

**THE VALUE AT THE INDUSTRY 4.0 AND THE DIGITAL TRANSFORMATION  
PROCESS: EVIDENCE FROM BRAZILIAN SMALL ENTERPRISES**

**O VALOR NA INDÚSTRIA 4.0 E O PROCESSO DE TRANSFORMAÇÃO DIGITAL:  
EVIDÊNCIAS DE PEQUENAS EMPRESAS BRASILEIRAS**

**EL VALOR EN LA INDÚSTRIA 4.0 Y EL PROCESO DE TRANSFORMACIÓN  
DIGITAL: EVIDÊNCIAS DE PEQUEÑAS EMPRESAS BRASILEÑAS**

Giovani Cruzara

Doutorando em Administração pela Universidade Federal do Paraná

[giovani.cruzara@outlook.com](mailto:giovani.cruzara@outlook.com)

<https://orcid.org/0000-0001-5128-5948>

Emanuel Campigotto Sandri

Doutorando, Programa de Pós-Graduação em Administração, Universidade Federal do Paraná

[emanuel.sandri@hotmail.com](mailto:emanuel.sandri@hotmail.com)

<https://orcid.org/0000-0002-4539-2090>

Ana Paula Mussi Szabo Cherobim

Professora, Programa de Pós-Graduação em Administração, Universidade Federal do Paraná

[cherobimanapaula@gmail.com](mailto:cherobimanapaula@gmail.com)

<https://orcid.org/0000-0001-9380-5403>

José Roberto Frega

Professor, Programa de Pós-Graduação em Administração, Universidade Federal do Paraná

[jose.frega@gmail.com](mailto:jose.frega@gmail.com)

<https://orcid.org/0000-0003-0648-0271>

Editor Científico: José Edson Lara  
Organização Comitê Científico  
Double Blind Review pelo SEER/OJS  
Recebido em 08.02.2020  
Aprovado em 25.02.2021



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

## Abstract

**Objective:** We use an approach that merge aspects from the literature of Value and the literature of Business Models, thus exploring aspects related to value proposition, value creation and value capture. More specifically, we analyze how these aspects were affected by in four small Brazilian organizations that were attending to the industry 4.0.

**Methodology:** To explore the relationship between the aspects of value and the industry 4.0/digital transformation, we conducted four case studies on small Brazilian enterprises. Our study is classified as being exploratory, with a cross-sectional perspective merged with a longitudinal approximation.

**Originality / relevance:** The origin of digital transformation is present in the areas of engineering and computer science and, therefore, resulting in technical studies, while the perspectives of economic and business management are still little explored in academia.

**Results:** The results demonstrate that all three aspects of value were affected by the industry 4.0, but with a greater level at the organizations classified as providers of digital technologies. Apart from that, we also identified that the organizations relied mainly on partnerships and organizational ecosystems to successfully address and overcome the changes created by Industry 4.0.

**Theoretical / methodological contributions:** We used a combination of the literature stream related to business model and the literature stream related to value. Thus, we provide an extension to these two streams of literature. Thus, expanding our understanding about the relationship between value and the industry 4.0/digital transformation by validating which items were qualitatively identified in these four organizations.

**Keywords:** Industry 4.0; Digital Transformation; Value proposition; Value creation; Value Capture

## Resumo

**Objetivo:** Utilizamos uma abordagem que mescla aspectos da literatura de Valor e da literatura de Modelos de Negócios, explorando aspectos relacionados à proposição de valor, criação de valor e captura de valor. Mais especificamente, analisamos como esses aspectos foram afetados em quatro pequenas organizações brasileiras que estavam atendendo ao setor 4.0.

**Metodologia:** Para explorar a relação entre os aspectos de valor e a transformação da indústria 4.0 / digital, realizamos quatro estudos de caso em pequenas empresas brasileiras. Nosso estudo é classificado como exploratório, com perspectiva transversal mesclada com aproximação longitudinal.

**Originalidade/Relevância:** A origem da transformação digital está presente nas áreas da engenharia e ciência da computação e, portanto, resultando em estudos técnicos, enquanto as perspectivas de gestão econômica e de negócios ainda são pouco exploradas na academia.

**Principais Resultados:** Os resultados demonstram que os três aspectos do valor foram afetados pelo setor 4.0, mas com um nível maior nas organizações classificadas como

fornecedoras de tecnologias digitais. Além disso, também identificamos que as organizações dependiam principalmente de parcerias e ecossistemas organizacionais para lidar com sucesso e superar as mudanças criadas pelo setor 4.0.

**Contribuições teóricas / metodológicas:** Neste artigo foi utilizada uma combinação corrente da literatura relacionada ao modelo de negócios e o a corrente relacionada ao valor. Assim, fornecemos uma extensão para essas duas vertentes teóricas. Desse modo, ampliando nosso entendimento sobre a relação entre valor e a transformação da indústria 4.0 / digital, validando quais itens foram identificados qualitativamente nas organizações estudadas.

**Palavras-chaves:** Indústria 4.0; Transformação digital; Proposição de valor; Criação de valor; Captura de Valor

## Resumen

**Objetivo:** Utilizamos un enfoque que fusiona aspectos de la literatura de Valor y la literatura de Modelos de Negocio, explorando así aspectos relacionados con la propuesta de valor, la creación de valor y la captura de valor. Más específicamente, analizamos cómo se vieron afectados estos aspectos en cuatro pequeñas organizaciones brasileñas que atendían a la industria 4.0.

**Metodología:** Para explorar la relación entre los aspectos de valor y la industria 4.0 / transformación digital, realizamos cuatro estudios de caso sobre pequeñas empresas brasileñas. Nuestro estudio se clasifica como exploratorio, con una perspectiva transversal fusionada con una aproximación longitudinal.

**Originalidad / relevancia:** El origen de la transformación digital está presente en las áreas de la ingeniería y la informática y, por tanto, resulta en estudios técnicos, mientras que las perspectivas de la gestión económica y empresarial aún están poco exploradas en la academia.

**Resultados:** Los resultados demuestran que los tres aspectos del valor fueron afectados por la industria 4.0, pero con un mayor nivel en las organizaciones clasificadas como proveedoras de tecnologías digitales. Aparte de eso, también identificamos que las organizaciones se basaron principalmente en alianzas y ecossistemas organizacionales para abordar y superar con éxito los cambios creados por la Industria 4.0.

