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Complexidade das Organizações

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Resumo

A adaptação às constantes mudanças dos mercados nacional e internacional é fundamental para que as respostas corporativas se vinculem à implementação de estratégias eficazes e eficientes. Contudo, o ambiente competitivo, fomenta a instabilidade e imprevisibilidade do mercado, colocando em causa a sustentabilidade das estratégias. É neste contexto que surgem as limitações associadas à forma de gestão tradicional, pautada pela necessidade de controlar o desconhecido. O reconhecimento das teorias da complexidade como nova base conceitual capaz de readequar as práticas de gestão aos ambientes organizacionais contemporâneos, é o ponto de partida para a compreensão das organizações como sistemas adaptativos complexos. Observar as organizações como sistemas complexos é admitir que a sua história - *path dependence* – a torna única na sua forma de pensar e agir no mercado.

A presente dissertação apresenta como objetivo geral estudar as organizações com base nos pressupostos das teorias da complexidade. Este objetivo, consubstancia-se em duas intenções fundamentais (1) analisar o estado da arte relativamente à complexidade no contexto das organizações e, (2) investigar qual a influência da complexidade no seu desempenho e sucesso.

Para investigar as organizações complexas, adotaram-se diferentes métodos de investigação. Numa primeira fase, recorreu-se ao VOSviewer com o objetivo de mapear e ilustrar a literatura científica desta área, ao longo do tempo. Numa segunda fase, com o intuito de avaliar a capacidade explicativa das variáveis identificadas na literatura, foi recolhida uma base de dados de 468 empresas, com e sem presença internacional. Posteriormente, foi realizada uma análise fatorial, uma análise discriminante e, uma análise de regressão linear múltipla.

Os resultados obtidos no primeiro artigo sugerem a complexidade como uma área com eminentes contributos na compreensão das organizações. No segundo artigo, a internacionalização, o número de funcionários, o tamanho, a alavancagem, a idade e o endividamento são identificados como os fatores com maior poder explicativo, apesar de se manifestarem insuficientes na medição da complexidade organizacional.

A complexidade é a característica subjacente às relações comerciais contemporâneas capaz de criar vantagens competitivas sustentáveis e, consequentemente, desenvolvimento organizacional e social. Estudar a complexidade das organizações, mais do que a medir, é compreendê-la. Tendo em consideração a reduzida produção científica desenvolvida no âmbito da complexidade das organizações, a presente dissertação reflete-se original e diferenciadora na interpretação das organizações hodiernas e da sua gestão contribuindo com novas formas de pensar a organização com base no entendimento proposto pelas teorias da complexidade.

Palavras-Chave: Complexidade das organizações, internacionalização, vantagens competitivas sustentáveis, sistemas adaptativos complexos, auto-organização.

Abstract

Adapting to the constant changes in the national and international markets is essential for corporate responses to link to the implementation of effective and efficient strategies. However, the competitive environment fosters market instability and unpredictability, calling into question the sustainability of strategies. It is in this context that the limitations associated with the traditional form of management arise, guided by the need to control the unknown. The recognition of complexity theories as a new conceptual basis capable of adjusting management practices to contemporary organizational environments is the starting point for understanding organizations as complex adaptive systems. Observing organizations as complex systems is admitting that their stories - path dependence - makes it unique in the way of thinking and acting in the market.

This dissertation presents as a general objective to study organizations based on the assumptions of complexity theories. This objective is based on two fundamental intentions (1) to analyze the state of the art in relation to complexity in the context of organizations and, (2) to investigate the influence of complexity on their performance and success.

To investigate complex organizations, different methods of investigation were used. In a first phase, VOSviewer was used with the objective of mapping and illustrating the scientific literature of this area over time.

In a second phase, in order to evaluate the explanatory capacity of the variables identified in the literature, a database of 468 companies was collected, with and without international presence. Subsequently, a factor analysis was performed, a discriminant analysis and a multiple linear regression analysis.

The results obtained in the first article suggest complexity as an area with eminent contributions in the understanding of organizations.

In the second article, the number of employees, size, leverage, age and indebtedness are identified as factors with greater explanatory power, despite being insufficient.

Complexity is the characteristic underlying contemporary business relations capable of creating sustainable competitive advantages and, consequently, organizational and social development.

To study the complexity of organizations, more than measuring, is to understand it. Taking into account the reduced scientific production developed in the context of the complexity of organizations, this dissertation is reflected in the interpretation of today's organizations and their management contributing to new ways of thinking the organization based on the understanding proposed by the theories of complexity.

Keywords: Keywords: Complexity of organizations, internationalization, sustainable competitive advantages, complex adaptive systems, self-organization.

Chapter I

Introduction

Introduction

The extinction of barriers to trade and the desire to conquer new markets, confront different cultures, regulated by disparate legal, legal and social standards, which lead to the environment conducive to the development of relationships that make the " Complexity" the watchword of contemporary business. Delineating an effective and sustainable competitive strategy in an environment guided by complexity means thinking, rethinking, reinventing and innovating traditional management standards, making it the great challenge of business management and internationalization, which should be overcome through complex thinking.

It is understood by complex thinking, a complementary reflexive thought strategy or form of thought, capable of gathering and, at the same time, recognizing the singular, the individual and concrete (Morin, 2006).

Corporate strategies capable of becoming sustainable competitive advantages impose management capable of understanding and mastering complex adaptive systems, where control is small due to insufficient knowledge, increased complexity and the fact that time is limited (Ritson, Johansen, & Osborne, 2012). The difficulty in measuring the contributions of complexity within organizations justifies the low scientific production on this topic. In this sense, this dissertation emerges as a starting point for the analysis of organizations as complex systems, which should be investigated based on a simultaneous quantitative and qualitative methodology.

According to Mintzberg et al. (2010) the difficulties managers face are creative opportunities that overcome the forms of strategic thinking. Observing organizations as complex adaptive systems, in a state of permanent imbalance, becomes the fundamental condition for, rather than remaining in the market, not standardized and absolutely unpredictable, achieving competitive advantages sustainable competition. Complexity is the necessary stimulus for change, creativity, flexibility, innovation, growth and progress, fostering opportunities for differentiation. On the other hand, the inflexibility and vice of management in predicting the non-predictable one that, coupled with overconfidence, barriers to effective strategic action (Mintzberg, 2004; Mintzberg et al.,2010).

The understanding that complexity is embodied in the tangle, inextricable and ambiguous relationship between the parties, reflects from the outset an insufficiency of human thought in the cognitive ability to evaluate all the possibilities of occurrence of multiple and dynamic scenarios, in a dubious and unknown environment, in a short time.

Associated with the concept of complexity emerges cooperation and competition between the parties, which requires organizational polyvalence, decisive for their survival (Stephen & Kunda, 2001).

Nevertheless, the adoption of strategies that have directed success in times of business may not guarantee success today. The feeling of resistance to the change of management bodies can be explained by misunderstanding and/or attachment to strategies that have already provided good results (Mintzberg, 2004). From the above, the *know-how* and the curve of the experience of organizations should be used to increase the sensitivity of reality observation, in order to provide creative and effective organizational responses to constant challenges and market changes.

The unpredictability associated with complex systems evokes the need to rethink strategies with a view to delineating and achieving competitive objectives that design the organization and idealize its future. The organizational future is only achieved if imagined and its success will only be possible if strategic planning takes into account its complexity. The maturity of markets and the evolution of corporate skills imposes a nonlinear global view on actions and facts, capable of absorbing and apprehending the dynamism needed for effective and sustainable strategic construction (Wittmann et al., 2013).

The scientific literature suggests primacy to the analogy between organizational reality and the contribution that the understanding of Theories of Complexity provide to the new and necessary notion of strategy: it is on the threshold of some "disorder" that the organization evolves, learns and self-organizes, treading innovative solutions capable of returning them the "order", in an environment guided by continuous disturbances, development and improvement.

By the above, it is essential to organize "resist change" with a view to internal efficiency and "promote change" with a view to adapting to the external environment that surrounds it – It is in this ambiguous organizational positioning that emerges complexity and will have repercussions in the way of observing and understanding reality, and acting efficiently and effectively.

Dealing with complexity implies proactivity in strategic deliberation and planning, implying the renunciation of traditional management paradigms and the search for dynamic management forms.

For the above, the present research presents as an analysis unit the organization, whose fundamental objective is to the analysis of organizations based on the understanding that complexity

proposes, as well as to ascertain which influences the complexity exercises in the performance of companies.

With a view to fulfilling and pursuing this objective, this dissertation is divided into four fundamental parts.

At first – Chapter I – the objectives are carried out, and the structure. Considering the relevance of complexity in understanding the contemporary reality of companies, in the second part – Bibliometric analysis: a contribution in understanding the Complexity of Organizations – a bibliometric study is carried out in order to measure the index of production and dissemination of knowledge in this area, through the analysis of the patterns of authorship and publications, existing in the scientific literature.

Following the general dissatisfaction associated with the performance of contemporary organizations in the face of the rapid pace of market change, follows the third part of the research – The influence of Complexity on the performance/success of organizations – with the fundamental intention of ascertaining what makes organizations more complex than others, as well as what variables, identified in the literature, that most contribute to the complexity of companies.

It is appropriate to point out that, in both chapters, a literature review was carried out, in order to (1) analyze the state-of-the-art in this field of investigation, and (2) identify the predictor variables of complexity existing in the literature.

For the different objectives outlined in each article, the most appropriate methodology was adopted. Thus, in the first article – Chapter II – a bibliometric analysis was performed using *Vosviewer* software. In the second article – Chapter III – a quantitative study was carried out through factorial analysis, discriminant analysis and multiple linear regression analysis.

Finally, in a fourth part – Chapter IV – of this dissertation, the main conclusions are exposed, accompanied by the answers to the problem questions, launched during the course of the investigation, as well as the identification of the limitations associated with the investigation.

Chapter II

Simplifying the Complexity of Organizations: A Bibliometric Analysis

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Simplifying the Complexity of Organizations: A Bibliometric Analysis

Abstract

This study includes a bibliometric analysis, aiming to map the scientific literature, through the visualization of networks that provide insights regarding the pertinence of the study of complexity in an organizational environment. The adopted methodological approach includes a literature review and the implementation of bibliometric analysis techniques. The analysed sample, collected from the scientific database of the ISI Web of Knowledge - WoS is composed of scientific articles published between 1900 and 2018. Initially, more than 500 studies were found, which, after refined, resulted in a total of 260 articles analysed.

Data were analysed at various levels, namely (1) evolution of publications and citations, (2) identification of the main sources and authors, and (3) building networks of words. VOSviewer software was used for systematic mapping and graphical illustration of the evolution of publications over time.

Our results suggest complexity as an area with eminent contributions for a better understanding of organizational context and dynamics, highlighting Management Science journal as the one with the greatest impact in literature and author Bill Mckelvey, as the one with the largest number of publications in this area.

Key words: Complexity, Organizations, Bibliometric analysis, VOSviewer.

1 Introduction

The contemporary society, with demanding consumers and competitive pressures, is increasingly dynamic, unstable and globalized. On the other hand, globalization has increased the complexity of the world, which, per se, is a system of open and "non-linear" relations, reflecting the need to build competitive advantages in order to survive and prosper in a constantly changing market (Business Dictionary, 2019).
So far, to our knowledge literature has been focusing on the evaluation of impacts and contributions of organizational complexity, impelling new ways of thinking regarding the study of organizations (Snowden & Boone, 2007; Singh, 1997; Geraldi et al., 2011), while others analyze the organizations in order to measure and identify complexity at different levels (Andreatta et al., 2009; Lin & Lee, 2008; Boone et al., 2007; Kirch et al., 2012).

In fact, studying the organizational environment based on Complexity Theories becomes challenging given the state-of-the-art of literature. Although all the analyzed studies provide important contributions and perspectives in the study and understanding of the complexity in different environments, the accomplishment of a complementary analysis of the literature, using specific *softwares*, allows to obtain additional information, capable of guiding future investigations. In this sense, it is justified to carry out a more complete and comprehensive analysis: the bibliometric mapping.

The construction and visualization of bibliometric networks are crucial not only for the identification of contemporary, potential and emerging areas of study, but also for the demonstration of the origin and evolution of the various areas of thought, constituting as a way of identifying fields of study additional. Thus, the bibliometric analysis proposed in this work was elaborated with the objective of: (1) identifying the existing research flows in the literature on complexity, (2) illustrate, through graphs and figures, the evolution of the concept, over time, and (3) identify potential areas of interest for current and future research in this field.

This work begins with a comprehensive view of the concept complexity - Chapter 2 - fundamental for the contextualization of the concept, through the exposition of definitions and conclusions extracted from studies. Subsequently, a description of the methodology adopted, is given - Chapter 3 - to identify, refine and proceed to the treatment of the literature that will be analyzed in this study, then a bibliometric analysis was carried out, where several maps were presented, fundamental for a multi-level analysis, namely (1) emergence and evolution of scientific production on complexity, (2) network evolution and co-citations and (3) network of words. Finally, the results are presented together with a critical analysis of the main findings - Chapter 4 - as well as the main limitations of the study and proposals for future research.

2 Literature review

2.1 Organizational Complexity

Corresponding to a global trend, the study of complexity, although it has evolved in the interim of more than 39 years, it has been subject of more investigations in the last decade, attracting the interest of researchers of several scientific areas. Studies carried out in order to apply the understanding and contributions of complexity in the various categories of scientific knowledge[1], denote, immediately, complexity as a holistic and emerging science in the best understanding of contemporary reality, in diverse contexts. In this sense, the study of organizations, based on the construct of complexity, becomes equally credible.

The concept of complexity analyzed in the organizational sphere, as a strategic factor in obtaining sustainable competitive advantages, acquired greater relevance mainly in the 1990s. However, previous studies demonstrate interest in this area, such as, Heylighen (1988), who underlines the need to develop new approaches, exempt from the reductionist analysis that characterizes classical science, proposing complexity as an intertwining of differentiation, distinction, variety, change and disorder, on one hand, and integration, connection, selection, invariance and order, on the other hand (Heylighen, 1988).

Stacey's (1996) research corroborates this new approach to the behavior and functioning of organizations as learning and self-organizing agents in that it proposes that the inhibition of anxiety caused by the unstable and metamorphic nature of business represses, simultaneously the impulses to the creativity (Stacey, 1996).

According to Pascale et al. (2000), it is imperative to analyze organizations as complex adaptive systems, because, like complex systems, organizations also find themselves uncontrollable, unpredictable and constantly changing (either in their internal or external environment). The authors also argue that every action taken by a given agent (internal or external to the organization) implies changes in the context (Pascale et al., 2000).

Despite the convergent proposals for definition of complexity[2] arising from authors in different scientific areas, the essence of the term "complexity" culminates in three, authentic, characteristics: interdependence, unpredictability and adaptability.

Complexity can be defined as the availability of "non-linear relations," or as the existence of interrelationships between individuals (of a particular organization), the organization and its external environment, that consequently may lead to need for organizational restructurings and adaptation to new realities (Business Dictionary, 2019). In this way, complexity urges as a characteristic of the system which must take into account all the historical events of the organization and context, as they are jointly responsible for their current performance as well as the numerous and proliferating contact networks and iterations of its individual components (Dekker et al, 2011).

According to Gell-Mann (1995/96) complexity can still be understood as the intricate interlacing or interdependencies found among agents (organizations, communities, among others) within a system and between the system and its environment, suggesting a symbiotic relationship between the organization and its environment. From this diversity of interactions that constitutes a given system, different and unpredictable results may emerge for the same actions (Gell-Mann, 1995/96). In this sense, unpredictability is highlighted, as the main characteristic that distinguishes the concepts "complexity" and "complicated"[3].

Bertalanffy (1998), when considering the organizational system, encourages future investigations, since, together with the understanding of dynamic, non-linear systems in other scientific disciplines, they suggest new ways of studying and understanding modern organizations and their management (Bertalanffy, 1998). Organizations contain within themselves a complex set of eight metaphors[4] that emphasize the need to "read and understand the world," i.e., to understand how individuals relate to each other, what meaning humans attribute to " things", and continually understand how complex it is (Morgan, 1997; Vesterby, 2008). Nevertheless, the ability to learn and understand the complexity of organizations is fundamental and dependent on their innovative and creative strategic choice (Ponchirolli, 2007).

Mckelvey (2004) identifies two different ways of approaching and investigating complexity, namely (1) a physical science and (2) a social science. In this sense, the science of complexity is embodied

[1] Table 1 – Appendix A
[2] Table 2 – Appendix A
[3] Table 3 – Appendix A
[4] Figure 1 – Appendix A

not only in a theory but in a set of theories – called Complexity Theories - that identify firms as "complex adaptive models" (Mckelvey, 2004).

When investigating literature, it became notorious, not only the scope of the concept, but also, and its use, essentially, under two different dimensions: (1) horizontal or operational complexity and (2) vertical or organizational complexity. These two approaches differ as the first one indicates the distance between the units of the firm and the last one refers to the depth of the its hierarchy or organizational structure (Daryani & Amini, 2016). Therefore, the hierarchical structure of organizations becomes necessary to reach a common goal, becoming more and more rigid the more complex the organization (Herbert, 1962).

According to Galbraith (1982), organizational design aims to combine not only the complexity of its environment and technology, but also the structural complexity of the organization (Galbraith, 1982).

Simon (1996) defined a complex system as the combination of a significant number of pairs between which many interactions are found (Simon, 1996). On the other hand, Thompson (1967) suggests that a complex organization consists of a set of interdependent parts, which together form a whole - the organization - which in turn is interdependent of some larger environment - the market, for example. Thus, organizational theory must integrate complexity as a fundamental variable in the characterization of the organizational environment and the environment (Thompson, 1967).

Firms are characterized by complex, non-linear dynamic systems insofar as they are the evolution of the structure of the organization that interacts in divergent and, of course, complex social, economic, and political systems. Firms also reflect the peculiar way in which their subsystems interact with each other at various levels, local, national and international, thus making it unreasonable to estimate forecasts in the long term, given that their environment is complex and dynamic. Therefore, the more complex the firm, the more necessary is a competent and creative management.

Looking at the nonlinearity characteristic of complex systems applied to the organizational context, one is led to conclude that, in practice, organizations (as non-linear systems), in an attempt to change a norm or solve a problem, will cause a drastic change throughout the enterprise, as a system, since changing a small part of a subsystem will radically change the behavior of the whole system. However, it should be stressed that the system as a "whole" can be very different from the sum of the parts or subsystems it includes (Casti, 1994; Daft & Lewin, 1990).

The organizational complexity construct encompasses a significant set of characteristics and organizational variables associated with a high level of differentiation and specialization of its resources, both at the level of the profession and at the level of innovative technology and access to information. On the other hand, firm size is not, alone, a variable that results in complexity (Bushman et al., 2004; Thompson, 1967).

There are also authors who consider organizational complexity as a reflection of the firm's internal dynamics and not only of the external dynamics of the metamorphic markets and constant technological evolution (Crispim & Barbosa, 2006).

Organizational complexity comes from diversity, instability, unpredictability, robust dependencies, synergies and needs for specialization, innovation and solutions (Daryani & Amini, 2016). The intensification of convergence with the rest of the world results in firms operating in different geographic areas, subjecting themselves to different international normative standards, unequal legal systems and significant cultural barriers (Sanders & Carpenter, 1998).

In fact, a new approach to the behavior and functioning of organizations, based on complexity, is devised. However, considering the difficulty in measuring the complexity construct (since the variables identified in the literature are insufficient), it is considered that the literature review on this subject, using bibliometric analysis, is not simple and it justifies this research. In addition, although there are studies that already explored organizations and their management, based on complexity, there is still little scientific production in this field. It is with this conceptual framework, summarized in this paper, that a quantitative bibliometric study, alluding to complexity, is proposed.

3 Review of the Bibliometric Analysis Literature

According to Meksenas (2009), the research encompasses a set of strategies for gathering information from the reality analyzed by the researcher (Meksenas, 2009). Therefore, this chapter is dedicated to the detailed explanation of the strategy and methodology used in the dynamization of the study, from the selection of articles to the extraction and analysis of the sample.

3.1 Adopted Research Strategy

Considering the transversality of the concept of complexity and, consequently, its interest and relevance in an organizational environment, our study aims to amplify and corroborate the state of art through a systematic literature review, profitable in showing its evolution in the areas of knowledge and, at the same time, a better understanding of the concept. Our aim was divided into three objectives, namely: (1) to develop a bibliometric analysis of the literature, with regards to complexity within an organizational environment; (2) to clarify the concept of complexity using bibliometric analysis tools, useful in the measurement of scientific productivity, through maps and clusters; (3) identify topics and areas associated with organizational complexity, basing it as a field of contemporary interest.

However, before carrying out the bibliometric analysis it is important to clarify about the methodological approach and to describe, briefly, the use of bibliometric techniques as an instrument for the evaluation of existing literature on a given area.

Bibliometrics is understood as the measurement of texts and large quantities of historical information, or the statistical and mathematical analysis of standardized information, which appears in scientific publications (Diodato, 1994). In this line of thought, bibliometric analysis consists of a set of techniques, carried out through specific software, aimed at quantifying the process of written communication (Ikpaahindi, 1985), with the objective of obtaining a consistent and standardized set of relevant indicators for the assessment of imminent authors or the importance of a discipline (Diodato, 2012).

Thus, bibliometric information allows the analysis of scientific production, based on the number of articles published in a certain category of knowledge, as well as on the number of citations, i.e., on the number of times an article is cited as a reference, in other articles of the literature. Although bibliometric articles have been published for several years, in fact, over the recent past they became more frequent, since, they offer indicators of thematic associations (common references), impact (number of citations), quality and activity with a focus on a certain area of knowledge.

In order to obtain an overall state-of-the-art, it became imperative to use VOSviewer software, which is profitable in the creation, visualization and exploitation of networks or bibliometric maps. This software was chosen because it is prepared to work efficiently with large datasets, providing a variety of mapping and clustering options, assisting researchers in identifying patterns hidden in the comprehensive scientific literature (Eck & Waltman, 2019; Diodato, 2012).

The selection criteria[5] for the articles in the initial sample resulted from a combination of topics and titles in the ISI Web of Knowledge (WoS) database, called Web of Science ™ Core Colletion.

The basic research of publications resulted from the combination of two keywords and one expression, in three lines of research that include the research by "Title" and "Topic". Our research started by searching for the word "Complexity" in the title, then adding a second line with the search term "Business" in the topic.. Subsequently, when adding a last and third line in the search, the "or" search option of publications was placed through the expression "Organizational Complexity" in the title. Once the search was activated, for the terms mentioned above, it became possible to obtain a total of 600 results, after being refined by categories, more specifically in the field of "Management" or "Business" or "Economics" or "Business Finance", compressing the sample to the 260 results. In this sense, the extracted sample included several typologies of documents, and more than half of all publications (172/260 = 66,15%) were reduced to scientific articles, published in time span of 39 years, between January of 1979 and December of 2018. Although no time restrictions were implemented, but 1979 is the year of the first publication in organizational complexity. if it were necessary, it would be preferable if the beginning of this analysis were to take place in 1979, because, in that year, the first publication complexity inherent in this database.

3.2 The origin and evolution of the concept of complexity

Although the complexity was always present in the environment, the introduction in literature occurred only in the year 1979, by Beyer & Trice, with the publication of a scientific article entitled “The Reexamination of the Relations between Size and Various Components of Organizational Complexity” in Administrative Science Quartely (ASQ). Through this article, the authors replicate and, consequently, reassess the results advocated by Blau and Schoenherr (1971) concerning the correlation between size and the various components of complexity, in a sample of 77 federal institutions. Although the results obtained by Blau and Schoenherr (1971) point to size as the predictor of complexity, in the case of the federal

[5] Table 4 – Appendix B

institutions investigated by Beyer & Trice, the results obtained are similar, the division of labor emerges as the most predictive variable of complexity (Beyer & Trice, 1979; Blau & Schoenherr, 1971). According to Beyer & Trice (1979), obtaining inconsistent results can be explained not only by the divergent size of the organizations studied, but also by the technology adopted.

