

---

**STRATEGY MATERIALITY AND TECHNOLOGY IMPLEMENTATION  
PRACTICES IN “INDUSTRY 4.0” CONTEXT**

**MATERIALIDADE DA ESTRATÉGIA E A IMPLEMENTAÇÃO DE TECNOLOGIA  
NA PRÁTICA NO CONTEXTO DA "INDÚSTRIA 4.0"**

**MATERIALIDADE DE LA ESTRATEGIA Y IMPLEMENTACIÓN DE  
TECNOLOGÍA EM LA PRÁTICA EM EL CONTEXTO DA "INDÚSTRIA 4.0"**

Angélica Pott de Medeiros

Doutoranda em Administração (PPGA/UFSC) Mestra em Administração (PPGA/UFSC)

Bacharela e Licenciada em Administração (UFSC)

apm\_angelica@yahoo.com.br

<http://orcid.org/0000-0002-7418-344X>

Rosalia Aldraci Barbosa Lavarda

Professora do Departamento de Ciências da Administração da UFSC.

Doutora em Administração pela Universitat de València -Espanha,

rblavarda@gmail.com

<https://orcid.org/0000-0002-1093-4486>

Rolf Hermann Erdmann

Professor Titular da Universidade Federal de Santa Catarina

Doutorado em Engenharia de Produção pela Universidade Federal de Santa Catarina, Brasil

rolf.erdmann@ufsc.br

<https://orcid.org/0000-0002-4094-2268>

Editor Científico: José Edson Lara  
Organização Comitê Científico  
Double Blind Review pelo SEER/OJS  
Recebido em 26.01.2020  
Aprovado em 13.04.2020



Este trabalho foi licenciado com uma Licença Creative Commons - Atribuição – Não Comercial 3.0 Brasil

## Abstract

**Purpose:** The study seeks to understand how strategy occurs as a practice in the technological context in light of the Industry 4.0.

**Approach:** Theoretical essay according to the assumptions of Whetten (2003).

**Originality:** Strategy is related to practice, technological context and Industry 4.0. These perspectives are still little explored in the literature, besides contributing to the understanding of the dynamics of the strategy, from a practical point of view.

**Findings:** Industry 4.0 will possibly intensify the interaction between different technological artefacts and users. This growth in complexity will result in an increase in the relevance of users' characteristics to the technology in practice. The experiences, knowledge, meanings, power relations, habits, norms, among other elements, will be central so that the use of technology in practice achieves the strategic objectives. This perspective comes from the practical lens of strategy because of the focus on what people actually do with the technologies in their activities.

**Contributions:** Considering the adoption of certain technologies, one must take into account the feedback of this technology, and the consequences of its uses. Due to its different possibilities of interpretation and uses, that is, its dynamicity.

**Keywords:** Materiality. Technology. Industry 4.0. Strategy as practice.

## Resumo

**Objetivo:** O estudo busca entender como a estratégia ocorre como prática no contexto tecnológico à luz da Indústria 4.0.

**Abordagem:** Ensaio teórico de acordo com os pressupostos de Whetten (2003).

**Originalidade:** A estratégia está relacionada à prática, contexto tecnológico e Indústria 4.0. Essas perspectivas ainda são pouco exploradas na literatura, além de contribuir para o entendimento da dinâmica da estratégia, do ponto de vista prático.

**Conclusões:** A indústria 4.0 provavelmente intensificará a interação entre diferentes artefatos tecnológicos e usuários. Esse crescimento na complexidade resultará em um aumento na relevância das características dos usuários para a tecnologia na prática. As experiências, conhecimentos, significados, relações de poder, hábitos, normas, entre outros elementos, serão centrais para que o uso da tecnologia na prática atinja os objetivos estratégicos. Essa perspectiva vem da lente prática da estratégia, devido ao foco no que as pessoas realmente fazem com as tecnologias em suas atividades.

**Contribuições:** Considerando a adoção de certas tecnologias, é preciso levar em consideração o feedback dessa tecnologia e as consequências de seus usos. Devido às suas diferentes possibilidades de interpretação e usos, isto é, sua dinamicidade.

**Palavras-chave:** Materialidade. Tecnologia. Indústria 4.0. Estratégia como prática.

## Resumen

**Propósito:** El estudio busca comprender cómo ocurre la estrategia como práctica en el contexto tecnológico a la luz de la Industria 4.0.

**Enfoque:** Ensayo teórico según los supuestos de Whetten (2003).

**Originalidad:** La estrategia está relacionada con la práctica, el contexto tecnológico y la Industria 4.0. Estas perspectivas aún se exploran poco en la literatura, además de contribuir a la comprensión de la dinámica de la estrategia, desde un punto de vista práctico.

**Resultados:** La Industria 4.0 posiblemente intensificará la interacción entre diferentes artefactos tecnológicos y usuarios. Este crecimiento en la complejidad dará como resultado un aumento en la relevancia de las características de los usuarios para la tecnología en la práctica. Las experiencias, conocimientos, significados, relaciones de poder, hábitos, normas, entre otros elementos, serán centrales para que el uso de la tecnología en la práctica alcance los objetivos estratégicos. Esta perspectiva proviene de la lente práctica de la estrategia debido al enfoque en lo que las personas realmente hacen con las tecnologías en sus actividades.

**Contribuciones:** Considerando la adopción de ciertas tecnologías, uno debe tener en cuenta la retroalimentación de esta tecnología y las consecuencias de sus usos. Debido a sus diferentes posibilidades de interpretación y usos, es decir, su dinámica.

**Palabras clave:** materialidad. Tecnología. Industria 4.0. La estrategia como práctica.

## 1. Introduction

In recent years, the demand for internal processes have become increasingly complex, making organizations seek to develop more flexible production systems based on new technologies. Given this, Industry 4.0 emerged, aiming at the development, enhancement and application of technological innovations, emphasizing the flexibility of production systems, as well as automation and integrated systems networked along the value chains (Saltiel & Nunes, 2017).

The Industry 4.0 principles were first disseminated by Kagermann, Lukas and Wahlster (2011), which corroborated with the plans for this initiative in Germany, published by Deutsche Akademie der Technikwissenschaften (acatech). The term “Industrie 4.0” was disseminated from this German initiative that brings together companies, politicians and academics, who formed this approach to strengthen the competitiveness of their manufacturing industry. Being exposed to the rest of the world at the Hannover Fair in Germany in 2011. This technological advance has impacted social, political and economic spheres and is considered an industrial revolution (Dombrowski & Wagner, 2014).

Historically, the insertion of technologies in organizations began in 1940, from the use of new energy sources and the increasing use of computer resources in production processes. The 'future' triggered the massification of technological products. From this, studies emerged highlighting the dynamics of these technologies in front of individuals. In this context, Mackenzie and Wajcman (1985) emphasize that social content has always been embedded in

technology, as technological artifacts develop from social visions. In the face of organizational theories, the thesis that technologies shape organizations by modifying production relations and organizational models was initially defended. In recent years, emerging perspectives have argued that social context and actors shape technological structures.