**Contribuciones teóricas / metodológicas:** Utilizamos una combinación de la corriente de literatura relacionada con el modelo de negocio y la corriente de literatura relacionada con el valor. Por lo tanto, proporcionamos una extensión de estas dos corrientes de literatura. De esta forma, ampliamos nuestra comprensión sobre la relación entre el valor y la industria 4.0 / transformación digital al validar qué elementos se identificaron cualitativamente en estas cuatro organizaciones.

**Palabras llaves:** Industria 4.0; Transformación digital; Propuesta de valor; Creación de valor; Captura de valor

## 1. INTRODUCTION

The expression industry 4.0 was first introduced by the German Government in 2011. It describes an organization where employees and machines interact with one another like on a social network, resulting in a greater level of integration and complexity (Kagerman, Wahlster, & Helbig, 2013).

To be characterized as an 'industry 4.0', the organization pass through a process called 'digital transformation', which encompasses the application of technologies such as the Internet of Things (IoT), cloud computing, big data, 3D printers, and advanced analytics to the organizations. The integration of those technologies ultimately results in the creation of a Cyber Physical Space (CPS) (Khaitan & McCalley, 2014), which represents the connection between the physical and the virtual world of an organization (Spath, Ganschar, Gerlach, Hammerle, Krause, & Schlund, 2013).

The literature points out that digital transformation demand changes for a number of organizational aspects: governance and regulatory frameworks (Weber, 2013), processes of creation and capture of value (Arnold, Kiel & Voigt 2017; Müller & Voigt, 2017, Müller, Buliga, & Voigt, 2018), organization business model (Kagerman, Wahlster & Helbig, 2013; Burmeister, Lüttgens, & Piller, 2016; Kiel, Arnold, & Voigt, 2017), and also dynamic capabilities (Orlandi, 2016; Zeng, Simpson, & Dang, 2017).

The origin of digital transformation originated is at the engineering and computer science streams, and thus displays a very technical background. That resulted in academic studies mostly exploring their technical aspects (Liao, Deschamps, Loures, & Ramos, 2017), while economic and business management perspectives are still underexplored at the academy (Burmeister, Lüttgens, & Piller, 2016; Müller & Voigt, 2017; Zeng, Simpson, & Dang, 2017).

In this sense, this study aims to understand how the aspects of value proposition, value creation and value capture were affected by the industry 4.0/digital transformation (Kagerman, Wahlster, & Helbig, 2013; Liao *et al.*, 2017; Müller, Müller and Voigt, 2018) at four small Brazilian enterprises. To do that, we merged the literature of business models with the literature of value, thus analyzing the construct value according to these three aspects previously mentioned. Later, we analyze four small Brazilian organizations that were attending to the digital transformation process.

The empirical results demonstrate that organizations classified as providers of technologies faced greater changes to their value aspects, while at the same time as that partnerships and organizational ecosystems were their main drivers to access and overcome the barriers related to the industry 4.0/digital transformation.

Our study is organized as follows: Section two encompasses our literature review, which encompasses the industry 4.0/digital transformation literature, as well as the aspects of value that we explore. Later, section three encompasses the methodological procedures, followed by section four where we explore the four organizations. Section five then presents a discussion about our findings and lastly section six encompasses the conclusions, research limitations and future research directions.

## **2. THEORETICAL BACKGROUND**

In this section we discuss the theoretical background that serve as the basis for our analysis. Our theoretical background encompasses first an overview of the digital transformation and the industry 4.0. Later we explore aspects of value, ultimately establishing its relationship with the industry 4.0.

### **2.1. The digital transformation and the Industry 4.0**

The industry 4.0 aims to represent an organization where technologies previously used in isolation are now connected (Kagerman, Wahlster, & Helbig, 2013). That is possible by a close connection between physical and cybernetic components, which ultimately creates the CPS (Khaitan & McCalley, 2014).

The CPS thus connects the physical to the virtual (Spath *et al.*, 2013). In other words, information technology systems are connected to the mechanical, electronic, and human resources that an organization has (Kiel, Arnold and Voigt, 2017).

To implement the CPS, the organization pass through a process called digital transformation, which results in the creation of a ‘smart factory’. That factory can be considered a practical example of an industry 4.0 organization, with resources connected to one another like a social network (Kagerman, Wahlster, & Helbig, 2013; Spath *et al.*, 2013).

Upon that, the integration of technologies allows an organization to extract a large volume of data in real time, thus affecting performance aspects and its relationship with the external environment (Kagerman, Wahlster, & Helbig, 2013; Doh, Deschamps & De Lima, 2016).

In this sense, the industry 4.0 can be defined as:

The technical integration of the CPS into the manufacturing and logistics processes, and the use of Internet of Things and Services (IoTS) in the industrial processes. Which will have implications for

value creation, business models, downstream services and the working organization as a whole. (Kagerman, Wahlster & Helbig, 2013:14)

In other words, the industry 4.0 is characterized by an increase on the digitalization and the automation processes, which can result in a greater communication level, mainly achieved due to the creation of a digital value chain (Oesterreich & Teuteberg, 2016: 122).

The Industry 4.0 is not characterized by the creation of novel technologies, but by an integration of already existing ones that ultimately result in a complex scenario (Khaitan & McCalley, 2014).

Digital transformation thus allows organizational actors to communicate promptly to one another, which takes decision making to a next step in terms of collaborations and inter-organizational relationships, such as collaborative networks. Some studies also point to a relationship between the digital transformation and the value creation processes (Kagerman, Wahlster, & Helbig, 2013), as well as to the innovation and creation of novel business models (Rudtsch, Gausemeier, Gesing, Mittag, & Peter, 2014; Burmeister, Lüttgens, & Piller, 2016; Arnold, Kiel, & Voigt, 2017; Müller, Buliga & Voigt, 2018).

## 2.2. Value Aspects

According to Sánchez-Fernández and Iniesta-Bonilla (2007), value is one of the most ill-defined concepts in management. The studies usually aim to explore strategic decisions at the organizations (Ito, Junior, Gimenez, & Fensterseifer, 2012). Thus, they assume that 'value' is out there, with aspects related to the imitability of resources also coming into play when we consider the organizational resources (Peteraf, 1993; Rumelt, 1984).

Value is often related to competitive advantage, where studies usually address questions related to value creation in order to explain how competitive advantage can be achieved (De Brito & Brito, 2012).