The analysis of the literature, a nonlinear (increasing and decreasing) geometric growth of publications on the complexity of the organizations per year[6] becomes clear, gaining particular prominence over the last decade (2008-2018), as it represents 5% of all registered publications (71/260) since 1979. Nevertheless, more than half of the publications (143) were published in the last 7 years. Since 2011, the number of publications observed has been equal to or greater than 12 per year. The year 2016 stands out as the year with the highest number of publications in this field of research, with 29 publications. Although irregular, it is possible to observe a growing trend in the publication of documents related to complexity, with peaks tending to increase in the years 2006, 2010 and 2016, with 11, 17 and 29 publications per year, respectively. The low number of publications can be explained by the difficulty in identifying the predictive variables of complexity and, consequently, in their measurement, observing the growing relevance of the concept to the scientific literature in the field of business sciences (since the suggest a steadily increasing trend). Although there was a (isolated) publication in 1979, this subject only received the attention of the literature from 1991. In fact, complexity is a multidisciplinary concept investigated in several different areas of knowledge, but with special emphasis in the area of business sciences[7], justifying the refining of the sample based on the domains of management, business, economics and of finance.

The 260 publications, carefully selected and considered in this study, present a mean citation rate of 16.17%, with a total of 4203 citations, of which 94 were never cited. Of the remaining 166 publications, 27 were cited only once, and 139 were cited two or more times, with the existence of a single scientific article with a total of 452 citations. Because the sample has an h-index equal to 32, it can be pointed out that the 32 most cited articles present quotations between 452 and 33 citations[8]. Nevertheless, this analysis also allows to identify and analyze briefly the objectives and main conclusions of the 10 articles that are more relevant in the study of the complexity in organizational environment.

3.3 Evolution and co-citation network

The initial sample of 260 articles was reduced to articles with at least 9 citations, resulting in a reduced sample of 11 articles. The same is to consider that of the 12206 citations that are observed in total, 11 studies are cited at least 9 times.. This criterion resulted in the construction of a network of co-citations composed of 11 articles, grouped in 3 clusters[9].

As far as sources[10] are concerned, it should be noted that 185 publications in academic journals (with quotations amounting 4099) and 75 publications in conference articles (with 104 citations in total) were registered in the 260 articles under analysis. Nonetheless, 21 scientific journals exhibit at least 52 citations. Harvard Business Review, Journal of Accounting & Economics, Human Relations and Organization Science are the publications with the highest number of citations in Management Science, having a total of citations of 452, 340, 300, 295 and 200, respectively. With regards to the number of articles published, in this field, it is noted that the most attractive journals are International Journal of Operations & Production Management and Journal of Business Research, with a total of 7 publications each, followed by Industrial Marketing Management with 6 articles published.

This bibliometric analysis was still useful for the identification of 4 clusters, inherent in publications with more than 50 co-citations Cluster formation, in this study, discusses the agglomeration of common variables in all 260 articles of the sample, allowing the identification of the areas where the complexity displays visibility.

These clusters, generated algorithmically, allow the identification of the most cited sources and the consequent proper classification of the clusters created[11]. The criterion adopted in the denomination of the generated clusters, involved an intensive research to the scientific areas to which each author is dedicated. Cluster 1 (1534 citations) emerges associated with Internationalization of Organizations, Cluster 2 (605 citations) agglomerates all publications in the area of Marketing, Networks and Leadership, Cluster

[6] Figure 2 – Appendix B
[7] Figure 3 – Appendix B
[8] Table 5 – Appendix B
[9] Figure 4 – Appendix B
[10] Table 6 and Figure 2 – Appendix B
[11] Figure 5 and Figure 6 – Appendix B

3 (617) identifies all publications within the scope of Management and Innovation, and finally Cluster 4 (137 citations) includes the remaining publications on Businesses.

Embracing the assumption that the number of citations is reflected in the influence and relevance of articles, authors, sources, among others, this research follows the analysis of the 42 most cited authors[12] of the 552 authors responsible for the development of 260 analyzed. Five of these authors have at least three hundred citations, with the most cited authors being Damanpour (452 citations), Bushman (300 citations), Chen (300 citations), Engel (300 citations) and Smith (300 citations). As for the number of publications Mckelvey (3 articles), Jacobs (2 articles), Singh (2 articles) and Woodside (2 articles) stand out.

As far as authors with more co-citations are concerned, it is important to note that, in order to obtain the map of co-cited authors, a minimum number of at least 20 co-citations was defined, with Bill Mckelvey topping the list with a total of 38 citations. From this analysis, 3 clusters of co-cited authors[13] emerge. Cluster 1 (195 citations) brings together research authors focused on Dynamic Capabilities. We follow Cluster 2 (165 citations) with the authors related to research in the field of Strategic Management and in Cluster 3 (122 citations), with the authors most directed to Complexity Theories.

3.4 Word Association Analysis

The lexical analysis of the set of keywords that can be most frequently found in the database, allows to deepen the understanding of the subjects investigated in the publications inherent to the organizational complexity. Thus, by defining the minimum number of occurrences of a keyword[14] to five, the network of words, consisting of 64 of the 1331 key words under study, was generated.

The results show the generation of six clusters of keywords[15]. Cluster 1 agglomerates words related to Management, Strategy and Competitive Advantage. Cluster 2 includes issues related to Complexity. Cluster 3 refers to Human Resources. Cluster 4 has terms related to the field of Leadership. Cluster 5 lists factors associated with the Entrepreneurship area. Finally, Cluster 6 emerges focused on Networking and Business Performance.

Thus, there is eminent evidence of an increase in publications in this field, which is why it is justified to consider the complexity, in an organizational environment, a relevant subject with contemporary interest. It is also worth mentioning the presence of the United States of America and England in this area of research, presenting publications in the order of 71 and 47 articles, respectively[16]. On the other hand, the representativeness of Portugal, in the literature, in the domain of complexity, is scarce, counting only with the publication of 5 articles[17].

4 Conclusions

The hybrid approach of literature review (qualitative component), combined with bibliometric analysis (quantitative component) has proved effective in measuring the rates of production and diffusion of scientific knowledge, as well as in the identification of multilevel patterns (authorship, citation, sources,...), amplifying the understanding and evolution relative to the holistic concept of complexity.

The organization, as an open system, develops relationships to generate business and prosper in the world-wide market (Damanpour, 1996). From these relationships, an undetermined number of interactions exist between each of its stakeholders, which allows organizations to be recognized as complex systems capable of developing effective adaptive solutions (Anderson, 1999).

The extension of the concept of complexity to organizations renews the business paradigm and their strategic management (Simon, 1962), emphasizing the pertinence of generating creativity, increasing communication (Weick, 1977), inducing change (Brown & Eisenhardt, 1997), to drive innovation processes (Damanpour, 1996) and to constantly improve through continuous learning (Stacey, 1996). Managers' leadership influences the adaptation of organizations to their surroundings (Anderson, 1999), which is why

[12] Table 7 e Figure 7 – Appendix B
[13] Figure 8 – Appendix B
[14] Figure 9 – Appendix B
[15] Figure 10 – Appendix B
[16] Figure 11 – Appendix B
[17] Table 8 – Appendix B

managers should drive (rather than abolish) the self-organizing capabilities of companies, often resigned to short-term goals productivity (Meadows, 2016).

Some authors (Sull & Eisenhardt, 2015; Simon HA, 1996) argue that complexity, which involves the contemporary world, is a "disguise" for simplicity suggesting that organizations use the complexity that surrounds them in an opportunity to deceive competition and achieve sustainable competitive advantages that guarantee long-term success.

Nelson & Winter (1982), aware of the need to construct a new approach to the behavior of organizations, propose to extend the understanding proposed by complexity to the process of "natural selection" developed in the field of biology. From this association, it becomes possible to interpret that complexity leads to the occurrence of a process of "natural selection" of the stronger companies to the detriment of the weaker ones (Nelson & Winter, 1982).

This bibliometric analysis showed an evolution, although intermittent, leading to a growing trend in the number of publications registered in this field, since more than half of the 260 articles analyzed were published in the last seven years (2012-2018). Nevertheless, the literature on complexity in organizations is scarce. This situation evokes and reinforces the need to understand, first and foremost, the complexity of an increasingly globalized world and then understand the complexity of the companies operating in it. In this sense, the study of the complexity of organizations becomes a great challenge for literature, since it is easier to understand it than to measure it (Vesterby, 2008).

In line with the results obtained, and driven by the assumption that scientific knowledge is cooperative and cumulative, the Management Science journal is considered to have the greatest impact in the literature on the complexity of organizations, based on their number of citations, followed by Harvard Business Review and Journal of Accounting & Economics, with 340 and 300 citations, respectively. On the other hand, the scientific journals that, based on the sample, published more articles are the International Journal of Operations and Production Management and the Journal of Business Research, since each of them has 7 articles published in this field.

As for the 552 authors responsible for the development of the 260 articles in the sample, Bill Mckelvey stands out as the author with the highest number of publications in this area and Fariborz Damanpour as the most cited author.

At the level of the lexical analysis carried out, the following words stand out as the most associated with the topic: Complexity, Management, Innovation, Business, Organization and Performance, due to the higher number of occurrences (154 in total).

The analysis of the scientific production at the level of the countries, although Portugal has 5 publications, the country that stands out with greater affluence are the United States of America, with 71 articles published in this field.

Therefore, it is fundamental to make the entire scientific community aware of the pertinence of the study of complexity in the organizational environment, since it reflects an area with strong contributions in the understanding of the organizations and the environment in which they operate.

It is also important to highlight the limitations recognized in this study. The first limitation is imposed by the methodological choices made, namely the fact that the data source was collected from the ISI Web of Knowledge index database, limiting the analysis to the publication registers in such database, and excluding other studies published in other scientific databases. It is also pertinent to point out, as a second limitation, the fact that our study considers the number of citations as an impact factor and relevance of the articles, since the most recently published articles are at a disadvantage to the detriment of the articles generating a temporal bias of analysis.

Recognizing the limitations of this study, it can be considered that this analysis contributes differently to the scientific literature, in that it outlines an emerging organizational environment that crosses insights with complexity, with the intention of describing organizations as systems where frequent changes are observed, fast and exclusive (Brown & Eisenhardt, 1997).

The main purpose of this study – aiming to review the literature with bibliometric analysis - we conclude that complexity (based on the contributions that Complexity Theories offer), besides proposing new ways of delineating and understanding the dynamic and non-linear behavior of organizations, also contributes significantly to the strategic management of firms as complex adaptive systems, satisfying the need for complex thinking in a context of asymmetries and uncertainty that characterize the contemporary market (Snowden D., 2003); (Weick, 1979); (Brown & Eisenhardt, 1997); (Morin, 2006).

For future research, it is suggested the use of robust software that credibilize the dynamization of studies of quantitative and qualitative statistical analysis, simultaneously, in the sense of integrating characteristics and measuring variables of the political, social and cultural environment that allow to

evaluate and analyze the real contribution of the complexity of organizations for their strategic management.

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Appendix

Appendix A: Literature Review – Complexity of Organizations

Table 1: Identification and analysis of papers on Complexity applied to different contexts and areas of scientific knowledge, namely, Social Sciences, Economics, Finance and Psychology

Comprehensiveness of the study of Complexity in Literature	
Scientific area	Article description and analysis
Social Sciences	Author(s): Mathews, White, & Long (1999)
	Title: Why Study the Complexity Sciences in the Social Sciences?
	Purpose(s): Provide a comprehensive view of the complexity sciences; Present grounds for the inclusion of complexity in organizational sciences; and Present an updated literature review on organizations that draws on the concepts and implications of the complexity sciences for organizational phenomena.
	Conclusion(s): The emerging sciences of complexity must be integrated into the meta-theoretical, substantive, and methodological levels of organizational analysis, since they have the potential to deepen and enhance their theoretical understanding. The complexity sciences are an emerging set of scientific perspectives on the complex behaviors of physical and natural systems, and can thus bridge limitations in understanding and explaining social phenomena.
Economics	Author(s): Colander, Holt & Rosser Jr. (2004)
	Title: The Changing Face of Mainstream Economics
	Purpose(s): To analyze the change of the economy, from the neoclassical or traditional presuppositions, to its development centered on dynamics, methods and complexity theory.
	Conclusion(s): The results suggest representativeness in the effective change of the economy. According to the authors, as work progresses and accumulates, the economist's focus changes and creates a new orthodoxy based on a broader view of complexity.
Finance	Author(s): Mantegna & Stanley (2000)
	Title: An Introduction to Econophysics: Correlations and Complexity in Finance
	Purpose(s): Study financial markets based on the introduction of concepts such as distributions of power laws, correlations, time series, unpredictable and random processes.
	Conclusion(s): Full knowledge of the statistical properties of the asset return dynamics is essential for the development and testing of a statistical model of the financial market. The dynamic properties of asset return dynamics - such as the continuous or discontinuous nature of their changes, the randomness of their volatility, and the knowledge of the function of asset returns - need to be identified to adequately represent, and possibly represent, solve the problem of calculating the prices of the options.
Psychology	Author(s): Pastor & García-Izquierdo (2017)
	Title: Complexity and social psychology of organizations
	Purpose(s): Present a complexity (nonlinearity, chaos, automatic organization ...) as a new and alternative perspective perspective on an old reductionist and simplifying paradigm; Observe organizations as complex adaptive systems and offer a synthesis of the applications and contributions of complexity to the Social Psychology of Organizations.
	Conclusion(s): The complexity paradigm allows us to better understand the behavior of complex systems, such as organizations; It is crucial to accept and assume complexity, as fundamental in social psychology, because this area is concerned with the chaotic and human relations that exist in the "social" component, which is obviously complex, indeterminate, uncertain and turbulent; In addition, Social Psychology of Organizations offers many valuable tools for organizing orderly but disorganized chaos, which is life in organizations.

Table 2: Proposals for definition of complexity found in the literature

Contextualization of the concept Complexity	
Definition proposals	*Theoretical support*
Complexity implies unpredictability and emergence of the new and change within the system. We are faced with a complex phenomenon when it is associated with a certain potential unpredictability, arising from the behaviors.	(Moigne, 1977)
Complexity is the consequence of a complex system, which has many parts or elements, which aggregate in a disordered or unexpected way, and cannot be circumscribed to a regular and periodic pattern. In this sense, the existence of complexity impels the verification of two fundamental characteristics, namely: (1) the multiplicity of elements; and (2) the connectivity of the elements, presenting a dual aspect, which means that, despite having divergent parts, these parts are joined by their interactions.	(Heylighen, 1988)
The perception of complexity lies in the difference between the variety of the observer and the variety of observed phenomena. If the difference is equal to infinity, the phenomenon is perceived as complex. If the result of the difference is null, it means that the observer knows all the states of the system, so the phenomenon is perceived as simple.	(Iarozinski, 2001)
"In the first instance complexity is the fabric of events, actions, interactions, feedbacks, determinations, happenings that constitute our own." In the first moment, complexity is a fabric of heterogeneous elements. fundamental world, "where order is inseparable from the chaos - paradox of the one and the multiple.	(Morin, 2006)

Table 3: Characteristics and their distinction between "Complex Systems" and "Simple Systems"

D*istinction: Complex or complicated?*		
Complex Systems	*Complicated Systems*	*Theoretical support*
Open, dynamic, chaotic, non-linear, self-organizing and adaptive relationships, that is, they react to variations in the environment	Linear relationships, which function in a predefined way, although sometimes not understood	(Larsen-Freeman, 1997)
The parties cannot be separated because they are strongly interconnected	The parts can be separated without compromising the system	(Snowden, 2003); (Heylighen, 1988)
Unpredictable behavior	Predictable behavior	(Moigne, 1977)
Constant change	Can be reduced	(Snowden, 2003); (Moigne, 1977)
Uncontrolled	Can be controlled or extinguished	(Snowden, 2003)
Example: the market	Example: a manufacturing process	

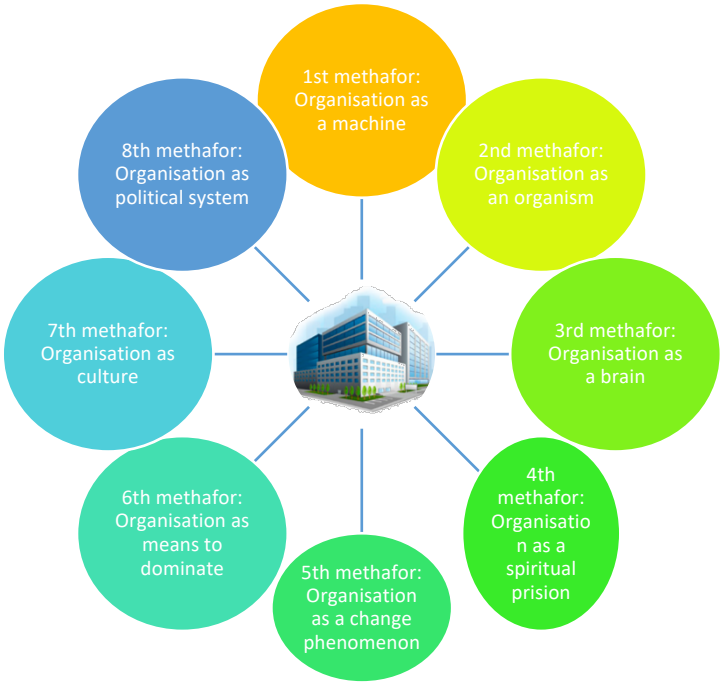

Figure 1:. Business dimensions of multifaceted nature, based on the eight metaphors of Gareth Morgan.
Source: Morgan G. (1997 p.360)

Appendix B: Bibliometric Analysis

Table 4: *Strategy and search criteria used for data extraction indexed to the Web of Science*

Research steps	*Criterion*	*Motivations for inclusion*	*Number of results*
Basic Search	Title: Complexity; and Topic: Business; or Title: "organi*ational complexity";	To organize research around Complexity in a general manner	600
Refine Search	Publications without temporal restrictions (1900 - 2018)	Agglomerate all registered publications inherent to complexity in an organizational context, in order to better analyze their evolution.	260
	Generality (consideration of all countries)	Ensure a multicultural view inherent in the construct "complexity".	
	Types of documents: (a) periodic articles; (b) conference papers (c) books; (d) book chapter	Collect all the results and contributions in the literature.	
	Research Domain: (1) Management, (2) Business, (3) Economics and (4) Finance	Focus research in the area of Business Sciences, based on four domains.	

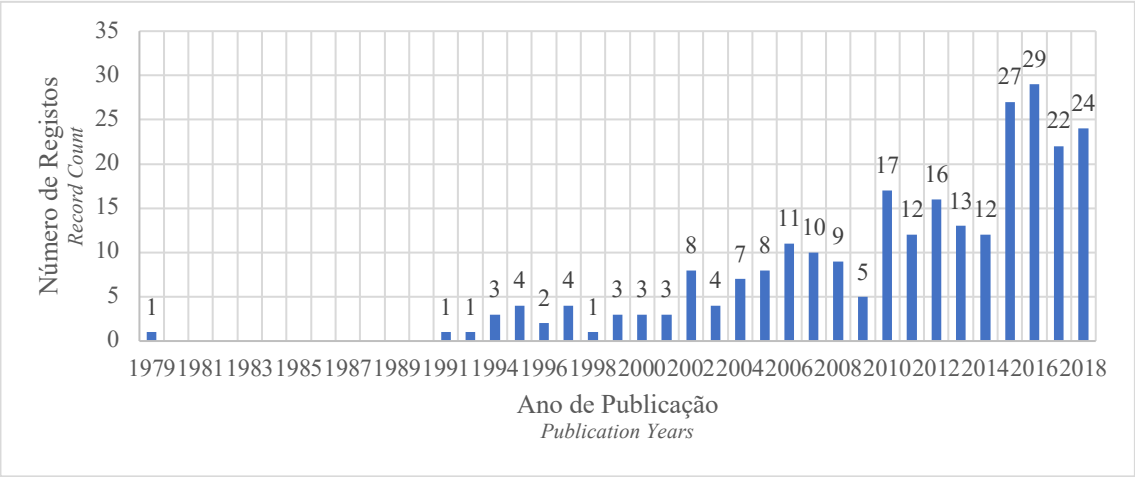

Figure 2: Bar chart inherent in the number of articles published, per year, between 1979-2018

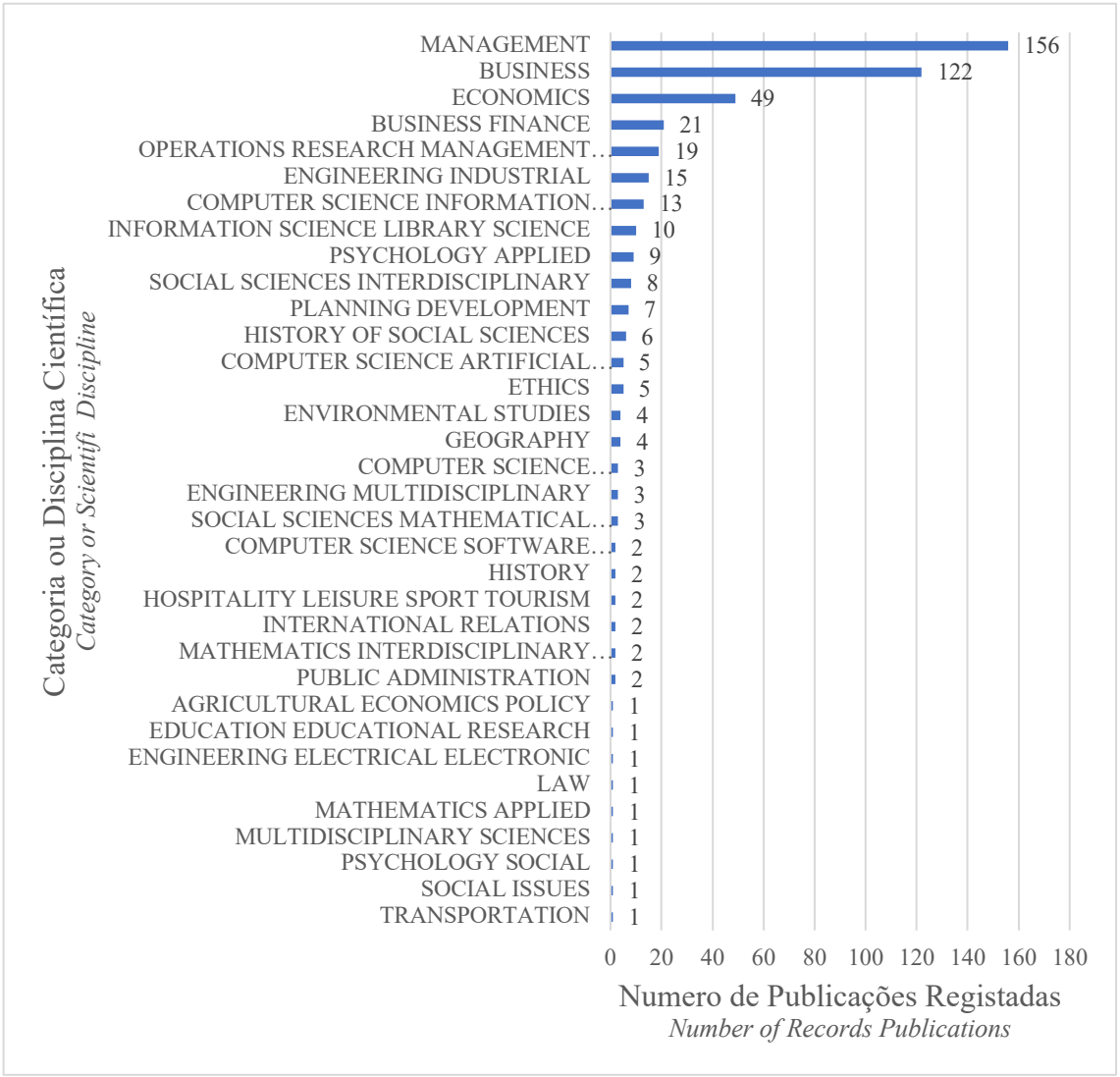

Figure 3: Number of publications registered by scientific category

Table 5: Most cited articles in the scientific literature in the scope of complexity.