Industry 4.0 has been widely discussed around the world (Rodrigues, Jesus & Schützer, 2016), which demonstrates the relevance and progress of the theme, both in academia and in industry (Anderl, 2014). According to a survey in the Scopus database, most studies worldwide focus on the areas of engineering and computer science. They focus primarily on the development of digital technologies in the new paradigm. Liere-Netheler (2017) points out that the theme is still significantly focused on technology, with studies developed within the field of engineering, with rare studies from a socio-technical perspective. It is observed that technologies have become ubiquitous in organizations. And, this presence produces social, cultural, behavioral and structural impacts on these organizations (Orlikowski, 2000). Dameron, Le and Lebaron (2015) argue that technologies are widespread in organizations and integrate work practices, influencing the way strategy is made. Thus, the understanding of the material nature of technologies and their impacts on strategy as practice are prominent. Given this, the present study seeks to understand how strategy occurs as a practice in the technological context considering Industry 4.0. The literature on the subject has revealed that both organizations are influenced by technologies and individuals (Barley, 1986; Orlikowski, 2000; Suchman, 2007; Kaplan, 2011; Leonardi, 2011).

Given this, for the development of this, we followed the assumptions of Whetten (1989) about the development of theoretical contributions, which highlights that contributions of this nature are very useful. As they imply the reflection of the concrete applications of a new thought, or a review. Whereas, it allows new research to verify the author's arguments.

Orlikowski (2000) states that the analysis of the theme fits into the perspective of strategy as practice in which information system researchers have been working for over forty years. Some of the studies even pioneered the practical perspective in management. Nevertheless, the perspective of strategy as practice has been directed to a greater understanding of strategy materiality (and more specifically sociomateriality), in which the study of technologies is relevant, possibly this relationship can be attributed to the fact that materiality is at the heart of the strategy. Strategy work, which is concerned with the way in which socio-material aspects, such as tools, locations and arrangements, interact with strategy formation.

The practical lens makes it possible to focus attention on what people actually do with technologies in their activities (Whittington, 2006).

Most studies focus on the area of information systems, which have challenged the orthodoxy of strategy by including the different internal and external actors in the analysis (Whittington; Cailluet & Yakis-Dougras, 2011). Nevertheless, it was found that the influence of technology on strategy formulation and implementation, as well as its impact on the identities and subjectivities of strategy professionals, need to be further studied (Whittington et al., 2011; Vaara & Whittington, 2012).

Jarzabkowski and Pinch (2013) report that much of the initial interest of this theme was in professional oriented journals. Only recently, as part of the strategy-as-practice movement, have strategic studies begun to penetrate the periphery of academic journals. Studies have focused on related tools and techniques, enabling technologies, accounting practices, and technologies in use.

This practical lens argues that, like technologies in use, strategy tools can facilitate or restrict their use. Given that their use depends not only on their properties and design, but also on the context and interpretations of the actors involved, who can use technologies in creative ways (Jarzabkowski & Pinch, 2013). This is an opportunity for both information system researchers and strategy-as-practice scholars to collaborate on the role of technology in strategy (Whittington, 2014).

Dameron et al. (2015) add that in recent years materiality has become a manifest topic in strategy research, based mainly on strategy-as-practice. Nevertheless, studies analyzing technologies and their influences are still scarce. That is, although the materiality of technologies is relevant in strategy, thematic studies on technologies and their influences are still needed.

## **2. Industry 4.0 and the emergency of “smart factories”**

Recently, manufacturing has come to encompass production processes that use information technologies to a greater degree. Thus, the theme “Fourth Industrial Revolution” has been widely addressed internationally, while in Brazil, the main diffusers are large multinational companies (Daudt & Willcox, 2016).

It is noteworthy that the first evolution dates from the late eighteenth century, and occurred through the innovation and mechanization of steam engines. Then, the second industrial revolution in the mid-nineteenth century consisted of the discovery of new media, energy sources, and mass production. Already the third industrial revolution started in 1970, called digital revolution, refers to the advancement of technologies and information technology in the production system, aiming to reduce time and costs (De Oliveira & Simões, 2017).

The fourth industrial revolution, or Industry 4.0, is a German-born term that was rapidly spread across Europe, also known as “smart factories” and “advanced production,” consisting of an evolution of concepts to achieve performance goals and continuous improvements. In the processes. In addition, it comprises a complex system as it is not limited to connecting machines, but networking between machines, assets, properties and information systems throughout the chain, and the product life cycle. These activities aim to increase production flexibility, quality and productivity, as well as mass customization (Fraga; De Freitas & De Souza, 2016).

This revolution is configured as a new era, in which the internet is the protagonist. It will contribute to the convergence of the most diverse technologies introduced in the industry. Thus, its essential elements would be the fusion of the real world with the virtual, the use of cyberphysical systems, and the information available in real-time to suppliers and customers. One of the main implications will be more individualized and flexible production and less intensive labor. At the same time, the manufacturing will cease to be mass, and will be customized (Daudt & Willcox, 2016).

Given the numerous concepts presented in the literature, Hermann, Pentek and Otto (2016) define the four key elements of Industry 4.0: (i) Cyberphysical systems: components that enable the interaction of the virtual world with the real through devices such as computers and sensors; (ii) Internet of Things: connects and integrates the different devices; (iii) Internet of Services: constitutes a new logic of offer and new business models, increasing the added value of services, with emphasis on customers; and (iv) Intelligent Factories: Based on the context, it advises individuals and machines in the development of the production process, taking into account information from the physical and virtual worlds.

It should be noted that the literature has different terms in reference to the theme, such as: Advanced Manufacturing (Lee, Bagheri & Kao, 2015), Industrie 4.0 (Hermann, Pentek & Otto, 2016), Smart Industry or Smart Factories ( Shrouf, Ordieres & Miragliotta, 2014), Industrial Internet of Things (Lee, Bagheri & Kao, 2015), among others. In the Brazilian

context, studies on the subject are still incipient and it is observed that the terms Industry 4.0 (National Confederation of Industry, 2016) and Advanced Manufacturing (Brazil, 2017) are used randomly, with no standardization.

As already mentioned, it is believed that Industry 4.0 will generate strong impacts on the market, creating new business, administrative and logistic models (Carmona, 2017). It is worth mentioning that the industry has a relevant participation in the Gross Domestic Product (GDP) in different countries. In view of this, the understanding about Industry 4.0 enables a strategic position of prominence to face future competitiveness (Santos, 2016).

It is important to point out that the Brazilian industry is still behind in the technological issue, compared to developed countries, as in the United States and Germany. It can be inferred that Brazil is still transitioning between the 2nd and 3rd Industrial Revolution, as it is still replacing traditional assembly lines, and introducing automation, electronics and robotics, at a slow pace, below what is needed to become competitive (Hahn, 2016).

