularly.

To enter into a relationship, strategic suppliers must have expertise in product and process technology, customized solutions, automation, flexibility, quality, cost and large-scale technological innovation capability to meet specific customer needs. They must avoid process variability and prevent defects, in addition to having trained

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personnel and transferring personnel to enable improvements and changes in practices and processes to develop new products and align cultural differences, avoiding problems in the relationship.

### **Conclusions, limitations and implications for future studies**

The purpose of this study was to identify and analyze how operational competencies are developed from the interaction of shared relational resources. The study was carried out in four supply chain dyads. According to the interviews, the companies developed relational synergies with their strategic suppliers, adopting operational competencies for the efficient use of resources. Notably, the companies used resources and skills to contribute to the relationship strategy to obtain greater relational income for the individual companies and the chain as a whole. Collaborative relationships are relevant because they enable the members to use integrative strategies to influence the development of competencies to create competitive advantage. It can be inferred that the relational approach promotes advances in which companies co-evolve from an initial and reactive stage to a stage of constant and shared learning, creating relational skills, changing their existing standards from an internal to a relational perspective, without harming the relationships among them, and seeking the maximization of the relational results in the long term.

Evidence of the development of operational competencies is reinforced by the relevance of information and knowledge constructs for orientation and adaptation in an environment of change and high competition through the use of collective skills to solve problems in the relationships between members. The exchange of information and knowledge is especially notable for its presence in the various relational mechanisms that radiate through the interrelated organizations.

It is worth noting that the study contributes to the theory of operations management concerning inter-organizational relationships, as it advances the field of relational view, highlighting the adoption of relational and integrative strategies, as well as broadening the competency literature debate.

There are limitations in the use of four companies from different industrial segments because it is not possible to generalize the results. However, given the cross-sectional nature of the research, new studies may adopt a longitudinal approach to verify the evolution in the area of operations. Future studies may also expand the unit of analysis to understand the role of the relationship between the business and strategic suppliers from a supplier's perspective. Thus, new research can be expanded to dyads, triads and business networks by investigating the various stages identified in the supply chain.

Nevertheless, in addition to the opportunity for future research, the conclusions of this study show that each theoretical approach is still only partially explored, thus opening up research gaps where answers are lacking and bringing new light to studies and practical applications. It should be emphasized that research on themes involving relational resources and operational skills, like the theme approached herein, is still at an early stage.

In addition to broadening the theoretical discussion as described above, the study offers a central contribution to dyads by investigating the process of operational performance through the use of relational resources.

Although these results are based on four organizational realities, they are not generalizable, and an exploration of the use of relational resources to compare the development of operational competencies is suggested. The taxonomy could, for example, be explored in different contexts, such as other segments or sectors.

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# Estimating credit and profit scoring of a Brazilian credit union with logistic regression and machine-learning techniques

Credit and profit scoring

321

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## Abstract

**Purpose** – Although credit unions are nonprofit organizations, their objectives depend on the efficient management of their resources and credit risk aligned with the principles of the cooperative doctrine. This paper aims to propose the combined use of credit scoring and profit scoring to increase the effectiveness of the loan-granting process in credit unions.

**Design/methodology/approach** – This sample is composed by the data of personal loans transactions of a Brazilian credit union.

**Findings** – The analysis reveals that the use of statistical methods improves significantly the predictability of default when compared to the use of subjective techniques and the superiority of the random forests model in estimating credit scoring and profit scoring when compared to logit and ordinary least squares method (OLS) regression. The study also illustrates how both analyses can be used jointly for more effective decision-making.

**Originality/value** – Replacing subjective analysis with objective credit analysis using deterministic models will benefit Brazilian credit unions. The credit decision will be based on the input variables and on clear criteria, turning the decision-making process impartial. The joint use of credit scoring and profit scoring allows granting credit for the clients with the highest potential to pay debt obligation and, at the same time, to certify that the transaction profitability meets the goals of the organization: to be sustainable and to provide loans and investment opportunities at attractive rates to members.

**Keyword** Credit unions

**Paper type** Research paper

## 1. Introduction

Credit unions use the financial resources raised via members to finance the loans of the same members. Mutual help with accessible conditions increases the financial returns of the community associated with the union over time (Polônio, 1999).

At the end of each fiscal year, the union returns the surplus to their members, either by cash distributions proportional to members' contributions and uses or by reinvesting it in the union, as stated in the bylaws (Geriz, 2010).

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Although profit is not the main objective of these organizations, they have to remain competitive to survive. Cooperatives need to implement liquidity and solvency controls, to search for economies of scale and to manage their financial assets efficiently (Silva Filho, 2002). Silva Filho (2002) advocates that credit unions should use management tools to measure performance and achieve goals to increase the effectiveness of the decision-making process.

The organizational structure of credit unions may create agency problems in the process of approving loans (Lima, Araújo, & Amaral, 2008). When a member applies for a loan in his or her institution, the granting decision depends on the judgment of the credit analyst who is designated by the credit union administration to assess the creditworthiness of its members. The fact that the members of a credit union are also its owners makes the judgment of the credit analyst vulnerable to the influence of applicants. Some members may seek benefits divergent of the best interest of the cooperative, as, for instance, insolvent debtors wanting to renegotiate bad loans.

The lack of objectivity in credit policies and the absence of reasonable internal controls are obstacles that hinder the sustainable growth of a credit union (Giarola, Santos, & Ferreira, 2009). Comparatively, major Brazilian financial institutions have been investing substantial amount of capital in technology for credit systems in retail operations. They use sophisticated statistical methods to open accounts, approve credit, determine limits, extend loans and perform collection actions to make the internal processes more efficient and allow for a credit portfolio, which is well balanced with the expected levels of risk and return.

In this context, credit risk modeling and loan profitability forecasting are useful resources to improve the performance of credit unions.

Credit scoring models are widely used in the financial industry to measure credit risk. The model estimates default probability (DP) based on customers' past behavioral and demographic characteristics (Lewis, 1992).

Profit scoring models are used to predict the profitability of a client or a transaction. This approach is based on the concept that nondefaulting borrowers may not generate sufficient revenue to offset the costs of maintaining their accounts, whereas defaulting borrowers may be profitable if they actively engage in credit transactions and honor most of their commitments (Sanchez-Barrios, Andreeva, & Ansell, 2016). The methodology addresses decisions regarding the selection of the desired risk combined with a return level and the formulation of strategies to acquire and retain profitable clients (Sanchez-Barrios et al., 2016).

Lima et al. (2008) argue that the agency conflict in credit unions can be mitigated by the adoption of efficient internal controls and clear governance rules.

We propose the use of a credit-scoring model combined with a profit scoring model for loan-granting decisions, determining an acceptable credit risk without excessive loss of profitability. The combined use of these approaches may improve the credit concession process, by not only lending to clients with the potential to pay off debt but also considering the expected profitability of the operation. It may reduce the agency problems and may improve the efficiency of credit unions, increasing the long-term viability of the organization. We expect that a process based strictly on objective and quantitative analyses provides loans suited for its members without favoring minor groups at the expense of the whole.

We contribute to the literature by comparing logistic and machine-learning approaches to subjective methods, and by combining credit scoring to profit scoring in a credit union context. As credit unions are private, it is difficult to have access to their data, and we are not aware of a similar analysis in Brazil. We had access to data of loans transactions granted

in 2015 and 2016 for only one credit union, but as the agency problems and granting processes are similar, our main findings will probably be applied to most corporations. Our results indicate that logistic models increase the GINI coefficient by 5.8 times when compared to subjective analyses and the area under the ROC curve (AUROC) by around 62 per cent. The random forest increases the GINI index further by 4 per cent and the AUROC by 2 per cent. We conclude that statistic models improve the efficiency of credit granting significantly.

## 2. Theoretical basis

Modern cooperatives emerged in 1844 in Rochdale, England, during the Industrial Revolution (Pinheiro, 2008). A group of weavers founded a cooperative based on ethical and behavioral principles, which have become the basis of contemporary cooperativism. Friedrich Wilhelm Raiffeisen founded the pioneering institution that served as a model for credit union activities in Germany in 1847. The German rural cooperatives had the following characteristics: unlimited and joint liability of members, that is, the member is accountable for debts contracted by the organization by pledging his or her private assets as collateral; members' votes have equal weights, regardless of their equity stake; and nondistribution of profits, surpluses or dividends. In 1856, Herman Schulze created the first urban credit union of Germany. The cooperatives founded by Herman Schulze differ from those of Raiffeisen's because they return dividends to members proportionally to their equity stake. The cooperatives that follow these rules are now known as cooperatives with a Schulze-Delitzsch model.

The first credit union in Brazil was Sociedade Cooperativa Caixa de Economia e Empréstimos de Nova Petrópolis, founded in Rio Grande do Sul in 1902 (Soares & Melo Sobrinho, 2008). It was a Raiffeisen-type cooperative, and it remains operational until today. After this pioneering initiative, other credit unions were created to serve rural communities.

Credit unions are financial institutions regulated by the Central Bank of Brazil through Resolution No. 4434 of 2015 ruled by the National Monetary Council. The liability of the partners may be limited or unlimited, as determined by the bylaws (Geriz, 2010).

In Brazil, credit unions have grown significantly in recent years along with their representativeness in the banking sector. Table I illustrates the growth of cooperatives in terms of assets and equity compared with consolidated banking data.

The compound annual growth rate (CAGR) of credit-unions aggregate equity (net worth, assets, deposits and credit portfolio) between 2011 and 2016 was in the range of 18 to 22 per cent. This exceeded the growth rate of other financial institutions. The representativeness of credit unions jumped from 4.1 per cent in 2011 to 6.6 per cent in 2016 of the consolidated banking sector net worth.

Despite not being the dominant model in the banking sector, not-for-profit financial institutions, like credit unions, play an important role in many countries (Canning, Jefferson, & Spencer, 2003). However, literature on credit unions is little when compared to other financial institutions (Cuevas & Fischer, 2006).

Credit unions offer lower interest rates to their members and return part of the cash surplus (the difference between revenues and operating expenses) to them if approved by the general assembly (Giarola et al., 2009). Those are advantages in comparison to other credit institutions. However, credit unions have to retain an adequate level of cash surplus to make the necessary investments in operating assets and risk management to offer lower interest rates and retain clients with higher credit risk in a highly competitive sector dominated by large institutions.

Segment	Aggregate equity	2011	2012	2013	2014	2015	2016	CAGR (%)
Credit unions	Net worth	16	19	23	27	32	37	18
	(% growth)		21	18	20	17	15	
	Assets	86	104	124	151	183	222	21
	(% growth)		20	20	21	21	22	
	Deposits	38	47	56	69	83	104	22
	(% growth)		23	20	22	21	25	
Banking sector (excluding credit unions)	Credit portfolio	36	46	58	68	76	84	18
	(% growth)		26	27	18	12	10	
	Net worth	371	439	433	459	481	519	7
	(% growth)		18	-1	6	5	8	
	Assets	4,274	4,981	5,456	6,199	6,863	6,935	10
	(% growth)		17	10	14	11	1	
Representativeness of credit unions	Deposits	1,595	1,647	1,751	1,830	1,928	1,957	4
	(% growth)		3	6	5	5	2	
	Credit portfolio	1,667	1,947	2,273	2,538	2,990	2,633	10
	(% growth)		17	17	12	18	-12	
	Net worth (%)	4.1	4.2	5.0	5.6	6.2	6.6	
	Assets (%)	2.0	2.0	2.2	2.4	2.6	3.1	
	Deposits (%)	2.3	2.8	3.1	3.6	4.1	5.0	
	Credit portfolio (%)	2.1	2.3	2.5	2.6	2.5	3.1	

**Table I.**

Growth of credit unions in Brazil (R\$bn)

Source: Banco Central do Brasil

Giarola et al. (2009) explain that credit union financial resources are mostly generated by deposits and the acquisition of equity by members, which are then transferred as loans to other members. Therefore, poor management affects all members negatively.