Marx (1867/1990) created a differentiation between *use-value* and *exchange-value*, apart from the well know *labor-value*. In his perspective, *use-value* is related to the satisfaction of a personal need, while the *exchange-value* is related to an economic aspect that will be defined by a social context (Ito *et al.*, 2012). In other words, *exchange-value* is related to an objective dimension (monetization), while the *use-value* is related to a subjective

dimension (perception of value by someone). In this sense, different people will have different needs, that if merged with information asymmetry will result in different perceptions of value.

The *exchange-value* is more objective than the *use-value*, so the measurement of competitive advantage usually relies on financial data to measure the 'value' generated by an organization (Pace, Basso, & da Silva, 2003) - (also see De Brito & Brito, 2012 for a practical example).

Pace, Basso and Da Silva (2003) for example, point out that another reason is the fact that financial variables are easier to be acquired, which facilitates the job of analysts when performing market analysis. Nevertheless, this study also points that variables from a non-financial dimension (ones related to the *use-value*), perform a huge influence on the organization performance, with some of them displaying a greater than the financial ones.

The subjective aspects of value lead us to a discussion about the aspects of value proposition, value creation and value capture. Grönroos (2008) states that in a general level, value creation entails a process to increase the customer wellbeing. Nevertheless, the same author points in another study (Grönroos & Voima, 2013) that value creation is not explicitly defined, being often addressed by the literature as something entangled with what is called co-creation of value. The idea of co-creation reflects a simultaneous value creation between the organization and its customer (which can also include other actors). In this sense, the organization delivers the value proposition to its customer to create value, also capturing part of the created value. However, it's important to clarify that the value is perceived and determined by the customer (Helkkula, Kelleher, & Pihlström., 2012).

Early studies related to value proposition highlighted the favorable points that an organization could achieve to determine the value delivery to its customers (Lanning, 1998), thus focusing only on the delivery of value (Bower & Garda, 1985). More recent studies connects the value proposition to an idea that also involves the customers that an organization has (Prahalad & Ramaswamy, 2004).

Although the value proposition can be defined as a promise (products or services) that are offered to the customers (Lanning & Michaels, 1988; Baden-Fuller & Haefliger, 2013), this process also encompasses other dimensions related to the customer, such as the customer relationship and the customer identification (Baden-Fuller & Haefliger, 2013), which results in aspects such as entrepreneurial activities (Bowman & Ambrosini, 2000); organizational

resources (Barney, 1991), specific activities (Porter, 1996), and also capabilities (Teece, 2014) being affected.

Value creation can thus be considered the combination of a value that the customer perceives from a service or product delivered by the organization (value proposition) being influenced by the identification and the relationship that an organization establishes with its customers (Baden-Fuller & Haefliger, 2013; Grönroos & Voima, 2013).

However, despite value capture being related to the value proposition and value capture, the former is usually addressed considering the idea of *exchange-value*, since the literature tends to address it based on an economic gain for the organization. This approach is very often used at the business model literature, such as Lecocq, Demil and Warnier (2006), Osterwalder and Pigneur, (2010), Baden-Fuller and Haefliger (2013), and also Teece and Linden (2017). Nevertheless, it's important to point that some studies also consider the value capture as something that goes beyond the economic dimension, such as the study of Davies and Chambers (2018), where the authors use a business model perspective that also encompasses the sustainable aspects of value capture.

For the present study however, we consider value capture as the method that an organization use to capture an economic amount of the value previously created. Thus, here we are focusing solely on the economic aspects of the value capture. The main reason is because this stream is more consolidated at the industry 4.0/digital transformation literature (Burmeister, Lüttgens, & Piller, 2016; Arnold, Kiel, & Voigt, 2017; Müller & Voigt, 2017). Thus, it provides a more grounded literature to explore this aspect of value.

Following that perspective, we are also considering that the organization have difficulties to 'capture' and retain the whole value that was created (Ito *et al.*, 2012), on a process that Lepak, Smith and Taylor (2007) calls 'value deviation'. In this sense, only part of the value is captured by the organization, and the remaining amount can be captured by their competitors and also by their own customers.

### 2.2.1. *The concept of Value at the Industry 4.0*

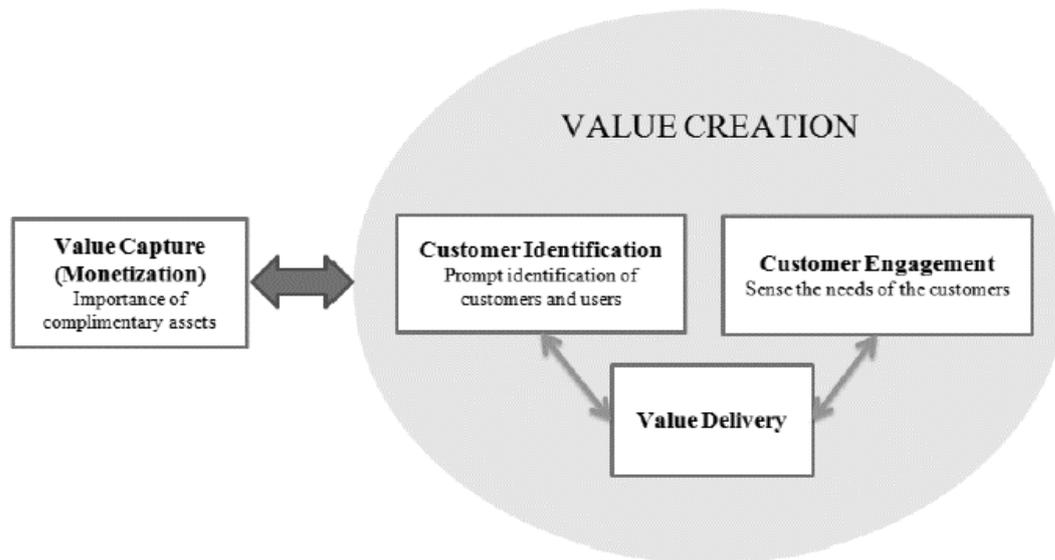
At the industry 4.0 literature some studies explore the concept of value based on the business models perspectives (Arnold, Kiel, & Voigt, 2017; Müller & Voigt, 2017). Although those studies usually explore some value perspectives, they focus on understanding how the business model was changed due to the digital transformation process (Burmeister, Lüttgens, & Piller, 2016; Arnold, Kiel, & Voigt, 2018). Thus, while some studies demonstrate that the

value proposition was the most affected aspect of business model (Burmeister, Lüttgens, & Piller, 2016; Arnold, Kiel, & Voigt, 2017), other studies point that the value proposition was only slightly affected at the organizations (Müller & Voigt, 2017 Müller, Buliga, & Voigt (2018) provides a good overview about different value's aspects. They performed case studies and identified the main items from the value aspects that were affected by the industry 4.0/digital transformation.