Even though the Brazilian industry has sought improvements in production processes, aiming to increase productivity. The lack of knowledge of the use of digital technologies in the industry, as well as their effective use is still evident. If, on the one hand, the national industry needs to be able to adapt to the fourth industrial revolution, on the other hand, it is evident that some measures by the public management are necessary, aiming at encouraging the development and providing support to the model.

According to Hahn (2016), the first steps towards Industry 4.0 have already been taken, with the creation of the Brazilian Industrial Internet Association (ABII), which aims to promote the industrial internet, as well as the strengthening of this scenario in the country. In addition, in December 2017 the Ministry of Science, Technology, Innovations and Communications (MCTIC, 2017) launched the Science, Technology and Innovation Plan for Advanced Manufacturing to provide access and insertion conditions for Brazilian companies in the context of Industry 4.0, supported by science, technology and innovation for development.

Research on this topic is still incipient, as verified by Aires, Moreira and Freire (2017), highlighting the importance of developing studies in this line. While in business, the theme is also relevant, given that different bodies, such as the National Confederation of Industry, have been working to help Brazilian companies achieve the fourth industrial revolution. Corroborating Russwurm (2014) argues that Industry 4.0 has enormous potential. Nevertheless, it is a relatively new concept, so its diffusion in Brazil is still limited, despite its potentialities.

Consisting of a research field still in the exploration phase, with a great potential for expansion (De Oliveira & Simões, 2017).

### **3. Materiality as interaction between the strategy as practice and technology**

Replacing the traditional top-down approach with more participatory and transparent or open strategies that involve multiple stakeholders communicating through transparent virtual environments (Whittington et al., 2011), coupled with technological advances in social media, have transformed communication processes within organizations, as well as altered social interactions and, as a result, these changes have affected the work of strategy in organizations. These disruptive environmental trends have forced organizations to become more innovative in their approaches to generating organizational strategies (Aten & Thomas, 2016).

With the “practical turn” in strategy, it was observed that objects and artifacts are associated with strategy, according to Whittington (1996). Jarzabkowski and Kaplan (2015) emphasize that an example of this is in business schools, where strategy has long been taught using different relevant tools, such as Porter's Five Forces (1980), strategic group maps according to McGree and Thomas. (1986), or the BCG Matrix developed by Henderson (1979). These same tools are still used by managers to support situation analysis and the assessment of strategic choices as they consider them rational decision-making processes. However, Mintzberg (1994) already criticized this over-reliance on these “technologies of rationality” as they may be inappropriate for decision making since they “defend a utopia of the mind against the realism of experience”. Given this, the strategy began to concern itself with the way in which the socio-material aspects (tools, places and arrangements) configure strategic influences. And, in fact, the strategy is conducted with different artifacts, tools, software, among others; so it is difficult to separate the strategist from the material arrangements in which the work of the strategy is carried out (Balogun, Jacobs, Jarzabkowski, Keep, & Vaara, 2014).

It is noteworthy that, besides exploring the influence of objects and artifacts on strategy formulation, the studies that constitute the practical turn argue that the strategy formation process comprises both the formulation and implementation of the organizational strategy, an inseparable process that encompasses actors, activities and structures and their impact on strategy outcomes. For these authors, this new perspective concerns not only formal strategic planning, but also processes and practices that make up the daily activities of organizational life and their impacts on organizational outcomes (Johnson, Melin & Whittington, 2003).

Different studies indicate that objects and artifacts can convey and foster strategic ideas, as well as influence and shape personal relationships in organizations (Spee & Jarzabkowski, 2011). In this sense, Dameron et al. (2015) argue that strategy is materialized through: (i) strategy tools; (ii) objects and artifacts; (iii) built spaces; (iv) human bodies; and, (v) technologies. Tools are the most common forms of material that strategists use, which represent a formalized way of conducting strategic analysis and decision making, their steps influencing final analysis and strategic decisions.

Objects and artifacts can be visible, tangible, or audible residues of acts of past meaning, distinct from tools, which are instrumental, and of technologies that mediate. Being concrete and/or discursive, textual and/or visual, physical and/or digital, there are several possibilities for their use in the daily process of organizations, in the production and delivery of goods and services, in the decision making that permeates the day. In the organizational day, strategic meetings are often full of objects and artifacts (Dameron et al., 2015).

Technologies are widespread in organizations, and integrated into work practices, influencing the way people make strategy. In addition, technologies extend from the traditional meaning of machines and equipment to textual devices and human knowledge (Dameron et al., 2015). Considering this, over time different studies have underlined that organizations and individuals are technology driven (Barley 1986; Orlikowski 2000; Suchman 2007; Leonardi 2011; Kaplan 2011; among others). Thus, its characteristics, such as language, labeling, design, compatibility and user options, possibly affect the configuration so that a given technology can be adopted in the strategy creation (and implementation) process.

Moreover, according to the study by Cornelissen, Keep and Vaara (2014), strategy-related work occurs within physical space boundaries, which correspond to strategic spaces in the view of Jarzabkowski, Burke and Spee (2015). Which consist of physical places like meeting room, corridors, offices, among others. Regardless of the type of location, some features are always present, such as color, wall location, type of flooring, type and arrangement of furniture, decorations, etc. Characteristics that may influence human behavior. Thus, the understanding of the material nature of the environments is important, especially for the possibilities of use that depending on how they will be explored (seeking more sobriety or greater relaxation) may affect the strategy formation process, characterizing the practice (Dameron et al., 2015).

It is remarkable that, even in view of the continuous presence of the non-human body in the strategy formation work, it has been neglected by the researchers, as argued by Dameron et al. (2015). However, there are some exceptions, which encompass the CEO's physical domain, the combination of speeches, artifacts, and top manager's bodies, as well as the influence of facial, physical, and verbal aspects on strategic meetings (Hodgkinson & Wright, 2002; Lebaron & Whittington, 2011; Liu & Maitlis, 2014; Jarzabkowski et al., 2015).

Therefore, materiality has become a recurring topic in strategy research, relying primarily on strategy-as-practice. This is because materiality is at the heart of strategy work, which is concerned with the way in which socio-material aspects such as tools, locations, and arrangements interact with strategy formation (Dameron et al., 2015). Nevertheless, the concept of materiality is often undefined or insufficiently explained.

However, given the multiplicity of materiality, Dameron et al. (2015) present three broad views on materiality. The first consists of *weak vision*, which highlights the object and how its properties affect behavior, objects and their characteristics are seen as relatively neutral and lasting. Studies from this point of view generally adopt a positivist approach, seeking cause and to effect relationships. Given it, this view is rarely represented in strategy studies.