Number	*Authors, Publication Year*	*Total Citations*
1	**Damanpour, F., 1996**	**452**
2	**Bushman, R; Chen, Q; Engel, E; Smith, A., 2004**	**300**
3	**Snowden, David J.; Boone, Mary E., 2007**	**260**
4	**Tsoukas, H; Hatch, MJ., 2001**	**166**
5	**Robson, Matthew J.; Katsikeas, Constantine S.; Bello, Daniel C., 2008**	**137**
6	**Singh, K., 1997**	**136**
7	**Geraldi, Joana; Maylor, Harvey; Williams, Terry, 2011**	**121**
8	**Barthelemy, Jerome; Quelin, Bertrand V., 2006**	**119**
9	**HaertT, SL.; Quinn, RE., 1993**	**101**
10	**Rueda-Manzanares, Antonio; Aragon-Correa, J. Alberto; Sharma, Sanjay, 2008**	**93**
11	Larsen, Marcus M.; Manning, Stephan; Pedersen, Torben, 2013	92
12	Benbya, Hind; McKelvey, Bill, 2006	79
13	Closs, David J.; Jacobs, Mark A.; Swink, Morgan; Webb, G. Scott, 2008	76
14	Mcarthur, AW.; Nystrom, PC., 1991	68
15	Kodeih, Farah; Greenwood, Royston, 2014	57
16	Azmat, Fara; Samaratunge, Ramanie, 2009	57
17	Mason, Roger B., 2007	57
18	Banker, RD; Slaughter, AS., 2000	57
19	Naveen, Lalitha, 2006	49
20	Child, John; Rodrigues, Suzana B., 2011	47
21	Halbesleben, JRB; Novicevic, MM; Harvey, MG; Buckley, MR., 2003	45
22	Beyer, JM.; Trice, HM., 1979	45
23	Kardes, Ilke; Ozturk, Ayse; Cavusgil, S. Tamer; Cavusgil, Erin, 2013	44
24	Sargut, Goekce; McGrath, Rita Gunther, 2011	44
25	Skaggs, BC; Huffman, TR., 2003	44
26	Lorino, Philippe; Tricard, Benoit; Clot, Yves, 2011	41
27	Kasilingam, RG., 1997	38
28	Dewenter, K; Novaes, W; Pettway, RH., 2001	37
29	Gottfredson, M; Aspinall, K., 2005	36
30	Schmitz, Christian; Ganesan, Shankar, 2014	33
31	Berry, TK; Bizjak, JM; Lemmon, ML; Naveen, L., 2006	33
32	Hurley, RF; Hult, GTM; Knight, GA., 2005	33

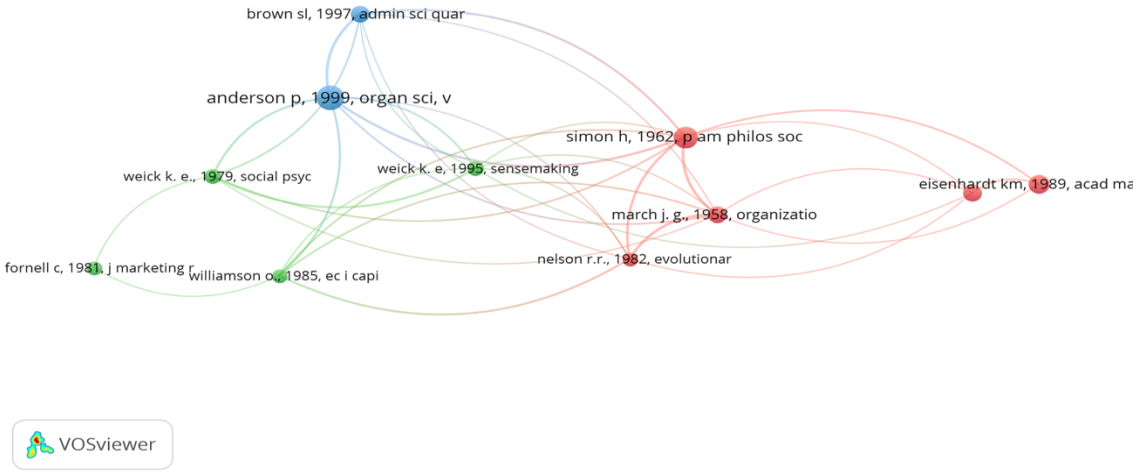

Figure 4: Network resulting from articles plus co-citations.

Table 6: Main sources of citations in the context of complexity.

Source Name	*Total Documents*	*Total Citations*
Management Science	1	**452**
Harvard Business Review	3	**340**
Journal of Accounting & Economics	1	**300**
Human Relations	4	**295**
Organization Science	4	**200**
Academy of Management Journal	2	180
International Journal of Operations & Production Management	**7**	180
Organization Studies	3	145
Industrial Marketing Management	**6**	139
Journal of Management Studies	2	135
Journal of Business Research	**7**	132
Journal of Business Ethics	5	120
British Journal of Management	1	93
Strategic Management Journal	1	92
Journal of Information Technology	2	84
Journal of Operations Management	1	76
International Business Review	2	70
Information Systems Research	1	57
Management Decision	1	57
Journal of International Business Studies	3	56
European Journal of Operational Research	2	52

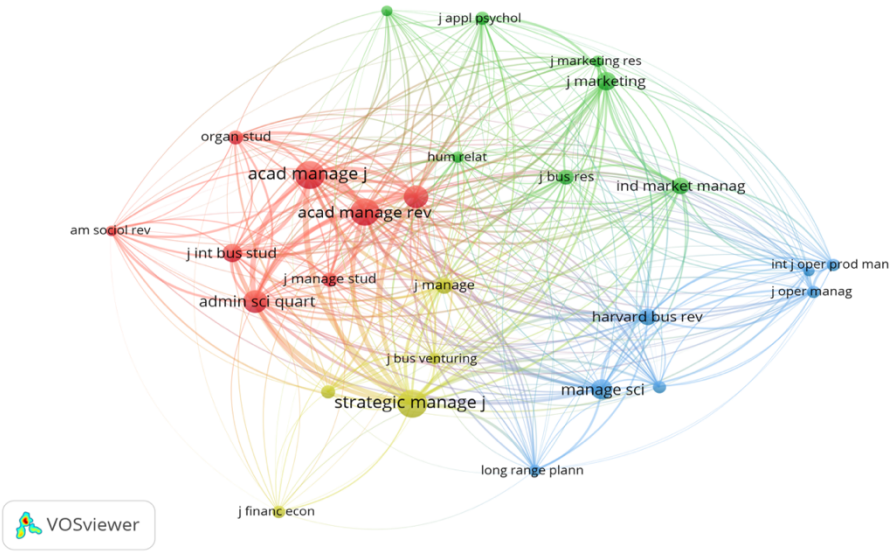

Figure 5: Network of sources co-cited in the 260 articles and respective clusters formed

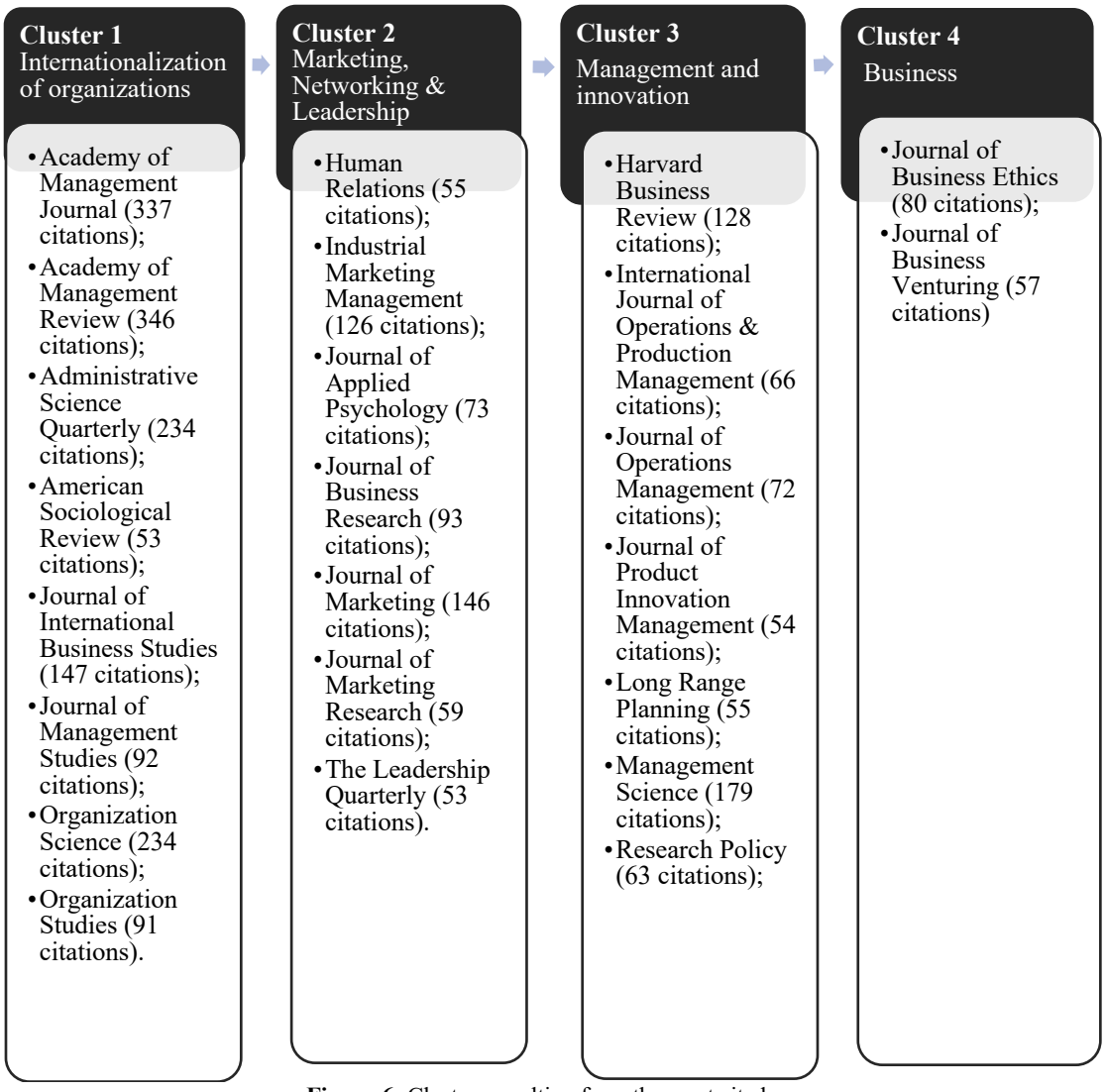

Figure 6: Clusters resulting from the most cited sources

Table 7: Main authors mentioned in the complexity domain

Author	*Documents*	*Citations*	*Author*	*Documents*	*Citations*
Aragon-correa, J. Alberto	1	93	Mason, Roger B.	1	57
Azmat, Fara	1	57	Maylor, Harvey	1	121
Banker, RD	1	57	Mcarthur, A.W.	1	68
Barthelemy, Jerome	1	119	Mckelvey, Bill	3	82
Bello, Daniel C.	1	137	Nystrom, P.C.	1	68
Benbya, Hind	1	79	Pedersen, Torben	1	92
Boone, Mary E.	1	260	Quelin, Bertrand V.	1	119
Bushman, R.	1	300	Quinn, R.E.	1	101
Chen, Q.	1	300	Robson, Matthew J.	1	137
Closs, David J.	1	76	Rueda-Manzanares, Antonio	1	93
Damanpour, F.	1	452	Samaratunge, Ramanie	1	57
Engel, E.	1	300	Sharma, Sanjay	1	93
Geraldi, Joana	1	121	Singh, K	2	136
Greenwood, Royston	1	57	Slaughter, S.A.	1	57
Hart, S.L.	1	101	Smith, A.	1	300
Hatch, M.J.	1	166	Snowden, David J.	1	260
Jacobs, Mark A.	2	92	Swink, Morgan	1	76
Katsikeas, Constantine S.	1	137	Tsoukas, H	1	166
Kodeih, Farah	1	57	Webb, G. Scott	1	76
Larsen, Marcus M.	1	92	Williams, Terry	1	121
Manning, Stephan	1	92	Woodside, Arch G.	2	53

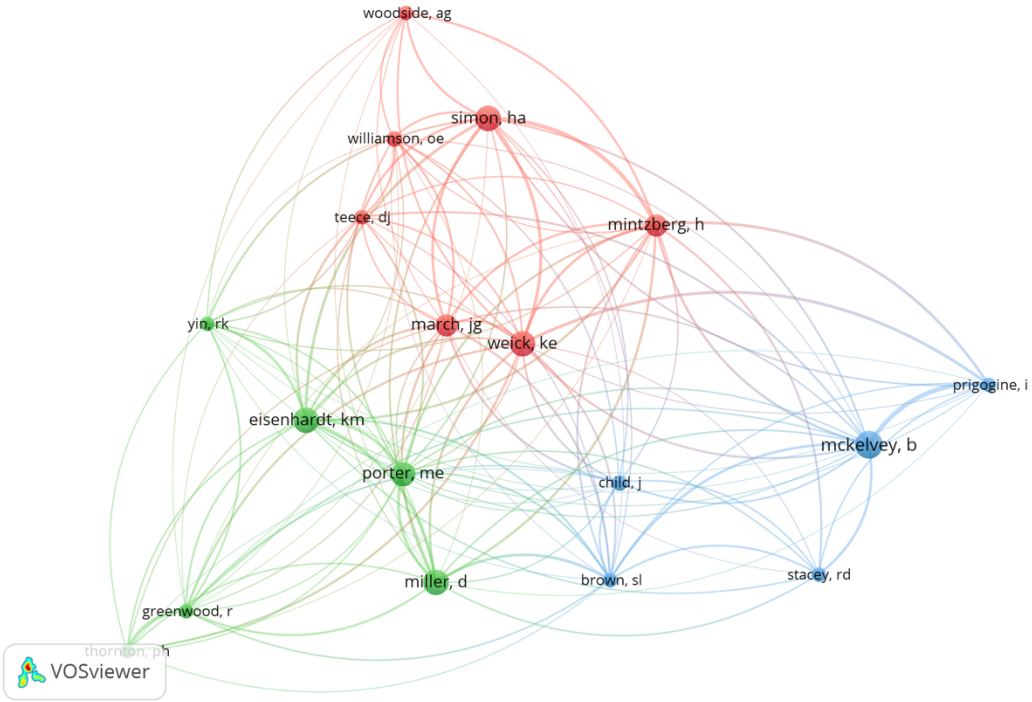

Figure 7: Network of authors co-cited in the 260 articles and respective clusters

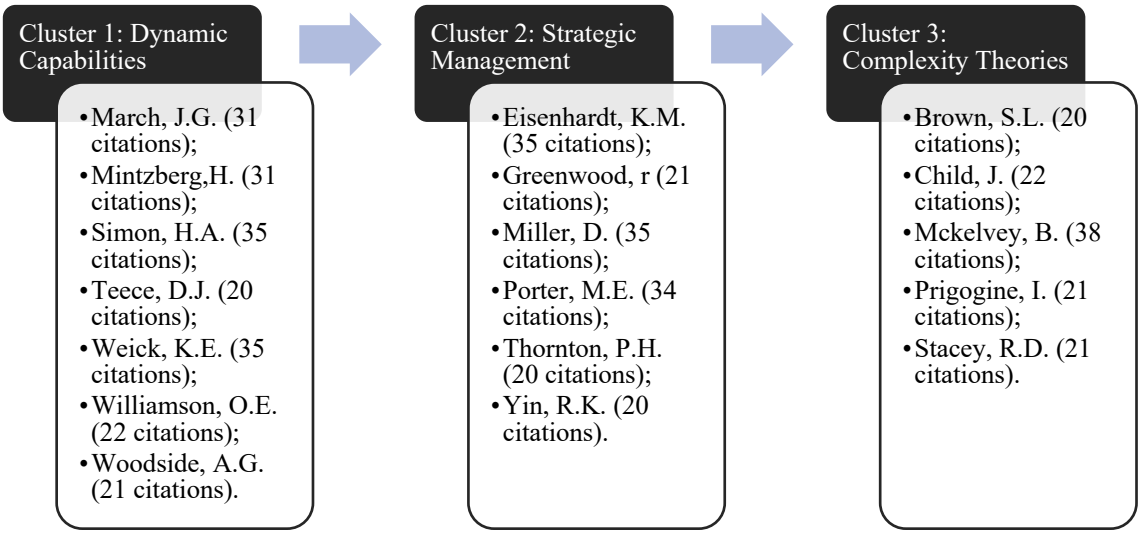

Figure 8: Clusters of more co-cited authors.

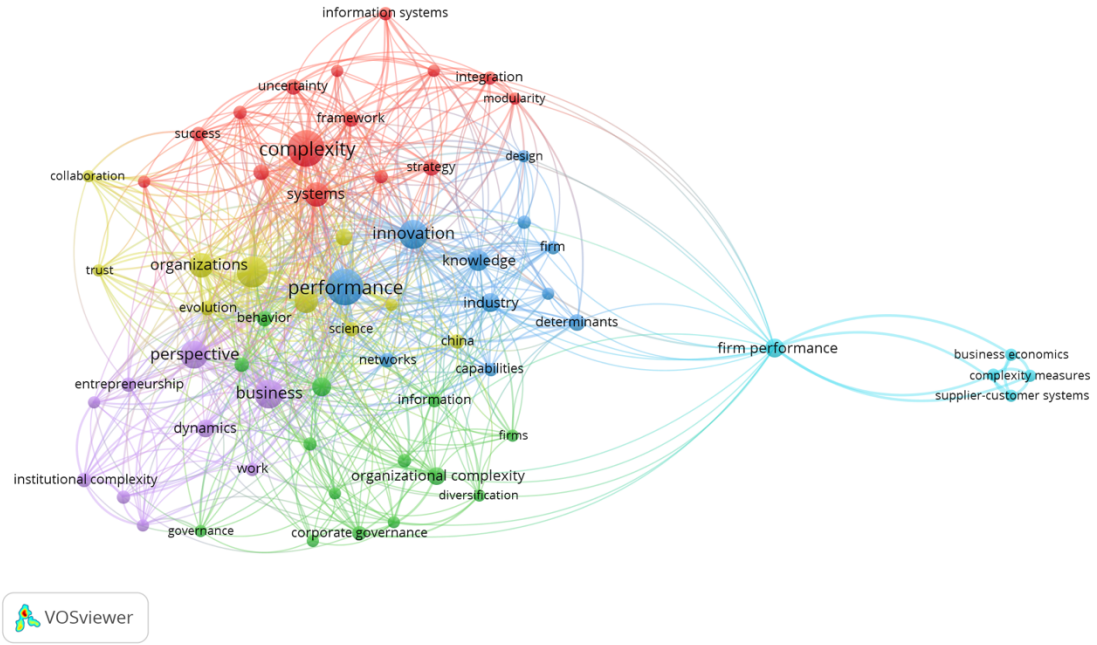

Figure 9: Network of words

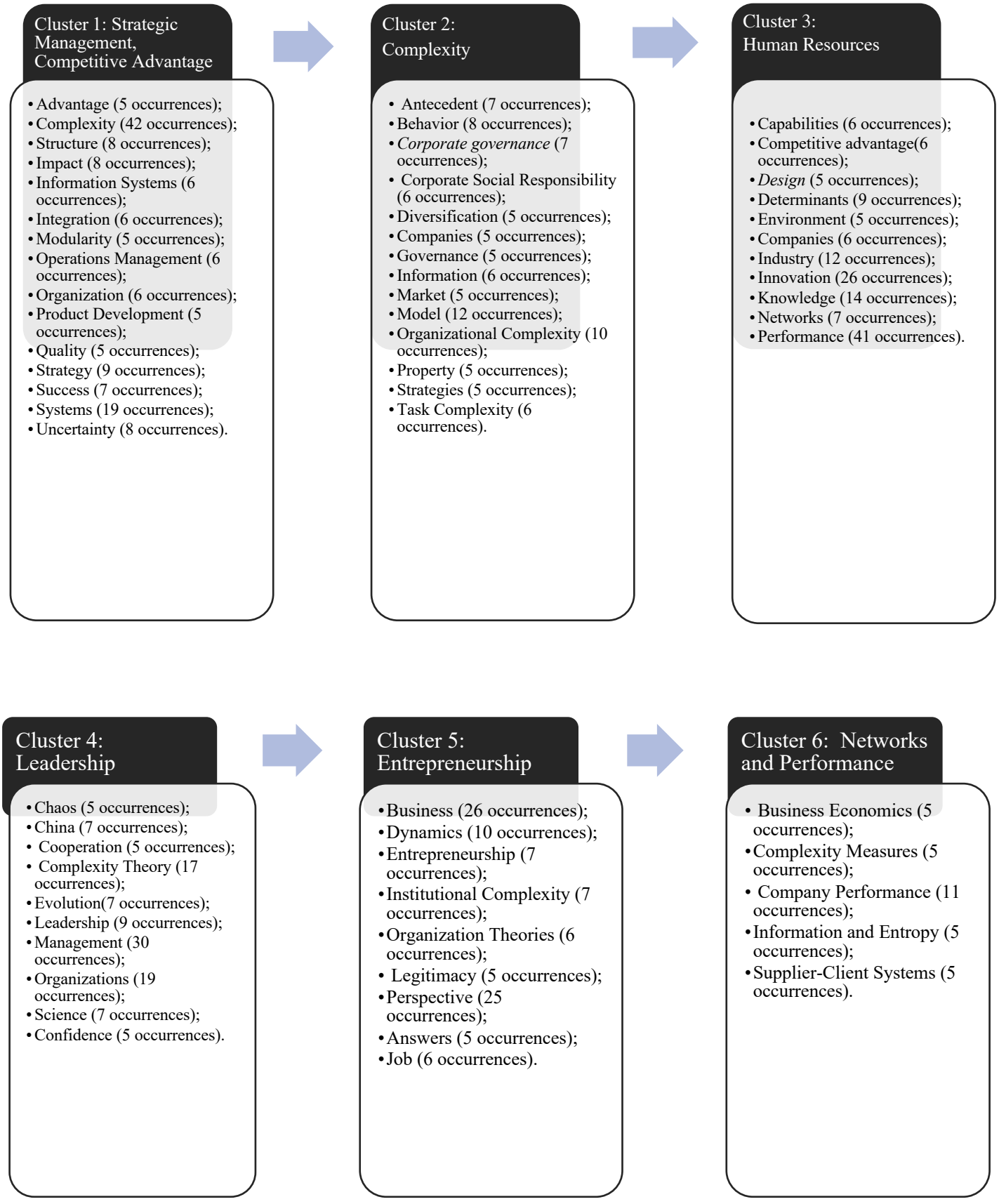

Figure 10: Higher frequency count of words

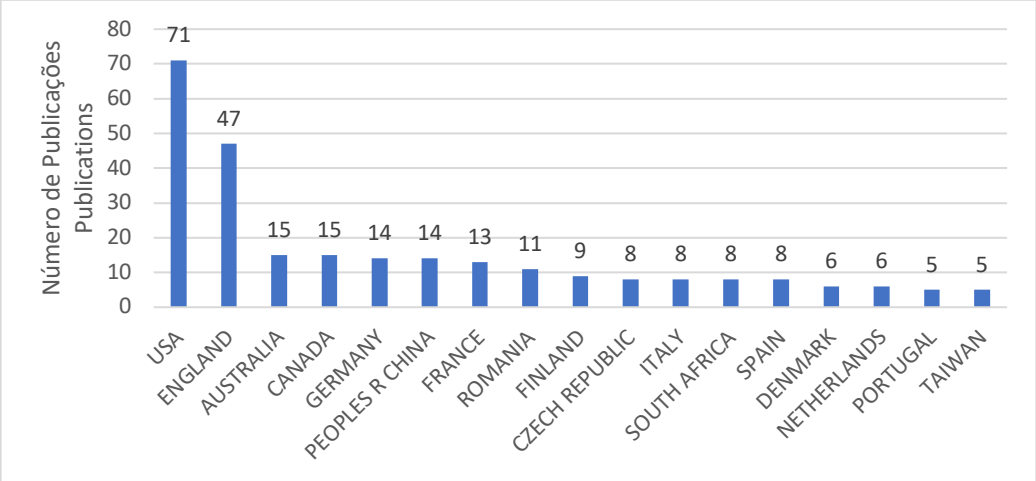

Figure 11: Bar chart illustrative of the number of publications by country.

