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BARRIERS AND ENABLERS OF DIGITAL TRANSFORMATION: AN EXPLORATORY ANALYSIS OF DIGITAL DEBT AND DEVOPS

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Trabalho Aplicado apresentado à Escola de Administração de Empresas de São Paulo da Fundação Getulio Vargas, como requisito para a obtenção do título de Mestre em Gestão para a Competitividade.

Campo do Conhecimento: Tecnologia da Informação

Orientador Prof. Dr. João Luiz Becker

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RESUMO

A rápida difusão das tecnologias digitais, aliada à grande quantidade de dados gerados pelas interações entre usuários e organizações, vem reinventando a forma como os mercados desenvolvem e aprimoram seus modelos de negócio. Não é raro ouvirmos que toda a empresa é uma empresa de tecnologia. Entretanto, esta velocidade não é adquirida de forma rápida, pois requer o desenvolvimento de recursos e capacidades organizacionais, além de um novo *mindset* digital para produzir uma estratégia capaz de vencer suas barreiras internas e alavancar os habilitadores desta transformação. As organizações incumbentes e já estabelecidas, encontram barreiras para sua transformação digital ao enfrentar restrições dos seus sistemas legados com suas necessidades de modernização, aposentadoria ou até mesmo substituição destes. Não somente isso, a pressão para entrega de novas propostas de valor de negócio, forçam tomadas de decisão técnicas, sub-otimizadas que cobram o preço da qualidade dos produtos e da flexibilidade das soluções. Esse acúmulo de deficiências do portfolio tecnológico da organização promovem um débito digital para com os seus clientes, minando sua proposta de valor. Novas técnicas e práticas, como o DevOps, vem emergindo neste contexto, para garantir um ciclo de melhoria contínua, aumentar a produtividade, atacar os problemas de qualidade dos produtos, modificar a cultura e endereçar novas abordagem de entrega de produtos digitais. Este estudo exploratório apresenta evidências de que os débitos digitais e o DevOps atuam respectivamente como barreiras e habilitadores da maturidade digital da organização, promovendo uma discussão sobre sua priorização destes na estratégia digital de negócio da organização. Uma proposta de aprofundamento da área acadêmica também é apresentada.

PALAVRAS-CHAVE: Transformação Digital, Devops, Débitos Digitais, Maturidade Digital, Descontinuidade de sistemas de informação, Débitos Técnicos

ABSTRACT

The rapid diffusion of digital technologies, combined with a large amount of data generated by interactions between users and organizations, has led to the reinvention of the way in which markets develop and improve their business models. It is not uncommon to hear that every company is a technology company. However, this status cannot be achieved quickly as it requires the development of organizational resources and capabilities, in addition to a new digital mindset to produce a strategy capable of overcoming its internal barriers and leveraging the enablers of this transformation. Incumbent and established organizations present barriers to their digital transformation when facing constraints from their legacy systems with their needs for modernization or even replacement. Furthermore, the pressure to deliver new business value propositions forces sub-optimal technical decisions that take a toll on product quality and the flexibility of the solutions. This accumulation of deficiencies in the organization's technological portfolio promotes digital debt with its customers, undermining its value proposition. In view of this, new philosophies, such as DevOps, have been emerging to ensure a cycle of continuous improvement, increase productivity, address product quality issues, change the culture, and adopt new approaches to deliver digital products. This exploratory study presents evidence that digital debt and DevOps act, respectively, as a barrier and enabler of the organization's digital maturity, promoting a discussion about their prioritization in the organization's digital business strategy. A proposal for deepening the academic field is also presented.

Keywords: Digital Transformation, DevOps, Digital Debt, Digital Maturity, Information Systems Discontinuance, Technical Debt

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SUMÁRIO

1. Introduction

The rapid diffusion of digital technologies, combined with a large amount of data generated by interactions between users and organizations, has led to the reinvention of the way in which markets develop and improve their business models. Organizations that are digitally transforming are 26% more profitable than their competitors and have a 12% higher market value (Henley, 2019). Through digital technologies, it is now possible to remove bottlenecks that were once insurmountable, reduce operational costs, and literally rebuild the value proposition of organizations. When it comes to digital technology, the word agility is what comes first to the minds of most executives (Ross, 2018).

However, this status cannot be achieved quickly as it requires a broader understanding of the organization's current scenario, its resources and capabilities, and a dynamic mindset to develop a strategy capable of overcoming its internal barriers (Skipper, 2020). Competition changes shape, and new entrants, born digital, do not have the weight of legacy systems or a culture built in an analog environment. The business dynamic, built on decades of activity in the segment, must be quickly changed. However, at some point in their lifecycle, these modern organizations will have to deal with the consequences of the design, technology, and culture decisions they make today, and thus, must prepare for future transformation cycles.

Digital transformation (DT) offers different opportunities to an organization’s strategy and market positioning (Trategy et al., 2013); however, information systems scholars and practitioners struggle to grasp what DT really is (Wessel et al., 2021). The concept of digital maturity (DM) can offer a base ground to understand, measure, compare, and evaluate existing digital capabilities (Kane et al., 2017). DM models provide a better understanding of where the organization stands in comparison to the competition and how it can achieve significantly more results from DT (Dieffenbacher, 2022).

Incumbent and established organizations have to face barriers to their needs of modernization due to the constraints of the legacy systems (Nyati, 2020). The discontinuity of current systems and technological obsolescence also contribute to the inertia challenge in the DT of organizations. Increasingly faster technological lifecycles, with hardware and software depreciation at a rate greater than the resolution capacity, put pressure on an organization's difficult task of deciding between value delivery and maintenance.

Information technology (IT) executives are pressured to make decisions that favor the speed of delivery of new features over those that improve product quality, generating technical debt (TD). Avgeriou et al. (2016), defines TD as a "collection of design or implementation constructs that are expedient in the short term, but set up a technical context that can make future changes more costly or impossible." This debt, in turn, accumulates as a result of these decisions, and over time, consumes the organization's resources, impacting its productivity, increasing its costs, and generating crises (Martini et al., 2014).

However, the extant scientific literature has not sufficiently explored the relationship between TD and information systems (IS) discontinuance process. IS discontinuance has been the subject of studies that highlight the impediments to IS replacement, IS disuse behavior of users, and reflections on continuous system modernization (Furneaux and Wade, 2017; Recker, 2014; Soliman and Rinta-Kahila, 2020). Other studies assess the impacts of IS legacy on an organization, focusing on their costs, management, and migration strategies (Crotty and Horrocks, 2017; Gholami et al., 2017; Rinta-Kahila, 2018).

New philosophies for software delivery, such as DevOps (Cogo, 2019), have emerged in this context to guarantee a cycle of continuous improvement, increase productivity, attack product quality issues, modify the culture, and address the organization's product life cycles. However, without an adequate management capacity, they inevitably impact an organization's DM and competitive advantage.