The second view of materiality is considered as moderate as it incorporates sensemaking approaches (Balogun & Johnson, 2004) in some technology studies. From this point of view, there is a relationship between objects and the social, as mutually dependent. That is, it focuses on the possibilities of action provided by the material that structures the social world (Leonardi, Nardi & Kallinikos, 2012). As it is more pragmatic, it is more commonly observed in strategy studies. Next, the third view may be called *strong vision*. This view includes some studies on technology and communication, based on the fact that the social and the material are intertwined and inseparable, that is, the materials are necessarily social and cannot be understood in the absence of context. This view rejects the idea that social and material are distinct and separable (Orlikowski, 2007).

Thus, from these approaches, it is understood that the materiality with the *strong vision* presented by Dameron et al. (2015) is what properly characterizes the interaction between the perspective of strategy as practice and technology that is increasingly inserted in the intricacies of organizational life. Technology serves as either the element that represents this materiality or the materializing element of strategy as discussed in the next section.

#### **4. Technology in practice as materializing strategy element**

Orlikowski and Gash (1994) argue that individuals use their skills, knowledge, assumptions, and expectations in relation to technology, and their use is influenced by training, previous experience and communication. These include the emotional and intellectual meanings that individuals associate technologies with their uses. Thus, the concept of technological frames, which consist of a set of expectations, assumptions and knowledge about technology, are shared or maintained within a social group. In addition, they influence the way individuals think and act when it comes to technology.

It is evident that the use of technology is strongly influenced by users' understanding of the properties and functionality provided. Comprehension has a strong influence on images, descriptions, ideologies, and demonstrations provided by sales people, consultants, and others (Orlikowski, Yates, Okamura & Fujimoto, 1995). While using the technological artifacts, people make use of the properties of the artifact that they understand (provided by the constitutive materiality, developed by the designers, and those added by the users).

Mussi (2008) points out that different studies indicate that technological frames of different social groups present difficulties with technology (McLoughlin, Badham & Couchman, 2000; Davidson, 2002; McGovern & Hicks, 2004; Puri, 2006). Corroborating, thus, what Orlikowski and Gash (1994) observed in their analyzes that differences in users and technology professionals in technology frames increase the difficulties and conflicts in the development, implementation and use of technology. An example of this phenomenon is a situation in which the same individual plays two roles in the institution, as a system's analyst and as a student. When evaluating the system in relation to its roles in the institution, as a technological professional, it considers a certain tool as excellent, but as a student, it considers that the software is lacking something. Thus, their considerations illustrate that knowledge, assumptions and expectations may be the result of technology attributes, individual characteristics and the environment (Mussi & Zwicker, 2012).

These findings corroborate Orlikowski (2000), who argues that technologies undergo transformations in their form and function, and that organizational researchers have resorted to the concepts of innovation, emergence, and improvisation in an attempt to explain new organizational forms and the use of technology in practice. Models assume that embedded

structures (built by designers in technological development) are appropriated by users while using technology. Moreover, the central aspect of these models are human actions, especially the actions of incorporation of structures within technology throughout its development, as well as the actions of appropriation of these structures during the use of technology.

Orlikowski (2000) proposed an extension to the structuring perspective of technologies from a practical point of view to examine how people interact with technologies in their practice. In general, this practical lens recognizes that two aspects of technology are confused, the first refers to technology as artifact (bundling of properties such as hardware and software) and the use of technology that is, what people actually do with the technological artifact in their practice. Moreover, on the one hand, technology consists of an identifiable and lasting relationship, a physical, economic policy and a socially organized phenomenon. Presenting material and cultural properties that surpass the actors' experience. This aspect refers to the technological artifact such as device or a gadget. On the other hand, the use of technology involves experiences, which are distinct among individuals, or even for the same individual, depending on the time and circumstance of the action. This aspect is called technology-in-practice, to refer to the use of these devices routinely in activities (Orlikowski, 2000).

Given this, when actors use a particular technology, they also choose how to interact with it. This way they can use them in different ways that were not anticipated by the developers. Orlikowski (2000) mentions that different studies (Gasser, 1986; Markus, 1994; Suchman, 1996) suggest that users can use technologies in ways not foreseen by designers, either by error and misunderstanding, or by intention or innovation. In addition, users often ignore, alter, or circumvent the properties of technologies. Additionally, users can shape or create the artifact to meet their needs.

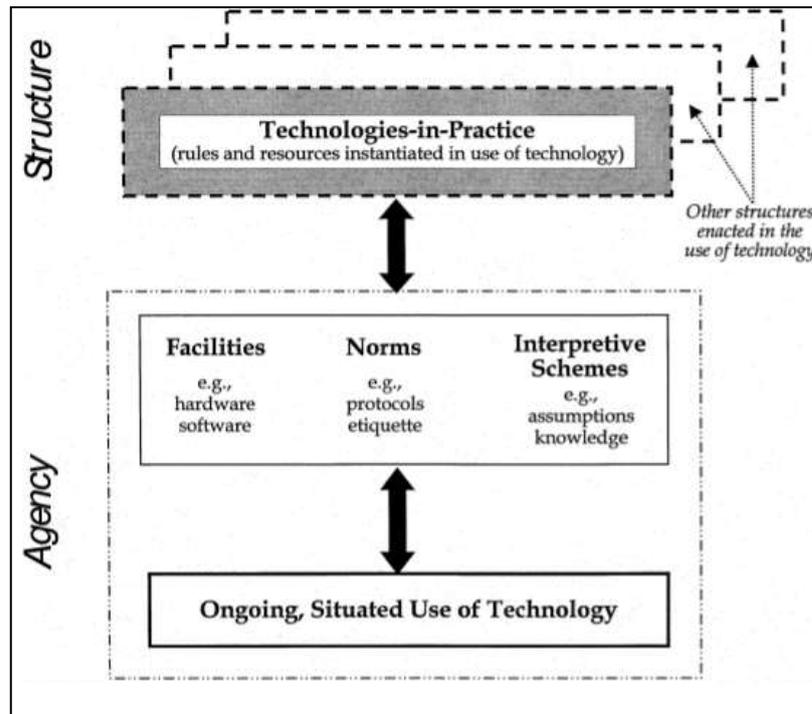
These arguments meet the concept of affordance. Based on Ecological Psychology, which focuses on research and interactions between the individual and the environment or object. Gibson (1966) conceived the term affordance, referring to what the object and environment provide to the individual as opportunities for action. In addition, it is emphasized that the object retains its meaning in what the individual perceives, that is, it is dependent on the relationship between its physical aspects and the individual's cognition (Gibson, 1979; 1986). From this, some studies on affordances of technologies emerged, aiming to understand the relationships between technologies and individuals (Anderson & Robey, 2017; Vieira, 2017). From this perspective, it is admitted that technologies shape and are shaped by the practices of individuals. And in an initial contact, individuals do not infer the physical properties

of the object itself, perceiving only the affordances, whereas it is determined not only by the object, but by the individual's interaction with it (Gibson, 1979).