Table 8: Description of the 5 articles published in Portugal, in the field of Complexity of Organizations

1	**Authors:** Martins, A.; Dinis, A.; Lopes, C.	0 Citations
	Title: Interpretative complexity and tax law changes: the taxation of corporate expenses in Portugal	
	Surce: Journal of Applied Accounting Research	
	Year Published:: 2018	
2	**Authors:** Bustinza, OF; Vendrell-Herrero, F; Gomes, E; Lafuente, E ; Opazo-Basaez, M; Rabetino, R; Vaillant, Y.	0 Citations
	Title: Product-service innovation and performance: unveiling the complexities	
	Source: International Journal of Business Environment	
	Year Published: 2018	
3	**Authors:** Pitsis, TS; Sankaran, S; Gudergan, S; Clegg, SR.	16 Citations
	Title: Governing projects under complexity: theory and practice in project management	
	Source: International Journal of Project Management	
	Year Published: 2014	
4	**Authors:** Baptista, CS	1 Citations
	Title: Product importance and complexity as determinants of adaptation processes in business relationships	
	Source: Journal of Business & Industrial Marketing	
	Year Published: 2014	
5	**Authors:** Ramos, C; Henneberg, SC; Naude, P.	18 Citations
	Title: Understanding network picture complexity: An empirical analysis of contextual factors	
	Source: Industrial Marketing Management	
	Year Published: 2012	

Chapter III

The influence of Complexity on the performance/ success of Organizations

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The influence of Complexity on the performance/success of Organizations

Abstract

The present study, applied to a set of 468 companies, presents as fundamental objectives (1) to find out what distinguishes companies by their degree of complexity in the continental territory, as well as (2) to analyze the influence of complexity on the performance of organizations. These objectives justified the use of various multivariate statistical techniques, namely Factor Analysis, Discriminant Analysis and Multiple Linear Regression. For the measurement of construct complexity, a literature review was carried out, first to identify a set of explanatory variables, such as: age, size, internationalization, debt percentage, medium and long-term debt, dependence on other people's capital, percentage of equity profitability and turnover of the company.

The results of the study suggest the existence of more variables for measuring the concept, pointing out, however, that of the variables under study, the total asset, indebtedness and age of the company are the variables that contribute the most to the increase in the complexity of companies, that is, the size, indebtedness and life cycle of companies strongly and constantly boost business complexity. On the other hand, indebtedness, internationalization, age and leverage of the company are revealed the predictor variables of the complexity that contribute most to the performance of companies. Nevertheless, there are many more variables, not identified in the literature that will contribute to a better measurement of the concept, allowing us to conclude that, in fact, the variables identified are relevant, but insufficient.

Keywords: Complexity of Organizations; Strategic Management; Performance; Factor analysis; Discriminant Analysis; Multiple Linear Regression.

1 Introduction

An organization's life cycle incorporates historical events triggered by unexpected and unpredictable situations. Nevertheless, the continuous evolution of technology and the growing process of globalization have enhanced the excessive increase in interrelationships and interdependencies, due to the need to meet new challenges and to remain in the market increasingly turbulent and competitive, becoming, in nature, increasingly complex organizations.

Considering the challenging nature of Tetenbaum's following words (1998): "Chaos theory shows us a world for more complex and unpredictable than Newton's physics can explain. Can we apply the theory to organizations?" , the present investigation, presents as objectives (1) to evaluate the explanatory capacity of the metric variables identified in the scientific literature as predictors of organizational complexity, as well as (2) to find out their influence on the performance of companies (Tetenbaum, 1998).

The above, it is intended, with this study, to confirm whether the variables age, size, percentage of indebtedness, dependence on capital of others, percentage of profitability of equity; percentage of internationalization and turnover, identified in the literature, allow measuring the construct of complexity, in order to expand its understanding and contribution in the performance of organizations.

With a view to the realization of such purposes, a statistical study was promoted, using the multivariate analysis of a sample collected in a database called "Iberian Balance Analysis System", hereafter abbreviatedly referred to as SABI. The use of this advanced data research and treatment tool allowed the measurement of a significant number of variables, pointed out in the literature as meters of complexity, inherent to a set of 468 Portuguese companies, of various legal typologies, located in the continental territory. From the sample collected, a Factor analysis (exploratory and confirmatory) was performed, followed by a Discriminant Analysis and a Multiple Linear Regression, using the *Statistical Package for the Social Sciences* (SPSS) software.

Thus, through Factor analysis, the variables that best explain business complexity are chosen in order to identify which factors contribute significantly to the distinction of companies as more or less complex. Therefore, with the use of Discriminant Analysis, it was intended to obtain a classification by groups, from the sample collected, in order to draw lessons in terms of the complexity applied to the international sphere of enterprises.

Based on the *loadings/scores* obtained with Factor analysis, the mathematical model of multiple linear regression was formulated in order to analyze the influence capacity of metric variables identified as complexity meters in the success, or failure, of organizations.

This investigation is divided into four chapters. In the first chapter, a literature review is presented, in order to deepen knowledge inherent to complexity in the organizational environment, fostered by market pressures and uncertainties and thus identify the predictor variables of complexity to be used in the analysis of the data to be tested by quantitative methods. The second chapter concerns the methodology adopted for the development of the statistical study, in particular the description of the research strategy, the justification for the origin of the data used and, finally, the adequacy of statistical methods to the objectives of the study. The following is the third chapter, whose objective is the discussion and interpretation of the main statistical results, obtained through the various multivariate techniques adopted. Finally, a fourth chapter arises, where the main conclusions, answers and limitations of the study are exposed.

2 Literature Review

2.1. Complexity of Organizations

The study of "complexity" implies the combination of several scientific theories, together, defined as the "Theories of Complexity" (such as chaos theory[18], dissipative structures[19] theory and complex adaptive systems theory[20]), that although they constitute a metaphorical and considerably, unclear approach, they are increasingly applied to the business reality, emerging as a starting point for the further study of "organizational complexity", in order to emphasize and elucidate organizational diversity and change and its management (Manson, 2001; Burnes, 2005; Brodbeck, 2002; Morgan, 1997; Bechtold, 1997; Lewis, 1994; Stacey, Griffin, & Shaw, 2002; Stacey, 2003; Tetenbaum, 1998).

Theories of Complexity presuppose the establishment of order in dynamic, unpredictable and nonlinear systems that work at the edge of chaos, through a process of self-organization, managed by a small number of "order-generating rules", which impose relative order and, at the same time, allow limited chaos (Frederick, 1998; MacIntosh & MacLean, 2001; Lewis, 1994; Stacey & Shaw, 2002; Wheatley, 1992) reflecting to organizations as complex adaptive systems (Ashmos & Duchon, 2000; Burnes, 2005; Haigh, 2002; MacIntosh & MacLean, 2001; Tetenbaum, 1998).

In good rigor, the "order-generating rules" create the conditions conducive to self-organization and, therefore, self-organization erects the fundamental conditions for the continuous transformation of "order-generating rules" (Bechtold, 1997; Tetenbaum, 1998).

Complex systems are constituted through independent but interactive and self-organized actors, because their elements discover how to self-organize themselves to promote change. Not achieving the stable balance, remain in the "chaos of chaos", between order and disorder, in prolific, complex and constant metamorphosis, which allows to measure that complex systems never reach stable balance, but also never collapse, a whereas creativity, growth and self-organization are at naturally ideal levels, allowing them to act within a complex, orderly and unpredictable disorder, guided by irregular but similar behavior with each other (Tetenbaum, 1998; Brown & Eisenhardt, 1997; Frederick, 1998; Jenner, 1998; Kauffman, 1993; Lewis, 1994).

By recognizing companies as complex adaptive systems, organizations, such as open, fluid and self-organized structures, are considered to be able to reconfigure themselves (both at the level of

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[18] The Theory of the Chaos reflects dynamic, nonlinear systems, full of complex and non-proportional behavioral patterns, suggesting that small changes at the beginning of an event can trigger severe, profound and unpredictable changes over time. Second, Tetenbaum "The Chaos Theory shows us a world much more complex and unpredictable than what Newton's physics might explain" – Free Translation of "Shifting Paradigms: From Newton to Chaos" pp. 21, by (Tetenbaum, 1998).

[19] The Theory of Dissipative Structures reflects the study of open and unstable systems, which have the capacity to self-organize in order to produce a divergent structure or behavior that cannot be provided for from state knowledge, previous (Stacey, 2003)

[20] The Complex Adaptive Systems Theory consists of a large number of agents, who behave according to their own principles of local interaction and that requires each agent to adjust their behavior to that of other agents (Stacey, 2003); (Stacey, Griffin, & Shaw, 2002).

connections and at the level of activities) through the creation of new, and more appropriate, rules, when background rules do not allow to deal effectively and efficiently with organizational changes (MacIntosh & MacLean, 1999; Bechtold, 1997; Wheatley, 1992; Burnes, 2005). Complex adaptive systems call for organizations to remain attentive and collect information about their own behavior and the environment that involves them, in order to adapt and co-evolve permanently in controversial environments and confused; (Brown & Eisenhardt, 1997; Ashmos & Duchon, 2000; Stacey, 1995).

In practice, carelessly stable organizations inhibit change, remain stagnant and culminate in the decline of the system. On the other hand, total disorder will overwhelm the system by change, which is why, at both ends, it is a fundamental condition the creation and establishment, continuous, of new rules capable of triggering a management based on limited chaos (MacIntosh & MacLean, 2001; Frederick, 1998; Stacey & Shaw, 2002).

For organizations to succeed, they must recognize themselves as complex adaptive systems and have an organizational structure, divided into flexible units that allow the absorption of complexity through interaction (between multiple agents), the continuous reorganization and development of new products, since, in this way, co-evolve and organize, continuously, with a view to maximizing their business performance and success (Stacey, 1995; Ashmos & Duchon, 2000; Wheatley, 1992; Jenner, 1998).

It should also be noted the importance of flexible units, or subunits, remain rigid enough for the change to occur in an organized manner, but not so rigid that it inhibits their occurrence (Brown & Eisenhardt, 1997).

According to Snihur and Tarzijan, the complexity of a business model must be in line with the organizational structure of the company with regard to the centralization or decentralization of the strategic decision-making process. For a business model with a low level of interdependencies, it corresponds to a lower level of complexity and therefore a decentralized organizational structure is required for a portfolio of autonomous business models. On the other hand, the functions that interconnect with a higher level of dependencies, soon more complexity among business models, must be centralized, while functions that engage dependently can be managed in a decentralized manner[21] (Snihur & Tarzijan, 2018).

Several authors (e.g (McDaniel & Walls, 1997; Stacey, 1995)) consider that the presence of a considerable number of ties and interrelationships between individuals, widely distributed, allow a variety of behaviors and interpretations, which make organizations more flexible and able to adapt to the environmental complexity. In the absence of such behavioral diversity, the organization, as a whole, will lose views that will lead to the simplification of its global vision, with regard to its surrounding environment (internal and external) and, consequently, will become unable to respond to significant changes (Weick, 1979).

Connections and information exchange allow the creation of immense and disparate interpretations of information within organizations and enable the creation of meaning between structural subunits. Nevertheless, the ability to learn and acquire specialized information increases, driving the reinterpretation of externalities and the cooperation necessary to foster evolution, continuous improvement and innovation as a result of a process of self-organization (Brown & Eisenhardt, 1997; Ashmos & Duchon, 2000).

When the intensity of the connections is accentuated, the internal self-organization overturns. The same is to consider that, as organizations manifest themselves more complex, they reflect more extensive contact networks, encouraging informality and non-centralization in decision-making and, consequently, their internal self-organization (Ashmos & Duchon, 2000). Entities that adopt organizational models with more decentralized structures become more able to reconfigure and reorganize autonomously, since a greater number of people, at various levels of the organization, are looking at the same issues with equal concern, suggesting more interpretations about the same reality and generating more opportunities for co-evolution (Ashmos & Duchon, 2000).[22]

Contemporary organizations, loaded with diverse objectives and priorities, only survive in highly turbulent and competitive contexts, through continuous innovation and improvisation, and their success

[21] The distribution of power, the degree of formalization, the complexity of the environment, the size of the company, the culture and business strategy, the technology and resources employed, are some of the factors that should be considered in choosing the business model more adapting: Centralized or decentralized model? (Mello, 2012).

[22] In **decentralized hierarchical structures** decision-making takes place in the corresponding area, with greater autonomy for the elements, creativity in solving the problem, positive competition between units, agility in the decision-making process, motivation and retention of talents, optimization, among others, (Mello, 2012). On the contrary, in the **centralized hierarchical structures**, decisions are the sole responsibility of the top manager, allowing greater control and evaluation, uniformity in procedures and decisions, among other (Mello, 2012).

will depend on the transversality of intensive communication (generation and sharing of knowledge), in real time, within an organizational structure guided by few and specific rules, which allows the maximization of the flow of information and meaning in the organization (Brown & Eisenhardt, 1997; Ashmos & Duchon, 2000; Garcia-Lorenzo, Lucia, Mitleton-Klly, Eve, & Galliers, 2003).

Managers must reinvent themselves, in order to manage order and disorder, simultaneously, but also to be able to restructure the organizational and control hierarchy, promote self-organization processes and recognize the need to encourage people to think creatively and innovatively, and it is crucial that agents feel free to organize themselves (Bechtold, 1997; Morgan, 1997; Kiel, 1994; Tetenbaum, 1998; Brown & Eisenhardt, 1997). Decision-making power should be delegated to individuals who have direct contact with the problems in question, as they are the ones with the most access to the information of the problem (Jenner, 1998).

According to Snihur and Tarzijan (2018) the construction of barriers to imitation was one of the positive externalities of complexity, which will allow the sustainable creation of competitive and corporate advantages, since, to imitate the leading company, the company follower, or would-be copycat, will have to imitate not only individual business models, but, above all, the interactions that are established, naturally and unpredictably, between them (Snihur & Tarzijan, 2018).

For the above, the complexity of organizations produces negative effects on imitation, due to the predominance of multiple and varied interdependencies (among the components of a business model) require greater effort in understanding and imitating a system, making it a process inevitably time consuming (Rivkin, 2000).

The complexity of organizations thus allows the creation of barriers to imitation[23], and consequently the creation of barriers to entry, since, one of Geroski's investigations suggests that 90% of the entries of companies in new markets occur by imitation, and only the remaining 10% can be considered innovative companies (Markides, 2015; Geroski, 1991).

Snihur and Tarzijan (2018) also suggest that the complexity of organizations allows differentiation before competitors, stressing that the competitive advantages of companies will be more lasting when associated with the creation of interdependencies between the constituent elements present in various business models (Snihur & Tarzijan, 2018).

It should also be noted that, in view of the existence of some studies that point to the high performance of a company that competes with a multiple business model, as a positive consequence (e.g. (Aversa, Haefliger, Rossi, & Baden-Fuller, 2015)) and other investigations, which consider the complexity of as a fundamental feature of companies operating with a multiple business model (e.g., (Berends, Smits, & Podoynitsyna, 2016; Bohnsack, Pinkse, & Kolk, 2014; Casadesus-Masanell & Ricart, 2010; Desyllas & Sako, 2013)); it can be considered that the increase in barriers to imitation, as a result of the complexity of organizations, emerges as a possible and potential explanation inherent to the high performance of companies (Aversa, Haefliger, Rossi, & Baden-Fuller, 2015; Casadesus- Masanell & Tarziján, 2012; Kim & Min, 2015).

Kauffman (1993) and Simon (1962) suggest that the complexity of organizations is, not only does the result of the number of activities and economic partners constituting the business model but also the number of interdependencies that remain between it. In a narrow sense, the number of interdependencies increases the need for coordination of economic activities and partners and the complexity of a system, since with the increase in the number of activities and economic partners, encourages the increased likelihood of interactions between them and, consequently, (increases) the complexity of the organization (Larsen, Manning, & Pederen, 2013; Kauffman, 1993; Simon H. A., 1962).

According to Andreatta & Olinquevitch (2009), companies become more complex, the higher their age, turnover, dependence on foreign capital and involvement with the international market, which means that the evolution and growth of companies contribute positively to the complexity of organizations, evoking the need to restructure, constantly (Andreatta, Silveira, & Olinquevitch, 2009). Companies with higher external revenues, with greater dependence on other people's capital and, with a greater number of segments, can be called complex. In turn, as the company evolves, the organizational hierarchy, operational activities and technological development are becoming increasingly complex (Coles, Daniel, & Naveen, 2008). Thus, the evolution of the life cycle of companies increases its complexity and, consequently, the need to define new management strategies, with a view to adapting them to the surrounding environment (Assunção, Luca, Gallon, & Cardoso, 2012). Nevertheless, the more diverse the business, the greater the number of diversified industries and products of the entity, the greater the complexity of its operations (Lin & Lee, 2008).

[23] Figure 9 – Appendix A

Business entities in various sectors and/or multiple geographic units face more complex environments both operationally – operational complexity – both in terms of information – complexity of information - in this sense, occur in more costs, compared to companies that choose an industrial and/or geographic focus strategy (Bushman, et al., 2004).

According to Bodnar, Tang and Weintrop (1998), operational complexity, arises when organizations make decisions within the framework of institutional and financial constraints (Bodnar, Tang, & Weintrop, 1998). On the other hand, the complexity of information stems from geographical dispersion, audit costs, divergent legal and accounting systems, monetary, cultural and linguistic differences (Reeb, Kwok, & Baek, 1998; Duru & Reeb, 2002); Denis, Denis, & Yost, 2002). As an example, multinational companies that, when operating in various markets, face a complex environment in the decision-making process, resulting in marked management difficulties, due to the diversity and cultural and legal inequality to which they are subject, in all markets that operate simultaneously and (Bushman et al., 2004; Reeb, Kwok, & Baek, 1998).

The complexity of organizations will have repercussions on how companies organize hierarchically and structurally, in order to strengthen their organizational nature, as a complex adaptive system to possible endogenous and exogenous changes to the company (Child, 1972). The organizational structure emerges as a means of management to stimulate or restrict communication, power, innovation, order and creativity (Kornberg & Clegg, 2003; Child, 1972). When organizations operate in ever-changing market environments, there is a vital need to define aggressive strategies for change, with a preference for more complex organizational structures that allow the absorption of complexity and diversity of the surrounding environment. On the other hand, when organizations are involved in an environment perceived as stable and immutable, the strategy will undergo the implementation of a simpler and mechanistic organizational structure, seeking to reduce complexity (Ashmos & Duchon, 2000; Boisot & Child, 1999).

Thus, organizations, in view of perceived complexity, present management responses that differ considerably between absorption or reduction of complexity (Ashmos & Duchon, 2000). These authors indicate that the reasons justifying the choice by managers by the reduction of complexity are summarized in the search for balance sustained by traditional and simplistic expectations of reality. However, organizations seeking the absorption of environmental complexity outweigh organizations whose response has been linked to the reduction of complexity (Ashmos & Duchon, 2000).

With the literature review, the evolution of management paradigms at various levels of complexity[24] became notorious, as well as the difficulty in measuring the construct of complexity, applied to organizations. If, on the one hand, some authors study complexity as an underlying characteristic of the environment (e.g., Dess & Beard (1984)) there are other authors who are based on organizational size (Child,1972) and the number of departments (Damanpour, 1996), the interdependencies existing between divisions (Zhou, 2013) or, even, the total number of interdependencies of activities and economic partners involved (Snihur & Tarzijan, 2018).

For Beyer and Trice (1979), size, formalization in relationships, the degree of specialization of personnel, vertical differentiation, horizontal differentiation, as well as division of work, were the privileged variables, in a thorough analysis of the various component's complexity of organizations (Beyer & Trice, 1979). The division of labor implies the subdivision of work tasks and the creation of individual and specific working positions, which allow the continuous absorption of the complexity of the function performed (Child, 1972).

According to Blau and Schoenherr (1971) (who identify vertical differentiation and horizontal differentiation, division of work and specialization of personnel as four components of complexity), size is the internal variable that arises as the primary cause of the organizational complexity (Blau, 1970) and (Blau and Schoenherr, 1971), supporting studies (e.g., (Meyer, 1968; Pugh, Hickson, Hinings, & Turner, 1968; Child & Mansfield, 1972; Blau e Schoenhen, 1971; Reimann, 1973; Child, 1972)) that demonstrate significant relationships between size and various levels of organizational complexity investigated in organizations with different natures.

Despite the causes that lead to complexity, within organizations are sometimes controversial in some studies (such as (Inkson, Pugh, & Hickson, 1970; Aldrich, 1972; Child & Mansfield, 1972; Mayhew, Levinger, McPherson, & James, 1972)); these dissymmetries in the results are commonly justified based on the size and technology incorporated by companies (Beyer & Trice, 1979; Ford & Slocum, 1977).

Studies (e.g., (Berger & Ofek, 1995; Lamont & Polk, 2002; Lang & Stulz, 1994; Servaes, 1996; Denis, Denis, & Yost, 2002)) suggest that diversified companies (in geographic sectors or regions) tend to

[24] Confront Figure 7 and Figure 8 - Appendix A

make lower profits than similar companies, which adopt focus strategy. On the contrary (Errunza & Senbet, 1984), they conclude that the geographical diversification strategy is associated with higher values (Bushman, Chen, Engel & Smith, 2004).

In fact, there is no consensus on the association of business diversification with the increase or decrease in the company's profits (Bushman, Chen, Engel & Smith, 2004).

Nevertheless, in a globalized market, it becomes increasingly delicate to study the primary causes, generating complexity, since complexity may come from multiple and diverse factors in different organizations, which means that if in an organization complexity came primarily from its organizational structure, in other organizations the primary cause of complexity may have been generated through the production process, which suggests that the results obtained in any complexity research is not necessarily cross-cutting and/or longitudinal (Meyer, 1972).

Currently it will become more useful to carry out an approach that relates business strategies to the size and various typicality's of complexity in organizations (Child & Mansfield, 1972) and, thus, complexity becomes a consequence of the strategic decisions and actions of managers in increasing the level of the organizational hierarchy or adding a subunit, differentiated, horizontally, driving the change of organizational complexity (Beyer & Trice, 1979; Child, 1972).

Boisot and Child (1999) identify two levels of complexity, based on density and variety of interactions, namely cognitive complexity – focused on the content of information flows – and relational complexity – focused on the structure of interactions that information flows allow to establish between agents (Boisot & Child, 1999).