DevOps transforms organizational culture while promoting innovation, collaboration and transparency in continuous cycles of development and modernization (Forsgren and Kersten, 2017; Jabbari et al., 2016; Luz et al., 2018). It addresses an organization's integration model (Wiedemann et al., 2020), acts on organizational agility (Bahaa et al., 2017), and promotes practices that prevent organizations from being constrained by TD or their systems design portfolio (Woodard et al., 2013).

Despite the efforts of researchers, existing theories do not connect the phenomena of IS discontinuance and TD, which in a strategic analysis, to impose a digital debt on an organization in relation to its market (Kapur, 2019). The implications of these phenomena on an organization's DT process (Vial, 2019), and whether DevOps can positively impact this challenge, also lack an explanation.

This exploratory study seeks to answer the following research question: "Do digital debt and DevOps act, respectively, as a barrier and enabler of DT in organizations?" To this end, this study intends to make five main contributions. The first aim is to develop the existing theoretical models to better explain the complex phenomenon of digital debt, DevOps, and their relationships with DM. The second intends to test the hypothesis that DevOps practices have a positive impact on an organization's DM. The third one tests the hypothesis that digital debt will be negatively associated with the organization's DM. The fourth evaluates the hypothesis that the presence of DevOps practices will be negatively associated with digital debt. Finally, the fifth one tests the hypothesis of a positive correlation between TD and IS discontinuance, as dimensions of an organization's digital debt.

The evidence in this study indicates that digital debt and DevOps act, respectively, as a barrier and enabler of an organization's DM, promoting a discussion on their prioritization in the organization's strategy. A proposal for deepening this academic field is also presented.

The work is organized into sections in the following order: literature review and hypotheses development, application of the methodological model, analysis, and study results, and finally, the conclusions, limitations, and recommendations for future work.

2. Literature review and hypotheses development

Despite several scientific efforts, the theory still does not appropriately relate the phenomena of DevOps and digital debt with an organization's ability to develop its DM. Considering an organization's quest for developing a digital strategy that establishes a sustainable competitive advantage, this study aims to provide a link between DevOps, digital debt, and its DM level.

First, an analysis of the organization's strategy theories will be presented, and the concept of digital business strategy will be defined. Then, we will discuss some scientific studies on the themes of DevOps and digital debt, divided between TD and IS discontinuance. Finally, the phenomenon of DM will be analyzed to understand how it can be measured from an organization's perspective.

2.1. Digital business strategy

To understand the processes inherent to the competitive advantage of organizations and its maintenance over time, several theoretical frameworks were structured. Porter's theory (1980, 1985) addresses an external view of the organization's competition, and the context in which it is inserted. Porter develops the idea that the organization's competitive advantage is based on how much its performance improves because of the competitive strategy it defines: cost leadership that aims at becoming the cheapest in the market; differentiation in the market in which the company distinguishes itself from its competitors by seeking superior value for its products and services; or focus on a specific market segment while ignoring others. In addition to the types of strategy, Porter also presents the five forces that shape market competition: the power of the organization to bargain with its suppliers; the threat of new entrants in the market; the threat of the organization's value proposition substitution; the organization's power to bargain with its buyers; and the competitive rivalry in the market.

Extending Porter's view, Barney (1991) presents a strategic perspective of a resource-based view (RBV) of the organization. The organization's internal approach defines that competitive advantage is achieved when it has and can use its valuable internal resources that are rare and difficult to imitate. When properly used, these resources produce a significant difference in the delivery of products and services. Using RBV on the basis of the strategic theory, studies connect the value of IT to the organization's business processes (Dehning and Richardson, 2002; Melville and Kraemer, 2004; Wade and Hulland, 2004; Wiengarten et al., 2013).

Despite the fact that the RBV generated a great change in strategic thinking, researchers identified that companies operating in highly competitive environments presented different competitive characteristics, and their internal resources did not have the necessary dynamics to achieve competitive advantage in these environments, mainly with the development of IT capabilities (Chen et al., 2014).

A new dynamic capability-based view theory of strategy (Eisenhardt and Martin, 2000; Teece, 2007, 2018; Teece et al., 1997) discusses the need for companies to develop these capabilities, enabling them to realize business opportunities, reconfigure their resources, and take advantage of them in anticipation of external competitive movements.

In order for the organization to reach a level of sustainable competitive advantage, its ability to react to market changes is essential (A. S. Bharadwaj, 2000; Weill et al., 2002); consequently, the IT capacity, becomes the central point of the organization as it enables the agility of business processes (Tallon, 2008).

In this context, Bharadwaj et al. (2013, p. 1) define a digital business strategy (DBS) as a rethink on the role of IT strategy: "*from that of a functional-level strategy — aligned but essentially always subordinate to business strategy — to one that reflects a fusion between IT strategy and business strategy. This fusion is herein termed digital business strategy."* They argue that in an environment of intense digital competition, organizations operate in intricate business situations and a digital strategy should not be conceived independently of factors such as the ecosystem, alliances, partnerships, and competitors. Business strategy and IT strategy cannot be dissociated, giving rise to a DBS (A. Bharadwaj et al., 2013).

A DBS, capable of digitally transforming the organization, allows the appropriation of technical value to achieve a business competitive advantage (Chae et al., 2018; Weill et al., 1994, 2002), mainly in competitive and rapidly changing environments (Eisenhardt and Martin, 2000; Teece, 2018). It encompasses the digitization of products and services along with the data that surrounds them (A. Bharadwaj et al., 2013).

2.2. Digital maturity

In the field of IS, researchers seek philosophical and scientific models to assess how IT is changing the world (Markus and Rowe, 2018). In the strategic and competitive field of organizations, DT is at the center of debates on strategy (Albukhitan, 2020; Chanias et al., 2019a; Fischer et al., 2020; Heredia et al., 2020; Holotiuk and Beimborn, 2017), relationship and value delivery to customers (Fernández-Rovira et al., 2021; Jain et al., 2021; Matarazzo et al., 2021), innovation (Hadjielias et al., 2021), and change in business models (Berman, 2012; Hinterhuber and Nilles, 2021).

Vial (2019, p. 2) argues that "*the scale, the scope, as well as the speed associated with the* DT *phenomenon call for research to consider DT as an evolution of the IT-enabled transformation phenomenon.*" To understand this context, it is important to precisely define DT, DM, and digital technology. Different terms should be used appropriately in every context.

Vial (2019, p. 1) defines DT as "*a process that aims at improving an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies.*" According to Singh et al. (2020, p. 1-2), an organization undertaking a DT uses "n*ew digital technologies such as* *social media, mobile access, analytics or embedded devices to enable major business improvements like enhancing customer experience, streamlining operations or creating new business models.*" Differently, Rossman (2018, p. 3) structures DM as "*the degree of adoption and application of digital technologies in corporate business models.*" Moreover, companies with a fine management of digital technology also have the best financial returns (M. Fitzgerald et al., 2013).