Taking it into account, Orlikowski (2000) infers that the use of technology by people is structured by experiences, knowledge, meanings, power relations, habits, norms, among others. This structuring is a specific set of standards and resources in practice that structure future use, as people continue to interact with technology in their practice. In this way, individuals constitute and reconstruct the structure of the use of technology. This human interaction with technologies is current, so that even if individuals determine practice through the current use of a technology, these actions are shaped by the use of technology, enacted in the past.

Although technology seems to stabilize in relation to its properties and functionality, this stability and its applications is only provisional. For the different elements that make it up continue to be developed, their functions may fail, new materials are created, new standards are set by users, among other things. Thus, technologies never completely stabilize because they are dynamic in nature and continue to evolve, and, at the same time, are modified, fixed and improved. These changes are not predictable due to the fact that it is implemented by individuals from different influences such as available technologies, political, cultural and environmental issues. That is, users can promulgate these different technologies in practice, due to the knowledge gained in the use of such technology, so users adjust technologies to their practice intentionally (Orlikowski, 2000).

The implementation of technology in practice becomes routinized. This continues use of technology, in turn, tends to reenact this technology in practice, further reinforcing it over time until it is guaranteed. From Giddens's (1979) model of the structural properties of affordances, Orlikowski (2000) developed a structure of technology in practice, Figure 1, the recurrent use of technology by people influence multiple structures, as well as technology in practice (particular structures of the use of technology promoted by users in recurrent interaction).



**Figure 1** - Implementation of technologies-in-practice.

Source: Orlikowski, W. J. (2000). Using technology and constituting structures: A practice lens for studying technology in organizations. *Organization science*, 11(4), 404-428.

In the continuous and localized use of technology, users attract pre-defined structures, both of technology in practice as well as other structures, by reconstituting them. This reconstitution may be deliberate or inadvertent. And yet, it occurs in two forms. The first form refers to reinforcement that is, users perform the same structures with unobservable changes. And in the second form of reconstitution, users change structures, these changes can be either modest or substantial.

The use of this practical lens, recognizes that the use of technology is situated and emerging. However, it does not mean that the use is different, as the same technology is used several times. Thus, technology becomes routine, guaranteed and even institutionalized in certain cases. This momentary stabilization of technologies in practice, enables researchers to seek limited generalizations about the use of technologies in order to observe specific types of users and technologies in different contexts. This identification of the structures of technology use is believed to corroborate researchers and practitioners in understanding why and how individuals use technologies and what are the consequences under different conditions (Orlikowski, 2000).

Still, in strategy as practice, it is assumed that individuals are intentional, knowledgeable, adaptive and inventive, and interact with technology in different ways and for

different goals. Whereas, when technology does not corroborate to achieve these goals, individuals abandon or alter it, or even change its goals (Orlikowski, 2000).

Currently, it has been observed that from the use of the Internet, organizations have sought to increase relationships and interconnections with other companies. This has increased the complexity and interdependence of artifacts, systems and technological infrastructures. It is speculated that this integration may limit users' freedom to experiment and modify the artifacts they use. As it is possible that these users become more dependent on the use of integrative technologies. However, it will depend on users' practices and their intentions and interpretations. Still, when making a technological investment, it is suggested that managers measure in addition to the returns on technology, the returns on the use of technology too. So, technology alone cannot increase or decrease performance, only its use can (Orlikowski, 2000).

Given the different influences exerted on technology in practice Whittington (2003) identified three elements in the strategy research agenda as social practice: a) praxis, b) practitioners, and c) practices, tools, technologies, among others. These elements can be analyzed from different angles, in isolation, as well as a broader analysis, as they are mutually dependent. For actions depend on the intention of the individuals who perform them (Zammuto, Griffith, Majchrzak, Dougherty & Faraj, 2007).

As highlighted by Whittington (2007) when considering tools in the view of strategy as practice, it is necessary to take into account the actors involved in the implementation of the strategy. That is because the organization consists on social interactions. Thus, in his study it is possible to find the importance of technology and materiality in strategy practice (Whittington, 2014). Like Jarzabkowski and Kaplan (2015), who based on Gibson (1979), developed a model for the analysis of the interrelations between actors and the possibilities of using strategic tools. From this, the authors argue that materiality has a central position in strategy, and is linked to different organizational practices.

## **5. Discussions and reflections considering industry 4.0 context**

Different studies have analyzed how technologies influence organizational behavior, using the most diverse tools, such as PowerPoint (Kaplan, 2011), mobile banking (Cernev, 2010), information systems (IS) used in the Brazilian banking sector (Tavares & Thiry-Cherques, 2011) and mobile internet (Lunardi, Dolci & Wendland, 2013, Iasbech & Lavarda,

2018), among others. In addition, the organizations analyzed in the literature were of different natures, ranging from hospital institutions (Queiroz & Moreira, 2007), higher education institutions (Mussi, 2008) and law firms (Hino & Cunha, 2013), for example. However, although these different organizations interacted with technologies, they do not fit in the concept of Industry 4.0, which is the focus of this analysis.

A study that can be considered seminal, linking affordances and Industry 4.0, was developed by Vieira (2017) and analyzed how different manufacturing strategies and perceptions about affordances influence the adoption of advanced manufacturing technologies. Verifying that teams with greater technology knowledge are better able to realize affordances of enabling technologies. Companies with different strategic priorities adopt different advanced manufacturing technologies. And companies that achieve greater strategic consensus between their technology teams and senior management adopt technologies that are more aligned with strategic priorities. Moreover, the adoption of specific advanced manufacturing technologies depends on the manufacturing strategy and the perceived applicability of their affordances to the company's manufacturing processes.

These results confirm the affordance theory and the sociomateriality of the strategy. For affordances depend not only on the technological artifact, but also on the interaction between the user and their application. Which are determined by the knowledge, skills, expectations, among other aspects related to individuals. And so different individuals have different interpretations and relationships with artifacts.