Nevertheless, the business model literature assists with the operationalization of the aspects of value. Thus, for the present study we merged the findings from the study of Müller, Buliga and Voigt (2018) with a business model perspective that encompasses the aspects of value proposition, value creation and value capture. An interesting study where business models are explored regarding the aspects of value is the one of Baden-Fuller and Haefliger, 2013, where the business model is explored in four dimensions: customer identification, customer engagement, value delivery and monetization.

While the first dimension - *customer identification* stress the fact that novel technologies require the organization to promptly identify who will be their customers and users, the second dimension - *customer engagement* stress that a properly sense of the customer/user needs will help to establish the value proposition for them. The third dimension - *value delivery*, represents the connection between the first and second dimensions, ultimately connecting it to the fourth dimension – monetization, which is considered the value capture and also where complimentary assets are emphasized (Teece, Pisano, & Shuen, 1997).

Figure 1 provides a summary of Baden-Fuller and Haefliger (2013) model, where we state that the value creation process encompasses the first three dimensions of the model (customer identification; customer engagement; and value delivery), which ultimately lead to the monetization of the model (the value capture).



**Figure 1.** Business model perspective used for the research  
 Source: The authors (2019), adapted from Baden-Fuller and Haefliger (2013)

### 3. METHODOLOGICAL PROCEDURES

To explore the relationship between the aspects of value and the industry 4.0/digital transformation, we conducted four case studies on small Brazilian enterprises. Our study is classified as being exploratory, with a cross-sectional perspective merged with a longitudinal approximation.

The selected approach is aligned with the perspectives of Eisenhardt (1989) and Yin (2014), since we aim to answer a research question that is based on ‘how something happens at a specific scenario’. Furthermore, the approach is also consistent with the industry 4.0/digital transformation studies, since those streams are still very little explored. Recent studies also used an exploratory approach at this scenario (Kiel, Arnold, & Voigt, 2017; Zeng, Simpson & Dang, 2017; Müller, Buliga, & Voigt, 2018).

The analyzed organizations are classified as small enterprises and are located over three different Brazilian States. All of them were attending to the digital transformation process at the time of the interviewees. Table 1 summarizes the main information for each of them.

**Table 1.**  
Analyzed organizations

Organization	Year of creation	Number of Employees	Number of Customers	State / Country	Main product / service
A	2015	12	8	Santa Catarina / Brazil	Service - Real time monitoring of temperature of refrigerated chambers
B	2015	4	10	São Paulo / Brazil	Service - Application of Computational Fluid Dynamics (CFD) technology that aims to improve engineering processes
C	2017	15	Informed as being more than 15	Paraná / Brazil	Service - Digital solution that connects people and processes thus assisting with the digital transformation
D	2017	15	Informed as being more than 20	Paraná / Brazil	Product - Industrial dumpsters with high durability

Source: The Authors (2019)

Data was collected primarily with semi-structured interviews with key employees at the organizations. We considered key employees the ones at managerial positions related to the implementation of the industry 4.0/digital transformation: Chief Executive Officer (CEO) and other high level managers, the Chief Information Officer (CIO), and the Chief Technology Officer (CTO), as well as engineers, analysts and developers that work directly with technologies used at the organizations. Our choice of key employees is aligned with other studies that have explored the digital transformation process (see Arnold, Kiel, & Voigt, 2017; Zeng, Simpson, & Dang, 2017; Müller, Buliga, & Voigt, 2018).

The interviewees consented with recording. Later, the audio files were transcribed using the software Express Scribe in order to avoid information to be lost or not utilized. Additional notes were also taken during the interviews in order to collect more information and increase the study validity. Table 2 summarizes the conducted interviews.

**Table 2.**  
Interviewees conducted at the organizations

Organization	Interviewee position	Number of Interviewees	Length of interview(s)
A	CTO	1	55 minutes
	CEO	1	40 minutes
	Developer	1	42 minutes
B	Executive Director	2	86 minutes
	Engineering Director	1	43 minutes
	Commercial Director	1	48 minutes
C	Operations Director	1	60 minutes
	Developer/ business partner	1	43 minutes
	Process and HR Manager	1	32 minutes
D	Industrial Manager	1	25 minutes
	External Consulting analyst	1	40 minutes

Source: The authors (2019)

Non-participatory observation was also performed in two organizations. According to Breakwell et al. (2010), that technique is characterized by the integration of the researcher to the observed group, but with the intent to observe only. That allows the researcher to access more data and also to capture the perception from the practical point of view of someone that is effectively inside the case being observed (Yin, 2014). Additional notes were also taken during the non-participatory observations in order to increase the amount of data and allow a more precise data triangulation. Table 3 summarizes the non-participatory observations.

**Table 3.**  
Non-participatory observations performed

Organization	Details	Number of observations performed	Length of observations
C	Meetings at organization business rooms	1	40 min
	Management team non-participatory observation	1	90 min
D	Production line non-participatory observation	1	60 min

Source: The authors (2019)

Additional data was collected from organizations' documents and archives as they might contain information that could be omitted by the interviewees (Yin, 2014).

To analyze the data, we used the content analysis (Miles & Hubberman, 1994), with the software ATLAS.ti version 8. The transcription files were coded, allowing us to split and reorganize the data in order to perform the inferences.

Each case was first analyzed individually, where we pointed the specificities and the interesting findings of each organization. Later, we perform a cross-case analysis, thus following Yin (2014) recommendations to have patters and differences identified.

At the next section we explore the cross-case analysis of the organizations, thus discussing their similarities and differences in terms of how their value perspectives where affected by the industry 4.0/digital transformation.

#### **4. A CROSS CASE ANALYSIS OF THE ORGANIZATIONS**

In this section we first present the business model of each organization. Then, we point out the organizations' value aspects, and later we address the most important aspects of value proposition, creation and capture for the digital transformation.

##### **4.1. Organizations business models**

It's interesting to point that three organizations were classified as technology providers (organizations A, B and C), while a single one was classified as a technology user (organization D). In other words, while the first three organizations provide industry 4.0 technologies, the fourth use only uses these technologies.