Lima et al. (2008) argue that the most important advantage of credit unions is the access to financial services to their members, even during credit rationing in the conventional financial market. The reduced tax burden is an important competitive advantage that allows cooperatives to have lower costs than other financial institutions in the retail sector.

The agency problem is a risk factor for the long-term sustainability of credit unions (Cuevas & Fischer, 2006). The agency theory postulates that the main interest of shareholders is profit maximization (Cornforth, 2004). Characteristics of the corporate control market, such as pressure from major shareholders, takeover threats and board monitoring align managers' interest with this goal. In cooperatives, the situation is different: they are established to serve the interests of their members; therefore, profit is a way to achieve a purpose and not a purpose itself.

Agency conflict has particular characteristics in credit unions: First, cooperative owners are also clients. Conflicts of interests between lenders and borrowers occur due to heterogeneity in customer preference for profitable applications or loans with attractive rates. Second, decisions made at a general assembly, including election of the administrative staff, are based on the vote of each member, with no distinction by individual equity stake. Finally, the members elected to the board are usually less technically qualified than experts working in the financial industry (Lima et al., 2008).

The more homogeneous the long-term concerns of the members, the lower the agency costs (Souza, 2017), and the vote will express the desire of the majority. Conversely, in highly heterogeneous credit unions, decisions will greatly differ among members. Therefore, shareholder organizations, whose profit maximization objective is better defined and achievable, tend to present more advantages (Hart & Moore, 1998).

The identification of variables related to the credit quality of members allows statistical and objective control of lending processes, increasing scalability and impartiality in decision-making, thereby reducing agency costs for the cooperative.

Credit unions operate on behalf of all members, and they are not motivated by profit (Taylor, 1971; Spencer, 1996). Members will most likely play both roles: lenders and borrowers. As long as the difference between the borrowers' and lenders' rates is reduced, credit unions have incentives to expand. The difference between borrowers and lenders' rates covers the long-run average costs of the unions. The combination of profit and credit scoring models may turn the credit granting process more efficient, thus reducing the average long-term cost of the union. This can result in a lower difference between borrowers and lenders' rate and, consequently, in a higher incentive for the credit union to expand.

### 3. Methodology

#### 3.1 *Credit and profit scoring models*

Fisher (1936) introduced the discriminant analysis, and Durand (1941) pioneered in proposing a credit-scoring model. Since the second half of the twentieth century, credit-scoring models have become a benchmark for the financial industry.

Profit-scoring modeling has emerged as part of a credit granting decision-making tool. Borrowers are grouped according to profitability ratios instead of default probabilities and credit losses (Sanchez-Barrios et al., 2016).

The increase in computational processing capacity enabled financial institutions to use more efficient models based on machine-learning techniques (Yap, Ong, & Husain, 2011). These techniques may have higher accuracy and robustness in analyzing nonlinear relationships than traditional techniques.

Decision trees (Srinivisan & Kim, 1987), artificial neural networks (Malhotra & Malhotra, 2003), k-nearest neighbors (West, 2000) and support vector machines (Schebesch & Stecking, 2005) are examples of techniques used for credit-scoring modeling. Logistic regression (So, Thomas, & Seow, 2014), artificial neural networks (Verbraken, Bravo, & Baesens, 2014), survival analysis (Sanchez-Barrios et al., 2016) and chi-square automatic interaction detector (Serrano-Cinca & Gutiérrez-Nieto, 2016) stand out among the techniques used for profit scoring modeling.

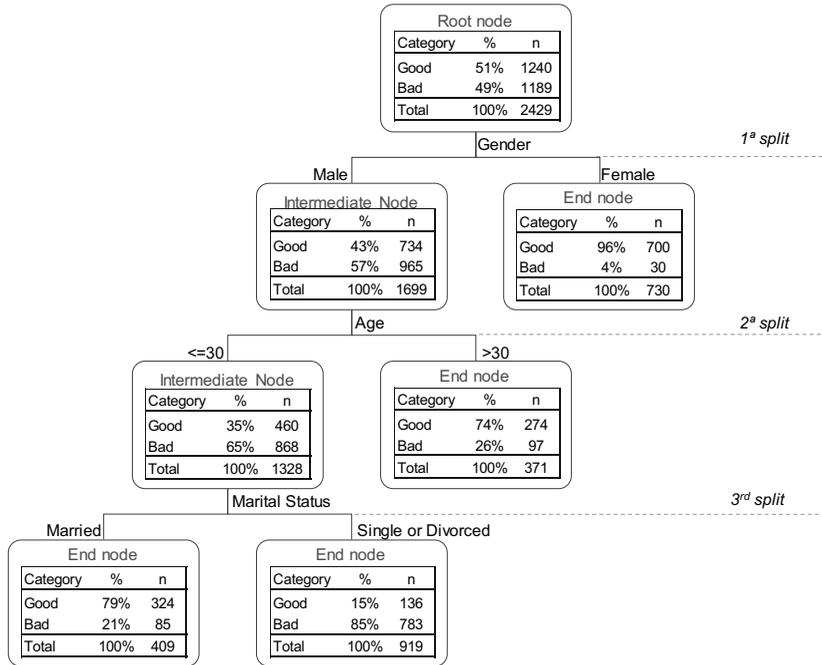
#### 3.2 *Random forests*

Random forest (Breiman, 2001) is a machine-learning technique that combines decision trees (Breiman, Friedman, & Stone, 1984). It may be used for data classification (categorical dependent variable) and regression (continuous dependent variable) problems, and it is an evolution of the bootstrap aggregating (bagging) algorithm (Breiman, 1996).

The classification and regression trees, proposed by Breiman et al. (1984), seeks the creation of homogeneous subsets by successive binary partitioning of data, until meeting predefined quality (or purity) criteria. The values or categories of the dependent variable are predicted based on the end nodes of the decision tree. Figure 1 exemplifies a decision tree.

Figure 1 shows the process of binary data partitioning into classes. From the root node, the variable that enables a better separation of groups according to a quality criterion is selected, yielding two new nodes. The process continues recursively, until meeting the stopping criteria.

In the bagging method, the data set is randomly divided into a large number of subsamples drawn from the original sample with replacement, generating a classification or



**Figure 1.**  
Representation of  
classification trees

**Source:** (Silverio, 2015)

regression tree for each subsample. The prediction is calculated as the mean (for regression) or the vote majority (for classification) of the responses of the trees generated with the subsamples. This technique generates more precise and stable results because the effects of noise and outliers are attenuated with the various samplings.

A key limitation of the bagging technique is the possibility of generating very similar trees, which in turn increases the prediction error rate of the model because the independent variables are always the same.

The random forests method has two steps in addition to the selection of subsamples performed in the bagging technique. Having  $M$  predictor variables in the data set,  $m < M$  variables will be randomly selected for each subsample in the construction of individual trees. The  $m$  value is kept constant during the model learning process. This feature enables reduction of prediction errors due to multicollinearity problems, for example.

When applied to credit-scoring prediction, random forest frequently exhibits better performance than conventional techniques (Jones, Johnstone, & Wilson, 2015; Lessmann, Baesens, & Thomas, 2015; Malekipirbazari & Aksakalli, 2015; Namvar, Siami, Rabhi, & Naderpour, 2018).

We estimated the credit-scoring models with logistic regression to verify whether the accuracy of the subjective analysis increases when including demographic and behavioral variables. Subsequently, we compared the results with the one obtained from the random forest algorithm. The comparisons are based on the Kolmogorov–Smirnov (KS) statistics, the Gini coefficient and the AUROC.

#### 4. Data description

We obtained our data from a Brazilian credit union. Behavioral and demographic variables of loans were observed in a 24-month period (from January 2015 to December 2016), totaling 2,012 observations. We considered personal loan transactions only. The credit union did not register rejected applications.

Each database record is a unique credit transaction that contains information about the characteristics of the loan, the borrower and the development of the outstanding balance. The last set includes the payment history, overdue payments and end-of-month financial statements.

We classify a client as a “bad” payer if he or she does not pay off their debt commitments within 90 days after the due date; and “good” otherwise.

We used the internal rate of return (IRR) on the loans as a profitability measure in profit scoring models, as proposed by Serrano-Cinca and Gutiérrez-Nieto (2016). The IRR calculation parameters are the cash flows of payments received and the costs involved in each contracted operation.

We used the following variables:

- *Type*: type of credit operation chosen by the applicant, such as personal loan, loan for acquiring goods and payroll loan;
- *Rating*: the credit rating subjectively assigned by the credit union to the loan transaction based on the client’s payment history records and information provided by credit bureaus such as Credit Protection Service and Serasa-Experian;
- *Income*: the borrowers’ proven monthly net income in Brazilian real;
- *Collateral*: information about available goods or property that can be used as collateral;
- *Reltime*: time elapsed between the date the checking account was opened and the date the loan transaction was settled, in years;
- *Interest*: nominal interest rate of the transaction;
- *Value*: value of the loan requested by the borrower in Brazilian real;
- *Debt*: Debt to disposable income ratio: the ratio between the value of the loan installment and the monthly income of the borrower;
- *Evhist*: number of months since the last occurrence of a late payment (delay higher than 30 days after the credit obligation due date) of a specific client in the past two years. In case there are no observed events for a given customer, this variable is zero; and
- *Term*: Term in days corresponding to the period between the transaction date and the contractually agreed loan settlement date.

The credit-scoring dependent variable Y receives value 0 (zero) if the client is “bad” and value 1 (one) if the client is “good.” Table II shows the statistics of variable Y in the sample.

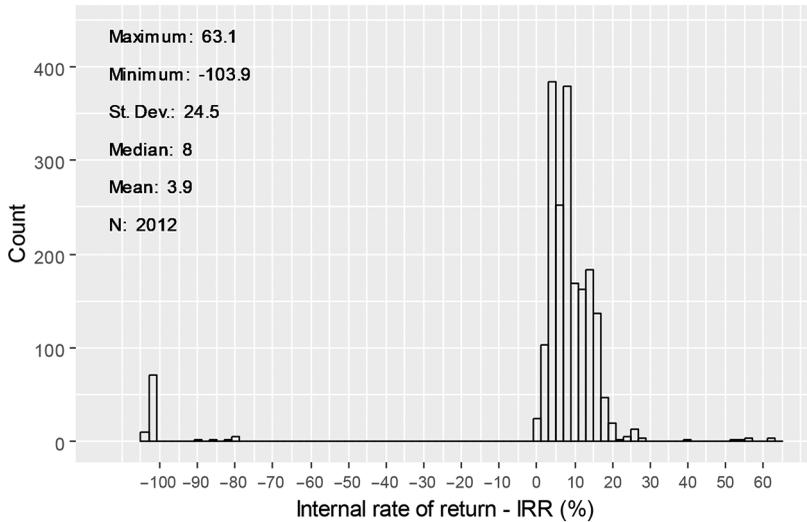
The dependent variable of the profit score model is the IRR on the transactions.

**Table II.**  
Dependent variable  
of credit risk  
classification

Events related to the dependent variable	Quantity	(%)
Operations with at least 90 days of delay (BAD)	174	9
Operations with less than 90 days of delay (GOOD)	1838	91
Total	2012	100

Figure 2 shows the histogram and statistics of the IRR-dependent variable. We observed that the distribution is asymmetric. The default events markedly shift the left tail of the distribution because these events are associated with significant losses. The distribution of the positive IRR values is concentrated in the range of rates of return from 5 to 15 per cent.