DT has been transforming the foundations of academic and professional fields of studies, in all areas of knowledge. Scientific studies assess the impact of this phenomenon in the social (Baptista et al., 2020; Conrad et al., 2020; Diller et al., 2020; Locsin et al., 2021; Solberg et al., 2020), political and governmental (da Silva Neto and Chiarini, 2021; Gong et al., 2020; Matthess and Kunkel, 2020; Senyo et al., 2021), environmental (Haftor and Climent, 2021), and health fields (Fletcher and Griffiths, 2020; Iivari et al., 2020; kesharwani and Tomar, 2021; Kiselicki et al., 2020; Spencer, 2021; Wilson, 2020).

Specialized professional consultancies highlight two paths in the DT of organizations: either it becomes a digital predator or a digital prey (Fenwick, 2015).Organizations that do not have a strategy to enhance their business and products with digital technology are losing their competitive advantage. Incumbent organizations ("*These are firms who have been traditionally operating in an industry for a long time with well-established business models, organization structures, and resource control structures.*" (Sambamurthy and Zmud, 2017, p. 24)) embracing DT (Chanias et al., 2019a; Sebastian et al., 2017) must position themselves between changing their value proposition and identity and improving existing business models, which can be enabled by the adoption of digital technologies (Wessel et al., 2021).

Studies are carried out in different sectors of the economy, such as industry (Erdős et al., 2020; Klippert et al., 2020; Kunkel and Matthess, 2020; Schumacher et al., 2020), financial services (Chanias et al., 2019b; Filotto et al., 2021; Ruault, 2020; Toucinho, 2020), health (Hermes et al., 2020; Kraus et al., 2021), automotive (Llopis-Albert et al., 2021), and manufacturing (Albukhitan, 2020; Zapata et al., 2020). These sectors invest heavily in technological capabilities to stand out in their markets and achieve their dreamed competitive advantage.

Nevertheless, small and medium-sized enterprises stand out with the possibility of radical changes in all business segments and appear as new entrants, increasing the competitiveness of the sectors (Heredia et al., 2020; Stich et al., 2020; Szopa and Cyplik, 2020). For nearly a decade, it has been said in the market that every company would be a software company (Kirkpatrick, 2011). However, it is not uncommon today to hear that "every company is a technology company" (Duffy, 2019).

To establish the best DBS, it is imperative that organizations are able to assess their DM, understand the barriers they are susceptible to, and determine which enablers should be leveraged and prioritized. Westerman et al. (2014) present evidence that companies with a greater DM have better organizational performance and state that companies dominating the digital aspects (digital masters) exist but are still rare.

Defining an organization's DM is a new and indispensable challenge to improve competitive advantage in an increasingly digital world, given that companies need to assess their and competitors' levels of maturity (Thordsen et al., 2020). Consultancies structure frameworks and scales in different aspects and dimensions (Catlin et al., 2013; Google, 2019) in an attempt to classify organizations and compare them.

Rossmann (2018) explains that a company reaches an adequate level of DM when it dominates certain organizational capabilities in eight different dimensions: strategy, business, technology, leadership, governance, human resources, operational expertise, and cultural expertise. It is not enough to master a digital technology; it is also necessary to apply it to business, with a strategic vision and adequate organizational culture, keeping it operational with quality and governance (Lunardi et al., 2017) and establishing a continuous cycle of improvement (B. Fitzgerald and Stol, 2014; Pang and Hindle, 2017).

This study seeks to assess the DM of organizations, using it as a base for measuring their ability to adopt digital technology in promoting DT. It aims to correlate the enabling factors and barriers: DevOps and digital debt, to an organization's DM to prove that they directly affect DT.

2.3. DevOps as enabler of digital transformation

The term DevOps is an acronym that combines the terms IT development and IT operations (Diel et al., 2016). The processes that are important for the delivery of digital products and for the software delivery life cycle (SDLC)have been historically treated separately (Cogo, 2019). The term first appeared in 2009 at the *Velocity* event, where Flickr presented a lecture titled "10+ Deploys Per Day: Dev and Ops Cooperation at Flickr." The idea of having a delivery mat capable of performing more than ten application deploys and still guarantee the quality of a software was completely new and disruptive. One of its spectators, Patrick Debois, promoted an event called "DevOps Day" in the same year (Mezak, 2018).

In the lifecycle of software or digital products, the profiles and objectives of the development teams (IT development) and systems administrators (IT operations) are diametrically opposite. Developers have the role and function of delivering value to the business in the shortest possible time, which is reflected in the delivery of new features, integrations, designs, etc. In contrast, system administrators are primarily responsible for preserving the business value, preventing outages, and ensuring the availability, stability, and service level agreements of the product. Changes (IT change management) in the environment generate new risks to this stability, which increases the friction between these two worlds. The greater the pace of change, the greater the risk to product/service stability.

Wiedemann et al. (2020) describe the ability of DevOps to work with operational alignment mechanisms or Intra-IT alignment. These mechanisms are divided into a tripartite model: individual componentization of the service architecture using microservices techniques to favor the simultaneous working of multiple teams; integrated responsibility between teams, which generates collective accountability in managing all SDLC tasks; and multidisciplinary knowledge that appropriates, deepens, and distributes skills and knowledge in all SDLC processes.

The speed imposed by the DT of organizations requires an increasingly faster and more agile value delivery process, with higher service levels. As an example, in October 2021, *Facebook* experienced a downtime of its services because of an outage during a change, which left *WhatsApp*, *Instagram,* and *Facebook,* among others, down for more than 6 hours worldwide. Users around the world reported problems in their businesses, inoperative communications, and general dissatisfaction, leading to the consideration of alternative means of communication for companies, as well as a debate on the hegemony of social networking services. The company's shares fell by 4.9%, while its founder, Mark Zuckerberg, lost more than $6 billion (Isaac and Frenkel, 2021; Lawler and Heath, 2021; Taylor, 2021).

Classic waterfall organizations lack the capabilities required to face the challenges of digital market environments (Fuchs and Hess, 2018; Kane et al., 2017). Organizations need to adapt to achieve a high rate of DM by developing a DBS, adopting systemic changes in how they organize and develop workforces and workplaces, and supporting and expanding small digital experiments (Kane et al., 2017). DevOps fits well into an organization's DT process, providing the agility and speed required for a rapid change while also fostering digital mindsets and experimentation (Overby, 2021).

DevOps is not only an internal alignment process or project management methodology (Banica et al., 2017); it also works with management practices (Agile processes, Lean management), culture (cooperation, response to failures, innovation, and bridging), and technology factors (cloud computing and automation), which directly impact the delivery approach of digital products and, in turn, the organization's results (Cogo, 2019).