Later, Beyer and Trice (1979) analyze each of these levels of complexity in two major types, considering that cognitive complexity can be measured based on the complexity of objective management and the complexity of strategy management, while relational complexity covers all variables that allow evaluating the complexity of interaction management - achieved when there are high levels of interaction of numerous groups of *stakeholders* in the process of taking strategic decisions - and the complexity of structural management – which is reflected in the internal variety observed in the organization[25] (Beyer & Trice, 1979).

While management requirements involved the adoption of long-term objectives (such as profit making), clear and limited, capable of transmitting meaning and motivation to its agents, currently, there is a constant need to define several objectives that do not compromise or direct the company in one sense, but which make it possible to confuse competitors; (Scott W. R., 1981; Hart & Banbury, 1994; Wernerfelt, 1984; Simon H. A., 1996; Simon H. A., 2013).

With regard, for example, to structural complexity, less complex and therefore highly centralized and formalized organizations lose the ability to spontaneously organize themselves because of the rules that make the exchange of information limited. On the other hand, organizations that are structured in a decentralized manner and thus less formal acquire the freedom necessary to reconfigure and voluntarily organize themselves, boosting the exchange of information and, reflecting, organizations more fluids. According to Galbraith (1974), organizations, by adopting decentralized structures, greatly increase their information processing capacity (Galbraith J. R., 1974).

From the above, there are several levels of complexity identified in the scientific literature[26] - Cognitive Complexity; Relational Complexity, Complexity of the Goal; Complexity of the Strategy; Complexity of Interaction; Operational Complexity, Structural Complexity and Linguistic Complexity – which relate and interconnect strongly, hindering the measurement and definition of this concept, being fundamental that, regardless of the context in which companies operate and insert, remain attentive to their environment, and prepared to cope with improvisations and inevitable changes, realizing their competitive strategy. In fact, the contributions and risks associated with complexity within organizations and their management become evident[27].

[25] Confront Figure 7 and Figure 8 - Appendix A
[26] Confront Table 35 - Appendix A.
[27] Confront Figure 8 - Appendix A

3 Methodology

3.1 Population, Sample and Data Collection

The practical component of this work consists in the performance of a statistical study, of a quantitative nature, using three multivariate techniques, namely Factor Analysis (exploratory and confirmatory) and Discriminant Analysis and Multiple Linear Regression. These techniques will be applied to a sample built by extracting quantitative data from the SABI platform, which contains detailed and useful information from more than 3 200 000 companies, existing throughout the Iberian Peninsula (Informa D&B Portugal, 2017).

The sample obtained, initially, consisted of a Top of 500 companies. In the database of the data search strategy, were selected carefully, (1) active companies, (2) in the legal form of Public Limited Company, Quota Company, Unipersonal Company by Quotas and Company in Company, (3) belonging only to the Portuguese continental territory (namely North and Central Portugal, Lisbon, Vale do Tejo, Alentejo and Algarve), excluding all entities located in the autonomous regions of Madeira and the Azores, respectively.

The sample extracted groups together two types of entities, namely 346 companies carrying out export/import operations and 122 companies that do not carry out any type of internationalization operations for goods and/or services, culminating in a final, refined sample consisting of 468 companies operating at the level of various sectors and whose financial data extracted, report as of December 31, 2016. It should also be noted that the choice, preferential, by the SABI, as a data source, is essentially due to the fact that it allows access to all financial information, of Portuguese companies, important for the definition of the methodology adopted and consequently, for the measurement of the variables pointed out in the literature as explanatory of business complexity. On the other hand, the choice of this data source restricted the research, to the extent that it does not provide information of a qualitative nature necessary so that one could consider other variables, identified in the literature, which imposed the selection of variables. The complementarity of this data source with other possible sources was also not possible, since the information collected from other sources would not be inherent in the same companies extracted from the SABI. Nevertheless, the use of SABI as a data source allowed the measurement of more than half of the variables identified in the literature, as explained by Table 6. Through the SABI, it was possible to build a database composed of 17 variables, including 6 qualitative and 11 quantitative.

For the quantification of business complexity, at the level of operational and organizational dimensions, and taking into account data access restrictions, in this study, life cycle, size, internationalization, leverage, indebtedness, medium/long-term debt, equity profitability and turnover were considered as explanatory variables.

3.2 Descriptive Analysis

Statistical analysis is primarily due to descriptive statistical research and, later, an inductive statistical study, as defined in Figure 1.

The first phase of research incorporates a descriptive statistical analysis, to some variables, which consists in the use of a set of methods, whose objective is to synthesize and represent in an understandable way the information contained in the sample data and then better understand the sample of the population. Therefore, a second phase is carried out through the inductive analysis, which allows us to make estimates and draw conclusions for the population from the information contained in the sample. Descriptive analysis includes frequency tables, descriptive measures, data exploration, and cross-information tables.

Of the 468 companies, 121 (25.9%) do not carry out internationalization operations. For the purposes of boosting this study, internationalization operations are meant to obtain revenues from abroad.[28]

The sector, predominantly, observed in this sample, is the industry sector, followed by "Other" sectors and the Trade sector.[29] The definition of the sectors of economic activity in which the entities operate, subject to study, referred to the "Portuguese Classification of Economic Activities Rev.3", abbreviatedly called CAE-Rev3, whose structure is published in the Gazette, pursuant to Decree-Law No. 381/2007 of 14 November (Instituto Nacional de Estatística, I.P., 2007).

[28] Confront Table 39 and Figure 10 - Appendix A
[29] Confront Table 42 and Figure 12 - Appendix A

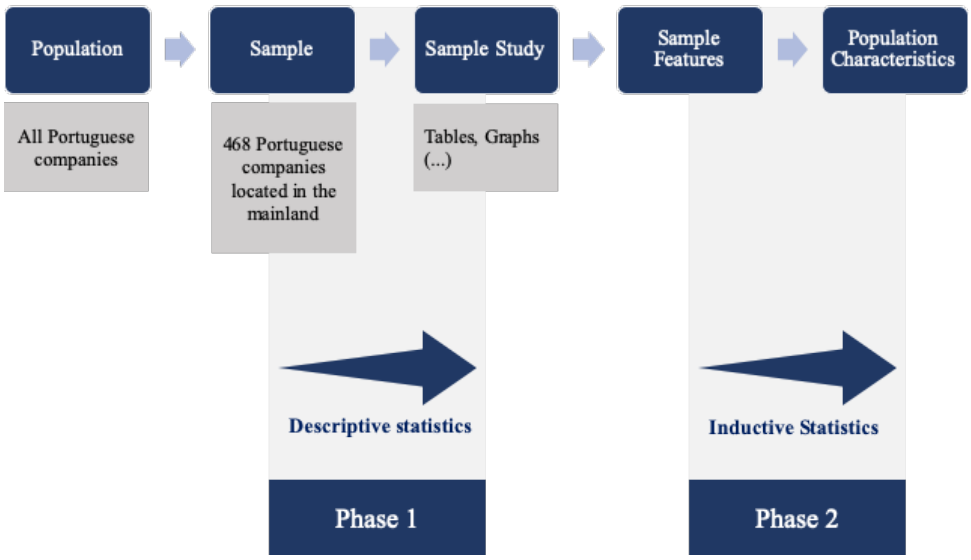

Figure 1: Phases of Statistical Analysis: Descriptive Statistics and Inductive Statistics

Of the total sample, 234 companies (50%) have a debt percentage of 55.01 or less. Nevertheless, of the 468 companies, 134 (28.6%) have no dependence on other people's capital. As regards legal form, Public Limited Companies are observable, followed by quota companies.[30]

It should be noted that the sample encompasses entities that, geographically, are located, influentially, in the districts of Lisbon, Porto, Aveiro and Braga. It should also be noted that of the 468 companies under study, entities remain, the size of which is considered medium and small, followed by large and micro entities, respectively.[31] The definition of the qualitative dimension of the companies, according to these categories, was referred to in accordance with Decree-Law 98/2015, more specifically the limits found under Article 9 of the same diploma, making it achievable, based on the extraction of the total number of employees performing functions in each of the entities, which make up the sample. (Ministério das Finanças, 2015)

Of the 468 valid cases, the average age of companies is 30,7 years. The most frequently observed age of all the companies that make up the sample is 26 years. The oldest company on the market has 127 years of exercise of the activity. The variation observed between the calculated mean age and the mean age of other random samples, but with the same dimension, which could have been obtained on the same population, is 0.980 years. This value indicates the existence of a significant dispersion between the middle ages obtained in similar samples of the same population. There is a confidence of 95% of the average for the age of companies is between 28.76 years and 32.61 years. The average trimmed to 5% is 28.88 years. It is estimated that all cases are available in ascending order, followed by the elimination of 5% of the largest and smallest cases, making the arithmetic mean to the other cases. It is a robust measure when data distribution is skewed. The median is 25 years, that is, 50% of companies have 25 years or less of the activity. [32]

Calculating $\frac{Skewness}{Std.Error\ of\ Skewness}$, you get 11.91. This is a value greater than 1.96, that is, this is a value that is not understood in the range $[-1.96; 1.96]$, it is concluded that the distribution of data is asymmetric positive. Calculating also, $\frac{Kurtosis}{Std.Error\ of\ Kurtosis}$, is obtained 8.79. As it is greater than 1.96, it means that the distribution of data is leptocubitic.[33]

[30] Confront Table 36; Table 37; Table 41 and Figure 13 – Appendix A
[31] Confront Table 43; Table 44 and Figure 14 – Appendix A
[32] Confront Table 38; Table 40 and Figure 11 – Appendix A
[33] Confront Table 38 – Appendix A

3.3 Association between variables and hypothesis tests

It is considered that there is an association between the two variables when the distribution of values of a variable is associated with the distribution presented by the other. In other words, when the distribution pattern of a variable is such that its variation is not random relative to the other.

The appropriate method to apply depends on the nature of the variables, object of study. In order to investigate possible causes related to FJU – "Corporate legal form" and Grupo_Ent "Entity Group – Internationalizes?" appropriate tests were promoted. The practices of analysis of associations between the variables used, for this purpose are: the contingency table, the Chi-Square test (statistical significance test), Cramer V (to test the strength of the association) and the test to the normality of the variables.

Thus, the first step consisted of the realization of the contingency table, since they are the simplest and most common way of showing the presence or absence of an association between variables. Through the analysis of Table 2 of contingency, it is noted that there is a prevalence of companies that carry out internationalization operations to have the legal form of A Public Limited Company. This means that, of companies carrying out internationalization operations (347 companies), the majority (67.1%) have the legal form of a Public Limited Company. Of the 121 companies that do not carry out any internationalization operation of their products, 92.6% are also Public Limited Companies.

Table 1: Contingency Table

			Grupo de Empresas - Internacionaliza?		Total
			Não	Sim	
Forma jurídica da empresa	Sociedade Anónima	Count	112	233	345
		Expected Count	89,2	255,8	345,0
		% within Forma jurídica da empresa	32,5%	67,5%	100,0%
		% within Grupo de Empresas - Internacionaliza?	92,6%	67,1%	73,7%
	Sociedade por Quotas	Count	6	88	94
		Expected Count	24,3	69,7	94,0
		% within Forma jurídica da empresa	6,4%	93,6%	100,0%
		% within Grupo de Empresas - Internacionaliza?	5,0%	25,4%	20,1%
	Sociedade Unipessoal por Quotas	Count	3	25	28
		Expected Count	7,2	20,8	28,0
		% within Forma jurídica da empresa	10,7%	89,3%	100,0%
		% within Grupo de Empresas - Internacionaliza?	2,5%	7,2%	6,0%
	Sociedade em Comandita	Count	0	1	1
		Expected Count	,3	,7	1,0
		% within Forma jurídica da empresa	0,0%	100,0%	100,0%
		% within Grupo de Empresas - Internacionaliza?	0,0%	,3%	,2%
Total		Count	121	347	468
		Expected Count	121,0	347,0	468,0
		% within Forma jurídica da empresa	25,9%	74,1%	100,0%
		% within Grupo de Empresas - Internacionaliza?	100,0%	100,0%	100,0%

Thus, the hypotheses to be tested are:

- H_0: The variables are independent;
- H_1: Variables are dependent.

Using Table 2 inherent in the Chi-Square test, an associated significance level equal to 0.000 is observed. In this sense, as $0.05 > 0.000$ we reject the null hypothesis, that is, there is statistical evidence to consider that the variables FJU and Grupo_Ent are dependent $0.05 > 0.000$.

Table 2: Association between variables (Chi-Square Tests)

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30,149[a]	3	**,000**

After a relationship of dependence between the legal form and the internationalization of companies is found, it matters now analyze the degree of association between them, through Table 3. The measurements of association between variables, as a rule, vary between zero and one, which means no relationship or perfect relationship, between variables, respectively.

Table 3: Intensity of association between variables (Symmetric Measures)

Symmetric Measures			
		Value	Approx. Sig.
Nominal by Nominal	Phi	,254	,000
	Cramer's V	,254	,000
	Contingency Coefficient	,246	,000
N of Valid Cases		468	

The results obtained in all these tests suggest the existence of a moderate association between the two nominal variables:

- Phi coefficient (0.254);
- Contingency Coefficient or C of Pearson (0.246);
- Coefficient V of Cramer (0.254).

From the above and, although it is not necessary to ascertain the normality of the distributions (n>30), the K-S test was performed, elucidative as to the fact that the variables do not follow a normal distribution according to the values contained in Table 4, where, suggesting the rejection of the null hypothesis (H0).$sig = 0.000$.

Hypotheses to test:

- The variables follow a normal distribution;
- Variables do not follow a normal distribution.

Table 4: K-S Normality Test

Tests of Normality[b]							
Forma jurídica da empresa		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Grupo de Empresas - Internacionaliza?	Sociedade Anónima	,431	345	,000	,590	345	,000
	Sociedade por Quotas	,539	94	,000	,262	94	,000
	Sociedade Unipessoal por Quotas	,526	28	,000	,361	28	,000

However, according to Maroco (2010), because the sample is considered large ($n > 30$) a normal distribution is assumed.

4 Multivariate Analysis

After an initial analysis of the database, object of study, multivariate investigation was continued with some variables pointed out in the literature, in order to ascertain whether, effectively allow measuring and, better understanding, business complexity. In this sense, the quantitative variables selected for the dynamics of the study of this dimension are those contained in Table 5.

Table 5: Explanatory variable, acronym, *Proxy*, theoretical support, expected relationship and source of complexity of the organizations

Complexity of Organizations						
Variables	Assumption	Initials	Measurement/Proxy	Expected Relationship	Theoretical support	Source
Company Life Cycle	Age	IDD	Difference between base year (2016) and start year	+	Boone et al. (2007); Ferreira, Ferreira e Raposo (2011); Linck, Netter e Yang (2008); Farias (2012) p.91; Andreatta, Silveira, & Olinquevitch, 2009	SABI
Size	Number of employees	NFU	Total number of persons employed by the company as at 31 December 2016	+	Boone et al. (2007); Ferreira, Ferreira e Raposo (2011); Kirch, Terra e Lima (2012); Coles, Daniel e Naveen (2008); Lin e Lee (2008); L inck, Netter e Yang (2008); Farias (2012) p.91	SABI
	Total Assets of the Company (December 31, 2016)	ATO	Total Asset Value of the Company (December 31, 2016)	+		SABI
Internationalization	Foreign Revenue	REX	Difference between the sum of sales figures obtained in the intra community and foreign markets and the total sales value obtained in 2016.	+	Boone et al. (2007); Ferreira, Ferreira e Raposo (2011); Kirch, Terra e Lima (2012); Coles, Daniel e Naveen (2008); Lin e Lee (2008); L inck, Netter e Yang (2008); Farias (2012) p.91	SABI
	Internationalization Percentage	INT	Difference between foreign revenue and total sales multiplied by 100.	+		SABI
Leverage	Leverage Percentage	ALA	Leverage percentage of the company (31 December 2016)	+	Ferreira, Ferreira e Raposo (2011); Coles, Daniel e Naveen (2008); Lin e Lee (2008)	SABI
Debt	Debt Percentage	END	Percentage of corporate debt (December 31, 2016)	+	Ferreira, Ferreira e Raposo (2011); Lin e Lee (2008); Linck, Netter e Yang (2008)	SABI
Medium to Long Term Debt	Dependency on the business of foreign capital	DCA	Total Debt Amount of Company over the medium / long term (ie over 1 year) (31 December 2016)	+	Farias (2012) p.91	SABI
Return on Equity	Percentage of return on equity ratio (ROE)	RCP	ROE = Net Income / Equity	+	Farias (2012) p.91	SABI
Turnover	Company's annual turnover in 2016	VNG	Business Turnover Value (31 December 2016)	+	Andreatta, Silveira, & Olinquevitch, 2009	SABI

4.1 Factor Analysis

Factor analysis is a statistical technique that allows you to represent or describe a number of initial variables from a smaller number of hypothetical variables, in order to decrease the data, maintaining the original information as much as possible. This multivariate technique can be used in two types of studies: exploratory studies and confirmatory studies. In this case, confirmatory factor analysis is the most appropriate for the purpose of the study, since it is intended to confirm that the variables found in the literature are measuring the concept of business complexity, in particular organizational complexity and complexity of operations (Correia, 2017).

The performance of a confirmatory factor analysis consists in the dynamization of measurement reliability tests to each of the identified scores. However, given that exploratory factor analysis makes more intuitive the construction of the scores to be tested, it was decided to perform, first and in addition, exploratory factor analysis. Another reason that led to an exploratory factor analysis was the construction of the database, object of study, since, in this way, the consistency of the database will be evaluated.

4.1.1 Exploratory Factor analysis

It is intended to apply factor analysis to the variables; REX; IDD; INT; NFU; ATO; END; DCA; CPR; VNG and ALA. Thus, it was tried to extract a small number of factors *(scors)* that allow to explain the contemporary complexity at the level of the 468 companies, which make up the sample.

The most relevant concepts in a factor analysis are essentially "Communality", "eigen value" or own value, Bartlett's measurement of scouting and the measure of adequacy of the KMO sample.

It should also be noted that the main presupposed that underlie factor analysis are based on normality (as the show is greater than 30 ($p = 468 > 30$), normality is assumed)[34] in linearity and in the homoscedasticity.

Table 6: Correlation Matrix

Correlation Matrix[a]										
		REX	NFU	ATO	END	DCA	IDD	RCP	INT	VNG	ALA
Sig. (1-tailed)	REX		,015	,392	,274	,325	,122	,238	,000	,000	,278
	NFU	,015		,062	,214	,341	,103	,394	,037	,002	,405
	ATO	,392	,062		,022	,000	,498	,346	,000	,000	,433
	END	,274	,214	,022		,043	,000	,000	,015	,019	,011
	DCA	,325	,341	,000	,043		,484	,364	,002	,000	,400
	IDD	,122	,103	,498	,000	,484		,008	,403	,093	,031
	RCP	,238	,394	,346	,000	,364	,008		,458	,440	,102
	INT	,000	,037	,000	,015	,002	,403	,458		,002	,063
	VNG	,000	,002	,000	,019	,000	,093	,440	,002		,440
	ALA	,278	,405	,433	,011	,400	,031	,102	,063	,440	

Considering a significance level equal to 0.01 ($\rho = 0.01$) and after careful and thorough analysis to Table 6, based on excel calculation, it is possible to verify that 66 of the 90 correlations are significant for this level. The same is to say that 73% of correlations show levels of high significance for this level.

Table 7: KMO and *Bartlett's Test*

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**,527**
Bartlett's Test of Sphericity	Approx. Chi-Square	1128,872
	df	45
	Sig.	**,000**

[34] Confront Table 46 – Appendix C

The KMO value recommended with regard to Factor Analysis is understood between]0,9; 1,0], being considered as an "Excellent" measure. Through Table 8, KMO, a value of 0.53 is obtained, which indicates that, due to the analysis of main components being understood in the range $]0.5 - 0.6]$ and, considering the Maroco adequacy scale, is considered as an "Acceptable" measure (Maroco, 2010).

Bartlett's scouting test allows us to ascertain whether the correlations between the variables, object of study, are high enough for factor analysis to be useful in estimating common factors. Using Table 7 it is also possible to verify that Bartlett's scouting test reaches the value 1128.872 with a df of 45, and, because the significance level is less than 0.05 ($sig = 0.000 < 0.05$), the null hypothesis is rejected (H0: the correlation matrix is equal to the identity matrix) that is, it is appropriate to use factor analysis, since the variables are correlated.

This analysis should be complemented with the analysis of the matrix of anti-image correlations, since this matrix of partial correlations between the variables, after factor analysis, allows evaluating the suitability of factor analysis to the variables under study.[35] Thus, as a result, the adequacy measure of the KMO sample is acceptable, but not very consistent, since only one adequacy value of the 53% sample was considered relevant to analyze the matrix of anti-image correlations. After careful analysis of the diagonal line of the matrix, which contains the adequacy measures of the sample for each variable, it is notorious that there are two variables that present values below 0.5, which means that the rex variables "External Revenues of the company" and ALA "Percentage of Leverage of the company" have an adequacy of less than 50%, which is why the respective variables of this study were eliminated, in order to obtain a greater correlation of the entire sample and sample, consequently a higher KMO value. The remaining values that complete the matrix of anti-image correlations (above and below the diagonal) with lower values represent partial correlations between the variables.

Table 8: KMO and Bartlett's Test (excluding rex and ALA variables)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**,538**
Bartlett's Test of Sphericity	Approx. Chi-Square	1029,064
	df	28
	Sig.	**,000**

In fact, Table 8 shows that, an existing correlation as a whole increased, appreciably, a percentage point, reaching through the extraction of rex ("External Revenues of the Company") and ALA ("Percentage of Leverage of the company)" to 54%. However, the suitability measure of this sample remains "Acceptable" on the Maroco scale (2010), which means that its elimination has not become significant. In this sense, and, stressing the fact that in the sample under study there is a significant number of companies that do not perform import/export activity and, as such, do not have external revenues, the study continued, considering both variables.

[35] Confront Table 45 - Appendix C

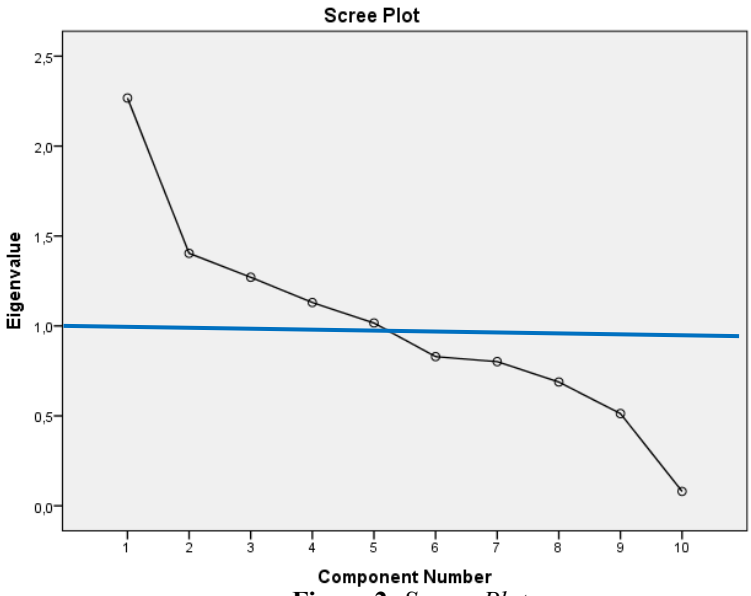

Figure 2: *Screen Plot*

Figure 2 analysis allows you to identify five factors with its own value greater than 1. According to the method of extraction of factors, it was possible to extract 5 factors representative of the sample under study, with values of its own greater than 1. In this sense, the complexity of the set was considerably reduced through these 5 components that explain 70,881% of the total variance, according to Table 19(meaning that there is a loss of information of only 29,119%).