Table III shows the descriptive analysis of the categorized independent variables. In each line, for each possible value of the categorical variables, one may find information regarding the number of bad or good clients in the sample and descriptive statistics for IRR. We applied chi-square homogeneity tests to assess whether the ratios of good and bad payers differ between the categories of the independent variables and the mean comparison test (analysis of variance – ANOVA) between the different possible values of the independent variables regarding the IRR. All tests, except for the COLLATERAL variable, identified significant differences at  $p < 0.01$ .



**Figure 2.**  
Histogram of the  
internal rate of return

Variable	Values	Credit classification		Internal rate of return		
		BAD Y = 0	GOOD Y = 1	Mean	Median	SD
TYPE	Other loans	39	43	-9.44	2.64	56.46
	Personal loans	104	1380	4.09	7.64	21.95
	Payday loans	11	399	8.88	10.26	13.20
	Vehicle financing	20	16	-30.56	4.55	52.08
RATING	Rating Non-A	27	4	-23.82	5.54	63.02
	Rating A	147	1834	4.33	8.00	23.17
COLLATERAL	Secured loans	157	1733	3.95	7.89	24.06
	Unsecured loans	17	105	3.07	10.83	30.55
INCOME	R\$1000 or less	10	32	-4.02	8.00	39.91
	R\$1000-R\$3000	107	1121	4.93	8.25	23.32
	R\$3000-R\$6000	26	487	4.84	7.16	19.48
	Greater than R\$ 6000	31	198	-2.30	7.73	34.17

**Table III.**  
Descriptive statistics  
of discrete variables

We did not find a significant difference between “good” and “bad” in the COLLATERAL variable according to the F-ANOVA test ( $p > 0.10$ ). This indicates that there is no significant contribution from COLLATERAL to the profit scoring models.

Table IV contains the descriptive analysis of the continuous independent variables. In each line, we present, for each variable, some descriptive statistics, the observed means for bad and good payers and the correlation between the variable and IRR. We used the  $t$ -test to compare the means of the independent variables between good and bad payers. Although the normality assumption of  $t$ -test is not achieved, the large sample size enables us to carry out the tests. We found significant correlations between IRR and all continuous variables, except for the variables VALUE, DEBT and TERM.

Variables VALUE and TERM are nonsignificant in all statistical tests. The results of the  $t$ -test improved after we applied the transformations of the variables outlined in Table V.

The value of the variance inflation factor (VIF) for the lnVALUE variable was 4.40, suggesting multicollinearity problems. When we excluded the maximum value, the VIF was 1.37, indicating the absence of strong multicollinearity among the variables.

The general specification of the logistic and linear models used in the paper is given, respectively, by the expressions (1) and (2):

$$\log\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \sum_{j=1}^k \beta_k x_{ji} \tag{1}$$

where  $p_i$  is the probability of the client  $i$  be good,  $k$  is the number of independent variables in the model,  $x_{ji}$  is the value of the independent variable  $j$  for client  $i$  and  $\beta_j$  are parameters,  $i = 1, \dots, n, j = 1, \dots, k$ :

Variable	Descriptive analysis				Relationship with the dependent variable Credit classification		
	Mean	Maximum	Minimum	SD	Mean for Bad (Y = 0)	Mean for Good (Y = 1)	Correlation coefficient with IRR
RELTIME	6.25	17.00	0.10	5.27	2.74*	6.58*	0.10**
INTEREST	28.14	241.66	12.68	12.08	42.71*	26.76*	-0.18**
VALUE	3912	106500	100	5252	4386	3867	0.01
DEBT	12.48	156.28	0.01	13.24	16.70*	12.08*	-0.03
EVHIST	0.14	16.00	0.00	0.98	0.64*	0.09*	-0.15**
TERM	515	1837	14	309	545	512	0.02

**Table IV.**  
Descriptive statistics of continuous variables

**Notes:** \* $p < 0.01$  – Significant at the 1% level (Student  $t$ -test); \*\* $p < 0.01$  – significant at the 1% level (Pearson correlation coefficient)

Variable	Description
LnRELTIME	Natural logarithm of RELTIME
lnVALUE	Natural logarithm of VALUE
lnDEBT	Natural logarithm of DEBT
sqrtEVHIST	Square root of EVHIST
sqrtTERM	Square root of TERM

**Table V.**  
Transformed variables used in the credit-scoring model

$$IRR_i = \beta_0 + \sum_{j=1}^k \beta_k \chi_{ji} + \varepsilon_i \quad (2)$$

where  $IRR_i$  is the value of IRR for client  $i$ , the others terms are similar to those previously described.

### 5. Results and discussion

We used the R programming language (R Core Team, 2000) to fit the models, and the *randomForest* package (Svetnik, Liaw, & Tong, 2003).

#### 5.1 Credit scoring models

We developed three logistic regression models. Model 1 (complete model) contains all independent variables selected for the study. Model 2 excludes the RATING variable. Model 3 contains only the RATING variable. Model 3 allows us to evaluate the performance of the current criterion used by the cooperative to decide if a credit should be provided; Model 2 uses all the information available, except the information provided by RATING, and Model 1 uses all the information available.

Table VI shows the analyses results. We observed that the complete Model 1 performs better than Model 3 and slightly better than, albeit very similar to, Model 2. Model 2 performs better than Model 3, which suggests that including other variables is more beneficial to the risk classification than using the RATING variable alone (subjective credit risk classification).

The variables COLLATERAL, lnDEBT, INCOME (greater than R\$6,000) and TYPE (other loans) are not statistically significant.

Variable	Model 1			Model 2			Model 3		
	<i>coef.</i>	<i>p</i>	<i>s.e.</i>	<i>coef.</i>	<i>p</i>	<i>s.e.</i>	<i>coef.</i>	<i>p</i>	<i>s.e.</i>
(Intercept)	-1.03	0.353	1.11	2.61	0.006	0.96	-1.91	<0.001	0.54
<i>TYPE</i>									
Payday loans	2.98	<0.001	0.55	3.00	<0.001	0.55			
Personal loans	2.38	<0.001	0.47	2.28	<0.001	0.46			
Other loans	0.13	0.839	0.66	-0.06	0.927	0.63			
RATING	3.88	<0.001	0.64				4.43	<0.001	0.54
<i>INCOME</i>									
R\$ 1000-R\$3000	1.01	0.047	0.51	1.01	0.039	0.49			
R\$ 3000 - R\$ 6000	1.39	0.015	0.57	1.32	0.015	0.54			
Greater than R\$ 6000	0.12	0.837	0.58	0.28	0.613	0.56			
lnRELTIME	0.50	<0.001	0.10	0.48	<0.001	0.10			
COLLATERAL	-0.22	0.554	0.37	-0.15	0.680	0.37			
INTEREST	-0.07	<0.001	0.01	-0.07	<0.001	0.01			
nDEBT	-0.01	0.964	0.13	-0.02	0.889	0.13			
sqrtEVHIST	-1.55	<0.001	0.20	-1.76	<0.001	0.21			
sqrtTERM	-0.06	<0.001	0.02	-0.05	<0.001	0.02			
N		2012			2012			2012	
AUROC		0.94			0.93			0.58	
GINI		0.88			0.86			0.15	

**Table VI.**  
Logistic regression  
models

The analysis of the signs of the TYPE variable shows that the product “Vehicle Purchase” has a higher credit risk than personal loan and unsecured loan products.

The model with the random forests technique created 500 classification trees, of depth 3.

Table VII outlines the quality indicators (AUROC, KS and Gini) associated with the logistic regression and random forest algorithm models (1). We observed that the random forest modeling performed better than the logistic regression according to the three indicators, in agreement with Jones et al. (2015), Lessmann et al. (2015), Malekipirbazari and Aksakalli (2015) and Namvar et al. (2018).

The size of the sample provided by the cooperative was not big enough to enable the partition of the data between a developing and a validation sample, so, to evaluate the performance of the techniques with out-of-sample data, we used the k-fold (Kohavi, 1995) cross-validation method to assess the generalizability of the models. In this method, we randomly partitioned the data into 15 mutually exclusive groups ( $k = 15$ ). By excluding a partition, we generated a model from the data collected for the remained partitions, which was subsequently assessed with the partition removed. The cross-validation findings were very similar to those assessed when using the model developed with all database observations, indicating that the random forests technique is better than the logistic regression technique. The minimum value of the KS statistic for the logistic model was 0.66, and the maximum was 0.70; conversely, for the random forests, the minimum value was 0.90, and the maximum value was 0.92. The minimum value of the Gini coefficient for the logistic regression model was 0.86, and the maximum was 0.88; the minimum value of the random forests was 0.90, and the maximum was 0.93.

### 5.2 Profit score model

We compared the profit score model developed herein by using the random forest technique to the model estimated by the ordinary least squares method with robust heteroscedasticity-consistent standard errors.

To attenuate problems due to the lack of linearity of the dependent variable and to improve the performance of the ordinary least squares regression model, we added quadratic variables to the set of continuous variables. Table VIII summarizes these variables.

For the profit scoring models, we used the same categorized variables used in the credit-scoring model.

Table IX contains the results of the regression analyses.

**Table VII.**  
Comparison of the performance of credit scoring models

Models	AUROC	KS	Gini
Logistic regression (Model 1)	0.94	0.69	0.88
Random forest	0.96	0.90	0.92

**Table VIII.**  
Quadratic variables added to the profit-scoring model

Variable	Description
RELTIME_QUAD	Square of RELTIME
INTEREST_QUAD	Square of INTEREST
DEBT_QUAD	Square of DEBT

Term	Coefficient	Standard error	<i>robust standard error</i>	
			Z	p
(Intercept)	-60.230	14.385	-4.187	3.E-05***
<i>TYPE</i>				
Payday loans	28.018	6.595	4.248	2.E-05***
Personal loans	25.976	6.614	3.928	9.E-05***
Other loans	25.734	8.186	3.144	2.E-03***
RATING	12.492	10.538	1.185	0.24
<i>INCOME</i>				
R\$ 1000-R\$3000	9.560	5.490	1.741	0.08*
R\$ 3000-R\$6000	9.373	5.524	1.697	0.09*
Greater than R\$ 6000	5.462	5.728	0.953	0.34
RELTIME	-1.224	0.492	-2.486	0.01***
RELTIME_QUAD	0.021	0.004	5.394	7.E-08***
COLLATERAL	3.049	2.898	1.052	0.29
INTEREST	0.358	0.166	2.157	0.03**
INTEREST_QUAD	-0.003	0.001	-4.315	2.E-05***
DEBT	3.471	0.774	4.486	7.E-06***
DEBT_QUAD	-0.002	0.001	-2.021	0.04**
sqrtEVHIST	-27.718	5.624	-4.929	8.E-07***
sqrtTERM	0.242	0.085	2.829	5.E-03***

**Notes:** \* $p < 0.1$ ; \*\* $p < 0.05$ ; \*\*\* $p < 0.01$

**Table IX.**  
OLS regression with  
robust standard  
errors

The results show that the variables RELTIME, INTEREST, DEBT and their respective quadratic terms RELTIME\_QUAD, INTEREST\_QUAD and DEBT\_QUAD are statistically significant, which suggests a nonlinear relationship between these variables and the IRR. Considering the amplitude observed in the sample (see minimum and maximum values in Table IV) of RELTIME and DEBT, the tests confirm a positive association between these variables and IRR. There is an inverted U-shaped relationship between IRR and INTEREST, with maximum IRR value of 60 per cent.

The variables RATING, COLLATERAL and INCOME (greater than R\$6,000) are not statistically significant, as expected by the descriptive analysis results. Few observations (229 cases) have INCOME variable (greater than R\$6,000) equal to 1, which may have contributed to the nonsignificant  $p$  value. The results for the RATING variable suggest that subjective credit scoring does not affect significantly the IRR of transactions. The variable TERM has a different sign in the profit-scoring model than it does in the credit-scoring model. This suggests that the transaction profitability increases with maturity.