DevOps also directly affects team satisfaction, reduces risks, and improves the team working conditions (Hemon-Hildgen et al., 2020). Acting on the work environment as a whole, these practices allow the implementation of a continuous model of digital product delivery, its maintenance (Pang and Hindle, 2017), and evolution (Vassallo et al., 2017). Organizations that are mature in DevOps are potentially better in the adoption of digital technology, and consequently, more disposed to reach higher rates of DM (Dieffenbacher, 2022; Hansen, 2021; Kane et al., 2017; A. Singh and Hess, 2017; Sogeti Labs, 2019). This work seeks to explore and test the hypothesis that DevOps has a positive relationship with the DM of organizations by acting as an enabler of DT.

Hypothesis 1(H1) – DevOps has a positive relationship with the DM of organizations.

2.4. Digital debt as barrier to digital transformation

The term digital debt, in the field of IS, is not yet consolidated. Rolland et al. (2018, p.4) define digital debt as "*a reflection of the accumulation of technical and information obligations of an organization, related to the maintenance and evolution capacity of its platform and infrastructure.*" In contrast, articles in technical journals define digital debt as deficits in technological capabilities and software assets (Kapur, 2019).

In our study, we designate digital debt in a business and competitive context as a technological capability deficit in an organization's technical portfolio that restricts its ability to perceive, seize, and transform business opportunities (Kapur, 2019; Nyati, 2020; Polites and Karahanna, 2012; Rolland et al., 2018; Shaw, 2002; Woodard et al., 2013).

Digital debt comes from systems in a phase of discontinuity, technological obsolescence, or TD itself.

Digital debt is not only related to operational issues. By affecting an organization's ability to establish a configurable digital infrastructure (Rolland et al., 2018), it restricts its design options (Woodard et al., 2013) and affects its ability to deliver competitive advantages to its customers, causing abandonment of its solutions (Benbasat and Barki, 2007; Turel, 2015; Wu and Lu, 2013; Xu et al., 2014). Digital debt acts as a barrier to achieving the capabilities needed for the organization's DT.

Next, we will review the literature on phenomena related to TD and IS discontinuance, structuring a correlation between them. We will also propose a test of the positive relationship hypothesis and the hypothesis that companies that work on their digital debt have a greater DM.

2.4.1. Technical debt

Competition in the digitization age also pressurizes companies to have a constant and fast value delivery cycle, especially when it comes to creating digital products. In this scenario, important decisions must be made, especially in the classic paradigm of quality, budget, and time (Ciancarini and Russo, 2020). In many cases, a delivery with a sub-optimal technical solution is performed, and a TD is generated. This TD, however, adds a future cost to solution design. In economic/financial terms, the costs of its correction may increase (interest) (Ampatzoglou et al., 2020) with the development of a solution that includes new designs and functionalities (Ampatzoglou et al., 2015).

Scientific literature approaches the themes on different fronts. TD has been studied in terms of its impact on organizational performance (Banker et al., 2021), product quality (Kolahdouz-Rahimi et al., 2020), prioritization, classification, and management models (Farias et al., 2020; Lenarduzzi et al., 2021; Martini et al., 2014; Ramasubbu and Kemerer, 2014). Furthermore, the impact on productivity (Besker et al., 2019) and morale of developments teams without a timely consideration of TD is also studied (Besker et al., 2020).

Recent studies demonstrate that TD is not only related to software codes but is also associated with different stages of the digital product lifecycle (Yli-Huumo et al., 2016). Sub-optimal technical deliverables are related to the requirements (Brown et al., 2010), design (Zazworka, Seaman, et al., 2011; Zazworka, Shaw, et al., 2011), architecture (Besker et al., 2018a; MacCormack and Sturtevant, 2016; Nord et al., 2012), testing (Brown et al., 2010; Mensah et al., 2018), and documentation phases (Kruchten et al., 2012).

Parker et al. (2017) demonstrate the fundamental role of development teams in the transforming organizational capacity and how large technology companies (Apple, Google, and Microsoft) used platforms for developers to leverage their strategy. The literature also correlates TD with its impact on the morale of the development team (Besker et al., 2020), the potential to cripple its productivity, and the delivery ability of an organization (Besker et al., 2018b, 2019).

Architectural technical debt (ATD), in particular, has been the object of study and is related to recurrent crises in productive environments. The accumulation of ATD occurs up to the trigger point of a crisis, where the business value of the solution is lost. Emergency processes are instituted so that ATD is paid as a priority. After the ATD correction, a new delivery cycle begins (Martini et al., 2014).

In a strategic approach, Woodard et al. (2013) propose that a digital organization holds a certain design capital, depending on the number of design options in its portfolio. This capital, in turn, depreciates in accordance with the accumulated TD. The organization's capacity to act may be constrained based on the amount of its accumulated TD. When the accumulation depreciates most of its portfolio of design options, the company is classified as debt-constrained or of poor quality. This approach positions TD as a barrier to the establishment of dynamic capabilities needed to reach sustainable competitive differential levels; however, measuring the level of TD of an organization is not simple (Lim et al., 2012).

It is essential that the company builds situational awareness (Besker et al., 2018a) of the level of TD it has and establishes a method for continuous monitoring (Martini et al., 2018) in order to take the necessary management actions (Besker et al., 2018a; Yli-Huumo et al., 2016). TD must be prioritized and managed using appropriate tools, processes, and strategies (Lenarduzzi et al., 2021).

Some specialist vehicles compare organizations drowning in TD to a Ponzi scheme (Berent-Spillson, 2019). In a traditional Ponzi scheme, new incoming capital is not used for investment but to pay off old debts. The scheme is maintained if there are new entrants to the business; however, eventually, several investors will demand their money back at the same time, and the scheme will collapse because the capital has already been spent.

Although the literature structures the impacts and management models of TD, a study on its relationship with the organization’s DM is essential for its prioritization and management.

2.4.2. Information systems discontinuance

The literature presents several studies related to the IS life cycle, mainly about its adoption, implementation, and use. However, the literature lacks analyses on the end of its life cycle and the complex decisions to be taken by managers when their systems are replaced, discontinued, or withdrawn (Furneaux and Wade, 2010; Soliman and Rinta-Kahila, 2020).

Discontinuing core systems affects the organization's productivity, constrains its internal capabilities, and increases maintenance and support costs. The systems in discontinuance do not fully meet the organization’s needs and do not follow a natural evolution of their processes, and their replacement entails a high risk that requires the participation of the highest level of executives in the organization to monitor its progress and strategy (McConnell and Walker, 2019).

User acceptance models for IS are well stablished in scientific literature (Schwarz and Chin, 2007; Van Der Heijden, 2004) and while executives are highly concerned with increasing satisfaction, retention, and reducing customer churn in their systems (Khan et al., 2015), some studies point that modern technologies and new IS may lead to customers switching services (Fan and Suh, 2014; Hoxmeier and Dicesare, 2000; Recker, 2006).