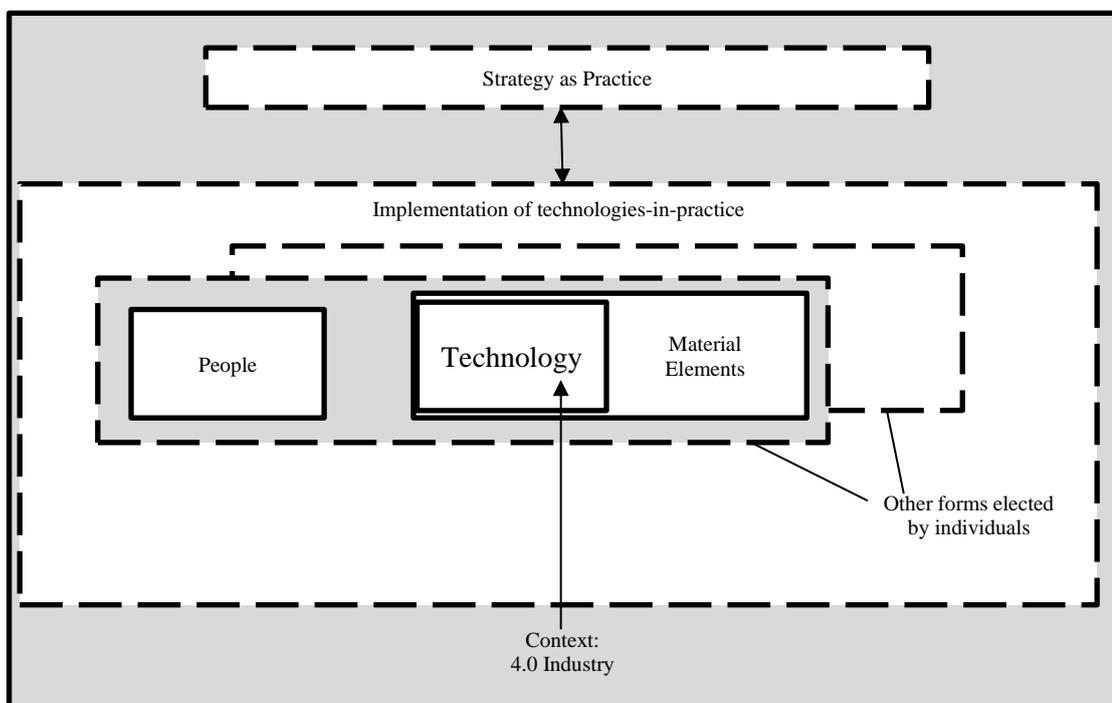
Given this, it is believed that in the context of Industry 4.0, human action gains evidence, considering that technological artifacts are not only their material properties, but also their interaction with the user, their experiences, expectations and goals. Users may use technologies in different ways, whether intended or not, and users may alter the properties of the technology artifact by setting up a two-way relationship between the individual and the technology. Whereas individuals constitute and reconstitute the structure of technology use, and these past experiences become the structure in the future.

Unlike the context prior to Industry 4.0, it is noted that one of the central elements of advanced manufacturing is the connectivity between machines, processes and people. This will possibly intensify the interaction between different technological artifacts and the users, despite the use of industrial automation. That is, this increase in complexity will result in broadening the relevance of users' characteristics to technology in practice. In other words, experiences,

knowledge, meanings, power relations, habits, norms, among other things, will be central elements for the use of technology in practice to achieve strategic goals.

An illustration of this dynamic refers to the use of smartphones compared to ordinary mobile phones. With the development of this technology it required a higher level of knowledge or experience in using it. And this feature made the handsets more present in the routine of the individual. And because smartphones consist of customizable devices, you can use them for the most diverse purposes, depending on the user's purpose, ranging from personal use to professional applications of varying levels of complexity.

Therefore, returning to the research question: How does strategy as practice occur in the technological context considering Industry 4.0? Strategy as practice is understood to occur through the interaction between people and material elements. The sociomateriality of technologies has human action as its central aspect, considering that individuals elect the use of a certain technology, as well as the form of interaction between both, and can use it from various configurations, planned or not. That is, the interaction between human and non-human elements characterizes the implementation of technology in practice in the context of Industry 4.0. Figure 2 illustrates these interactions.



**Figure 2** - Strategy as Practice in the Technological Context of Industry 4.0

Projects aimed at the implementation of Industry 4.0 require the combination of knowledge for the perception and practice of new technologies, which have recently become available to individuals. In the cases analyzed by Vieira (2017), it was observed that, in a certain case, the company developed multidisciplinary teams, while another company inserted an experienced automation professional in the technology area.

Moreover, the concern with technological knowledge is preponderant, given the identification of the potential of Industry 4.0 technologies in the context and business strategy; as well as its implementation (Vieira, 2017). In short, these teams are capable of handling the different domains of technology. Activities that emphasize affordance theory (Anderson & Robey, 2017), especially on the interaction of the individual with the technological artifact, and the importance of the qualities of individuals in this process, while a multidisciplinary team, or a more experienced professional, expands the possibilities in the perception of affordances and strategic decisions of the organization, to which, in these cases, refer to the implementation of Industry 4.0. It should be noted that, in addition to the aspects related to the technological artifact and the individuals, the organization's strategy also influences the implementation of projects towards Industry 4.0. Given the above follow the final considerations of this theoretical essay.

### **Final remarks**

The present study aimed to understand how strategy as practice occurs in the technological context considering Industry 4.0 from a theoretical survey involving a synthesis of the state of the art about Industry 4.0, strategy as practice, strategy materiality of strategy, technological frames and technology in practice.

With the support of Whetten (1989) that allows reflection on theoretical arguments, it was possible to identify that technology, structuring element of Industry 4.0 consists of a materializing element of strategy as practice that is, these artifacts can transmit and foster strategic decisions besides influencing social relations in the organization (Orlikowski, 2000).

Moreover, given the sociomateriality of technologies, from the contributions of Orlikowski (2000), Leonardi (2011) and Kaplan (2011), it can be stated that human action is a central aspect, considering that individuals choose the use of technology, as well as the form of interaction between them, and can use it in various ways, whether foreseen or not. Highlighting the strong influence of the understanding of the individual in the use of technology in practice.

This interrelationship does not remain stable, as the corresponding constituent elements are being developed, highlighting the dynamic nature of interactions and technologies. Given this, when considering the adoption of technologies, one should consider not only the returns of that technology, but also the returns of its use. Due to their different possibilities of interpretation and use, i.e. their dynamics (Orlikowski, 2000).

In the context of Industry 4.0, based on the study by Vieira (2017), it is believed that the interaction between different technological artifacts and the user will be intensified due to the connectivity between machines, processes and people. Increasing the relevance of users' characteristics in face of technology in practice, their experiences, knowledge, meanings, power relations, habits, norms, among other things, so that the use of technology in practice achieves strategic goals.

The study has some limitations, mainly related to the fact that it consists on a theoretical rather than empirical approach. The theoretical approach, besides being an option that carries the researcher's bias, it is also associated with the increasing difficulty in selecting what is serious and relevant in the journal bases and repositories. Much relevant research may not be published in major journals, as a large amount of research that does not advance knowledge overloads scientific publication and evaluation systems.

Future studies suggest empirical analysis in organizations that adopt the principles of Industry 4.0, as well as startups and technology-based companies, in view of the high degree of interaction and use of technologies in practice. Finally, it is expected that the contributions and suggestions presented in this study can stimulate further research. Both theoretical and empirical, aiming to contribute and broaden the horizon of students, researchers and entrepreneurs. Both in management and related research fields, highlighting the importance that Technological advances have always had for the development of organizations and will continue to have. Intensifying as people are feeling the consequences of this development in improving the quality of everyday organizational life.