The random forest technique used the same variables of the regression models. Table X shows the performance indicators for both methodologies. The mean squared error (MSE) of the random forests model (MSE = 183.29) is considerably lower than the MSE of the linear regression model (MSE = 427.61). This is consistent with the comparison using the

**Table X.**  
Profit-scoring  
modeling results

MSE random forest	MSE linear regression	R <sup>2</sup> random forest	R <sup>2</sup> linear regression
183.29	427.61	0.70	0.29

coefficients of determination. The random forests model has a higher explanatory power for the values observed (0.70) than does the linear regression model (0.29).

Similar to the credit-scoring models, we used the k-fold cross-validation method (Kohavi, 1995) to assess the generalizability of the profit-scoring models. We observed MSE values ranging from 409.68 to 439.32 for the linear regression and values ranging from 175.70 to 202.41 for the random forest. Conversely, the  $R^2$  statistic ranged from 0.27 to 0.30 for the linear regression model and from 0.67 to 0.71 for the random forest model.

### 5.3 Joint analysis of credit scoring and profit scoring

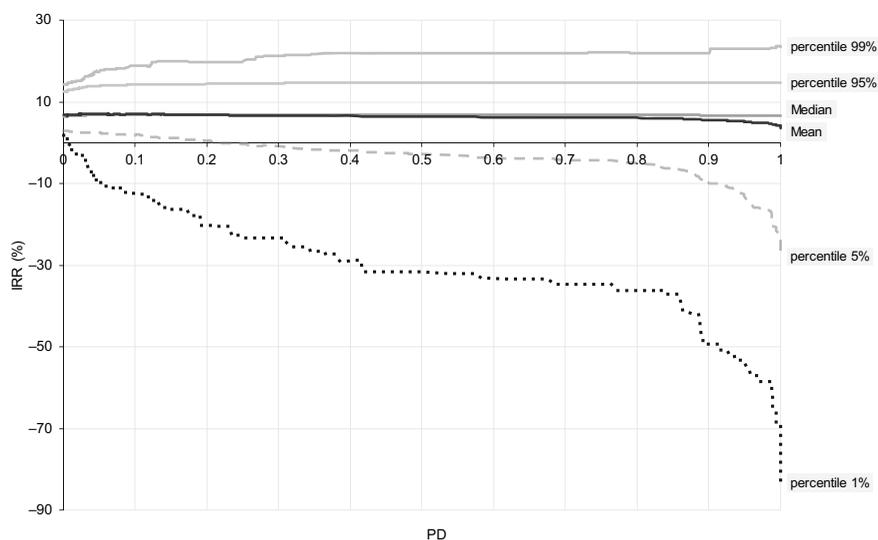
Joint analysis of credit scoring and profit scoring may improve decision-making by identifying the worst credit score that can be accepted without losing profitability of the loan portfolio and keeping the risk of losses due to default at an acceptable level.

Figure 3 shows the mean, median and 1, 5, 95 and 99 per cent percentiles of the expected IRR as a function of the predicted DP. This is an exploratory analysis due to limitations of the database. We observed that only 5 per cent of the clients classified with a 0.2 DP have an IRR less than 0 per cent and that 1 per cent of these clients have a predicted IRR less than -20 per cent. The mean and median portfolio varies little, with a slight increase in mean return: 6.7 per cent IRR for a DP of 0, and 7 per cent IRR for a DP of approximately 0.13, subsequently falling slightly and then more sharply for DPs greater than 0.7.

## 6. Conclusions

The objective of credit unions is to lend money at accessible rates to people that face credit restriction. Those people join the unions to borrow and to invest financial resources in a mutual financial help system. To have a sustained operation, credit unions must be efficient in the credit granting decision, reducing the exposition to severe losses caused by default of credit obligations. Therefore, credit risk analysis is crucial to the survival of credit unions.

Subjective credit analysis is still very common in Brazilian credit unions. It brings both operational and moral risks to these cooperatives because loans may be granted to clients



**Figure 3.** Descriptive analysis of the expected IRR as a function of the predicted default probability

with high credit risks. Agency problems may arise, as the loan applicant is also a member of the cooperative; the agent that will make the credit granting decision is appointed by the board of directors, and the board of directors is elected by the members of the credit union.

Replacing subjective analysis with objective credit analysis using deterministic models will benefit credit unions. The credit decision will be based on the input variables and on clear criteria, turning the decision-making process impartial. The definition of a cut-off credit quality will allow defining the maximum acceptable level of risk for new transactions, and therefore risk management. The choice of independent variables related to credit risk is a basic condition for the objective analysis to present satisfactory results.

According to the logistic regression model, the following variables are significant ( $p < 0.05$ ) in discriminating “bad” and “good” clients: type of transaction, subjective credit risk rating, income, length of banking relationship, interest rates, history of defaults and transaction term. However, our analysis has limitations due to data constraints. The sample loan transactions are hired and finalized in a two-year period (from 2015 to 2016). Because vehicle-financing products have longer maturities, the analysis of the impact of this variable in the default prediction would demand a longer period of data collection.

The joint use of credit scoring and profit scoring allows granting credit for the clients with the highest potential to pay off debt commitments and, at the same time, to certify that the transaction profitability meets the goals of the organization: to be sustainable and to provide loans and investment opportunities at attractive rates to members.

We used logistic and random forest analysis (a machine-learning technique) for accessing credit scoring for clients. We used OLS and random forest analysis to assess the profit scoring of clients.

The values of the Gini and AUROC indicators suggest that the credit-scoring models have a much higher predictive quality than subjective analyses. This evidence supports the literature, according to which subjective credit analysis performs worse than objective credit analysis.

The random forest technique performs better than the logistic regression method for credit scoring. We expect that machine-learning techniques will improve the cooperative financial performance, as the losses avoided will not translate into additional costs for the organization.

A combination of profit scoring and credit scoring analysis enables us to assess the effect on the mean profitability of the loan portfolio and the risk of losses caused by accepting clients with worse credit quality. This is a useful tool for loan decision-making. The savings generated help to reduce funding rates by improving the supply of credit, thereby contributing to the objectives of the credit union.

For future research studies, we suggest using other popular machine-learning techniques, such as artificial neural networks and support vector machines, for modeling of credit scoring in credit unions. For profit scoring, we suggest profitability analysis using the risk-adjusted return on capital as the dependent variable. Regularization techniques, such as lasso and elastic net, can be used to eliminate coefficients that are mostly irrelevant to the explanation for the observed effects. We can use the survival analysis technique to assess whether profits or losses can be predicted in late payment events and in early settlement of loan agreements.

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# Managing critical services through hybrid arrangements

Critical services

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337

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## Abstract

**Purpose** – Building on the literature of hybrids in the context of public organizations, this paper aims to discuss under which conditions hybrids can adequately provide “critical services”, a subset of public services characterized by their simultaneous exposure to externalities, socio-economic cohesion and legitimacy concerns.

**Design/methodology/approach** – The authors collect indications from two stylized examples, prisons and defense, to develop propositions as a step toward assessing the potential role of hybrids as alternatives to direct public provision or full privatization in the delivery of critical services.

**Findings** – This paper examines the conditions under which hybrid arrangements outperform the polar cases of public bureaus and full privatization in the delivery of a specific subset of public goods that the authors identify as “critical services”.

**Originality/value** – The authors suggest that there might be comparative advantages in relying on hybrid arrangements rather than the usual solutions of fully private or fully governmental provision. However, they also submit that these advantages are conditional to the capacity of hybrids to reconcile competing interests to achieve socio-economic cohesion, to combine capabilities dispersed among partners to benefit from positive externalities and to satisfy legitimacy concerns with respect to the role of government.

**Keywords** Public-private partnerships, Hybrids, Critical services, Prisons, Defense

**Paper type** Conceptual paper

## Introduction

The pertinence of hybrid arrangements to deliver public services is a controversial subject. Some challenge the ability of these arrangements to address citizen needs

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Sandro Cabral and Claude Ménard contributed equally to the conceptualization and writing of the paper.



effectively (Chen, Hubbard, & Liao, 2013; Hodge & Greve, 2007). However, despite numerous problems, the number of agreements such as public-private partnerships (PPPs) around the globe is ever growing (World Bank, 2017), including in the delivery of *critical services* where governments are traditionally the sole provider.

Critical services can be characterized as services that are no direct inputs to other economic activities and:

- must deal with *externalities* that directly affect the life of citizens;
- are needed to secure *socio-economic cohesion*; and
- raise issues of *political legitimacy*.

Services meeting these criteria deserve special attention because they pose problems of coordination among suppliers; generate specific contractual hazards; raise issues regarding the modalities of control; and pose questions about the ability of providers to measure, charge, and collect adequate fees from the beneficiaries and about the capacity of end-users to pay these services according to their usage. If not properly solved, these problems may generate discontinuities threatening fundamental socio-economic functions. Military operations, cybersecurity, correctional activities, defense systems are some examples of critical services that demand further investigation.

In this paper, we aim to identify and analyze conditions under which hybrids can enable critical services provision and outperform not only government direct-provision but also full-fledged privatization. Based on the hybrid governance literature on, and using indications provided by two stylized examples, prisons and defense, we build three testable propositions addressing under which conditions hybrids can effectively deliver adequate critical services. We focus on prisons and defense because we find these sectors particularly relevant to understand how hybrids can manage complexity to achieve socio-economic cohesion, how they can combine capabilities to address externalities, and how they can satisfy concerns of legitimacy regarding their capacity to deliver appropriate critical services. At the same time, these examples help delineating the limits these conditions impose on hybrid solutions and identifying factors that potentially discard them as credible alternatives.

Our paper, which is conceptual, contributes to the literature by offering a view beyond the “pure public” versus “pure private” dichotomy and by improving the existing knowledge on hybrid governance, particularly PPPs. More specifically, we address the boundary conditions in which hybrids are feasible alternatives in the highly sensitive context of critical services. Our arguments are organized as follows. First, we discuss the concept of “critical services” and its three defining conditions. Second, we take advantage of the growing literature on hybrids to identify specific conditions under which the delivery of critical services through such arrangements can be a feasible and even superior solution. The next three sections introduce examples that lead to propositions opening ways to rigorously assess the potential advantages of hybrids in delivering critical services. We are fully aware that these examples remain what they are: illustrative. Nevertheless, they shed light on issues encapsulated into our analysis and propositions. Drawing lessons from these examples, the last section discusses limitations that hybrid solutions face and concludes.

### **Critical services: definition and characteristics**

The concept of critical services only partially overlaps with the traditional concept of public goods. The presence of non-rivalry in consumption and non-excludability characterizes public goods. These properties explain why actors rarely produce these goods at a market

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equilibrium price, or in many cases, at any price at all. Normally, the resulting market failures require government intervention, with taxes funding this public interference (Pigou, 1932; Weimer & Vining, 2005).

Coase (1960, 1974) challenged this “interventionism,” arguing that voluntary settlements among private parties may often solve externality problems at lower transaction costs than those associated to government intervention. Following Coase’s challenge, two other Nobel Prizes awardees discussed the organizational mechanisms most appropriate to provide specific services such as prisons and defense (Hart et al., 1997; Williamson, 1999). Recent contributions went further, highlighting the possibility that neither private nor public management can guarantee the optimal provision of some “public” services (Iossa & Martimort, 2012; Warsen et al., 2018).

Although it has not yet permeated the academic literature, the idea of “critical services” as referring to a specific category of public goods has already contributed to some significant reorientation in public policies. The adoption of European Directive 2008/114 (EU, 2008) and the USA Presidential Directive 21 (USA\_White\_House, 2013) are illustrative of an increasing concern for services that can carry systemic risks, potentially challenging the continuity of strategic economic functions and threatening social cohesion. In this paper, we consider as “critical” those services:

- crucial to maintain social cohesion thus guaranteeing the continuity of socio-economic interactions;
- providing means to monitor externalities that can impact the capacity of agents to safely organize their activities; and
- tightly interwoven with legitimacy issues rooted in collective values regarding the expected role of public authorities.