The systems discontinuance process, in many cases, can be reflected in complex decision-making and can translate into barriers to the organization’s DT Forces of change can lead to several challenges for an organization, such as deficiencies in system capacity, reliability, availability of support, and cost of that support. In contrast, the investments made in the systems and their technical integration exert a continuity inertia. These opposing forces influence managers’ decisions on system replacements (Furneaux and Wade, 2011).

The process of IS discontinuance can manifest in five different forms: rejection, regressive discontinuance, quitting, temporary discontinuance, and replacement (Soliman and Rinta-Kahila, 2020). Replacement is a particular and special form of discontinuance, consisting of different processes that include discontinuing incumbent IS and adopting alternative IS (Soliman and Rinta-Kahila, 2020).

Despite a significant effort in the scientific literature to assess the psychological and behavioral factors related to the discontinuity of systems by users and organizations, there is still a shortage of studies on technical factors that motivate this phase of the IS life cycle (Shaw, 2002).

The concept of obsolescence is generally linked to the concepts of technological progress (change, improvement, development, evolution, and technological advancement), and the term technological obsolescence is still vaguely defined, bringing out the idea of obsolete or out-of-date technologies (Mellal, 2020). However, this term is not used extensively in IS studies to describe parts or pieces of hardware (Solomon et al., 2000), but heavily used in the military context to describe military assets at a lower level than those of the potential enemies (planes, tanks, radar, communications, etc.) (Pantano et al., 2013; Sandborn, 2013; P. Singh and Sandborn, 2006).

Furneaux and Wade (2017) present an interesting view on the subject. They argue that digital innovation and new product development processes promote rapid aging of existing systems, which no longer reflect the state-of-the-art technology. The rapid changes that occur during the DT give rise to an interesting phenomenon: even when products are found to be functionally adequate, they are obsolete in terms of technology (Furneaux and Wade, 2017). This process increases support costs, when available, and technological complexity, resulting in a loss of service quality.

Specialized journals already identify legacy systems as barriers to the DT of organizations (Nyati, 2020), and the literature, although still in development, recommends obsolescence risk management (Pantano et al., 2013; P. Singh and Sandborn, 2006) and an early analysis of technological obsolescence in design processes (Boikos, 2020; Brock et al., 2019; Brooke, 2000). This ongoing process of obsolescence tends to impact the level of acceptance of products and services, forcing users to change providers.

This study intends to evaluate the hypothesis that TD has a positive correlation with IS discontinuance, which can be translated as a barrier to the DT of organizations. The better the management of TD, the better the management of obsolete IS.

Hypothesis 2(H2) – There is a positive relationship between TD and IS discontinuance.

Another hypothesis highlighted is that digital debt, considered in this study as a combination of TD and IS discontinuance, has a negative correlation with the DM of an organization. The higher the organization's digital debt, the lower its DM; conversely, the better the organization's digital debt management, the greater its DM.

Hypothesis 3(H3) – Digital debt has a negative correlation with the DM of organizations or digital debt management has a positive correlation with the DM of organizations.

Finally, the study aims at testing the hypothesis that DevOps has a negative relationship with the organization's digital debt. In other words, the greater the adoption of DevOps, the better the management of the organization's digital debt will be. DevOps, in addition to acting as an enabler of DT, also contributes to minimizing the effects of the barrier caused by digital debt.

Kim et al. (2013) define four types of IT work: business initiatives; internal IT projects, mostly when infrastructure and IT operations teams are building new environments or automating processes; changes and updates, often generated from the two previous types of work; and unplanned work such as outages, problems, and crises generated by other types of work. Unplanned work impacts an organization's work-flow and forces its IT management to reallocate and reschedule IT projects (Ciancarini and Russo, 2020).

TD can be classified into different types of work, based on the maturity and awareness of an organization's IT team. Fowler (2009), in its TD quadrant, structures that the IT team, when making a technical decision, can be inadvertent (they do not know the problems) or deliberate (they know about the problems); they can also be prudent (deal with consequences later) or reckless (do not plan for future) while dealing with TD. However, TD accumulation improves the odds of outages and problems, and at some point, leads to an increase in the number of unplanned IT works (Besker et al., 2017; Leite et al., 2019).

Kim et al. (2013) also structure five ideal values and principles that surround the most important IT challenges affecting organizations: locality and simplicity; focus, flow, and joy; improvement of daily work: psychological safety; and customer focus. All these principles and values are inhered in the DevOps philosophy, and IT teams are debating how DevOps and its continuous improvement mindset can address the digital debt of organizations (Avgeriou et al., 2016; Holvitie et al., 2018; Pureur, 2022; Wiedemann and Wiesche, 2018).

Hypothesis 4(H4) – DevOps has a negative relationship with digital debt or DevOps has a positive relationship with digital debt management.

2.5. Research model

The research model was established using latent constructs established in the literature, and multiple measurement items were used to build the online survey. Table 1 presents the selected constructs, their definitions, and their references in the literature.