At *organization A*, the value proposition is defined by the interviewees as being a "Temperature monitoring solution that can generate cost and energy savings for the organizations". In this sense, what they provide is a service that ultimately create cost savings for their customers. To create value, they merge their value proposition with an internal and an external search for customers (using their network contacts to have it done). The organization employees also attended to events related to the industry 4.0 and the digital transformation to seek potential customers.

About the customer relationship, the interviewees emphasized the importance of the cost and energy savings for their customers. As stated by the CTO "[...] we had to emphasize the importance of cost and energy savings, as they [customers] do not see value from the digitalization itself". Prior to emphasizing cost and energy savings, they were not having success on acquiring customers.

According to the interviewees, that change allowed them to create value and continue their services improvement, as well as the acquisition of more organizational resources, such as new employees and technological equipment.

To capture the created value, the organization uses a pay-per-use model, with their customers being charged on a monthly basis according to the number of temperature sensors that are installed.

At *organization B*, we identified two different value propositions. A first one is related to consulting services provided by the organization (the digitalization of engineering processes, that allows simulations to check for cost and energy savings). A second proposition is related to R&D services that the organization provide (They've partnerships for R&D with their customers in order to have new products and services created).

To create value, their value propositions are merged with an identification of customers performed with the assistance of the ecosystem that they are member. Furthermore, they also use personal contacts and events related to digital transformation to identify potential customers. Despite that, the Commercial Director states that: “We rely mainly on the ecosystem where we are inserted to acquire customers, some additional customers come from our contacts and from events that we attend, but they represent only a small portion.”.

Considering the customer relationship, this organization also focus on demonstrating cost and energy savings for their customers. However, here the interviewees also point the importance of a very strong trust relationship with their customers. It is because digitalization of engineering processes usually involves sensitive information, as pointed by the Executive Director: “Our customer has to trust us because engineering plants are sensitive information [...]. I mean, you’re not going to simply give it to anyone that knocks on the door offering this type of service”.

We also identified two value capture mechanisms at this organization. The first one is a fixed price model merged with a success rate model (where the organization takes some percentage over the improvement performed by their services). The second one is a mechanism related to their second value proposition (R&D services), which is a pay-per-use model. At that model their customers charged on a monthly basis.

At *organization C*, we identified their value proposition as being the digitalization and the application of industry 4.0 technologies to industrial processes, thus assisting their customers to digitally transform themselves.

Their approach is merged with an identification of customers that relies mainly on their ecosystem and network contacts, with some employees also attending to events related to industry 4.0/digital transformation to identify potential customers.

Considering their customer relationship, they map their customers progress based on weekly meetings, and their software can be adapted depending on the customer demands, which allows them to assist both organization that are entering the digital transformation, as well as organizations that already have a great development level.

To capture value, this organization uses a pay-per-use model, with customers charged on a monthly basis. The Operations Director also stated that they are starting to use the success rate model (same model used by organization B), but that is still on the development stage.

At *organization D*, we identified that their value proposition is based on three main items: product quality, deliver time and lower costs. Their main product are industrial dumpsters that are assembled upon the welding of steel plates. Those dumpsters are then sold to their customers. The Industrial Manager stated that they managed to develop a welding technique that results in less cuts to the steel plates, and thus allow them to achieve their value proposition.

Organization D also displayed a different approach to identify potential customers, relying mainly on their internal marketing team to have customers identified.

Apart from that, while the first three organizations demonstrated a more informal relationship with their customers, organization D maintained a formal relationship, thus having a lot of service level agreements with their customers.

As this organization was classified as a user of industry 4.0, a lower a development level when it comes to industry 4.0/digital transformation was observed. Thus, despite the fact that they are creating and capturing value, they still do not create value on the context of the industry 4.0. Their value capture mechanism, for example, relies mainly on a fixed price model, where their customers are charged considering the number of products that are acquired.

#### **4.2. The value aspects at the organizations**

One of the first identified differences is that while first three organizations (A, B and C) have a value proposition based on a service for their customers, organization D offers a

product. In this sense, organizations A, B and C displayed an approach similar to the one described at other industry 4.0 studies, with a shift to a service based model, called 'servitization of the business models' (Kagerman, Wahlster, & Helbig, 2013; Burmeister, Lüttgens, & Piller, 2016; Kiel, Arnold, & Voigt, 2017).

Nevertheless, interviewees from organization D mentioned that they have plans to change their model and offer services instead of products (which will be the rent of their industrial dumpsters). That is planned once they start to use more industry 4.0/digital transformation technologies. Thus, they are aware about the shift from 'value residing on the product' to the 'value residing on the service being provided' that is pointed out by the industry 4.0 literature.

Interviewees from organizations A, B and C stated that value capture was the hardest dimension of the model to achieve. The Commercial Director of Organization B, for example, stated that: "There are multiple stakeholders involved when we consider our relationship with other organizations.", while the Operations Director from Organization C mentioned that "[...]it's difficult to 'benchmark' an innovation when it comes to industry 4.0, since a novel solution usually does not have similar competitors to identify how much would be a reasonable price." These statements are directly aligned with the concept of 'value deviation' (Lepak, Smith, & Taylor, 2007), where the value is deviated from the organization that created it, also being captured by other actors involved on the process.

It's interesting to point out that one critical item identified for industry 4.0/digital transformation was the partnerships. Partnerships are expected to enhance the value created, but at the same time they can also create more challenges to capture the value, since more stakeholders get involved in the process.

The importance of partnerships is also related to the complimentary assets (Teece, Pisano, & Shuen, 1997). Those assets are owned by an organization but are only able to create value when connected to other assets (usually in possession of other organizations). At organization A, for example, the CTO stated that: "Our software cannot generate value by itself, we need the temperature sensors and also a good internet connection to create value". In other words, they software need complimentary assets that the organization does not have in order to successful create value. Organizations B and C also displayed a similar scenario when it comes to complimentary assets, since we identified that they also need assets provide by their partners in order to successful create value.

However, at organization D, a different scenario was identified. Here this type of assets was not identified as being important for the value aspects of the organization. In other words, this organization relies mainly on their own assets to deliver, create and capture value.

This could be related to the fact that while organizations A, B and C displayed a greater maturity level at industry 4.0/digital transformation, organization D is still taking its first steps to digitally transform itself, currently only evaluating the implementation of the industry 4.0 technologies. Furthermore, while organizations A, B and C complained about the challenge to capture the value that was created, organization D did not have such complaints. Their interviewees only state that they believe that value capture will be more difficult when they start to use more digital technologies.