Table 9: Extraction Method, Principal Component Analysis, Total Variance Explained

Total Variance Explained			
Component	Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	2,197	21,971	21,971
2	1,370	13,699	35,670
3	1,291	12,909	48,579
4	1,144	11,437	60,016
5	1,086	10,865	**70,881**

From the analysis of Table 10 of communalities, which exposes the amount of total variance of the original variable explained by the common factors, it is possible to verify that the percentage of variance of each variable explained by the extracted common factors is greater than 50% (in 9 of the 10 variances, which corresponds to appreciably 90%).

The Variable RCP ("Percentage of profitability of the company's equity") is the one that has the least in common, ($[48{,}8\%] < 50\%$), with the remaining variables. However, it is maintained in factor analysis, as it is pertinent to the study.

On the other hand, the variable ATO ("Total asset (in Euro units) achieved by the company on "12/31/2016" is the one with the most communality (93.2%) with the remaining variables.

Table 10: *Communalities*

Communalities		
	Initial	Extraction
REX	1,000	,764
NFU	1,000	,733
ATO	1,000	,932
END	1,000	,600
DCA	1,000	,885
IDD	1,000	,646
RCP	1,000	,488
INT	1,000	,651
VNG	1,000	,608
ALA	1,000	,782

When analyzing Table 10 with the main component matrix, values below 0.50 are omitted, being extracted 5 components, according to the "Rotated Component Matrix" matrix. This last step is applied with the objective of dividing the initial set into subsets, using the use of the orthogonal rotation algorithm, more specifically varimax. In this sense, the following are the 5 factors with the following name:

- Factor 1: Size and capital of the company;
- Factor 2: Indebtedness and Profitability of the company's Own Capital;
- Factor 3: Internationalization of the company;
- Factor 4: Number of company employees;
- Factor 5: Age and leverage of the company

Table 11: *Rotated Component Matrixa – Varimax*

Rotated Component Matrix[a]					
	Component				
	1	2	3	4	5
ATO	,963				
DCA	,932				
VNG	,590				
END		,751			
RCP		,672			
REX			,847		
INT			,634		
NFU				,853	
ALA					,852
IDD					,559

4.1.2 Confirmatory Factor Analysis

Table 12: Measurement reliability - value de *Cronbach's Alpha* for the 5 factors extracted.

Reliability Statistics			
		Cronbach's Alpha	N of Items
Factor 1	Size and capital of the company;	,695	3
Factor 2	Debt and Profitability of the company's Own Capital;	,326	2
Factor 3	Internationalization of the company;	3,631E-07	2
Factor 4	Number of company employees;	*	1
Factor 5	Age and leverage of the company	,008	2
*This factor cannot be measured because it has only one variable (NFU)			
Complexity of Organizations		,518	10

Confirmatory factor analysis allows the evaluation of the reliability or consistency of a given measure. In this case, the reliability of the five factors extracted from the sample under study is evaluated, in order to confirm its relevance in the definition and measurement of the concept of business complexity, by calculating the value of Cronbach's Alpha, whose function is to evaluate the internal consistency of the factors.

From the analysis of Table 12 it is found that all 10 variables identified in the literature have a positive Alpha value understood in the range [0; 1], and factor 1 consists of 3 variables (ATO, DCA, VNG), which presents a higher value with, appreciably 0.7, suggesting that the consistency of factor 1 is "Reasonable" (Pestana & Gageiro, 2008).

It should also be noted that the concept of complexity, measured by the 10 variables found in the literature, presents a positive Alpha value of 0.52, but "Inadmissible", since it is less than 0.6 (Pestana & Gageiro, 2008).

4.2 Discriminant Analysis

The discriminating analysis can be understood as a dependent multivariate statistical technique, useful for investigating and/or evaluating differences between groups and classifying entities within groups, based on known discretionary variables.

Through the application of this technique it is possible to study the relationship between a dependent variable, not metric, with two or more metric independent variables. In this sense, the discriminant analysis allows the classification of the sample in several groups, having as reference a non-metric dependent variable, providing for the inclusion of an individual in a given group.

Fisher's discriminant analysis is a simple discriminant analysis, since it is characterized by dividing the sample into a maximum into two groups.

The greater the integration and participation of companies in the international market, the greater their degree of internationalization and, consequently, the more complex and competitive the company will become (Sanders & Carpenter, 1998; Lin & Lee, 2008).

In fact, a division will be carried out by groups based on the metric and non-metric variables mentioned in Table 13.

Table 13: Discriminant Analysis - Nonmetric dependent variable and metric independent

Multivariate Technique	Non-metric dependent variable	Metric Independent Variables
Simple Discriminant Analysis	Company Group - Does it Internationalize? For two Levels (0; 1) such that: 0 = She does not internationalizes 1= She internationalizes	NFU - Total number of persons employed by the company ATO - Total Assets END - Debt DCA - Dependence on other people's capital IDD - Age RCP - Return on equity VNG - Business volume ALA - leverage percentage VNG - Volume of business
Total Variables	**1**	10
Note: The sample contains 468 business cases.		

It should be noted the exclusion of rex ("External Revenues") and INT ("Internationalization Percentage") since they are closely related to the groups that are intended to be obtained. Using discriminant analysis, it is intended to ascertain whether the eight independent variables have the power to discriminate against two groups of companies, namely companies that internationalize (more complex undertaking, that is, which carries out operations of internationalization) and which do not internationalize (less complex "so-called" company, that is that it does not carry out internationalization operations).

The Discriminant Analysis is based on three fundamental assumptions, namely:

1. Multivariate normality;
2. Multivariated homoscedasticity;
3. Absence of multicollinearity.

4.2.1 Multivariate Normality

The K-S test is used in order to analyze normality. However, when the sample is large (sample greater than 30 cases), normality tests fail, as observed in this study. In order to address this situation, the theorem of the central limit is used, since, as we repeat experiences, they tend to become normal. This theorem advocates that, as the sample size increases, the sample distribution of its mean is increasingly approaching a normal distribution. In this sense, the normal distribution of the variables under study is assumed, since the sample integrates more than 30 cases.

ANOVA: Analyze the differences between groups

Homogeneity of variables

Hypotheses to test:

- H_0: The means of the groups are the same;
- H_1: The means of the groups differ.

Table 14: Tests of Equality of Group Means

Tests of Equality of Group Means					
	Wilks' Lambda	F	df1	df2	Sig.
NFU	,997	1,232	1	466	**,268**
ATO	,967	15,895	1	466	**,000**
END	,975	11,890	1	466	**,001**
DCA	,980	9,715	1	466	**,002**
IDD	,986	6,579	1	466	**,011**
RCP	,997	1,601	1	466	**,206**
VNG	,996	1,914	1	466	**,167**
ALA	,992	3,576	1	466	**,059**

The equality tests of the means of the groups, whose results are explicit in Table 14, more commonly referred to as tests of equality of group means investigate the differences between groups. When significant levels of less than 0.05 ($\rho = 0.05$) are obtained, the null hypothesis is rejected, the means of the groups are equal. In this case, the variables NFU, CPR, VNG and ALA have a significance level greater than 5%, which means that, the null hypothesis cannot be rejected, that is, these variables probably do not contribute to the model. On the other hand, the variables ATO, END, DCA and IDD present significance levels that make up values below 5%, which allows us to conclude that these variables probably contribute significantly to the model.

As regards value F, it should be noted that small F points to the fact that, when the ten independent variables are considered individually do not differ between groups. On the other hand, the higher the value of F, the greater the degree of divergence between the groups. In this sense, the ATO variable is substantially better, suggesting it is a variable that can differentiate between groups.

From the analysis of Table 14, it is also observed that all variables have a value of approximately 1, which means that the means of the groups are equal. Still, among all variables under analysis, the ATO variable, since it has a lower value $Wilks'\lambda$ (meaning that there are significant differences between groups).

4.2.2. Multivariate homoscedasticity (Box's M Test)

Hypotheses to test:

- H_0:Matrices of variance-covariance are equal for both groups;
- H_1:Variance-covariance matrices differ for both groups.

Table 15: *Box's M* Test

Test Results		
Box's M		6011,679
F	Approx.	162,719
	df1	36
	df2	181310,390
	Sig.	**0,000**

Tests null hypothesis of equal population covariance matrices.

In line with the Box's M test, for a significance level of 0.00, less than 5%, the null hypothesis is rejected, the matrices of variance-covariance are equal for both groups. This result, observable through Table 15, evidences the existence of heteroscedasticity rather than homoscedasticity, which is why the second assumption of discriminant analysis is not fulfilled.

4.2.3. Absence of multicollinearity

Table 16: Pooled Within-Groups Matrices

Pooled Within-Groups Matrices									
		NFU	ATO	END	DCA	IDD	RCP	VNG	ALA
Correlation	NFU	1,000	,063	,029	,012	,065	-,016	,127	-,016
	ATO	,063	1,000	,067	**,904**	,022	-,030	,459	-,008
	END	,029	,067	1,000	,058	-,197	,207	,087	,093
	DCA	,012	**,904**	,058	1,000	,019	-,025	,318	-,001
	IDD	,065	,022	-,197	,019	1,000	-,106	,070	,098
	RCP	-,016	-,030	,207	-,025	-,106	1,000	-,011	,054
	VNG	,127	,459	,087	,318	,070	-,011	1,000	,001
	ALA	-,016	-,008	,093	-,001	,098	,054	,001	1,000

Multicollinearity allows us to verify the correlation levels between variables, in general, in weak or moderate. The 8 independent variables cannot be highly correlated. From the analysis of Table 16, it is verified that, in general, the correlation levels between the variables are weak or moderate. However, only between the variables ATO and AD there is a correlation level of 0.9, that is, greater than 50% showing no multicollinearity. In this sense, there is statistical evidence to ensure compliance with the assumption of absence of multicollinearity.

Estimate the coefficients of the discriminant function, ensuring the significance of the functions

Table 17: Eigen values

Eigenvalues				
Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	,080[a]	100,0	100,0	**,272**

a. First 1 canonical discriminant functions were used in the analysis.

Through the analysis of Table 17, it is observed that, due to the existence of only two groups, the procedure exposes only one discriminant function. The value itself assigned to the discriminant function is 0.080 and represents 100% of the variance explained. The canonical correlation square shows that, appreciably, 7% of the variance of the formed groups is explained by the discriminant function. $(0.272)^2 = 0.073984$.

Table 18: *Wilks' Lambda*

Wilks' Lambda				
Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	,926	35,388	8	**,000**

It is important to note that the interpretation of discriminant analysis only makes sense if discriminant functions are statistically significant. The null hypothesis – the means of the groups are equal – can be tested through Wilks' Lambda, whose result is in Table 18 and the lower the value, the greater

ability to discriminate the function has. Since the significance is less than 0.05 ($\rho = 0.00 < 0.05$), the null hypothesis is rejected so the means of the groups in the function are equal. In this sense, it can be attested that the derived function is significant, that is, it can discriminate cases into two groups.

Ascertain the contribution of variables to the discriminant function

Table 19: Standardized *Discriminant Functional Coefficients Padronizados*

Standardized Canonical Discriminant Function Coefficients	
	Function
	1
NFU	,156
ATO	**1,166**
END	,407
DCA	-,502
IDD	-,376
RCP	,089
VNG	-,177
ALA	,316

Table 19 highlights the contribution of each variable to the discriminant function. The higher the value of the coefficient, the greater the relative importance of the variable concerned, since it contributes more significantly to the discriminating power of the function. Thus, the largest coefficient displayed by Table 20 belongs to the ATO variable, which is the variable that most contributes to the discriminant function. In other words, the "total assets of companies as of 12/31/2016" is the most relevant variable in group discrimination.

It is concluded through this analyses that the Variable ATO is the one that best allows to distinguish the group of companies that carry out internationalization operations, and, consequently, more complex, which means that this variable is a discriminant variable.

Table 20: Structure Matrix

Structure Matrix	
	Function
	1
ATO	**,655**
END	,566
DCA	,512
IDD	-,421
ALA	,310
VNG	,227
RCP	,208
NFU	,182

Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions

With the attentively analysis of table 20, it is possible to examine the contribution (ordered, by the absolute value) of each variable to the discriminant function, without the effect of collinearity. Thus, it is notorious that the variable that presents the greatest contribution is the ATO following the NDC variable and DCA.

Classify cases

Through Table 21 it is possible to analyze the values obtained for the classification of functions.

Table 21: Classification of Functions

Classification Function Coefficients		
	Grupo de Empresas - Internacionaliza?	
	Não	Sim
NFU	9,533E-05	2,349E-05
ATO	6,893E-10	8,507E-11
END	,115	,104
DCA	-1,146E-09	-4,584E-10
IDD	,088	,099
RCP	,008	,007
VNG	-5,316E-10	-2,753E-10
ALA	,000	,000
(Constant)	-6,166	-4,635
Fisher's linear discriminant functions		

The coefficients obtained by Fisher's function allow classifying cases into groups. In this way, it is said that:

$$D_1 = -6.166 + 0.00009533 \times NFU + 0.0000000006893 \times ATO + 0.115 \times END + 0.000000001146 \times DCA + 0.088 \times IDD + 0.008 \times RCP + (-0.0000000005316) \times VNG + 0.00 \times ALA$$

$$D_2 = -4.635 + 0.00002349 \times NFU + 0.00000000008507 \times ATO + 0.104 \times END + (-0.0000000004584) \times DCA + 0.099 \times IDD + 0.007 \times RCP + 0.0000000002753 \times VNG + 0.00 \times ALA$$

Interpretation of discrimination and validation results

Analyzing Table 22, in the results of the classification it is found that the percentage of correctly classified cases (*hit ratio)* is 76.7%. In cross-validation, a percentage of correctly classified cases of 75.0% is obtained.

Table 22: Classification Results

Classification Results[a,c]					
Grupo de Empresas - Internacionaliza?			Predicted Group Membership		Total
			Não	Sim	
Original	Count	Não	**13**	108	121
		Sim	1	**346**	347
	%	Não	10,7	89,3	100,0
		Sim	,3	99,7	100,0
Cross-validated[b]	Count	Não	**5**	116	121
		Sim	1	**346**	347
	%	Não	4,1	95,9	100,0
		Sim	,3	99,7	100,0

a. 76,7% of original grouped cases correctly classified.

b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.

c. 75,0% of cross-validated grouped cases correctly classified.

4.2.4. Stepwise Method

The stepwise method (step-by-step) is very useful in the selection of variables with discriminative capacity, so that the discriminant analysis is performed only with these variables. The analysis starts without variables, and in the following steps the variables are added or removed, depending on their discriminative capacity. It should be noted that this method begins by delimiting the variable whose average is of higher differentiating and continuous degree, step-by-step, to group to the next best variable

Wilks Lambda methods, Mahalanobis Distance and Group F Ratio support and assist in determining the variables to integrate or remove from the model.

For the implementation of the method stepwise, was selected the Lambda method of Wilks, in order to support the decision-making of the variables to be considered in the study. In Table 23 the variables considered in the model are observable.

Table 23: Variables Considered in the Model

Variables Entered/Removed[a,b,c,d]									
Step	Entered	Wilks' Lambda							
		Statistic	df1	df2	df3	Exact F			
						Statistic	df1	df2	Sig.
1	ATO	,967	1	1	466,000	15,895	1	466,000	,000
2	END	,947	2	1	466,000	13,007	2	465,000	,000
3	IDD	,939	3	1	466,000	10,059	3	464,000	,000

At each step, the variable that minimizes the overall Wilks' Lambda is entered.

a. Maximum number of steps is 16.

b. Minimum partial F to enter is 3.84.

c. Maximum partial F to remove is 2.71.

d. F level, tolerance, or VIN insufficient for further computation.

In three steps:

1) The variable ATO "Total asset (in Euro units) reached by the company on 12/31/2016" entered;
2) Then the NDR variable "Company Debt Percentage on 12/31/2016";
3) Finally, the IDD variable "Company age on 12/31/2016"

Table 24: Variables under Analysis

Variables in the Analysis				
Step		Tolerance	F to Remove	Wilks' Lambda
1	ATO	**1,000**	15,895	
2	ATO	,996	13,796	,975
	END	,996	9,817	,967
3	ATO	,994	14,180	,968
	END	,956	7,003	,953
	IDD	,960	3,997	,947

With the observation of Table 24, it is found that as the variables are introduced, the value of Lambda of Wilks decreases. Nevertheless, a variable with little tolerance contributes little to the model. In this study, the variable with the lowest tolerance is the END "Percentage of Indebtedness of the company on 12/31/2016", with the value of 0.956. On the other hand, the variable that contributed the most to the model is the ATO "Total asset (in Euro units) achieved by the company on 12/31/2016". Nevertheless, the table suggests that all variables manifest high tolerance levels, which is why they can be considered in the analysis, verifying the absence of multicollinearity.

Table 25: Variables Not Considered in Analysis

Variables Not in the Analysis					
Step		Tolerance	Min. Tolerance	F to Enter	Wilks' Lambda
0	NFU	1,000	1,000	1,232	,997
	ATO	1,000	1,000	15,895	**,967**
	END	1,000	1,000	11,890	,975
	DCA	1,000	1,000	9,715	,980
	IDD	1,000	1,000	6,579	,986
	RCP	1,000	1,000	1,601	,997
	VNG	1,000	1,000	1,914	,996
	ALA	1,000	1,000	3,576	,992
1	NFU	,996	,996	,714	,966
	END	,996	,996	9,817	**,947**
	DCA	,183	,183	1,249	,964
	IDD	1,000	1,000	6,787	,953
	RCP	,999	,999	1,848	,963
	VNG	,789	,789	,244	,967
	ALA	1,000	1,000	3,571	,960
2	NFU	,995	,992	,575	,946
	DCA	,183	,183	1,191	,945
	IDD	,960	,956	3,997	**,939**
	RCP	,955	,952	,505	,946
	VNG	,786	,786	,472	,946
	ALA	,991	,987	2,508	,942
3	NFU	,990	,955	,803	,937
	DCA	,183	,183	1,188	,937
	RCP	,951	,920	,333	,938
	VNG	,781	,781	,274	,938
	ALA	,977	,943	3,334	**,932**

The variables under study that have a lower value of Lambda Wilks enter the model. In this sense, through the analysis of Table 25, we can conclude that the first variable to be considered in the model was the ATO "Total asset (in Euro units) reached by the company on 12/31/2016", with a Lambda Wilks equal to 0.967. The second variable to enter the model was the END "Company Debt Percentage on 12/31/2016", with a Lambda Wilks of 0.947. The third variable to be inserted in the model was the IDD "Age of the company on 12/31/2016", with a Lambda Wilks equal to 0.939. Finally, the fourth variable that is considered in the model is called ALA "Percentage of Leverage of the company on 12/31/2016".

Hypotheses to test:

- H_0: The means of the groups in the functions are the same;
- H_1: The means of the groups in the functions differ.

Table 26: *Wilks' Lambda*

Wilks' Lambda									
Step	Number of Variables	Lambda	df1	df2	df3	Exact F			
						Statistic	df1	df2	Sig.
1	1	,967	1	1	466	15,895	1	466,000	,000
2	2	,947	2	1	466	13,007	2	465,000	,000
3	3	,939	3	1	466	10,059	3	464,000	,000

With the analysis of Table 26, there are significance levels equal to 0.00 for all variables, which means that because they are less than 5% ($\rho = 0.00 < 0.05$), the null hypothesis is rejected, the means of the groups in the functions are equal. Thus, it is confirmed that the function is discriminating.

Table 27: *Eigen Values*

Eigenvalues				
Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	,065[a]	100,0	100,0	,247

a. First 1 canonical discriminant functions were used in the analysis.

It should also be noted that 6% $[(0.247)^2 = 0.061009]$ of the variance of the formed groups is explained by the discriminant function, as shown in Table 27.

Coeficientes da função de classificação

Table 28: Classification Function Coefficient

Classification Function Coefficients		
	Grupo de Empresas - Internacionaliza?	
	Não	Sim
ATO	2,098E-10	-1,176E-10
END	,116	,104
IDD	,086	,096
(Constant)	-6,060	-4,526

Fisher's linear discriminant functions

Through the information contained in Table 28, it is possible to verify the classification of the coefficients of the function, relevant to the calculation of the equations, since:

$$D_{(\text{não } Internacionalizam)} = -6{,}060 + 0{,}00000000002098 \times ATO + 0.116 \times END + 0.086 \times IDD$$
$$D_{(internacionalizam)} = -4526 - 0.0000000001176 \times ATO + 0.104 \times END + 0.096 \times IDD$$

The observation of Table 29 allows us to verify that the percentage of complex companies currently classified was approximately 75.6% (primitive classification). In turn, in cross-validation the percentage is approximately 75.4% of the original classification.

Table 29: Classification Results

Classification Results[a,c]					
Grupo de Empresas - Internacionaliza?			Predicted Group Membership		Total
			Não	Sim	
Original	Count	Não	**8**	113	121
		Sim	1	**346**	347
	%	Não	6,6	93,4	100,0
		Sim	,3	99,7	100,0
Cross-validated[b]	Count	Não	**7**	114	121
		Sim	1	**346**	347
	%	Não	5,8	94,2	100,0
		Sim	,3	99,7	100,0

a. 75,6% of original grouped cases correctly classified.

b. Cross validation is done only for those cases in the analysis. In cross validation,

c. 75,4% of cross-validated grouped cases correctly classified.

4.3. Linear Regression

In this chapter, a new multivariable technique called Multiple Linear Regression, with *enter* estimation method, is used as an attempt to establish relationships between variables and predict the value of a metric dependent variable from a set of independent, metric or non-metric variables, with a view to creating a capable model, observable in Scheme 2, to elucidate the influence of variables identified in the scientific literature as predictor organizational complexity in the performance of companies. In this sense, the fundamental objective is to analyze the quantitative influence of the constituent variables of the five factors/*scores*/*loadings* – (1) Size and capital of the company, (2) Indebtedness; (3) Internationalization of the company, (4) Number of employees of the company, (5) Age and leverage of the company – in the performance of companies , that is, to ascertain whether the 5 factors constituted by the variables identified in the literature as predictors of complexity, have an influence on the performance of organizations. For the purpose of achieving this objective, the performance shall be considered to be measured by the ratio of capital profitability, as it measures the company's ability to generate results from the capital invested by shareholders, providing an indicator comparable to market profitability and the cost of debt.