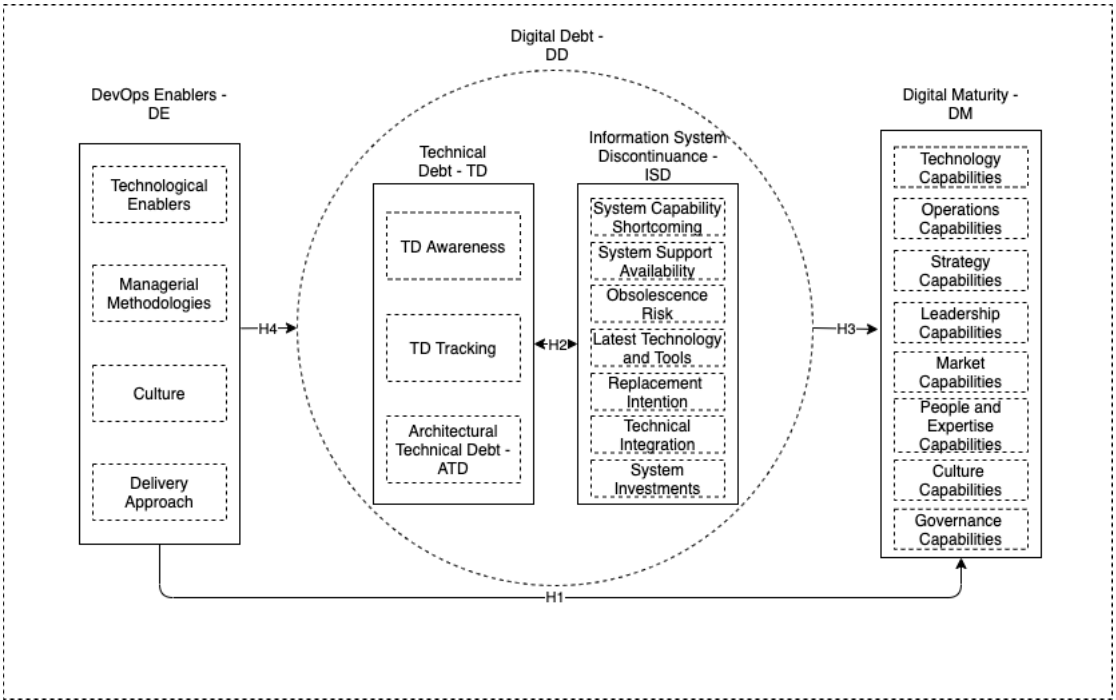

Fig. 1 Research model

Fig. 1 is a graphical view of the hypotheses presented in the previous sections and establishes the exploratory model of the relations between DevOps, digital debt, and DM based on constructs extracted from the literature and presented in Table 1.

DM will be measured according to Rossmann (2018), in a second-order construct derived from eight dimensions of organizational capabilities: strategic, leadership, market, operational, people and expertise, cultural, governance, and technology.

The constructs to measure the DevOps phenomenon were selected from the study by Cogo (2019). Technological enablers (TE), management methodologies (MM), and culture affect the delivery approach (DA) of the organization. In the structural model, DA will be correlated with the selected constructs for digital debt and DM.

For the phenomenon of digital debt, constructs of IS discontinuance, extracted from Furneaux et al. (2011) and Wittkowski et al. (2013), and TD, extracted from Martini et al. (2018) and Besker et al. (2017), were selected and adapted.

The TD is structured from management factors (TD awareness and TD tracking) and the presence of ATD. Management factors should point to a positive correlation with DM and a negative correlation with ATD to support H1.

The intention to replace an information system relies on factors that contribute to this replacement, such as the deficiencies in the existing IS (system capabilities shortcomings (SCS)) and the available support to the IS in use (system support availability(SSA)). Factors that contribute to the inertia and continuity of these systems, such as the investments already made (systems investments (SI)) and the complexity of integration with systems in discontinuance (technical integration (TI)), impact the willingness of executives to replace obsolete IS (replacement intention (RI)).

Other factors that contribute to the treatment of discontinuance of systems and even to their outsourcing include the risk of obsolescence of the organization’s IT assets (obsolescence risk (OR)) and the organization’s willingness to use new technologies (latest technology and tools (LTT)). To support H2, the SCS, IT, and OR constructs must point to a negative correlation with DM, while it is expected that the SSA, SI, LTT, and RI constructs will point to a positive correlation.

Table 1. Survey research constructs and definitions

Phenomenon	Constructs	Definition	Literature Sources
DevOps	Technological Enablers	"Refers to the composition of IT assets (e.g., software, hardware, and data). It enables IT staff to develop, diffuse, and support various system components quickly and to react to changing business conditions and corporate strategies. A firm can, therefore, use these technologies to take better advantage of existing IT resources to exercise business strategies and support necessary structural changes. Such IT capability becomes an asset for an organization in sustaining competitive advantages in the marketplace." Technological enablers are a second-order construct composed of the automation and cloud computing dimensions.	(Cogo, 2019)
	Managerial Methodologies	"The collection of IT processes in areas of planning, decision-making, coordination, and control. The management factor is the IT staff's ability to manage resources to transform them into business value at an organization." Managerial methodologies are a second-order construct composed of the Lean management and Agile management dimensions.	
	Culture	"In organizational settings, corporate values form the foundation of corporate culture and provide a basis for appropriate behavior. There is a tight linkage between cultural values and the subsequent behaviors and actions of social groups. In this sense, values can be seen as a set of social interaction through which people act and communicate. The study of organizational values may be particularly useful in explaining certain behaviors with respect to how social groups interact with and apply IT in organizational contexts." Culture is a second-order construct composed of the bridging, cooperation, fail, and innovation dimensions.	
	Delivery Approach	"It is the translation of the previous three factors (Technology, Management, and Culture) into the results we see coming from the IT department. As the other three factors represent the abstract part of how the organization works, the Delivery Approach focuses on the practical level of acting on these beliefs. The Delivery Approach is the way of showing that enabling factors such as Technology, Management, and Culture are not only thought out in a strategic level for the company but are actually a part of the operational software delivery process of the organization."	
Digital Debt	TD Awareness	The level of awareness of the technical debt in an organization's systems.	(Martini et al., 2018; Besker et al., 2017)
	TD Tracking	The level of monitoring of the technical debt present in an organization's systems.	
	ATD	The level of architectural technical debt present in the organization's systems.	
	System Capabilities Shortcoming	"Limitations in the functionality of an information system that undermine its ability to meet organizational needs."	(Furneaux et al., 2011)
	System Support Availability	"Availability of the vendor and other support capabilities considered important to the continued use of an information system."	
	Obsolescence Risk	"The risk of asset obsolescence."	(Wittkowski et al., 2013)
	Latest Technology/Tools	"The desire of the firm to use the latest technology and tools available."	
	Replacement Intention	"A belief by those who are responsible for the decision to replace an information system that the system should, in fact, be replaced."	(Furneaux et al., 2011)
	Technical Integration	"The extent to which an information system relies on Integration sophisticated linkages among component elements to deliver required capabilities."	
	System Investments	"The financial and other resources committed to the acquisition, implementation, and use of an information system."	

Table 1. Survey research constructs and definitions

Phenomenon	Constructs	Definition	Literature Sources
Digital Transformation	Digital Maturity	"The degree of adoption and application of digital technologies in corporate business models." This is a second-order construct that includes eight dimensions: strategic capability, leadership capability, market capability, operational capability, people and expertise capability, cultural capability, governance capability, and technology capability.	(Rossmann, 2018)
	Strategic Capability	"Explicitness of strategy formulation, cross-functional implementation, transformative impact, degree of evaluation"	
	Leadership Capability	"Commitment, style, role, adoption of digital strategy by executives"	
	Market Capability	"Generated customer value, relative innovativeness, degree of digitalization, implemented value co-creation"	
	Operational Capability	"Degree of agility, level of process integration, quality of resources, quality of cooperation"	
	People and Expertise Capability	"Degree of expertise, implementation of learning routines, employee adoption of digital strategy, specialization on digital assets"	
	Cultural Capability	"Level of transparency, agility, empowerment, attitude toward change"	
	Governance Capability	"Coordination mechanisms, level of alignment, measurability, target orientation"	
	Technology Capability	"Adoption and usage of technologies for data management, customer interaction, process automation, digital workplace"	

3. Research methodology

In line with the research question and work objectives, the exploratory study used a deductive research method with a quantitative approach (Creswell, 2003; Neuman, 2011). Therefore, systematic literature review procedures substantiated a research model and its hypotheses. A survey was designed and applied in order to collect the data. Data analyses were based on structural modeling techniques to test the hypotheses.