Services such as defense, police, prisons and related judicial support; or other services – Williamson (1999) gives the example of diplomacy – needed to secure these three functions are critical in that respect: they have direct implications on a society’s capacity to organize economic activities, maintain cohesion among its constituencies, and secure its territory. Flaws in the provision of these services might challenge the stability or integrity of a society (Brown & Jacobs, 2009). We discuss each dimension in turn.

#### *Three defining functions: social cohesion, externalities and legitimacy*

Critical services differ from public goods in that they can allow excludability and may exhibit rivalry in consumption. Moreover, in their conventional acceptance public goods are not primarily intended to deal with externalities while *simultaneously* securing socio-economic cohesion and economic stability; and they do not *necessarily* face legitimacy challenges if provision is secured by non-governmental actors. Therefore, public goods do not satisfy our three criteria all together. Critical services also differs from the more recent concept of critical infrastructures in that these services do not provide direct inputs for other economic activities, contrarily to electricity, transportation, or sanitation, for example (Kunneke et al., 2010).

The defining functions of critical services also impose specific constrains. First, maintaining socio-economic cohesion is essential to guarantee the integrity of a society, to reduce disparities, to support productive investments, and to help nations circumventing economic challenges (Smith, 1976). Dealing with market failures through adequate provision of critical services is crucial to assure social peace (Polanyi, 1957). In market economies, governments usually complement market forces in maintaining social order (Brown &

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Jacobs, 2009) through the provision of specific critical services. For example, governments secure relationships among citizens by the development of defense systems to prevent foreign intrusion that would challenge the continuity of social interactions.

Second, the adequate provision of critical services can also generate positive externalities. It can impact the welfare of a wide range of individuals through services that can hardly rely on exclusive market provision (Milgrom & Roberts, 1992). Examples are the need to protect property rights, to guarantee safe trading activities, and/or to secure interactions among organizations. Border security; systems to prevent money-laundering, tax evasion and corruption; and defense systems and prisons (Bures, 2017) are illustrative of critical services, whose proper provision can hinder negative externalities that would otherwise impose costs on third parties (Pigou, 1932).

A third set of constraints, of particular significance for our analysis, comes out of the legitimacy issue. Legitimacy concerns the social acceptance of the modalities through which critical services can be delivered: it refers to the alignment (or misalignment) between the organizational arrangement chosen and the citizens' expectations framed by values and beliefs regarding the role of public authorities (Meyer & Rowan, 1977). Legitimacy plays a particularly important role in critical services, such as defense systems, in which providers are at high risk of being exposed to public disapproval (Vergne, 2012). In specific institutional settings, a given arrangement (e.g. full privatization) might be perfectly legal and effective, but generate instability due to challenges by strategic constituencies, while in other settings in which performance criteria prevail a similar arrangement might be unconditionally accepted (Hirsch & Andrews, 1984).

### **Hybrids and the delivery of critical services**

If we accept the idea that critical services have specific characteristics, what is the most adequate and acceptable organizational solution for their provision? We argue that under specific circumstances, "hybrid" arrangements combining resources from otherwise legally and economically distinct entities can be feasible alternatives. Joint ventures or PPPs are typical examples. These arrangements differ from markets and hierarchies with respect to four dimensions: incentive intensity, administrative controls, performance attributes and contract law (Williamson, 1999). According to Makadok and Coff (2009) hybrids are market-like in some of these dimensions while simultaneously hierarchy-like in others, a combination that requires the development of specific mechanisms of governance (Menard, 2013; Reuer & Devarakonda, 2016).

#### *Why would governments go hybrid to deliver critical services?*

The literature initially focused on hybrids in the context of private agreements. In choosing to go hybrid, parties to a transaction would decide to share essential rights because they expect to:

- better deal with uncertainty by pooling resources;
- benefit from spillover effects; and
- ease the monitoring of non-contractibility and the allocation of joint rents through relational contracts (Makadok & Coff, 2009; Menard, 2013; Parmigiani & Rivera-Santos, 2011).

Concisely, "hybrids" develop because parties expect benefits from jointly calibrating rights, control, and incentive schemes, thus facilitating adaptability and improving performance through lower transaction costs.

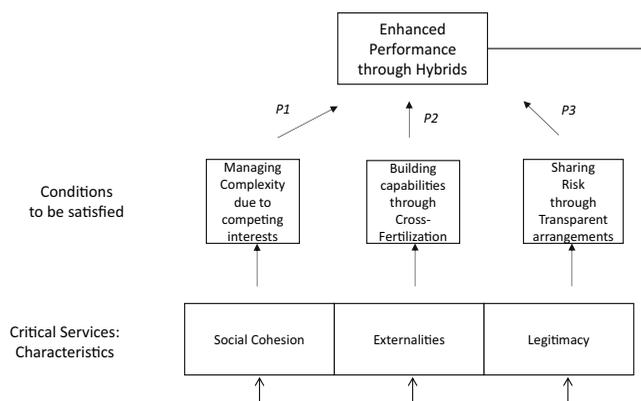
These properties have increasingly attracted the attention of contributors intrigued by the potential role of such arrangements in the provision of public goods and services (Bel, Brown, & Warner, 2014; Bovaird, 2004; Joldersma & Winter, 2002). These arrangements take many different forms and names (e.g. coproduction, PPPs, consortia) but share the central feature of hybrids: *substantial decision and property rights are pooled among parties*, in our case between public authorities and private actors.

However, considering the challenging functions that critical services must satisfy, why and how would such arrangements be relevant for their delivery? Without referring to the concept of critical services, numerous authors have raised this question for the provision of services such as defense and prisons. The inherent complexity involved in the provision of such services along with criticisms regarding the presence of profit-oriented firms in doing so create additional challenges to the perspective of adopting hybrid solutions (Forrer, Kee, Newcomer, & Boyer, 2010; Brown, Potoski & Van Slyke, 2010; Cabral & Santos, 2018). The sustainability of these arrangements is particularly worrisome when criticality is high (Grimsey & Lewis, 2004). On the other hand, it has also been argued that implementing public-private ventures can yield value creation (Mahoney, McGahan, & Pitelis, 2009). This is likely to occur because idiosyncratic capabilities developed through collaborative interactions (Sanderson, 2009; Cabral et al., 2013), injection of market incentives (Hefetz, Warner, & Vigoda-Gadot, 2014), and effective monitoring of private contractors (Cabral et al., 2010; Pierce & Toffel, 2013). Combining these advantages could allow hybrids to improve performance, reduce contractual hazards, and increase perception of probity, thus helping these forms to address simultaneously social cohesion, externalities, and legitimacy more effectively than polar forms (full privatization vs. full governmental provision).

### *The alignment issue*

We argue that three conditions must be fulfilled to have hybrid solutions aligned with the defining criteria of critical services (socio-economic cohesion, externalities and legitimacy), thus making it possible for hybrid arrangements to outperform full-fledged privatization and government provision. Figure 1 summarizes this alignment issue, at the core of our analytical approach, between the characteristics of the critical services and the organizational conditions that must be satisfied.

More specifically, we submit three theoretical propositions that intend to capture this alignment issue. In this conceptual paper, we do not test the validity of these propositions.



**Figure 1.**  
Our analytical framework

We rather follow the pattern of some economics, management and public administration leading scholars (Ansell & Gash, 2008; Hart et al., 1997; Rangan, Samii, & Van Wassenhove, 2006), building our propositions and illustrating the applicability of our framework with real-world examples from two critical services: prisons and defense. The selection of these two domains is motivated by:

- (1) their tight correspondence with our criteria (their role in maintaining socio-economic cohesion; their capacity to mitigate negative and foster positive economic externalities; their status in legitimizing governmental action); and
- (2) the multiplication of controversial initiatives to introduce hybrid arrangements in the delivery of these services.

We offer examples from Australia, Brazil, European Union, France, Germany, South Africa, the UK and the USA. We are aware that these are only examples; they are not demonstrations nor do they provide a comparative analysis based on an extensive qualitative or quantitative investigation. This is beyond our scope at this point.

### **Condition #1: managing complexity to achieve cohesion**

Our characterization of critical services emphasizes their importance in assuring economic continuity while keeping social cohesion. Indeed, the joint presence of a high level of criticality with non-contractible aspects, for example due to uncertainties coming out of technological requirements or performance measurement, makes the delivery of these services particularly exposed to contractual hazards and risks of opportunistic behavior. We argue that there are circumstances under which hybrid arrangements present advantages when it comes to reconciling competing interests and dealing with technological and financial complexities, thus positing them in a favorable position to secure socio-economic cohesion.

#### *Assuring cohesion through adequate provision of prisons and defense services*

To build the argument, we first consider some experiences of provision of prison and defense services through hybrid arrangements, and we point out conditions under which they might have outperformed alternative solutions.

Prison services face important financial constraints, accentuated by diverging interests. The provision of this critical service requires significant investment in non-redeployable infrastructures and in human capabilities to guarantee a secure environment for inmates, staff, and citizens. Prisons involve several stakeholders, which makes their regulatory design and performance measurement particularly complex (Boin, James, & Lodge, 2006). This complexity is amplified by permanent conflicts between rules imposed by public authorities and those implemented by the inmates themselves. Although communities tend to pay little attention to conditions of incarceration, social concern about safe confinement is universal, with prisons primarily expected to guarantee order and security rather than to provide services for inmates (Wacquant, 2009). This concern for securing social cohesion and controlling negative externalities clearly underlies the choice by Hart, Shleifer and Vishny (1997) of prison services to illustrate their discussion on the “proper scope of government”.

Empirical evidence suggests that there are circumstances under which hybrids may have comparative advantages in facing these complex factors while circumventing flaws associated to full privatization and full governmental provision. Total privatization in corrections remains very controversial. Performance in prisons is far from perfectly contractible and observable,

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which opens room for opportunism, with incentives for private operators to cut costs at the expense of quality of confinement (Hart et al., 1997). Drawing on the 2000 *Census of State and Federal Adult Correctional Facilities*, Makarios and Maahs (2012) showed quality shading in full-fledged privatization in the USA, with private prisons doing worse than public ones in treatment and education to inmates. In the same context, Gaes et al. (2004) argue that security is lower in private prisons. Examples of negative effects of prisons privatization where the government has limited controls of the correctional activities have also been observed in South Africa (Rynne & Harding, 2016; Sloth-Nielsen, 2003).

By contrast, Harding (2001) and Lundahl et al. (2009) argued that overall private contractors did not worsen the conditions and even contributed to improvements in prisons when they pooled rights and tasks with governments. Empirical results from Australia even suggest greater attention to the conditions of confinement in privately operated prisons (English, 2013), with enhanced services compatible with decreased costs when there is intense interactions between public authorities and private partners (OCIS, 2011). Cabral, Lazzarini & Azevedo (2010) showed similar advantages in Brazil, with prisons under hybrid governance reporting escapes 96 per cent lower than in publicly operated prisons, fewer deaths and similar or enhanced performance in medical care and legal aid for inmates. Quality improvements in prisons are also observed in the French experience of private participation, particularly with respect to management, food, cleaning, and health care facilities (Cour\_des\_Comptes, 2006). However, these solutions differ for pure privatization. Indeed, a noticeable condition for their success is the constant interactions between public and private actors, which allowed prison managers to deal with the inherent complexity of the corrections reality and to promote enhanced accountability standards (Cabral & Santos, 2018).