The interviewees from organizations A, B and C also displayed specific complaints about challenges to address the interests of all stakeholders, since the digital transformation resulted in a complex connection and more information being exchanged between the organizations. That lead to concerns regarding their value chain, which is also aligned with findings from other studies such as Arribas and Alfaro (2017) and Shin (2017).

### **4.3. Most important value aspect items for the digital transformation**

Müller, Buliga and Voigt (2018) develops a study and identify the digital transformation/industry 4.0 items that most affected the value proposition, value creation and value capture at the organizations. Considering their findings, we coded the interviews aiming to identify the most frequently mentioned by the interviews, as well as the ones that represented their greatest challenges. At the next sections, we explore those items in more details considering the aspects of value proposition, value creation and value capture. It's important to note that while items were effectively identified at organizations A, B and C, at organization D they are only based on interviewees perception for the future, as they do not yet in an industry 4.0 scenario.

#### *4.3.1. Value Proposition*

Here we identify that in all four organizations products and services more scalable to the customer demands was considered a very important item. At organization A and C real time monitoring was also identified, while at organization B and D less maintenance was considered an important item.

Furthermore, manufacturing and product simulation (organization B) and human-machine interfaces (organization C) was also identified. At table 4 we've summarized the items related to value proposition identified at the organizations.

**Table 4.**  
Items identified at the analyzed organizations

Value proposition group	Value proposition item	Organizations where it was identified
Product	Larger product spectrum	None
	Less maintenance required	None
	Versatile and Flexible products	A, B, C and D
	Higher quality and output of production machines	D
	Incorporation of manufacturing data in products and in product management system	A and C
	Products tailored to customer demands	A, B, C and D
	Human-machine interfaces	C
Service	Machine retrofitting services	None
	Real time monitoring	A and C
	Remote maintenance	A and C
	Digitalization services for customers	B and C
	Data Analytics services	B
	Manufacturing and product simulations	B and C
	Virtual product development	B and C
Engineering and product configuration services	B and C	

Source: The Authors (2019), adapted from Müller, Buliga and Voigt (2018)

According to table 4, we note that at the service group, only organizations A, B and C had items identified (with emphasis to organizations B and C). Organization D, on the other hand, only had items from the product group identified (which is consistent to the fact that this organization currently deliver value to its customers in the form of a product).

Nevertheless, organizations A, B and C (the ones that provide services) also have items identified on the product group. The reason for that seems to be the fact that these organizations combine a number of products in the form of a service in order to deliver value: Organization B, for example, uses 3 different products (an software, the temperature sensors, and the internet connection) to create a service of real time temperature monitoring.

#### 4.3.2. Value Creation

At the value creation, we identified that organizations A, B and C had more items identified than organization D. Nevertheless, organization D was the only one that displayed

the item increase of productivity, which is related to the fact that while organizations A, B and C provide digital transformation solutions to other organizations, organization D aims to acquire solutions related to digital transformation, thus increasing their in-house productivity.

At table 5 we've summarized the items identified at the organizations: organization C was the one that displayed more items related to the value creation, also being the only where technology-based training and support in a failure recognition was identified.

On the other hand, most items mentioned by organizations A, B and C were related to partners and suppliers' group, which is related to the importance of partnerships at the industry 4.0/ digital transformation (Shin, 2017).

**Table 5.**  
Items identified at the analyzed organizations

Value creation group	Value creation item	Organizations where it was identified
Production equipment	Increase on productivity	D
	Energy savings and load-balance	A, B and C
	Higher fault resistance	None
	Faster access to manufacturing data	C
	Machine health monitoring	None
	Increase in-house production	None
	Lower stocks	None
	Easier production maintenance	None
Workforce	Higher employee integration	A, B and C
	New types of jobs and workplaces	C and D
	Technology-based training	C
	Support in a failure recognition	C
Partners and suppliers	Higher inter-company connectivity	A, B and C
	Co-design of the value offered	B and C
	Joint data analysis	A, B and C
	Innovative partnerships	A, B and C
	Higher transparency and reliability	B
	Increased virtual contact and standardization	A, B and C

Source: The authors (2019), adapted from Müller, Buliga and Voigt (2018)

#### 4.3.3. Value Capture

At the value capture organization C was again the one with more items identified. All organizations displayed the item Increase of subscription models like pay-per use and pay-per-feature, which were already in-place at organizations A, B and C and on the plans for

future development at organization D. At table 6 we've summarized the items that were identified at the organizations.

**Table 6.**  
Value capture items identified at the analyzed organizations

Value capture group	Value capture item	Organizations where it was identified
Customer groups	New customer groups (B2B)	A, B, C and D*
	Intensification of risks and opportunities for customer retention	A, B and C
Customer interaction	Customer contacted via digital platforms	A, B and C
	Easier interaction through digital communication	A and C
	Co-design and co-engineering with customers	B and C
	Higher cost transparency	None
	Joint decision making	C
	Value chain integration with customers	A, B and C
	Suppliers become more transparent to customers	None
Payment methods	Digital accounting and automated invoices	None
	Increased payment reliability	None
	Process simplification	None
	Increase of subscription models like pay-per-use and pay-per-feature models	A, B, C and D

Source: The authors (2019), adapted from Müller, Buliga and Voigt (2018)

Note: \* Organization D was already attending to the B2B segment prior to start its digital transformation.

We note that subscription models were identified in all organizations. However, no other item from the group Payment methods group was identified at the organizations. Furthermore, we only identified two items from organization D, which is aligned to the fact that they are not yet capturing value considering the industry 4.0/digital transformation. The reason for that is because organizations A, B and C, already display a greater maturity level when it comes to the industry 4.0. As a result, these organizations display more items related to the customer interface group, which is aligned with other studies such as Gerlitz, (2016) and Kiel, Arnold and Voigt, (2017).

## 5. DISCUSSION

The results are similar to findings present by other studies that explored the industry 4.0/digital transformation (Burmeister, Lüttgens, & Piller, 2016; Arribas & Alfaro, 2017; Kiel, Arnold, & Voigt, 2017; Jerman, Erenda, & Bertonecelj, 2019). In this sense, the findings

demonstrate that 'value' is subject to change when we consider the digital transformation. That result in challenges such as cultural barriers and multiple stakeholders involved in the process.

Some barriers are specific to the Brazilian scenario, such as some customers not 'trusting' solutions created by Brazilian organizations, while other are related to specific aspects of the process, such as the 'success rate model', which is yet not fully understood and thus prevent organizations from having a flexible value capture.