3.1. Research instrument

The research instrument was based on the constructs disseminated in scientific articles and formed in multi-item scales, as shown in Table 1. All scales were normalized to a 5-point Likert scale to reduce the respondents' "level of frustration" (Babakus and Mangold, 1992) and thus, maximize the response rate (Wilkinson and Birmingham, 2003), given that the survey instrument contains 125 response items (construct scales, control variables, and a latent variable designed to control the common method bias (CMB)).

The survey was designed to be applied online by means of the Qualtrics tool (Qualtrics, 2021) with no collection of sensitive data and maintaining the anonymity of the respondents. Initially, the participant consent form is presented, and the electronic acceptance is then collected. In order to avoid bias of the survey instrument, the blocks of DevOps, TD, IS discontinuance, and DT phenomena were presented randomly to each respondent. The blocks presented a header with the concept of each phenomenon, helping with the objective of the answers. The items were also presented randomly within each block, not following the order of the scales they represented (Wilkinson and Birmingham, 2003).

The item blocks had a blocking configuration which only allowed proceeding to the next block when all the answers were completed. This procedure was adopted to prevent missing data bias. At the end, the control questions were applied, ending the participation of the respondents.

3.2. Scale adaptation

In order to preserve the semantic value of the original research scales (available in English), the back-translation technique into Brazilian Portuguese was used (Brislin, 1970). The technique consists of the translation of the scales by an individual who is fluent in the target language, that is, in which the research will be applied. Subsequently, another individual, native in the scale's original language, performs a back translation. At this point, the original scale and the back translation are compared to assess their semantic equivalence (Brislin, 1970).

The technique was used in the selected scales with two researchers performing the compliance analysis. The compliance analysis pointed out three scales with semantic issues, which were promptly corrected. Table 2 presents the scales with semantic imperfections (original scale in English, its translation into Portuguese, the back translation, description of the semantic correction and the final scale). The other scales were considered adequate in the assessment and were included in the final research instrument, which is presented in Appendix 1.

Table 2 – Scales with semantic imperfections corrected after back-translation analysis

Identification	Original scale	Portuguese translation	Scale after back translation	Semantic correction	Final Portuguese scale
DM.TEC04	Digital technologies are the mainspring for the further development of products and services.	As tecnologias digitais são essenciais para o desenvolvimento de novos produtos e serviços.	Digital technologies are essential for the development of new products and services.	*"Further development of products and services"* has a different semantic value to *"new products and services*"	As tecnologias digitais são essenciais para o futuro desenvolviment o de produtos e serviços.
SD.LTT01	The use of the latest IT (max. 3 years old) has a significant effect on the quality of our services/products	A utilização das mais novas tecnologias de informação (máximo 3 anos de idade) afetam significativamente a qualidade dos nossos produtos/serviços.	The use of the newest information technologies (maximum 3 years of age) significantly affects the quality of our products / services.	*"3 years old"* has a different semantic value to *"3 years of age*"	A utilização das mais novas tecnologias de informação (máximo 3 anos) afetam significativamen te a qualidade dos nossos produtos/serviço s.
SD.TCI03	There is considerable technical complexity underlying this system.	Existe uma considerável complexidade técnica derivada dos sistemas em descontinuidade da nossa empresa.	There is considerable technical complexity derived from our company's discontinued systems.	The term "*underlying*" has a different semantic value to "*derived.*"	Existe uma considerável complexidade técnica subjacente aos sistemas em descontinuidade da nossa empresa.

The scales of the DevOps and IS discontinuance constructs were adapted to assertive Likert scales in short sentences. The term "this system" used in the scales of the

IS discontinuance constructs was used in the original scale to designate a system in discontinuity announced in the question header.

In the case of ATD scales, the original design introduced the research statement that guided the response to the scales. This header was transposed to the body of the scales, allowing a greater flexibility in the survey design.

For the DevOps constructs, the researcher of the original article (Cogo, 2019) was contacted and provided the original scales in Portuguese. Their collaboration with the scientific studies carried out here are acknowledged.

3.3. Data measurement and analysis

Data collection was performed through an online survey and addressed to IT professionals working in the Brazilian market using the convenience sampling method recommended by Etikan (2016) and Sekaran and Bougie (2016). In SI, it is common for scientific research to use the approach of using the individuals belonging to a particular organization as the sources of information, since they have relevant knowledge (Cogo, 2019; Ping-Ju Wu et al., 2015).

Brazil is an emerging economy, ranked as the 12th largest in the world in 2020 (World Bank, 2020), with growth forecasts in all sectors of the economy (Carvalho and Souza Jr., 2021). Calicchio and Fiorini (2020) present several business and development possibilities in Brazil, enabled by factors such as clean and cheap energy, food exports and high productivity in agribusiness, customer-centric approach, a multi-billion dollar market for innovation and startups, the reinvention of the financial market and financial services, the restructuring of infrastructure, engineering and technology talent hub, the improvement in productivity and quality of social and public services, and a new wave of Brazilian multinationals bringing innovation to the world. These factors provide the right environment for the growth of the DT phenomenon along with its barriers and enablers, as indicated by the Organization for Economic Cooperation and Development (OECD) in its studies on challenges and opportunities (OECD, 2020).

The research collected 187 cases of companies operating in different sectors of the Brazilian economy, and after processing the data, a total of 53 cases were discarded. Mostly, completely blank answers or those with the same value for all scales (straight line) were discarded, as recommended by J. Hair et al. (2017). The final sample consisted of 134 valid cases.

The sample size reached the minimum defined by Barclay et al. (1995), who established a minimum sample of 10 times the number of predictors or independent variables in the most complex regression of the structural model (The initial structural model presented 11 independent variables in the most complex regression of the model, resulting in a minimum sample size of 110 cases). The G*Power tool (Erdfelder et al., 2009) was also used for sample size analysis (Cohen, 1992), which established a minimum of 89 cases, using the *a priori* method, with the effect size parameters f^2=0.15, α err prob=0.05, Power (1-β err prob)=0.95, and number of predictors=11.

Respondents have different hierarchical profiles and roles in the IT field, with 52% being executives or managers (C-level, IT manager, development manager, systems manager, information security manager, etc.); 32% analysts, IT engineers, or specialists; and 17% in other IT functions (consultants, researchers, coordinators, etc.).

The sample distribution shows a large participation from the service sector, with 57% of the responding companies in this category, followed by government with 17%, financial services with 11%, industry with 8%, manufacturing with 3%, agribusiness with 3% and a 1% representation from the third economic sector. Most of the responding organizations are large, with 71.43% of respondents presenting a revenue of more than R$ 300 m (BNDES, 2021). In terms of number of employees, 61% have more than 3,000 employees.