As for defense services, their significance in maintaining social cohesion by securing a territory and rights of its inhabitants make them unambiguously critical. Moreover, many governments have an incentive to develop domestic capabilities in hope of positive economic externalities coming out of local production of military and defense equipment (Levine, Mouzakis, & Smith, 2000). However, the technological complexity of these systems often exceeds what governments can do efficiently (Oudot, 2010). Also, full governmental provision may not be possible or desirable because of red-tape, which thwarts the flexibility needed to develop new and uncertain technologies (Depeyre & Dumez, 2008). On the other hand, full privatization put too high a risk on societal needs for protection, while the high level of sunk costs may deter private operators to fully assume the risks involved in arms-length contracts (Leyden & Link, 1993).

These elements may explain why government and suppliers tend to share rights in defense systems. Requirements for innovative technologies and capabilities and geopolitical aspects motivate the choice of organizational arrangements with joint decision rights, against an arms-length contractual approach that often leads to cost increases, as observed in US defense cases (Depeyre & Dumez, 2008). Referring to the US Coast Guard's Deepwater project, Brown et al. (2010) argue that a non-cooperative approach may explain inferior results in complex projects in the defense sector, while evidence from the British defense sector shows that joint decision-making generates positive results (Sanderson, 2009). Similarly, Lohmann and Rötzel (2014) demonstrate that hybrid arrangements in the German defense ease the management of complex technologies and better address government needs than arms-length contracts. European Union policy makers emphasize the role played by public-private collaboration in complex domains such as the maritime security, thanks to improved risk management and more effective crisis response (European Commission, 2014). Similarly, it has been shown that public-private arrangements help to increase national system's resilience in sensitive domains such as cybersecurity (Bures, 2017). It has

also been acknowledged by different public authorities (European Commission, 2007) that hybrids help developing interoperability of defense systems, which is crucial to secure socio-economic cohesion.

*Reconciling competing interests in complex settings*

What these examples suggest is that there is the potential for hybrids to efficiently manage complexity in contexts in which critical services are crucial to secure socio-economic cohesion. However, the relevance of choosing hybrid solutions is conditional to a better identification of factors generating this complexity.

There are indeed different sources of complexity, which can arise from supply and/or demand forces. On the supply side, complexity in the production and delivery of critical services may come out of *technologies* requiring expertise that the government may not have, or of *financial constraints*, either because the government does not have the resources needed, or because private operators need external support (e.g. refinancing). On the demand side, complexity can develop when users of critical services have ambiguous or diverging preferences, thus increasing demand diversity (Fountain, 2001). This diversity often grows out of the multiplicity of stakeholders with different perceptions of what to expect from critical services, forcing governments to find ways to conciliate competing interests (Klein, Mahoney, McGahan, & Pitelis, 2013)[1].

How can hybrids outperform polar forms (markets and hierarchies) in dealing with these complex situations? One argument is that in comparison to, say, standard public procurement, they facilitate coordination between governments and private operators (Makadok & Coff, 2009), which can attenuate contractual hazards (Domberger, Farago, & Fernandez, 1997) and promote the flexibility needed to address diffuse interests and avoid adverse effects (Klein et al., 2013). Indeed, critical services often involve several synergistic and competing tasks, for example, operation and maintenance in defense systems. Acting as “principal,” a government can facilitate coordination among suppliers involved by combining incentives and authority, thus crafting more efficient governance (Makadok & Coff, 2009). Formal partnerships with private suppliers can also allow a government to benefit from their expertise, improving its own capacity to address complex technological situations and reconcile divergent interests (Gordon & Poppo, 1991; Oudot, 2010).

When it comes to financial constraints, hybrids might facilitate access to innovative financial mechanisms, such as new equity funds jointly crafted by public and private partners (Erol & Ozuturk, 2011) or revenue guarantees based on put options (Cabral & Silva, 2013). Hybrids can also help handling the lack of financial resource for government, while private partners benefit from public authorities remaining ultimately liable, as well illustrated by numerous PPPs agreements (Hodge & Greve, 2007). Pooling resources might also mitigate risk of capture and of opportunistic behavior by providing incentives that attenuate both quality issues observed in full privatization and motivation problems that plague government provision (Cabral et al., 2010; Hart, 2003). Actually, to get adequate rewards for their participation, private partners have incentives to meet the variety of demand; and governmental authorities, at least those in democratic regimes,[2] have incentives to control quality to satisfy their constituencies and maintain social cohesion, particularly when critical services face adverse circumstances (Friedkin, 2004). We summarize these arguments as follows:

- P1. The higher the need to face competing interests and constraints in the provision of critical services, the higher is the opportunity for hybrids to prevail over markets and hierarchies for managing complexity and securing socio-economic cohesion.

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**Condition #2: dealing with externalities**

Dealing with externalities is a criterion on which the concept of critical services overlaps with the concept of public goods. However, it differs because of its interdependence with the two other criteria, particularly social cohesion. Indeed negative externalities coming out of inadequate critical services challenge the security of persons and property rights, for example if prisons do not play their role of confinement or if defense systems do not assure required protection against external aggressions. We shall argue that there are circumstances in which hybrid provision of critical services can mitigate negative externalities and generate positive externalities. This is likely to occur when coordination capabilities of governments are aligned with distinctive efficiency-driven abilities from non-governmental actors.

*Capitalizing capabilities in the delivery of prison and defense services*

Combining public and private capabilities in prison services can lower the costs of containing dangerous individuals under control while promoting social reinsertion (Reasons & Kaplan, 1975). In a study on Brazilian prisons, Cabral, Lazzarini and Azevedo (2013) show that hybrids improve related performance indicators; however, these gains are conditional to previous experience of private entrepreneurs with: dealing with governments and monitoring security issues. The authors argue that the combination of coordination by public authorities with incentives and flexibility of private operators put hybrid arrangements in a favorable position to address simultaneously supporters of law and order and advocates of more humane treatment. Data from the Australian prison service confirms such cross-fertilization and positive results when public and private capabilities combine (English, 2013; OCIS, 2011). More specifically, empirical evidence suggests that these benefits prevail over results from the exclusive delivery of prison services by a hierarchical public entity and by a fully privatized prison if control rights are actually shared, an important condition to motivate pooling capabilities (Cabral & Saussier, 2013).

Similarly, important positive externalities might come out of the hybrid delivery of defense services, thanks to pooled capabilities. Besides its role in securing a community, in many countries defense is a structuring component of economic activities, involving complex supply chains and generating significant export revenues (Yakovlev, 2007). However, the increasing complexity of defense systems makes it unlikely that all strategic capabilities can be concentrated in the government. Building partnership with private operators might do better in capitalizing on disperse knowledge. Although government agencies tend to keep fundamental research within their domain (Mazzucato, 2013), activities related to the development of critical technologies increasingly rely on arrangements that facilitate cross-fertilization.

Casual evidence collected from the development of the Brazilian air-to-air missile MAA-1A Piranha illustrates this cross-fertilization. In this case, a hybrid arrangement allowed six government engineers to absorb knowledge about the technical features of the system under development, while contractor employees got the opportunity to learn about the way technical requirements are developed by defense officers and about the inherent bureaucracy when transacting with government. One additional benefit of hybrids comes from the incremental nature of innovation in defense systems. In facilitating information exchange and knowledge accumulation among a larger number of individuals, the hybrid arrangement was crucial for the accumulation of joint experience that led to the updated MAA-1B version of this missile through PPP. The development of the strategic missile M-51 by Airbus Defense and Space provides a very similar example (Moura & Oudot, 2017).

Public-private interactions combining disperse capabilities has also been observed in French defense contracts, with indications that it diminishes negative externalities through reduced information asymmetries and cost overruns (Kapstein & Oudot, 2009). In Germany, evidence shows that opportunistic behavior from outside suppliers in the defense industry decreases when the rate of renegotiations increases because private partners have an interest in building a positive reputation of cooperative behavior (Lohmann & Rötzel, 2014).

*Hybrids as learning arrangements*

The above examples suggest that public authorities go hybrid because they expect cross-fertilization from cooperation with private partners when capabilities are disperse among parties, a positive externality acknowledged by public administration and strategic management scholars (Brinkerhoff & Brinkerhoff, 2011; Cabral et al., 2013). Besides benefiting from the technical expertise of private partners, public authorities may capitalize on their managerial skills, and/or their knowledge of the demand for critical services (Baum & McGahan, 2013). Symmetrically, private partners can expect benefits by taking advantage of shared information and knowledge to posit themselves on future transactions, with this specific government or with other (public or private) partners. More generally, it has been shown that strategic alliances between public and private actors in costly and complex projects in critical services, such as aerospace and defense, have allowed contracting parties to mutually benefit from specific capabilities (Harrigan, 2017).

However, to reap these benefits public authorities must maintain technological and organizational skills internally to supervise the supplier(s) efficiently while securing the transfer of information and knowledge (Pierce & Toffel, 2013). Indeed, building capabilities involves learning and experimentation (Zollo & Winter, 2002). For example, the creation of centers of excellence focused on PPP (e.g. “Partnership UK”) has induced the extensive diffusion of best practices in these hybrid agreements (Iossa & Martimort, 2012). Enduring cooperation also develops reputational assets that enable synergies, prevent opportunism, and mitigate contractual hazards (Sanderson, 2009).

As shown in several empirical studies, by joining complementary capabilities previously dispersed and disconnected, hybrids boost more flexible solutions, creating conditions to outperform full outsourcing to private operators or full integration within a public bureau (Cabral et al., 2013; Rangan et al., 2006). Constant interactions in the decision-making for multiple, combined activities favor hybrid performance (Gulbrandsen, Thune, Borlaug, & Hanson, 2015) with possible spillover to other activities as well (Kivleniece & Quelin, 2012). Hence, when dealing with externalities that require the coordination of dispersed capabilities, hybrids will likely outperform polar forms. Formally:

- P2. The more disperse are the capabilities required for addressing externalities in critical services provision, the higher are the chances for hybrids to outperform markets and hierarchies.

**Condition # 3: satisfying legitimacy**

Political legitimacy is a key value when it comes to the delivery of critical services. Indeed, government is expected to guarantee a secure provision of these services; but in doing so it faces important risks with respect to the cost, quality, and timing of delivery (Hart et al., 1997). Further, all citizens can benefit from critical services at some point, which may feed high expectations but also claims for public accountability especially when private actors are involved in the delivery of such sensitive services (Bures, 2017). In this context, the

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acceptance of hybrid solutions and their capacity to outperform polar forms greatly depend on the way arrangements manage risk and deal with transparency standards.

*Dealing with legitimacy in the delivery of prisons and defense services*

The intervention of private operators in prisons and defense has raised strong debates about its legitimacy, as illustrated by the scandal surrounding the private management of prisons under military supervision in Iraq (Hansen, 2015). Full privatization of prisons, with control rights transferred to private operators, has been questioned on theoretical ground with the argument that cost cutting could threaten quality (Hart et al., 1997), a point that empirical studies in the USA tend to support (Dilulio, 1988; Makarios & Maahs, 2012).

One way for governments to circumvent information asymmetries is through intense on-site oversight of the private partner (Lazerges, 1997). Although performance and efficiency are important features, accountability is sensitive to public opinion and political actors. This makes pressure for improved transparency particularly acute when private actors are engaged in the delivery of prison services (Cabral & Santos, 2018). In France, public supervisors keep residual control rights over decisions that affect quality while civil servants jointly act with the private operator (s) in the prison routines (Cour\_des\_Comptes, 2010). However, the impact of these controls on legitimacy largely depends on public standards such as rectitude, respect of contractual obligations (Williamson, 1999) and on the capacity and willingness to monitor private contractors (Cabral et al., 2013). This also requires adequate incentives for public supervisors, usually based on reputational aspects, career concerns and long-term labor contracts if no faults are detected, (Cabral et al., 2010). Symmetrically, empirical evidence shows that the acceptability and performance of hybrids in prisons also depend on private entrepreneurs having proper control over the inputs necessary to achieve the assigned goals. French and Brazilian experiences demonstrate that the capacity of private operators to invest in highly specific assets required to secure buildings, to develop and implement security devices, and to train employees are key features for successful partnerships and to address legitimacy concerns (Cabral & Saussier, 2013).