Apart from that, since our cases include three organizations that presented a higher level of digitalization (organizations A, B and C), and a fourth one with a smaller degree of digitalization (organization D), we managed to identify differences between their value proposition, value creation and also value capture, as it was demonstrated at tables 4, 5 and 6.

At organizations A, B and C items related partnerships and the ecosystem were constantly mentioned by the interviewees, thus demonstrating the importance of partners (specially suppliers), for the digital transformation. AT organization D, on the other hand, strategic partnerships to have industry 4.0/digital transformation implemented was identified as being necessary for their development. As stated by the External Consulting analyst: "I've already identified that the organization cannot implement industry 4.0 technologies by themselves, which is one of the reasons of why I'm providing services to them. So, I'm looking for other partnerships to assist us with the development."

Since organizations A, B and C had a greater maturity level at the industry 4.0 more items from the customer interaction group were identified. Organization D, on the other hand, did not mention items on the customer interaction, only pointing to an idea of a payment method based on subscriptions for the future. This further enhances findings from other studies, where improvements on the customer experience is seen as a common outcome for industry 4.0/digital transformation (Gerlitz, 2016; Arribas & Alfaro, 2017; Pesce, Neirotti, & Paolucci, 2019).

Furthermore, as organizations A, B and C answered to the challenges relying mainly on their partnerships, the complimentary assets became more important to continue the value creation process. Organization D, on the other hand, did not displayed digital transformation partnerships with other organizations, but the data collected revealed that partnerships is the strategic plan to address the industry 4.0/digital transformation challenges.

As pointed by Oesterreich and Teuteberg, (2016), the industry 4.0/digital transformation creates what the author calls digital value chain, and despite the fact that specific aspects of the digital value chain were not explored at the present study, our findings point that multiple stakeholders' interests will act on the value chain of the organizations. Thus, in order to continue the value creation and value capture processes the organization will need to manage these multiple interests (Pesce, Neirotti, & Paolucci, 2019). That creates a challenging scenario that could result on internal competition between the partners, ultimately destroying the competitive advantage achieved by the organizations.

## 6. CONCLUSIONS

The present study aimed to explore how digital transformation affected the aspects of value at four small Brazilian organizations. We used a combination of the literature stream related to business model and the literature stream related to value. In this sense, while the first stream assisted us to operationalize and better understand how the aspects of value were defined at the organizations, the second stream assisted us to code the data and thus identify the digital transformation items that affected the value aspects at the organizations.

Thus, we provide an extension to these two streams of literature, thus expanding our understanding about the relationship between value and the industry 4.0/digital transformation by validating which items were qualitatively identified in these four organizations

It's also important to address our study limitations. First, the selected cases are small organizations from the southern region of Brazil. Thus, they've specific characteristics that prevent generalizations. Nevertheless, our objective was not to produce generalizations, but to explore an in-depth scenario at the organizations, providing an exploratory study related to the aspects of value. Second, the interpretation of data is always limited to the researchers' cognitive aspects. However, by following the guidelines of Eisenhardt (1989) and Yin (2014), we aimed to increase the validity of our study and minimize this limitation.

Considering our findings and the study limitations, future research should consider a broader scenario when exploring the aspects of value, thus considering an ecosystem level of analysis. Furthermore, studies could also explore the complimentary assets (Teece, 1986) at the industry 4.0/digital transformation, as the importance of those tend to increase as for organizations that are digitally transform themselves. Lastly, the concept of digital value chain should be further explored as well.

With our study, we barely scratched the relationship between value and industry 4.0, and we sustain that this relationship is a very fruitful avenue to be further explored.

### Acknowledgement

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.

### REFERENCES

- Arnold, C., Kiel, D., & Voigt, K. I. (2017). Innovative business models for the industrial internet of things. *BHM Berg-und Hüttenmännische Monatshefte*, 162(9), 371-381.
- Arribas, V., & Alfaro, J. A. (2018). 3D technology in fashion: from concept to consumer. *Journal of Fashion Marketing and Management: An International Journal*.
- Baden-Fuller, C., & Haefliger, S. (2013). Business models and technological innovation. *Long range planning*, 46(6), 419-426.
- Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, 17(1), 99-120.
- Bititci, U. S., Martinez, V., Albores, P., & Parung, J. (2004). Creating and managing value in collaborative networks. *International Journal of Physical Distribution & Logistics Management*.
- Bower, M., & Garda, R. A. (1985). The role of marketing in management. *McKinsey Quarterly*, 3(1), 34-46.
- Bowman, C., & Ambrosini, V. (2000). Value creation versus value capture: towards a coherent definition of value in strategy. *British journal of management*, 11(1), 1-15.
- Breakwell, G. M., Hammond, S., Fife-Schaw, C., & Smith, J. A. (2010). *Métodos de pesquisa em psicologia*. Artmed Editora.
- Burmeister, C., Lüttgens, D., & Piller, F. T. (2016). Business model innovation for Industrie 4.0: Why the “Industrial Internet” mandates a new perspective on innovation. *Die Unternehmung*, 70(2), 124-152.
- Davies, I. A., & Chambers, L. (2018). Integrating hybridity and business model theory in sustainable entrepreneurship. *Journal of Cleaner Production*, 177, 378-386.
- Brito, R. P. D., & Brito, L. A. L. (2012). Ventaja competitiva, creación de valor y sus efectos sobre el desempeño. *Revista de Administração de Empresas*, 52(1), 70-84.
- Doh, S. W., Deschamps, F., & de Lima, E. P. (2016). Systems Integration in the Lean Manufacturing Systems Value Chain to Meet Industry 4.0 Requirements. In *ISPE TE* (pp. 642-650).
- Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review*, 14(4), 532-550.
- Gerlitz, L. (2016). Design management as a domain of smart and sustainable enterprise: business modelling for innovation and smart growth in Industry 4.0. *entrepreneurship and Sustainability Issues*, 3(3), 244-268.
- Svensson, G., & Grönroos, C. (2008). Service logic revisited: who creates value? And who co-creates?. *European business review*.
- Grönroos, C., & Voima, P. (2013). Critical service logic: making sense of value creation and co-creation. *Journal of the academy of marketing science*, 41(2), 133-150.