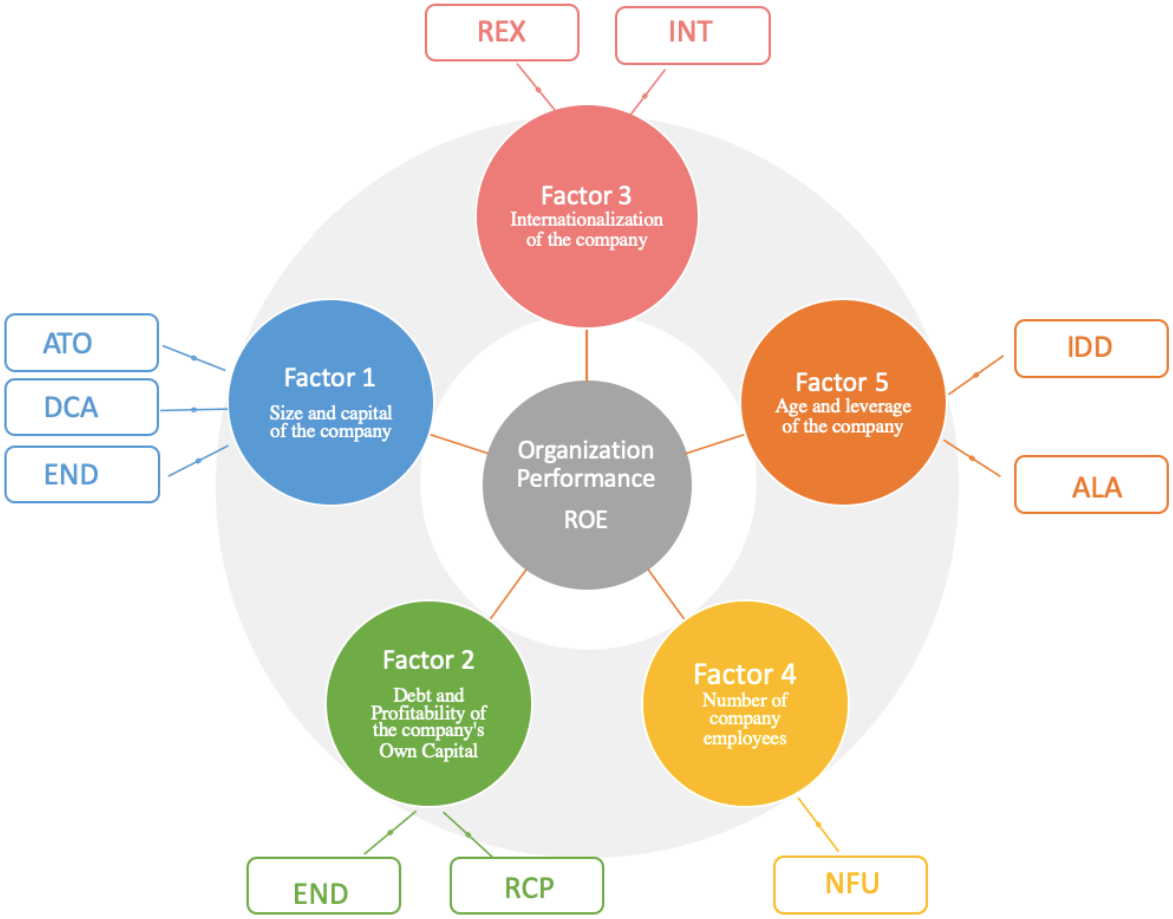

Figure 3: Proposal of mathematical model, made based on the extraction of the five *scors* of Factor Analysis

4.3.1. Analysis of variance of the Linear Regression model

Table 30: Coefficient of determination of the mathematical model of Linear Regression

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,698a	0,488	0,482	27,46881

a Predictors: (Constant), REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1

The coefficient of determination (R^2) measures the proportion of variability that is explained by regression and allows us to analyze whether the linear regression line fits the dataset. Through the analysis of Table X (Model Summary), it is observed that the adjusted coefficient of determination is equal to 0.482 (Ra2=0.482), which means that 48.2% of the total variability of corporate equity profitability (ROE) is explained by independent variables. The same means that the (1) size and capital of the company, (2) the

indebtedness, (3) internationalization, (4) the number of employees and the (5) age and leverage of the company explains 48.2% of the profitability of the company's own capital.

Regression Anova

In order to analyze the variance of the linear regression model, the following hypotheses are presented to be tested:

- H_0: $\beta_1 = \beta_2 = \cdots = \beta_3 = 0$; and
- H_1: ∃i: $\beta_i \neq 0$ $(i = 1, \ldots, p)$.

Table 31: Linear Regression Anova

ANOVAa						
Model		Sum of Squa	df	Mean Square	F	Sig.
1	Regression	331824,464	5	66364,893	87,955	,000b
	Residual	348595,517	462	754,536		
	Total	680419,981	467			

a Dependent Variable: Percentagem de rentabilidade do capital próprio a 31/12/2016

b Predictors: (Constant), REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1

Using Table 31 referring to regression ANOVA, a level of significance associated with 0.000 is observed, that is, less than 0.05, which is why we reject the null hypothesis (H_0) with 95% confidence. In this sense, there is at least one independent variable with a significant effect on the variation of the dependent variable "Profitability of Equity", evidencing a highly significant mathematical model.

Table 32: Linear Regression model coefficients

Coefficients a						
Model		Unstandardized B	Coeficients Std. Error	Coefficients Beta	t	Sig.
1	(Constant)	21,973	1,27		17,305	0
	REGR factor score 1 for analysis 1	0,337	1,271	0,009	0,265	0,791
	REGR factor score 2 for analysis 1	-18,871	1,271	-0,494	-14,846	0
	REGR factor score 3 for analysis 1	17,459	1,271	0,457	13,735	0
	REGR factor score 4 for analysis 1	2,199	1,271	0,058	1,73	0,084
	REGR factor score 5 for analysis 1	6,683	1,271	0,175	5,258	0

a Dependent Variable: Percentagem de rentabilidade do capital próprio a 31/12/2016

Testing H0:Bi=0 and, based on Bonferroni correction, for a significance level of 0.05/6, only F2, F3, F5 are significant for the model.

The analysis of the coefficients of determination of R2, mentioned in TABLE Z, suggests the following adjusted model:

$$\widehat{ROE}: 21{,}973 + 0{,}337F_1 - 18{,}871F_2 + 17{,}459F_3 + 2{,}199F_4 + 6{,}683F_5$$

Thus, the variables Indebtedness (F2), Internationalization (F3) and Age and Leverage of the company (F5) are the ones that contribute the most to explain the behavior of the profitability of the capital of companies.

4.3.2. Validation of assumptions

Waste Analysis

With regard to waste analysis, it can be considered that the residues are correlated since the Durbin-Watson[36] test value is equal to 2.

Nevertheless, standardized values[37] present approximate maximum and minimum values.

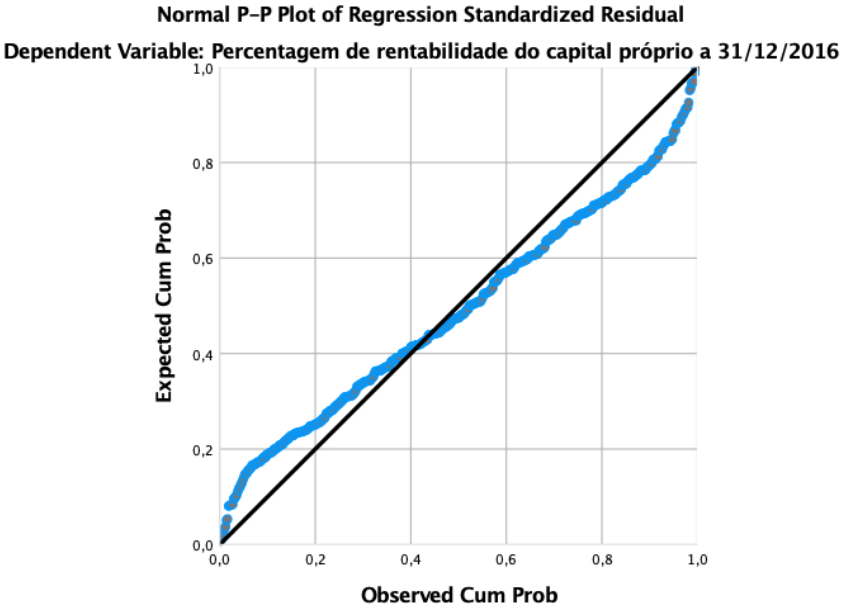

Figure 4: P-Plot waste standardized linear regression

Based on the analysis of Figure 4, we can see that the points are close to the diagonal, it is therefore expected that the residues present an approximately normal distribution.

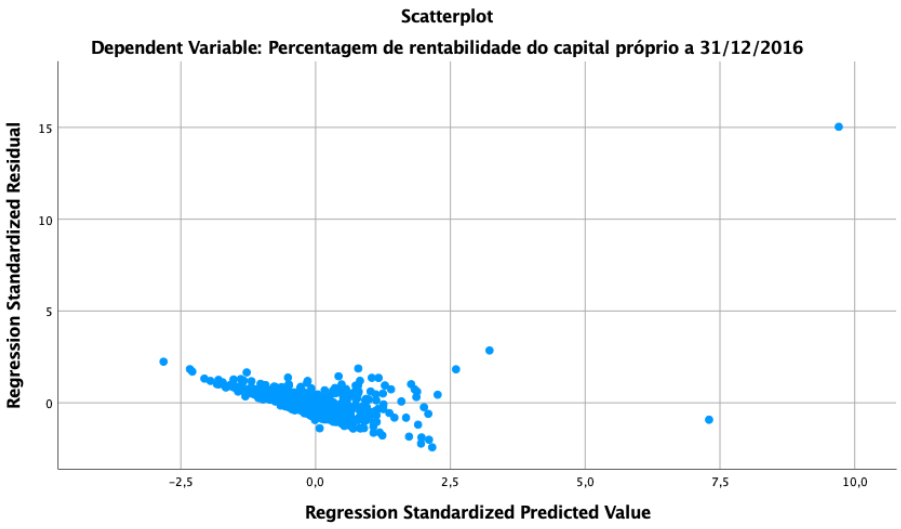

Figure 5: Predictive values standardized linear regression

[36] Confront Table 47 - Appendix C
[37] Confront Table 48 - Appendix C

The dispersion of the residues around the average value (zero), visible through Figure 5, is not random. Similarly, the variance of waste does not appear to be relatively homogeneous.

Based on the One-Sample Kolmogorov-Smimov[38] test, it is noted that the variable residues follow a normal distribution to a significance level of 5% or 10%.

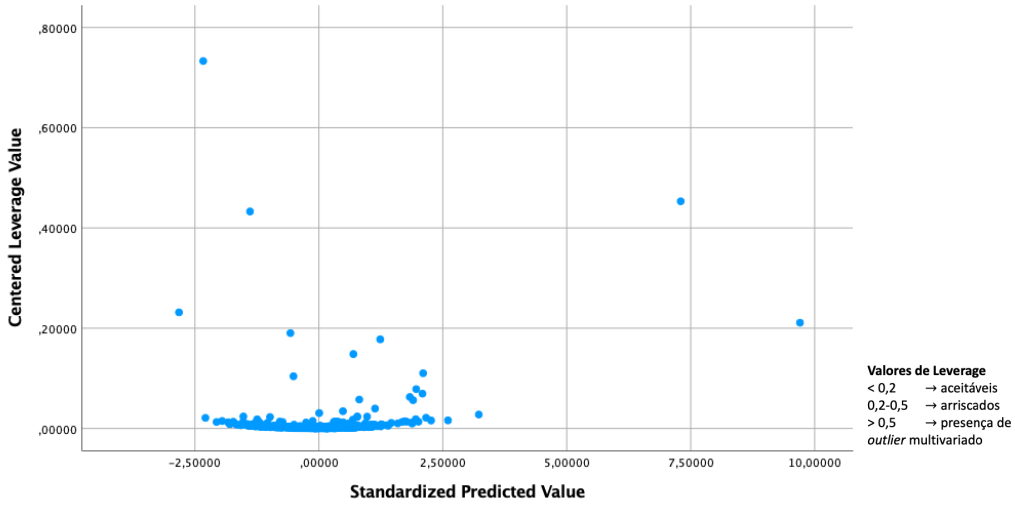

Figure 6: Values of Leverage

The centered values of the influence of each case *(Leverage)* in the adjustment of the model allow to identify possible *outliers*. With the careful analysis of Figure 6, there is the presence of a multivariate *outlier* (case 350), as well as cases 348 and 349 are far away from the rest.

Table 33: Analysis of absence of multicollinearity - T and VIF

Coefficients a								
Model		Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	VIF
1	(Constant)	21,973	1,27		17,305	0		
	REGR factor score 1 for analysis 1	0,337	1,271	0,009	0,265	0,791	1,000	1,000
	REGR factor score 2 for analysis 1	-18,871	1,271	-0,494	-14,846	0	1,000	1,000
	REGR factor score 3 for analysis 1	17,459	1,271	0,457	13,735	0	1,000	1,000
	REGR factor score 4 for analysis 1	2,199	1,271	0,058	1,73	0,084	1,000	1,000
	REGR factor score 5 for analysis 1	6,683	1,271	0,175	5,258	0	1,000	1,000

a Dependent Variable: Percentagem de rentabilidade do capital próprio a 31/12/2016

Based on the analysis of Table 33, all independent variables present in the model reflect T=1 and VIF=1. Thus, since T has no value close to zero and VIF is not greater than 5, we can conclude that there are no multicollinearity problems.

Table 34: Proportion of variance of regression coefficients

Collinearity Diagnosticsa									
Model	Dimension	Eigenvalue	Condition Index	Variance Proportions (Constant)	REGR factor score 1 for analysis 1	REGR factor score 2 for analysis 1	REGR factor score 3 for analysis 1	REGR factor score 4 for analysis 1	REGR factor score 5 for analysis 1
1	1	1	1	0	0,01	0,65	0,110	0,230	0
	2	1	1	0,28	0,01	0,16	0,500	0,040	0
	3	1	1	0	0	0	0,000	0,000	1
	4	1	1	0	0,03	0,12	0,170	0,690	0
	5	1	1	0	0,95	0,01	0,020	0,030	0
	6	1	1	0,72	0	0,07	0,2	0,02	0

a Dependent Variable: Percentagem de rentabilidade do capital próprio a 31/12/2016

[38] Confront Table 49 - Appendix C

Through Table 34, it is noted that the number of dimensions is equal to the number of parameters in the model. In all six dimensions, the values themselves and the Condition Index are equal to 1 respectively. The proportion of variance in each of the regression coefficients associated with all variables of the model are not excessively high, remaining equal to or less than 0.07, not suggesting any problem of multicollinearity.

5 Conclusions

The incessant demand for adaptation to the new realities of the contemporary global market, imposes on organizations an increasing capacity of dynamic management, since the traditional paradigms of business management gradually unravel effective and efficient in achieving organizational strategies and objectives.

The scientific literature suggests that the complexity of organizations presents a negative relationship with imitation, thus becoming a barrier to entry into new markets. Nevertheless, complexity emerges, as a "cry" of literature to the need to change the paradigms of strategic management of companies. Organizational structure and strategic management are seen as decisive in dealing with the complexity of the business.

Contemporary organizations are increasingly analyzed on the basis of a dynamic management approach, as opposed to traditional approaches. Increasing the level of complexity of the organization makes it difficult to predict events and transparency of organizational objectives and missions by different business units, imposing profound changes in the management of organizations, in particular with regard to its organizational structure, balanced distribution of decision-making power and continuous learning strategy (Bechtold, 1997; Bushman et al., 2004; Beeson, 2000; Sargut & McGrath, 2011).

In fact, complexity makes organizations more dynamic, flexible and adaptable, which is why managers must join forces to absorb complexity, driving the acquisition of greater knowledge and, consequently, opportunity to differentiate themselves from competitors, create barriers to entry and imitation, building sustainable competitive and corporate advantages, which allow better performances (Ashmos & Duchon, 2000).

Statistical measurement techniques that simplify reality compromise the intrinsic nature of complexity. According to Heylighen (1988) it is not possible to analyze a complex system, and in this sense, the construct of complexity, separating its components into independent elements, without this system being destroyed (Vesterby, 2008).

The complexity of companies can be considered as the quantity and diversity of elements and relationships that, at the same time constitute a unique organizational standard (Vesterby, 2008).

Through Factor Analysis, it was possible to verify that the 10 variables found in the literature are relevant, but insufficient for the realization of the consistency of the concept of complexity of organizations, which suggests the existence of other relevant variables for their measurement and definition.

The discriminant analysis, at two levels and, considering that, as the degree of internationalization increases, the level of complexity of the organizations also increases, it has made it possible to conclude that the variables subject to study are end-of-power discrimination. Nevertheless, the variables ATO (associated with the size of the company), END (company indebtedness) and IDD (age, associated with the company's experience in the market) are the ones with the highest discriminative power, respectively, having been observed in the classification of the results that (either in the original classification or in cross-validation) most of the 468 cases were correctly classified (Lin & Lee, 2008; Sanders & Carpenter, 1998)

The use of multiple linear regression allowed us to conclude that the five factors obtained with factor analysis explain about 48% of the company's performance. This allows us to ask that complexity has effectively significant influence on performance and subsistence and conquest of the national and international contemporary market.

The results obtained may be justified by the fact that they also contribute to the definition of complexity, political, cultural and social factors that have not been included in this investigation (Lin & Lee, 2008; Sanders & Carpenter, 1998).

In this sense, the fact that it is not possible to validate the term business complexity only with these quantitative variables, evidences from the outset, the breadth of the concept of complexity, stressing the fact that some authors consider that the complexity companies are influenced not only by intrinsic variables to the company, but also by variables that are extrinsic to it (Crispim & Barbosa, 2006).

From the above, the results obtained call into question the research hypothesis, suggesting high limitations in the realization of the complexity construct of organizations. The choice of SABI as a data source and, consequently, the attempt to measure business complexity, only with quantitative variables constitute limitations of this study. The impossibility of universalizing the conclusions obtained in this investigation and the use of ratios as a way to measure some variables identified in the scientific literature, reflect imminent limitations to the investigation. In addition, the study only reflects the financial information of an economic year (2016), namely the last year of available information, ignoring the history of companies.

Although quantitative analysis is realistic, it genuinely ignores qualitative analysis that, by definition of complexity, will become fundamental for a better understanding of the concept. In addition, it should be borne in mind that statistical methodologies are static as opposed to the metamorphic nature of "Complexity" (Vesterby, 2008).

In fact, the existing literature on complexity in organizations is still very scarce, given the complexity of the concept itself, and there is still no method conceived and capable of measuring complexity significantly. This situation evokes and reinforces the need to understand, first, these systems, that is, to understand the complexity of an increasingly globalized world is fundamental for understanding the complexity of companies themselves. Still, business complexity will never cease to exist, making it easier to understand it than to measure it (Vesterby, 2008).

Once the multivariate statistical analyses were completed, and although the results obtained did not manifest themselves enticing, the affirmative answer to the relevant question cast by Tetenbaum (1998) was clear at the beginning of the investigation: "Can we apply the theory to organizations?" In fact, the explanatory power of the so-called Theories of Complexity drives an effective and dynamic observation of the organization, motivating the shift of fundamental paradigms to survive successfully in contemporary national and international markets. From the above, complexity management emerges as the decisive factor for some companies to be more successful than others, emphasizing the relevance of the continuous alignment of individual and organizational objectives, due to maximizing the management of complexity, based on a fundamental characteristic: self-organization.

Considering the fundamental objectives of this study have been full field, it is finally suggested that in future investigations, should be adopted methods capable of analyzing both the quantitative and qualitative dimensions of the complexity of organizations and improve and consider more variables capable of significantly defining characteristics and structures of a different political, social and cultural nature, in order to better analyze and understand the extent of complexity to organizations. Another proposal for future research is to study the complexity of organizations in the high-tech and knowledge-intensive sectors.

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Appendices

Appendix A – Literature Review: Complexity of Organizations

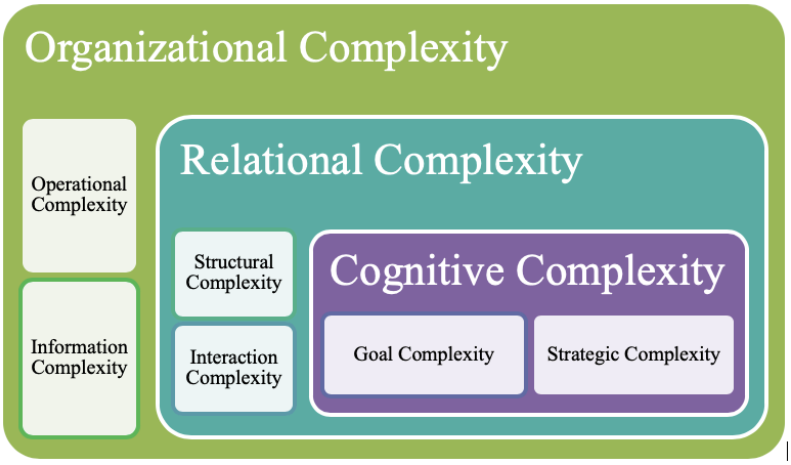

Figure 7: Measurement of cognitive and relational complexity, influencers of Organizational Complexity.

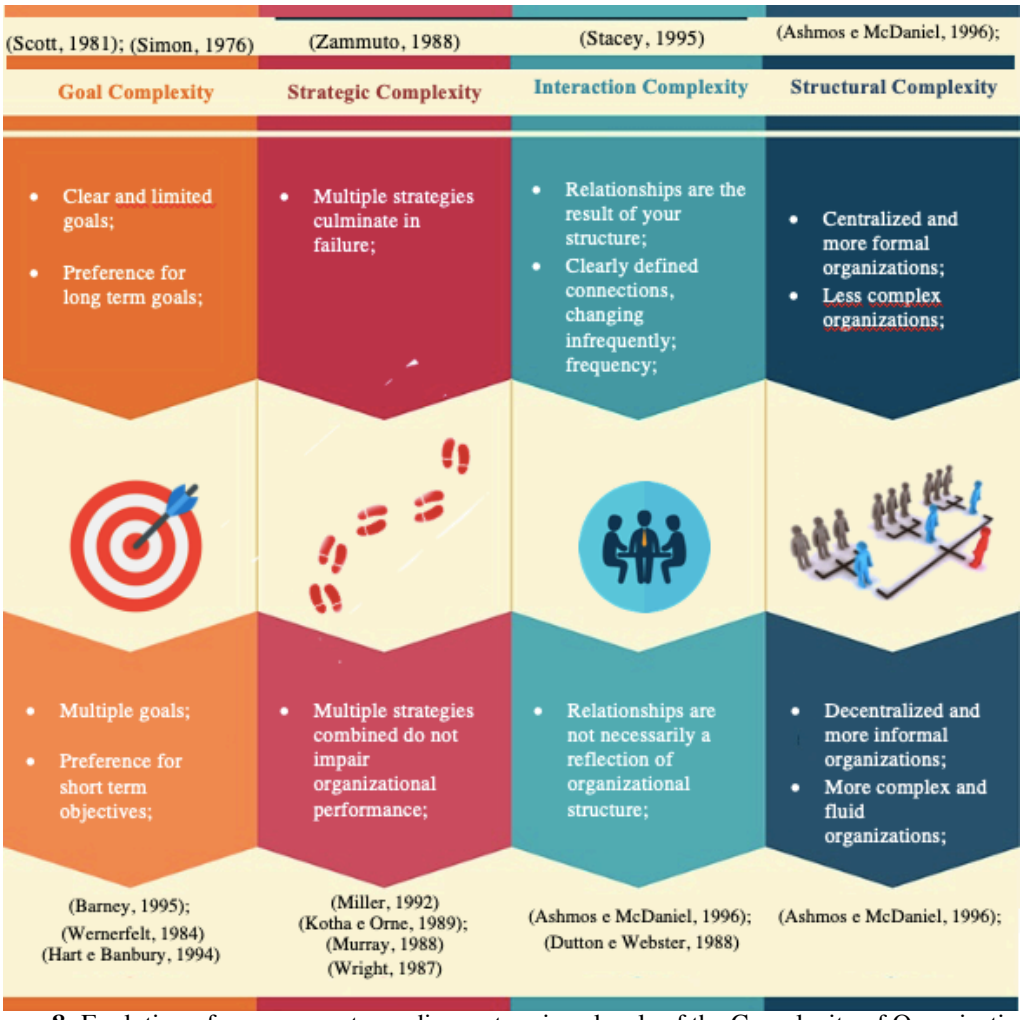

Figure 8: Evolution of management paradigms at various levels of the Complexity of Organizations.