In the defense industry, the capacity of hybrids to assure efficient coordination while reducing costs plays a crucial role in forging legitimacy. In an empirical study of the high technology segment of the French defense system, Ménard and Oudot (2010) showed that PPPs in the development of innovative projects with high uncertainty, high specific investment and highly unpredictable variations in costs relied on flexible risk-sharing rules to ease coordination. However, to satisfy legitimacy concerns, this relational dimension must satisfy two conditions: trust and transparency.

In this sensitive and increasingly complex industry, trust depends on the continuous interactions among partners, which partially explains why defense contractors often hire former members of the military. Besides absorbing skilled human resources, this strategy likely carries benefits from close ties with active-duty officers, better collaboration and reduced risks (Brook, Dilanian, & Locker, 2009). Repeated interactions are expected to engender better control over risks while avoiding adversarial relationship (Sanderson, 2009). It is particularly so when adjustments and renegotiations respond to the materialization of risks, as suggested by evidence from German defense contracts (Lohmann & Rötzel, 2014).

However, this relational dimension may also threaten the legitimacy of hybrids as it raises issues of collusive behavior (Markusen, 2003) and secrecy (Parker & Hartley, 2003), thus reinforcing the need for transparency. The existence of watchdog agencies and audit commissions may mitigate these effects, for example the Defense Contract Audit Agency or the Defense Contract Management Agency in the USA or the Cour des Comptes in France.

Technical features may also obstruct collusion and reduce the risk of opportunism: turning a blind eye to technical flaws may end up in detectable failures, so that private partners have an incentive to provide reliable critical services to maintain long term and effective relationships (Ng, Maull & Yip, 2009). Furthermore, as the defense industry is exposed to controversy because of the destructive potential of its products, technical credibility and expertise also foster legitimacy in this industry (Baum & McGahan, 2013).

*Risk management, transparency and legitimacy*

More generally, a major threat to hybrid solutions comes from incentives for governments to transfer risks management to private operators, especially when these risks are high and difficult to monitor. On the other hand, full privatization of critical services easily feed the view that public authorities are abandoning their duties without evidence of the effectiveness of this solution (Hodge, 2006). Risk transfer may also engender disruptions, due either to *technological factors*, as when technology is new or not well understood by the private operator or suffer from flaws unforeseen by partners (Kunneke et al., 2010); or to *institutional factors*, coming from malignant political forces (e.g. “third party opportunism”), incompetent regulators, or biased judiciary (Spiller, 2009). These factors expose full privatization to high contractual hazards and public controversies. In that respect, hybrids can mitigate or even overcome these risks, particularly when public authorities do not have the managerial capabilities required to properly monitor risks across all phases of the value chain (Mahoney et al., 2009). Contracts framing adequately public-private interactions, particularly if complemented by guiding documents and control devices (Van Den Hurk & Verhoest, 2016), help leading to a non-adversarial approach and positive outcomes (Sanderson, 2009), mitigating resistance to private involvement in critical services and reinforcing the legitimacy of hybrid arrangements.

However, benefitting from these solutions also depends on the capabilities of private actors to control the resources necessary to reach expected targets (Menard, 2013) and of public partners to make payments conditional to effective advances in a project (Shen, Platten, & Deng, 2006). Benefits for private partners are also contingent to guarantees against the hazards of expropriation once investments have been made (Ng & Loosemore, 2007). These are necessary to reduce risk aversion (Makadok & Coff, 2009) and stimulate collaborative behavior (Brown, Potoski & Van Slyke, 2010).

When facing a social context of skepticism regarding the benefits of private participation in critical services, more conditions must even be fulfilled to make hybrid solutions accepted as legitimate. Transparency and accountability standards are compelling factors for all parties to hybrid solutions in that respect (Forrer et al., 2010). Information on amounts spent, contractual obligations, performance indicators, and mechanisms to assess conformity must be disclosed (Hodge & Coghill, 2007). Governmental capabilities to adequately monitor the contract must be available, which requires technical expertise and non-propensity to engage in illicit arrangements (Cabral et al., 2013). Legitimacy through transparency can also be reinforced by independent governmental agencies, NGOs, and other external “watchdogs” (Bovaird, 2004) that tend to be much more thorough when critical services are delivered by hybrids than through traditional public provision (Cabral & Santos, 2018; English, 2013). Indeed, the fear of illicit behavior can push toward reinforcing control over partners, which may generate some rigidity but also provides incentives for superior performance as parties are aware that if the legitimacy of going hybrid is challenged, calls to switch back to public provision will develop. Superior levels of public scrutiny can also avoid misuse of critical services by economic and political elites to oppress the wider society. Overall, the presence of effective risk allocation and clear sharing rules can reduce the risk of adversarial

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collaboration (Sanderson, 2009) and facilitate acceptance of hybrid solutions. We summarize these elements as follows:

- P3. The more transparent are risk sharing rules and monitoring devices, including watchdog agencies, the better are the chances of hybrids to outperform polar arrangements while being accepted as legitimate solutions.

### Discussion and conclusion

This paper examined the conditions under which hybrid arrangements that contractually combine resources from public authorities and private operators can outperform the polar cases of public bureaus and full privatization in the delivery of a specific subset of public goods that we identified as “critical services”. This concept builds on the accumulation of recent reports and empirical studies[3] and on insights from theoretical contributions about the specificity of some public goods (Hart et al., 1997; Williamson, 1999; Kunneke et al., 2010). Following indications from this literature, we argued that the production and delivery of these services raise questions about their most appropriate modality of organization. We suggested, and substantiated with stylized examples from two critical services, prisons and defense, that there might be comparative advantages in relying on hybrid arrangements rather than the usual solutions of fully private or fully governmental provision. However, we also submitted that these advantages are conditional to the capacity of hybrids to reconcile competing interests to achieve socio-economic cohesion, to combine capabilities dispersed among partners to benefit from positive externalities and to satisfy legitimacy concerns with respect to the role of government.

Notwithstanding the possible success of hybrids under these conditions, there are also factors that may hamper their capacity to achieve positive results. First, there might be misalignment between the transfer of substantial decision rights to a private partner and the sunken investments required. Typically, non-negligible portions of the investments and the associated risks remain on the shoulders of public authorities, thus challenging the benefits of PPPs (Hodge & Greve, 2007). Second, the continuing interaction between private operators and public authorities in hybrid arrangements exposes decision-makers to influence costs, capture, and illicit arrangements. Corruption and deviant behavior can be overcome only if conditions of transparency and accountability are met, which requires relatively sophisticated institutional settings and civil servants highly immune against these distortions (Cabral & Lazzarini, 2015). Third, there is the crucial problem of acceptability. The proper alignment between social norms and the delivery conditions of these services is central to enhanced performance. To reach social acceptability (Scott, 2008), the actions of providers must be perceived as desirable and appropriate within a socially constructed system of norms and beliefs (Suchman, 1995). Gaps or even conflicts between social norms of users and preferences of critical services providers may challenge the acceptability of arrangements involving non-governmental agents, especially when the government does not or cannot monitor these agents properly (Forrer et al., 2010).

### *Implications for theory*

Without neglecting these limiting factors, our framework sheds light on the well-defined circumstances under which hybrids might outperform alternative arrangements in the delivery of critical services. Our insights contribute to the ongoing debate in the public administration/management literature and among practitioners about the role of organizational solutions that differ from extended outsourcing or full privatization and from

the in-house provision of public services by public bureaus (Bel et al., 2014; Van Den Hurk & Verhoest, 2016; Warsen et al., 2018). Focusing the attention on “critical services” enabled us to push further in the direction suggested by some scholars about potential gains from public-private interactions and their implications on value creation (Kivleniec & Quelin, 2012).

Our contribution also fosters the dialogue between public management and strategic management (Boyne & Walker, 2010; Mahoney et al., 2009). By integrating strategic management constructs such as capabilities, our paper offers an enhanced understanding about the role of hybrids in public service performance improvement, thus contributing to refine strategic management theories and enlarge their scope beyond business-level policies (Barney, 2005; Ring & Perry, 1985).

#### *Implications for practice*

Our analysis also addresses aspects relevant for policymakers who have to choose and create organizational solutions for delivering critical services. Our propositions allow the identification of necessary conditions under which public-private collaboration in critical services might work, thus helping public managers and politicians in the decision process. They also suggest the key role of specific capabilities among public and private actors to make hybrids successful solutions in delivering critical services. Governments and private actors must leverage their ability to effectively procure and manage goods and services delivered through joint action. In the same vein, firms and public authorities should promote internal structures that allow them to code and retain the accumulated learning from previous and current collaborations, for example by developing adequate information systems and coopting committed managers[4].

#### *Wrapping it up*

Besides the development of specific capabilities to deal with the peculiarities of critical services and engender a collaborative approach, we pointed out the importance of appropriate motivations to deal with risk allocation and the gains from adequate control mechanisms. The absence of accountability structures enabling a more transparent contracting environment is likely to jeopardize the legitimacy of hybrids in critical services. Policymakers must be aware of these aspects before stimulating a massive participation of private actors in critical services, otherwise the observed results can be as bad as, or even worse than those obtained via polar modes, and have deterrent effects on future potentially beneficial projects.

Finally, we emphasized through the examples of prisons and defense that positive results from choosing hybrids can be expected only if specific conditions are met. Public management literature will benefit from future studies that offer a more thorough comparative analysis using primary sources. Further research efforts can also promote data collection to allow quantitative tests to substantiate or challenge our analysis. We are aware that this is not an easy task as the very nature of critical services often makes information a strategic issue. Nevertheless, we are confident that future works can collect additional empirical evidence and test them against our propositions.

#### **Notes**

1. International cooperation in the defense industry is illustrative: the European NH-90 helicopter exists in 23 versions in order to satisfy different functions prioritized by participating governments.

2. We are aware that critical services can be used to sustain the dominance of local elites at the expense of oppressing significant portions of the wider society (North, Wallis, & Weingast, 2009). This is particularly true in autocratic regimes with lower accountability standards. In these institutional settings, the private participation in critical services can generate an opposite effect compared to what we propose and social cohesion will not hold.
3. Significant examples are: Moteff, Copeland, & Fisher (2003), the Directive on European Critical Infrastructures (Dec. 08, 2008), the US Presidential Policy Directive 21 (Feb. 12, 2013), Financial Stability Board (2013).
4. As already noted by Palay (1985, p. 168) successful agreements require “high premium on personnel with long memories, sound hearts, and a penchant for looking both ways before crossing the street”.

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## ThinkBox

Sustainability  
development  
goals

# The quest for achieving United Nations sustainability development goals (SDGs)

## Infrastructure and innovation for responsible production and consumption

357

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### 1. Introduction

Since the sustainability development goals (SDGs) were unveiled in 2015 (United Nations, 2015), there has been an enhanced drive for individuals, organisations and governments to know how to best achieve them. This is illustrated in the analysis provided by Parker (2017) which shows a clear trend of increased number of publications (from 13 to 25 per cent) related to sustainability science since 2000. The importance of addressing the SDGs is very high, but *how can academics, practitioners, policy-makers and wider stakeholders help achieve them?*



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Academics with interest in sustainability are drawing upon knowledge from different disciplines to tackle some of the complexities of achieving SDGs. Research “hot” themes such as; sustainability, resilience, complexity, risk, development, etc., have come to the fore in many grand challenges and related research projects. However, such big projects have their own complexities in their execution as they span boundaries not only in terms of disciplines, but also in terms of countries, cultures, vested interests, etc. So it has been suggested that a system’s thinking approach is needed (PRME, 2019) which provides a holistic view for the management of the complexity that the sustainability issues bring.