## References

- Aires, R. W. A., Moreira, F. K., Freire, P. (2017). Indústria 4.0: competências requeridas aos profissionais da quarta revolução industrial. *Congresso Internacional de Conhecimento e Inovação*, Brasil, 7.
- Anderl, R. (2014). Industrie 4.0-advanced engineering of smart products and smart production. In *Proceedings of International Seminar on High Technology* (Vol. 19).

- Anderson, C., Robey, D. (2017). Affordance potency: Explaining the actualization of technology affordances. *Information and Organization*, 27(2), 100-115.
- Aten, K., Thomas, G. F. (2016). Crowdsourcing strategizing: communication technology affordances and the communicative constitution of organizational strategy. *International Journal of Business Communication*, 53(2), 148-180.
- Balogun, J., Jacobs, C., Jarzabkowski, P., Mantere, S., Vaara, E. (2014). Placing strategy discourse in context: Sociomateriality, sensemaking, and power. *Journal of Management Studies*, 51(2), 175-201.
- Balogun, J., Johnson, G. (2004). Organizational restructuring and middle manager sensemaking. *Academy of management journal*, 47(4), 523-549.
- Barley, S. R. (1986). Technology as an occasion for structuring: Evidence from observations of CT scanners and the social order of radiology departments. *Administrative science quarterly*, 78-108.
- Brasil. (2017). Ministério da Ciência, Tecnologia, Inovações e Comunicações (MCTIC). *Plano de CT&I para Manufatura Avançada no Brasil: Pro Futuro Produção do Futuro*. 2017.
- Carmona, A. L. M. (2017). *Análise dos impactos da indústria 4.0 na logística empresarial*. Trabalho de Conclusão de Curso, Engenharia de Transportes e Logística, Universidade Federal de Santa Catarina, Florianópolis, Brasil.
- Cernev, A. K. (2010). *Mobile banking no Brasil: eventos críticos, trajetória e cenários esperados*. Tese de doutorado, Escola de Administração de Empresas, Fundação Getúlio Vargas, São Paulo, Brasil.
- Confederação Nacional da Indústria - CNI. (2016). *Desafios para Indústria 4.0 no Brasil*. 1. ed. Brasília: CNI.
- Cornelissen, J. P., Mantere, S., Vaara, E. (2014). The contraction of meaning: The combined effect of communication, emotions, and materiality on sensemaking in the Stockwell shooting. *Journal of Management Studies*, 51(5), 699-736.
- Dameron, S., Lê, J. K., LeBaron, C. (2015). Materializing strategy and strategizing materials: why matter matters. *British Journal of Management*, 26.
- Daudt, G. M., Willcox, L. D. (2016). *Reflexões críticas a partir das experiências dos Estados Unidos e da Alemanha em manufatura avançada*. BNDES Setorial, Rio de Janeiro, 44 , p.[5]-45.
- Davidson, E. J. (2002). Technology frames and framing: A socio-cognitive investigation of requirements determination. *Mis Quarterly*, 329-358.
- de Oliveira, F. T., Simões, W. L. (2017). A indústria 4.0 e a produção no contexto dos estudantes da engenharia. *Simpósio de Engenharia de Produção*, Brasil.
- Dombrowski, U., Wagner, T. (2014). Mental strain as field of action in the 4th industrial revolution. *Procedia CIRP*, 17, 100-105.
- Fraga, M. A. F., de Freitas, M. M. B. C., de Souza, G. P. L. (2016). LOGÍSTICA 4.0: CONCEITOS E APLICABILIDADE—UMA PESQUISA-AÇÃO EM UMA EMPRESA DE TECNOLOGIA PARA O MERCADO AUTOMOBILÍSTICO. *Caderno PAIC*, 17(1), 111-117.
- Gasser, L. (1986). The integration of computing and routine work. *ACM Transactions on Information Systems (TOIS)*, 4(3), 205-225.
- Gibson, J. J. (1966). *The senses considered as perceptual systems*.
- Gibson, J. J. (1979). A study in the Psychology of decorative art. *Unpublished manuscripts*. Cornell University.
- Gibson, J. J. (1986). *The ecological approach to visual perception*. Ed. New Jersey: Lawrence Erlbaum Associates.

- Giddens, A. (1979). *Central problems in social theory: Action, structure, and contradiction in social analysis* (Vol. 241). Univ of California Press.
- Hahn, J. R. (2016). A Era da Internet Industrial e a Indústria 4.0. *Produção em Foco*, Brasil, p. 1-4.
- Henderson, B. D. (1979). *Henderson on corporate strategy*. Abt Books: Cambridge, Mass.
- Hermann, M., Pentek, T., Otto, B. (2016). Design principles for industrie 4.0 scenarios. In *2016 49th Hawaii international conference on system sciences (HICSS)* (pp. 3928-3937). IEEE.
- Hino, M. C., Cunha, M. A. (2013). A Tecnologia na Prática dos Escritórios de Advocacia no Brasil. *Proceedings of the Nineteenth Americas Conference on Information Systems*, Chicago, Illinois, August 15-17.
- Hodgkinson, G. P., Wright, G. (2002). Confronting strategic inertia in a top management team: Learning from failure. *Organization studies*, 23(6), 949-977.
- Jarzabkowski, P. (2004). Strategy as practice: recursiveness, adaptation, and practices-in-use. *Organization studies*, 25(4), 529-560.
- Jarzabkowski, P. (2005). *Strategy as practice: An activity based approach*. Sage.
- Jarzabkowski, P., Burke, G., Spee, P. (2015). Constructing spaces for strategic work: A multimodal perspective. *British Journal of Management*, 26, S26-S47.
- Jarzabkowski, P., Kaplan, S. (2015). Strategy tools-in-use: A framework for understanding “technologies of rationality” in practice. *Strategic Management Journal*, 36(4), 537-558.
- Jarzabkowski, P., Pinch, T. (2013). Sociomateriality is ‘the New Black’: accomplishing repurposing, reinscripting and repairing in context. *M@n@gement*, 16(5), 579-592.
- Johnson, G., Melin, L., Whittington, R. (2003). Micro strategy and strategizing: towards an activity-based view. *Journal of management studies*, 40(1), 3-22.
- Kagermann, H., Lukas, W. D., Wahlster, W. (2011). Industrie 4.0: Mit dem Internet der Dinge auf dem Weg zur 4. industriellen Revolution. *VDI nachrichten*, 13(1).
- Kaplan, S. (2011). Strategy and PowerPoint: An inquiry into the epistemic culture and machinery of strategy making. *Organization Science*, 22(2), 320-346.
- LeBaron, C., Whittington, R. (2011). Sensemaking in organizations: multimodality in strategy work. *Annual Meeting of the Academy of Management*, San Antonio, Texas.
- Lee, J., Bagheri, B., Kao, H. A. (2015). A cyber-physical systems architecture for Industry 4.0-based manufacturing systems. *Manufacturing letters*, 3, 18-23.
- Leonardi, P. M. (2011). When flexible routines meet flexible technologies: Affordance, constraint, and the imbrication of human and material agencies. *MIS Quarterly*, 35, p.147-167.
- Kallinikos, J., Leonardi, P. M., Nardi, B. A. (Eds.). (2012). *Materiality and organizing: Social interaction in a technological world*. Oxford University Press.
- Liere-Netheler, K. (2017). Analysis of Adoption Processes in Industry 4.0. In *International Conference on Computing and Wireless Communication Systems* (2).
- Liu, F., Maitlis, S. (2014). Emotional dynamics and strategizing processes: A study of strategic conversations in top team meetings. *Journal of Management Studies*, 51(2), 202-234.
- Lunardi, G. L., Dolci, D. B., Wendland, J. (2013). Organizations' use of mobile internet: adoption factors and impacts on performance/Internet movel nas organizacoes: fatores de adoçao e impactos sobre o desempenho. *RAC- Journal of Contemporary Administration*, 17(6), 679-704.
- Mackenzie, D. Wajcman, J. (1985). *The social shaping of technology: How the refrigerator got its hum*. Milton Keynes-Philadelphia.