- Heger, B. K. (2007). Linking the employment value proposition (EVP) to employee engagement and business outcomes: Preliminary findings from a linkage research pilot study. *Organization Development Journal*, 25(2), P121.
- Helfat, C. E., & Martin, J. A. (2015). Dynamic managerial capabilities: Review and assessment of managerial impact on strategic change. *Journal of management*, 41(5), 1281-1312.
- Helkkula, A., Kelleher, C., & Pihlström, M. (2012). Characterizing value as an experience: implications for service researchers and managers. *Journal of service research*, 15(1), 59-75.
- Ito, N. C., Hayashi Junior, P., Gimenez, F. A. P., & Fensterseifer, J. E. (2012). Valor e vantagem competitiva: buscando definições, relações e repercussões. *Revista de Administração Contemporânea*, 16(2), 290-307.
- Jerman, A., Erenda, I., & Bertoncej, A. (2019). The Influence of Critical Factors on Business Model at a Smart Factory: A Case Study. *Business systems research journal: international journal of the Society for Advancing Business & Information Technology (BIT)*, 10(1), 42-52.
- Kagermann, H., Wahlster, W., & Helbig, J. (2013). Recommendations for implementing the strategic initiative Industrie 4.0: Final report of the Industrie 4.0 Working Group. *Acatech, München*, 19-26.
- Khaitan, S. K., & McCalley, J. D. (2014). Design techniques and applications of cyberphysical systems: A survey. *IEEE Systems Journal*, 9(2), 350-365.
- Kiel, D. (2017). What do we know about “Industry 4.0” so far. *International Association for Management of Technology*, 26.
- Kiel, D., Arnold, C., & Voigt, K. I. (2017). The influence of the Industrial Internet of Things on business models of established manufacturing companies—A business level perspective. *Technovation*, 68, 4-19.
- Lanning, M. J., & Michaels, E. G. (1988). A business is a value delivery system. *McKinsey staff paper*, 41(July).
- Lecocq, X., Demil, B., & Warnier, V. (2006). Le business model, un outil d'analyse stratégique. *L'expansion management review*, (4), 96-109.
- Lepak, D. P., Smith, K. G., & Taylor, M. S. (2007). Value creation and value capture: A multilevel perspective. *Academy of management review*, 32(1), 180-194.
- Liao, Y., Deschamps, F., Loures, E. D. F. R., & Ramos, L. F. P. (2017). Past, present and future of Industry 4.0—a systematic literature review and research agenda proposal. *International journal of production research*, 55(12), 3609-3629.
- MARX, K. (1990). *Capital: a critique of political economy*. London: Penguin Books. (Original published in: 1867).
- Miles, M. B., Huberman, A. M., Huberman, M. A., & Huberman, M. (1994). *Qualitative data analysis: An expanded sourcebook*. sage.
- Müller, J., & Voigt, K. I. (2017, May). Industry 4.0—Integration Strategies for Small and Medium-sized Enterprises. In *Proceedings of the 26th International Association for Management of Technology (IAMOT) Conference, Vienna, Austria* (pp. 14-18).
- Müller, J. M., Buliga, O., & Voigt, K. I. (2018). Fortune favors the prepared: How SMEs approach business model innovations in Industry 4.0. *Technological Forecasting and Social Change*, 132, 2-17.
- Normann, R. (2001). *Reframing business: When the map changes the landscape*. John Wiley & Sons.

- Oesterreich, T. D., & Teuteberg, F. (2016). Understanding the implications of digitisation and automation in the context of Industry 4.0: A triangulation approach and elements of a research agenda for the construction industry. *Computers in industry*, 83, 121-139.
- Orlandi, L. B. (2016). Organizational capabilities in the digital era: Reframing strategic orientation. *Journal of Innovation & Knowledge*, 1(3), 156-161.
- Osterwalder, A., & Pigneur, Y. (2010). *Business model generation: a handbook for visionaries, game changers, and challengers*. John Wiley & Sons.
- Pace, E. S. U., Basso, L. F. C., & Silva, M. A. D. (2003). Indicadores de desempenho como direcionadores de valor. *Revista de administração contemporânea*, 7(1), 37-65.
- Pesce, D., Neirotti, P., & Paolucci, E. (2019). When culture meets digital platforms: value creation and stakeholders' alignment in big data use. *Current Issues in Tourism*, 22(15), 1883-1903. Available at: <<https://doi.org/10.1080/13683500.2019.1591354>>.
- Peteraf, M. A. (1993). The cornerstones of competitive advantage: a resource-based view. *Strategic management journal*, 14(3), 179-191.
- Pitelis, C. N. (2009). The co-evolution of organizational value capture, value creation and sustainable advantage. *Organization studies*, 30(10), 1115-1139.
- Porter, M. E. (1996). What is strategy?. *Harvard business review*, 74(6), 61-78.
- Rudtsch, V., Gausemeier, J., Gesing, J., Mittag, T., & Peter, S. (2014). Pattern-based business model development for cyber-physical production systems. *Procedia CIRP*, 25(1), 313-319.
- Rumelt, R. P. (1984). Towards a strategic theory of the firm. *Competitive strategic management*, 26(3), 556-570.
- Sánchez-Fernández, R., & Iniesta-Bonillo, M. Á. (2007). The concept of perceived value: a systematic review of the research. *Marketing theory*, 7(4), 427-451.
- Shin, D. I. (2017). An exploratory study of innovation strategies of the internet of things SMEs in South Korea. *Asia Pacific Journal of Innovation and Entrepreneurship*.
- Ganschar, O., Gerlach, S., Hämmerle, M., Krause, T., & Schlund, S. (2013). *Produktionsarbeit der Zukunft-Industrie 4.0* (Vol. 150). D. Spath (Ed.). Stuttgart: Fraunhofer Verlag.
- Teece, D. J. (2014). A dynamic capabilities-based entrepreneurial theory of the multinational enterprise. *Journal of international business studies*, 45(1), 8-37.
- Teece, D. J., & Linden, G. (2017). Business models, value capture, and the digital enterprise. *Journal of Organization Design*, 6(1), 1-14.
- Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic management journal*, 18(7), 509-533.
- Weber, R. H. (2013). Internet of things—governance quo vadis?. *Computer Law & Security Review*, 29(4), 341-347.
- Yin, R. K. (2014). *Case study research: Design and methods (applied social research methods)*. Thousand Oaks, CA: Sage publications.
- Zeng, J., Simpson, C., & Dang, B. L. (2017). A process model of dynamic capability development: Evidence from the Chinese manufacturing sector. *Management and Organization Review*, 13(3), 643-673.