In the triple bottom line sense, the dimensions of sustainability are: economic, social and environmental dimensions; however, each these are sometimes in direct opposition to one another. Despite evidence that organisations should pursue both social and environmental targets to be truly sustainable (Wang and Sarkis, 2013), there is growing evidence that most of the time, organisations aim to survive financially and that is what takes priority. *So how do we bring together divergent views and provide an agreement for achieving SDGs?*

It has been argued that education is paramount (Parker, 2017) because of its direct impact on economic growth, innovation, responsible consumption and development of partnerships, which will then foster looking after life in our environment (land, water and energy), which will then lead to the achievement of all the other SDGs. In this vein, organisations such as Principles for Responsible Management Education (PRME, 2019) foster responsible management education, by forming the leaders of the future with a conscious preparation on environmental issues. *So is management education enough to achieve SDGs?*

Tools such as the SDGs Industry Matrix (United Nations Global Compact and KMPG, 2016) and the step-by-step guide on incorporating SDGs into the business’ strategy (Anthesis group, 2019) can be useful for organisations to start conversations and mapping towards achieving their SDGs. For example, some opportunities for shared value can be identified, namely: sustainable products, sustainable production, low cost products and enterprise development. Also, some general tips for climate change profits (UN Global Opportunity Explorer, 2019, p. 37), such as: know your climate change facts and options, set targets and timescales, tackle barriers together, do not be late to the game and get the pricing right. *So can these tools, processes, etc., align to progressing SDGs that are in the language of the change makers?*

From the industrial perspective, we can see the challenge of how industry can relate to some but not all SDGs. For example, global organisations, such as McDonald’s and Unilever, have identified the key SDGs and started mapping their initiatives towards achieving them within their supply chains and wider stakeholders. In the case of McDonald’s (2019), their focus on SDG 2: zero hunger, SDG 8: Decent work and Economic growth, SDG 12: responsible production and consumption and SDG 13: Climate Action. They have set up yearly goals and present their annual progress on their website. In the case of Unilever (2019), it is proposed that 14 of the 17 SDGs are strongly linked to their initiatives. They have set ambitious targets, for example, to become not only carbon neutral but also carbon positive by 2030. However, this raises the question of: *whether the SDGs comprise a universal language to communicate with stakeholders, for example, policy-makers, suppliers, consumers, etc.?*

Some commentators (Euromed Management France, 2012) suggest that the 2030 deadline to achieve SDGs is too soon, given that most of the damage to the environment has been self-inflicted by the human race for centuries. *So how can the next decade of action help organisations achieve sufficient progress towards the SDGs?*

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This paper is provided as follows. First, a comparison is given between the UK and Brazil, in terms of their contexts and feasibility of progress towards these SDGs. This is because of the combination of industrial maturity with relative natural resources scarcity (UK) versus industrial emergence with natural resources abundance (Brazil) highlight the importance of these two countries to achieve SDGs in the next decade. Second, it will provide a challenge around guiding industrial sectors towards sustainability. From an organisational strategy point of view, SDG 9: on infrastructure, industrialisation and innovation and SDG 12: on responsible consumption and production, appear as a starting point for the journey. Third, a future research agenda and a possible way to measure success is provided.

## 2. Country contexts: the UK vs Brazil

The polarised contexts of two chosen countries is presented next. First, the UK provides an example of post-industrialisation with relative scarcity of natural resources. Second, Brazil provides an example of an emerging economy with abundant natural resources and good industrialising capabilities. So *how can the SDGs be achieved by organisations operating in these two polarised contexts?*

On the one hand, the UK was the origin of the industrial revolution a couple of centuries ago (BEIS, 2016, p. 5), which has in part served its purpose for its economic prosperity, but it has also incurred in the depletion of some natural resources. As a developed country, one of the grand challenges in the UK industrial strategy is clean growth (BEIS, 2018), and as a result, some steps towards achieving its reduction in carbon emissions have been taken, that is, 43 per cent of 1990 levels in 2017. With a view of achieving 80 per cent reduction by 2050 (CCC, 2019), it faces some sustainability-related challenges, such as: low productivity in comparison to other developed economies and the gap between regions in terms of distribution of wealth (Roberts, 2018, pp. 20-21).

On the other hand, Brazil is a developing country, part of the so called “BRIC” countries (Brazil together with Russia, India and China), which has high potential for industrialisation and wealth in future. However, basic problems, such as (lack of) sanitation, safety and equal opportunities, are still present. So Brazil has identified the following SDGs: 1, 2, 3, 5, 9 and 14 as its priorities (Brazil Government, 2017). Brazil can be arguably regarded as the most bio-diverse country in the world, as its geographical territory holds most of the Amazon in our planet, so sustainability is to be embedded in any future plans for progress and development (OECD, 2018). So it is of interest to monitor its carbon emissions targets because of deforestation in the years to come.

## 3. SDG 9: build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation

The opportunities for shared value are listed by the United Nations Global Compact and KMPG (2016) and can be summarised as: the need to create sustainable industrial zones, find alternatives to traditional building materials, microfinance, government dialogue.

In the case of the UK, innovation is at the centre of its government actions and their future plans. It is difficult to find an area where innovation is not mentioned, from data analytics, to helping the ageing society; innovation appears many times in BEIS (2016). In fact, there is the perception that the UK is the world’s most innovative economy. The UK government provides funding and helps organisations become innovative; many of the initiatives can be aligned to SDGs and sustainable industrialisation (Innovate UK, 2018).

In the case of Brazil, it is proposed that SDG 9 provides an opportunity to integrate economic growth with social inclusion (Brazil Government, 2017). In that report, it is stated that

there are some initiatives, such as the Investment Partnership Programme to foster collaboration between Public and Private sectors, to contribution towards generation of jobs and increase the contribution to the gross domestic product (GDP). As well as, the National Programme Start-up Industry connection can match industry needs with start-ups available. In this vein, another recommendation in the OECD (2018) report is that more focus on lending activities need to be carried out for start-ups and innovation projects. On the fostering innovation part, it is suggested that Brazil has been fostering the scientific and technological research capabilities in the past few decades. In this connection, the Geostatic Satellite for Defence and Strategic Communications was to be activated in 2017 to increase the traffic of communication and enhanced internet broadband provision (Brazil Government, 2017).

As we can see both the UK and Brazil face some opportunities and challenges ahead, progress is being made in relation to SDG 9.

#### **4. SDG 12: responsible consumption and production**

The opportunities for shared value are listed by the United Nations Global Compact and KMPG (2016) and can be summarised as: design and produce equipment which is easy to repair, refabricate, take circular economy principles on board, embrace innovative technologies, reduce, recycle and energy efficiency and lower energy consumption. The challenges around the circular economic and the need for collaboration serve to emphasise the need for a systems approach to develop the UK's established industrial base further.

One of the challenges that is recognised for industry is the complex nature of problems and opportunities and hence the need for collaboration. It is recognised that common, open-source toolboxes are needed to support change of practice. Such toolboxes need to span all business disciplines and be supported by a common language. If professionals working across the disciplines within a single company (from purchasing to engineering to finance) and across sectors can communicate easily, then practices for responsible consumption and production will develop and spread more readily (IET, 2017).

It is estimated that by 2050, the world will need around 60 per cent more food to cope with the increased demand from the projected population of 9bn (BEIS, 2016). So the drive for clean growth in production but also in consumption is paramount. In this connection, the UK is making efforts in the Circular Economy front by fostering investment in different initiatives, such as: "farm to fork", design for recycle and bio-economy strategy (BEIS, 2016). In relation to food: Brazil's global major exports (Brazil Government, 2017) include: soybean (10.4 per cent), iron ore (7.2 per cent), chicken and beef (5.6 per cent), petroleum oil (5.4 per cent), cars and planes (4.9 per cent), sugar (4.5 per cent), cellulose (3 per cent) and coffee beans (2.6 per cent). There is a report by DEFRA (2006) on the effects of how the consumption of soybean in the UK and how that appears to affect deforestation in Brazil. So this highlights the need to see the global connections of supply and demand in the world. More recently, the UK's 25 Year Environmental Plan specifically refers to SDG 12 where the UK's domestic consumption has an impact on other countries (DEFRA, 2018a).

Within the UK, there are significant initiatives (such as Made Smarter) as well as significant practitioner events and publications on digital manufacturing. There is the recognition that lean systems can be further enhanced through the deployment of digital innovations. Currently, the emphasis is on greater material and labour productivity; however, there is the opportunity to extend this specifically to resource efficiency as well as sustainable development more widely.

Furthermore, the alignment of legislation on climate legislation and the SDGs to be supported by benchmarking. This is especially important given the new Environment Bill will put environmental ambition and accountability at the very heart of government (DEFRA, 2018b).

Also, in the UK, the promotion the “future of mobility” transportation grand challenge will look at ways to achieve low carbon transport, which currently accounts for 40 per cent of total energy used. In particular, it is emphasised that the cost of clean technologies, systems and services should be reduced in all sectors. It is noted that Brazil is reported to have a relatively clean domestic supply of energy with 40 per cent energy coming from renewable resources (Brazil Government, 2017).

In relation to SDG 12, both the UK and Brazil have synergies that can be utilised for further improvement towards the achievement of their vision.

## 5. Future research agenda

Based on the research questions placed in the introduction, we would like to propose the following research agenda topics for the next decade. First, the need to consider the context in which the goals are going to be affected, that is, in a developed country where many things that are taken for granted: education, health, safety, etc. The application of the SDGs will have a different lens than if they were to be applied to a developing economy. Such consideration of context would recognise the potential challenges for a developed economy where there is significant legacy and, therefore, significant challenges in changing from industrial assets to education provision. Second, SDGs are prioritised in different ways according to their importance in the context and predominant sectors, for example: infrastructure and innovation take priority in developing countries, whereas responsible consumption and production take priority in developed countries. However, it would not be advised to ignore the level at which the other SDGs place a role too. Third, develop a common language that is understood by academics, practitioners and policy-makers which allows for the synergy of ideas to be meaningful and make progress more quickly. Fourth, increase our understanding how the consolidation of existing digital technologies and new technologies emerging could be exploited to improve the efficiency and effectiveness of our consumption and production systems. This would include both maximising the efficiency of our use of resources as well as maximising the sharing of our knowledge of tools and practices that deliver such resource efficiency. Finally, it is paramount to acknowledge and assess the connections between the different supply and demand patterns that affect one another in relation to a systemic approach to development.

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# RAUSP Management Journal

## Number 3

249 Editorial board

### EDITORIAL

250 The peer-review process: doing good and doing well

253 Financial indicators, informational environment of emerging markets and stock returns

Renata Turola Takamatsu and Luiz Paulo Lopes Fávero

269 Conceptualizing and qualifying disruptive business models

Giovana Sordi Schiavi, Ariel Behr and Carla Bonato Marcolin

287 Adoption of health information technology in the mobile emergency care service

Jonatas Wendland, Guilherme Lerch Lunardi and Décio Bittencourt Dolci

305 Operational competencies and relational resources: a multiple case study

Fernando Nascimento Zatta, Elmo Tambosi Filho, Fernando Celso de Campos and Rodrigo Randow Freitas

321 Estimating credit and profit scoring of a Brazilian credit union with logistic regression and machine-learning techniques

Daniel Abreu Vasconcellos de Paula, Rinaldo Artes, Fabio Ayres and Andrea Maria Accioly Fonseca Minardi

337 Managing critical services through hybrid arrangements

Sandro Cabral and Claude Ménard

### ThinkBox

357 The quest for achieving United Nations sustainability development goals (SDGs): infrastructure and innovation for responsible production and consumption

Luisa Huaccho Huatuco and Peter D. Ball