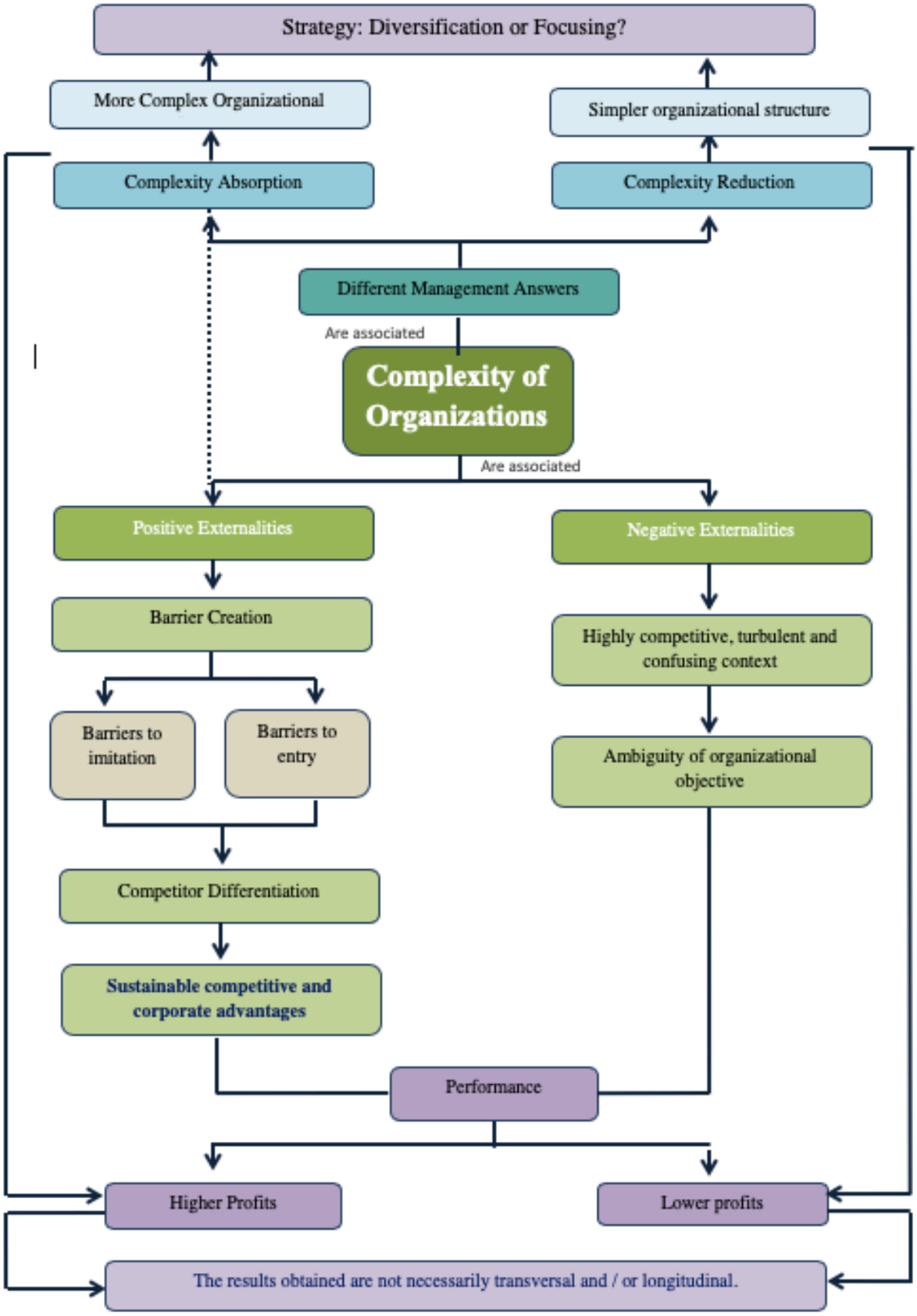

Figure 9: Synthesizing of the externalities associated with the Complexity of Organizations, in the management
Source: Own Elaboration (2019) based on (Ashmos e McDaniel, 1996; Snihur, Y., & Tarzijan, J., 2018; Markides, C., 2015; Sargut, G., & McGrath, R. G., 2011; Errunza, V. R., & Senbet, L. W., 1984; Berger, P. G., & Ofek, E., 1995; Lamont, O., & Polk, C., 2002; Servaes, H., 1996; Lang, L. H., & Stulz, R. M., 1994; Denis, D. J., Denis, D. K., & Yost, K., 2002).

Table 35: Dimensions of the Complexity of Organizations, as well as the inherent explanatory variables identified in the scientific literature

Complexity of Organizations						
Dimensions	**Definition**	**Variables**	**Nature of the variable**	**Initials**	**Expected relationship**	**Theoretical support**
Operational Complexity	It arises when organizations make decisions under institutional and financial constraints.	Total number of activities and economic partners	Quantitative	NAP	+	(Bodnar, Tang, & Weintrop, 1998); (Snihur & Tarzijan, 2018); (Kauffman, 1993)
		Number of interdependence between activities	Quantitative	NIA	+	
		Partner Interdependence Number	Quantitative	NIP	+	
Structural Complexity	It consists in observing a varied internal structure. Structural complexity is greater in considerably decentralized and less formal organizations. Increasing size creates structural differentiation in organizations.	Size	Quantitative	TAM	+	(Ashmos & Duchon, 2000); (Beyer & Trice, 1979); (Damanpour, 1996); (Zhou, 2013)
		Number of Departments	Quantitative	NDP	+	
		Formalization in relations	Quantitative	FOR	+	
		Number of interdependencies between departments	Quantitative	NID	+	
		Vertical differentiation	Quantitative	DFV	+	
		Horizontal Differentiation	Quantitative	DFH	+	
		Division of work	Quantitative	DVT	+	
		Degree of specialization	Quantitative	GES	+	
Interaction Complexity	It occurs when there are high levels of participation of numerous stakeholder groups in the strategic decision making process.	Number of participants in the decision making process	Quantitative	DEC	+	(Ashmos & Duchon, 2000) ;
Relational Complexity	Focuses on the structure of interactions between agents.		Qualitative	RLC	+	(Boisot & Child, 1999)
Strategic Complexity	When the organization simultaneously performs a variety of strategic models.	Number of strategies that make up the business plan of the company	Quantitativa	EST	+	(Ashmos & Duchon, 2000)
Information Complexity	audit costs, different legal and accounting systems, currency differences, cultural and linguistic differences.	Audit costs as a percentage of total costs incurred by entity	Quantitative	AUT	+	(Bodnar, Tang, & Weintrop, 1998); (Reeb et al.,1998); (Duru & Reeb, 2002); (Denis, Denis, & Yost, 2002)
		Number of legal and accounting systems in which the company operates simultaneously	Quantitative	SLC	+	
		Number of Operational Languages	Quantitative	LIG	+	
		Cultural analysis	Qualitative	CLT	+	
Goal Complexity	When organizations have many and varied goals	Number of organizational objectives	Quantitative	NOB	+	(Ashmos & Duchon, 2000)
Cognitive Complexity	Emphasizes the content of information that flows between agents.		Qualitative	COG	+	(Boisot & Child, 1999); (Ashmos & Duchon, 2000)

Appendix B – Descriptive Analysis

Table 36: END Variable Frequency - "Company Indebtedness Percentage on 12/31/2016

Percentagem de Endividamento da empresa a 31/12/2016				
	Frequency	Percent	Valid Percent	Cumulative Percent
55,01	1	,2	,2	50,0

Table 37: Frequency of variable DCA - "Dependence on capital unrelated to 31/12/2016

Dependência da empresa de capital alheio a 31/12/2016 (valores em unidades de Euro)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	,00	134	28,6	28,6	28,6

Table 38: Descriptive analysis for the IDD variable - "Company age on 12/31/2016"

Descriptives			Statistic	Std. Error
Idade da empresa a 31/12/2016	**Mean**		**30,69**	,980
	95% Confidence Interval for Mean	Lower Bound	**28,76**	
		Upper Bound	32,61	
	5% Trimmed Mean		28,88	
	Median		25,00	
	Variance		449,898	
	Std. Deviation		21,211	
	Minimum		0	
	Maximum		127	
	Range		127	
	Interquartile Range		23	
	Skewness		**1,346**	**,113**
	Kurtosis		**1,978**	**,225**

Idade da empresa a 31/12/2016		
N	Valid	468
	Missing	0
Mean		30,69
Mode		26
Std. Deviation		21,211
Minimum		0
Maximum		127
Percentiles	25	17,00
	50	25,00
	75	40,00

N	Valid	468
	Missing	0
Skewness		1,346
Std. Error of Skewness		,113
Kurtosis		1,978
Std. Error of Kurtosis		,225

Table 39: Frequency of the variable GO - "Group of Companies - Internationalizes?"

Grupo de Empresas - Internacionaliza?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Não	121	25,9	25,9	25,9
	Sim	347	74,1	74,1	100,0
	Total	468	100,0	100,0	

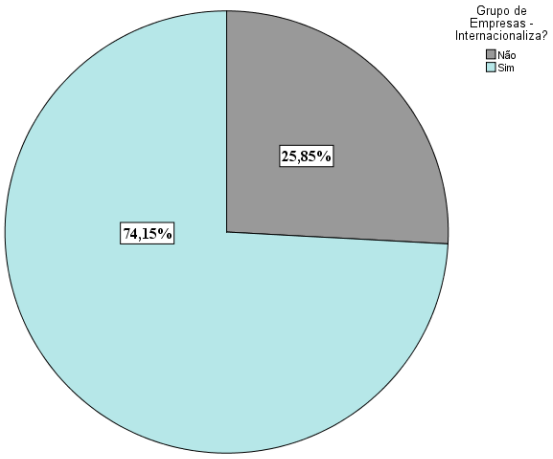

Figure 10: Circular Chart for the variable "Group of Companies - Internationalizes?"

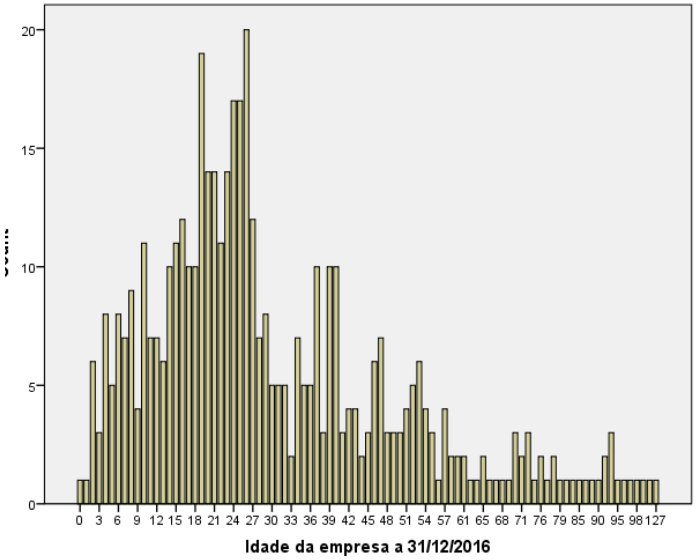

Figure 11: "Bar Chart for the company's age variable on 12/31/2016"

Table 40: Frequency of the IDD variable - "Age of the company on 12/31/2016"

Idade da empresa a 31/12/2016				
	Frequency	Percent	Valid Percent	Cumulative Percent
26	20	4,3	4,3	56,0
127	1	,2	,2	100,0
Total	468	100,0	100,0	

Table 41: Frequency of variable FJU - "Legal form of the company"

Forma jurídica da empresa					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sociedade Anónima	345	73,7	73,7	73,7
	Sociedade por Quotas	94	20,1	20,1	93,8
	Sociedade Unipessoal por Quotas	28	6,0	6,0	99,8
	Sociedade em Comandita	1	,2	,2	100,0
	Total	468	100,0	100,0	

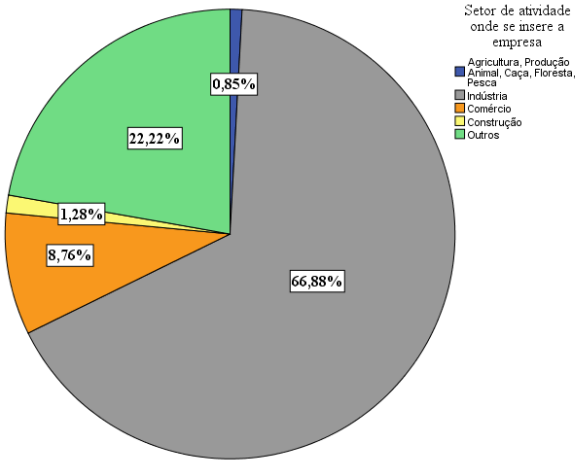

Figure 12: Circular chart for the variable "Activity Sector where the company is inserted"

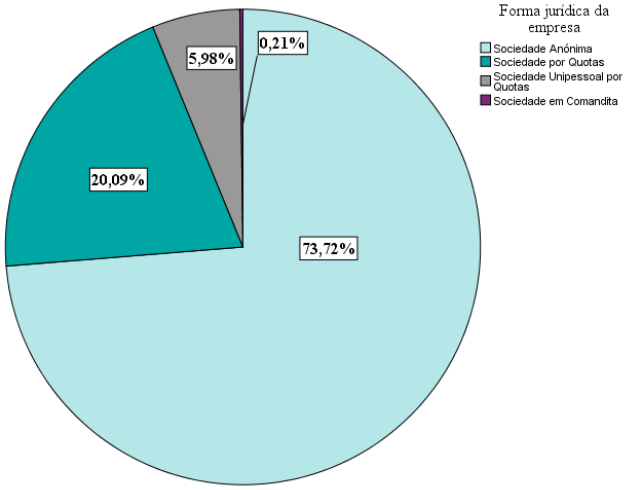

Figure 13: Circular chart for FJU variable - "Corporate legal form"

Table 42: Frequency of the variable SET - "Sector of activity where the company is inserted"

Setor de atividade onde se insere a empresa					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agricultura, Produção Animal, Caça, Floresta, Pesca	4	,9	,9	,9
	Indústria	313	66,9	66,9	67,7
	Comércio	41	8,8	8,8	76,5
	Construção	6	1,3	1,3	77,8
	Outros	104	22,2	22,2	100,0
	Total	468	100,0	100,0	

Table 43: Frequency of the TIP variable - "Qualitative dimension of the company"

Dimensão qualitativa da empresa a 31/12/2016					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Microentidade	34	7,3	7,3	7,3
	Pequena Entidade	77	16,5	16,5	23,7
	Média Entidade	294	62,8	62,8	86,5
	Grande Entidade	63	13,5	13,5	100,0
	Total	468	100,0	100,0	

Table 44: Frequency of the Variable DST - "District location of the company"

Localização distrital da Empresa					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Aveiro	69	14,7	14,7	14,7
	Beja	3	,6	,6	15,4
	Braga	64	13,7	13,7	29,1
	Bragança	1	,2	,2	29,3
	Castelo Branco	7	1,5	1,5	30,8
	Coimbra	11	2,4	2,4	33,1
	Évora	3	,6	,6	33,8
	Faro	4	,9	,9	34,6
	Guarda	4	,9	,9	35,5
	Leiria	20	4,3	4,3	39,7
	Lisboa	114	24,4	24,4	64,1
	Portalegre	3	,6	,6	64,7
	Porto	100	21,4	21,4	86,1
	Santarém	22	4,7	4,7	90,8
	Setúbal	12	2,6	2,6	93,4
	Viana do Castelo	14	3,0	3,0	96,4
	Vila Real	1	,2	,2	96,6
	Viseu	16	3,4	3,4	100,0
	Total	468	100,0	100,0	

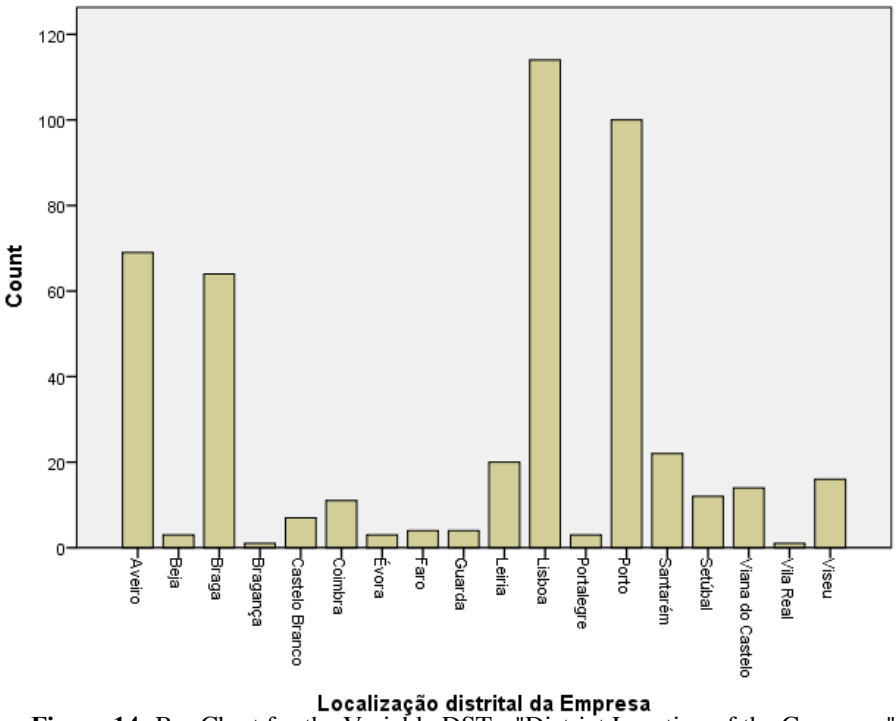

Figure 14: Bar Chart for the Variable DST - "District Location of the Company"

Appendix C - Multivariate Quantitative Study

Factor Analysis

Table 45: Anti-image matrix

Anti-image Matrices											
		REX	NFU	ATO	END	DCA	IDD	RCP	INT	VNG	ALA
Anti-image Correlation	REX	,441[a]	-,087	,047	,034	,002	-,030	-,050	-,255	-,327	,013
	NFU	-,087	,567[a]	-,079	-,039	,081	-,057	,016	,079	-,044	,023
	ATO	,047	-,079	,522[a]	-,004	-,900	,036	,011	,085	-,399	,012
	END	,034	-,039	-,004	,562[a]	-,014	,212	-,193	,066	-,077	-,111
	DCA	,002	,081	-,900	-,014	,521[a]	-,029	-,001	-,051	,230	-,011
	IDD	-,030	-,057	,036	,212	-,029	,501[a]	,073	,023	-,067	-,115
	RCP	-,050	,016	,011	-,193	-,001	,073	,569[a]	,003	,019	-,046
	INT	-,255	,079	,085	,066	-,051	,023	,003	,566[a]	,115	,057
	VNG	-,327	-,044	-,399	-,077	,230	-,067	,019	,115	,567[a]	,005
	ALA	,013	,023	,012	-,111	-,011	-,115	-,046	,057	,005	,469[a]

a. Measures of Sampling Adequacy(MSA)

Table 46: K-S Normality Tests

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
IDD	,154	468	,000	,894	468	,000
REX	,336	468	,000	,360	468	,000
NFU	,396	468	,000	,160	468	,000
ATO	,431	468	,000	,120	468	,000
END	,035	468	,200*	,980	468	,000
DCA	,457	468	,000	,073	468	,000
RCP	,277	468	,000	,366	468	,000
INT	,173	468	,000	,870	468	,000
VNG	,397	468	,000	,202	468	,000
ALA	,434	468	,000	,165	468	,000

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Multiple Linear Regression Analysis

Table 47: Waste analysis, based on Durbin-Watson calculation

Model Summaryb					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	,698a	0,488	0,482	27,46881	2,006

a Predictors: (Constant), REGR factor score 5 for analysis 1, REGR factor score 4 for analysis 1, REGR factor score 3 for analysis 1, REGR factor score 2 for analysis 1, REGR factor score 1 for analysis 1

b Dependent Variable: Percentagem de rentabilidade do capital próprio a 31/12/2016

Table 48: Waste analysis, based on the Durbin-Watson Test

Residuals Statistics a					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Va	-53,2367	280,6445	21,9725	26,65605	468
Residual	-66,56434	412,94553	0	27,32137	468
Std. Predicte	-2,821	9,704	0	1	468
Std. Residua	-2,423	15,033	0	0,995	468

a Dependent Variable: Percentagem de rentabilidade do capital próprio a 31/12/2016

Table 49: Waste analysis - Residual statistics

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		468
Normal Parameters a,b	Mean	0
	Std. Deviatio	27,32136912
Most Extreme Difference	Absolute	0,107
	Positive	0,107
	Negative	-0,099
Test Statistic		0,107
Asymp. Sig. (2-tailed)		,000c

a Test distribution is Normal.

b Calculated from data.

c Lilliefors Significance Correction.

Chapter IV

Conclusion

Conclusion

The complexity as an epistemic concept guided by the unpredictability, ambiguity and multiplicity of interactions leads to a multiplicity of realities, which in turn will be analyzed and interpreted equally differently, depending on the experiences of each organization, that is, in the same way that no company is equal to another, but only itself, the complexity that each embodies differs considerably from the others. The ability to mitigate the internal and/or external instability that comes from it implies the constant reinvention of managers, with a view to adapting organizations to the permanent demands of the market.

The realization of a bibliometric analysis suggested complexity as an area with eminent contributions in better understanding of organizational context and dynamics.

The research methodology adopted, more specifically the use of quantitative methods - Factor analysis, Discriminant Analysis and Multiple Linear Regression Analysis – proved to be fruitful but, insufficient, which, in a way corroborates the impossibility of "measuring" organizational complexity, not suggesting the existence of standardized and clear relationships of "cause-effect".

Despite the strong evidence that complexity is inevitable and necessary for business development and development, it should be borne in mind that, with regard to business performance or success, the complexity perceived by the manager and all parties should be a "whole", the differential factor in success, therefore, is based on the interpretation of reality that business strategies will be outlined and the efforts necessary to transform barriers into opportunities will be outlined.

All organizations are subject to competitive pressures and operate in more or less complex environments, and it is the dynamic management and interpretation that is made of the reality that will reveal the company's (in)success. Ensure the satisfaction of stakeholders, adopt and implement strategies capable of ensuring sustainable competitive advantages, training in dynamic, uncontrollable and uncertain scenarios, regardless of the sector of activity, displace the managers of their comfort area, which is why information and communication between the parties proves indispensable in the strategic path, to patrol.

This research work made it evident that it is in the interaction between parts that complexity is generated, and soon as the inevitable interaction in the construction of the business, the understanding and interpretation of complexity acquires the predominant role in the success of the same. In addition, since the organization is an open system, immune from delineated borders, there is greater difficulty in defining and transmitting the mission and vision global, to each part of the system.

Despite the historical events of organizations have an influence on their identity and how they will subsequently react to the perceived complexity of the parties, which means that complexity constitutes a barrier to the imitation of competition , becoming central to analyze company the company for the definition of strategies authentic and adjusted to the internal and external environment that surrounds them. The competitive and competitive environment of today's markets generates organizational diversity, leading to different results arising from the same strategy when implemented in different organizations. This new reality suggests the complexity, and understanding that theories give it, as an eminent alternative to the understanding of organizations as dynamic systems and thus in the construction of a dynamic management paradigm capable of ensuring the good business performance and success.

Although contemporary society is commonly designated as a knowledge society, in good rigor, the complexity that currently characterizes it assigned a new characteristic: dynamism, which evokes the need to develop the ability to learn and to apprehend the knowledge that it is already ended, transforming it into fruitful information in the development of management tools and paradigms, capable of promoting the adaptation, reinvention and success of organizations.

By the above, linear and reductionist thinking simplifies reality, deceiving the way of observing and understanding the reality of organizations that should be analyzed as a complex system, therefore, unfinished.

Satisfied all the objectives and challenges that this dissertation proposes and challenges to which this dissertation was proposed, it is concluded that complexity is the means for understanding contemporary organizations and the world that involves them, because their interpretation implies the adoption of complex thinking, open and flexible, to which the inclusion of differences, uncertainties and diversities underlying the dynamic view of management is underlying, decisive in the evaluation of national and international contexts and in anticipation of consequence, necessary for decision-making effective strategic actions.

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