- March, J. G. (2006). Rationality, foolishness, and adaptive intelligence. *Strategic management journal*, 27(3), 201-214.
- Markus, M. L. (1994). Electronic mail as the medium of managerial choice. *Organization science*, 5(4), 502-527.
- McGee, J., Thomas, H. (1986). Strategic groups: theory, research and taxonomy. *Strategic management journal*, 7(2), 141-160.
- McGovern, T., Hicks, C. (2004). How political processes shaped the IT adopted by a small make-to-order company: a case study in the insulated wire and cable industry. *Information & Management*, 42(1), 243-257.
- McLoughlin, I., Badham, R., Couchman, P. (2000). Rethinking political process in technological change: socio-technical configurations and frames. *Technology Analysis & Strategic Management*, 12(1), 17-37.
- Mintzberg, H. (1994). *The rise and fall of strategic planning: reconceiving roles for planning, plans, planners*. Free Press: New York.
- Mussi, C. C. (2008). *Avaliação de sistemas de informação e frames tecnológicos: uma perspectiva interpretativista*. Tese de Doutorado, Universidade de São Paulo, São Paulo, 387p.
- Mussi, C. C., Zwicker, R. (2012). Making sense of technological frames: a study of social interpretations of information technology in the organizational context. *RAC- Journal of Contemporary Administration*. 16(3), 418-437.
- Orlikowski, W. J. (2000). Using technology and constituting structures: A practice lens for studying technology in organizations. *Organization science*, 11(4), 404-428.
- Orlikowski, W. J. (2007). Sociomaterial practices: Exploring technology at work. *Organization studies*, 28(9), 1435-1448.
- Orlikowski, W. J., Gash, D. C. (1994). Technological frames: making sense of information technology in organizations. *ACM Transactions on Information Systems (TOIS)*, 12(2), 174-207.
- Orlikowski, W. J., Yates, J., Okamura, K., Fujimoto, M. (1995). Shaping electronic communication: The metastructuring of technology in the context of use. *Organization science*, 6(4), 423-444.
- Potter, M. E. (1980). *Competitive strategy: Techniques for analyzing industries and competitors*. Free Press: New York.
- Puri, S. K. (2006). Technological frames of stakeholders shaping the SDI implementation: A case study from India. *Information Technology for Development*, 12(4), 311-331.
- Queiroz, A. C. S., Moreira, D. A. (2007). NEW TECHNOLOGIES AND ORGANIZATION´S TRUST: A CASE STUDY IN THE CONTEXT OF HEALTH ORGANIZATION. *Revista de Negócios*, 12(1), 42-55.
- Rodrigues, L. F., de Jesus, R. A., Schützer, K. (2016). Industrie 4.0 – A Literature Review. *Revista de Ciência & Tecnologia*, 19(38), 33-45.
- Russwurm, S. (2014). Industrie 4.0 – from vision to reality. *SIEMENS Industry Sector – Background Information*.
- Saltiel, R. M. F. Nunes, F. (2017). A indústria 4.0 e o sistema Hyundai de produção: suas interações e diferenças. *Simpósio de Engenharia de Produção*, 5, Joinville, Brasil.
- Santos, P. R. (2016). Indústria 4.0 – sistemas inteligentes para manufatura do futuro.
- Shrouf, F., Ordieres, J., Miragliotta, G. (2014). Smart factories in Industry 4.0: A review of the concept and of energy management approached in production based on the Internet of Things paradigm. In 2014 *IEEE international conference on industrial engineering and engineering management* (pp. 697-701). IEEE.

- Spee, A. P., Jarzabkowski, P. (2011). Strategic planning as communicative process. *Organization Studies*, 32(9), 1217-1245.
- Suchman, L. (1996). Supporting articulation work. *Computerization and controversy: Value conflicts and social choices*, 2, p. 407-423.
- Suchman, L. (2007). *Human-machine reconfigurations: Plans and situated actions*. Cambridge University Press.
- Tavares, E. Thiry-Cherques, H. R. (2011). Interaction between information systems and work in the Brazilian banking sector. *Journal of Business Management*, 51(1), p.84-97.
- Vaara, E., Whittington, R. (2012). Strategy-as-practice: Taking social practices seriously. *The Academy of Management Annals*, 6(1), 285-336.
- Vieira, R. C. (2017). *Manufatura avançada: a influência da estratégia da manufatura e da percepção de affordances*. Dissertação de Mestrado, Universidade de São Paulo, São Paulo.
- Whetten, D. A. (1989). What constitutes a theoretical contribution? *Academy of Management Review*, 14(4), 490-495. Doi: 10.5465/AMR.1989.4308371
- Whittington, R. (2003). The work of strategizing and organizing: for a practice perspective. *Strategic organization*, 1(1), 117-125.
- Whittington, R. (2004). Estratégia após o modernismo: recuperando a prática. *RAE-Revista de Administração de Empresas*, 44(4), 44-53.
- Whittington, R. (2006). Completing the practice turn in strategy research. *Organization studies*, 27(5), 613-634.
- Whittington, R. (2007). Strategy practice and strategy process: family differences and the sociological eye. *Organization studies*, 28(10), 1575-1586.
- Whittington, R. (2014). Information systems strategy and strategy-as-practice: a joint agenda. *The Journal of Strategic Information Systems*, 23(1), 87-91.
- Whittington, R. (1996). Strategy as practice. *Long range planning*, 29(5), 731-735.
- Whittington, R., Cailluet, L., Yakis-Douglas, B. (2011). Opening strategy: Evolution of a precarious profession. *British Journal of Management*, 22(3), 531-544.
- Zammuto, R. F., Griffith, T. L., Majchrzak, A., Dougherty, D. J., Faraj, S. (2007). Information technology and the changing fabric of organization. *Organization science*, 18(5), 749-762.