Table 3 shows the comparison of respondents by company size in relation to revenue and number of employees.

Table 3 – Organization size

Revenue	%	Number of employees	%
Up to R$ 360,000	1.10%	Up to 9	1.05%
R$ 360,000 to R$ 4.8m	6.59%	10 to 19	3.16%
R$ 4.8m to R$ 300m	20.88%	20 to 49	7.37%
R$ 300m to R$ 1bn	13.19%	50 to 99	3.16%
R$ 1bn to R$ 5bn	36.26%	100 to 499	11.58%
More than R$ 5bn	21.98%	500 to 999	4.21%
		1,000 to 2,999	8.42%
		3,000 to 4,999	26.32%
		More than 5,000	34.74%

3.4. Missing data and data distribution

Missing values are natural in quantitative research (Allison, 2001; Dong and Peng, 2013). Commonly, in scientific research, missing data are treated with deletion techniques such as listwise or pairwise deletion, or by using the mean of indicators to replace the missing values. These techniques, however, in addition to reducing the sample size, tend to generate an unwanted bias in the analyses (Bovaird et al., 2007). For the treatment of missing data, first, a missing completely at random (MCAR) test was performed using IBM's SPSS software (IBM, 2020). The result was not statistically significant (χ^2=605.580, DF=561, p-value=.094), indicating that the data are MCAR and thus enabling the use of the multiple imputation technique (Guyon and Pommeret, 2011).

From this point onward, the chosen technique for the replacement of the missing data was multiple imputation. Five rounds with the regression method were applied and the mode of the results was used in the final version of the sample. Best practices, such as restriction on possible value ranges, seed fixation for process reproducibility, and result evaluation to avoid impossible combinations, were adopted (De Goeij et al., 2013; Guyon and Pommeret, 2011).

After treating the missing data, the sample distribution of research items was assessed by means of the skewness and kurtosis metrics. Two items presented sub-optimal reference values [all $|Sk| < 2$ and $|Ku| < 2$; Hair et al., (2017)] and were removed from the model (*SD.OSR01, DM.TEC04*).

3.5. Statistical technique

A structural equation model, based on partial least squares regression (PLS) and path model (PLS-PM), was selected for the research. The definition of the technique is given by factors inherent to the research and its objective (Hair et al., 2019). The first is related to the complexity of the structural model, which is composed of several constructs, indicators, and relationships; the second refers to the research objective of exploring extensions of the already established theory and its increasing complexity; finally, the sample population is restricted to the employees of Brazilian companies participating in the study.

The analysis was conducted with the initial research model using the SmartPLS tool (v. 3.3.3) (Ringle et al., 2015). All decisions to exclude items and latent variables (LVs) from the model followed the validity and reliability criteria shown in Table 4. Possible correlations not structured in the initial model were not analyzed to avoid the researcher's bias in the exploratory analysis.

3.6. Measurement model

For the measurement model, a two-step approach was adopted. This approach is recommended when first-order constructs present different numbers of indicators (Bido and Da Silva, 2019; J. Hair et al., 2017).

First-order constructs were measured, and the processes recommended by Bido and Da Silva (2019) and J. Hair et al. (2017) were followed. Evaluation rounds of discriminant validity, convergent validity, reliability, and factor loadings were carried out and the measures recommended by the authors were applied, until an adequate and valid measurement model was reached. The acceptable literature parameters used in the study are described in Table 4.

Table 4 - Reliability and validity

What to check?	What to look for in PLS?	What is acceptable?	This Research
Reliability			
Indicator Reliability	“Outer Loadings” numbers	Square each of the outer loadings to find the indicator reliability value. 0.7 or higher is preferred. If it is an exploratory research, 0.4 or higher. (Hulland, 1999)	Items between 0.7 and 0.6 were kept. Items below 0.6 were excluded from the final model.
Internal Consistency Reliability	“Reliability” numbers	Composite reliability should be 0.7 or higher. If it is an exploratory research, 0.6 or higher. (Bagozzi and Yi, 1988)	All above 0.7
Validity			
Convergent Validity	“AVE” numbers	It should be 0.5 or higher (Bagozzi and Yi, 1988)	All above 0.5
Discriminant Validity	“AVE” numbers and Latent Variable Correlations	Fornell and Larcker, (1981) suggest that the “square root” of AVE of each latent variable should be greater than the correlations among the latent variables	All above the requested threshold

After the model validation rounds, the ATD, SCS, TI, and SI constructs did not achieve the validity or reliability indices or were left with a single valid indicator and subsequently removed from the model. Tables 5 and 6 present the factor loadings of the indicators and the correlation matrix of the LVs of the final model.

Table 5 - Matrix of correlations** between latent variables (n=134)

	1	2	3	4	5	6	7	8	9	10	11
1 – TD Awareness	**0.861***										
2 - Culture	0.336	**0.908***									
3 - Delivery Approach	0.304	0.906	**0.932***								
4 - Digital Maturity	0.297	0.568	0.591	**0.859***							
5 - Latest Technology and Tools	0.128	0.249	0.241	0.361	**0.795***						
6 - Managerial Methodologies	0.227	0.791	0.810	0.534	0.193	**0.920***					
7 - Obsolescence Risk	-0.045	-0.225	-0.223	-0.181	0.023	-0.174	**0.757***				
8 - Replacement Intention	0.260	0.398	0.296	0.241	0.356	0.242	0.057	**0.822***			
9 - System Support Availability	0.169	0.315	0.354	0.249	0.269	0.239	0.033	0.312	**0.834***		
10 - Technology Enablers	0.215	0.685	0.742	0.545	0.242	0.741	-0.160	0.254	0.292	**0.859***	
11 – TD Tracking	0.737	0.389	0.399	0.391	0.096	0.327	-0.100	0.366	0.158	0.403	**0.804***
Composite Reliability	0.851	0.933	0.930	0.957	0.771	0.917	0.727	0.806	0.872	0.849	0.879
Average Variance Extracted (AVE)	0.741	0.824	0.869	0.737	0.632	0.847	0.573	0.675	0.695	0.737	0.646

* The values in the diagonal are the square root of AVE.

**All correlations are significant at 1%.

Table 6 - Matrix of factor loadings* (cross loadings) (n=134)

	Managerial Methodologies	Technology Enablers	Delivery Approach	Culture	TD Awareness	TD Tracking	Digital Maturity	Latest Technology and Tools	Obsolescence Risk	Replacement Intention	System Support Availability
Agile**	**0.915**	0.640	0.721	0.709	0.191	0.286	0.500	0.174	-0.144	0.207	0.225
Lean**	**0.925**	0.721	0.768	0.745	0.226	0.315	0.483	0.181	-0.176	0.237	0.215
Automation**	0.722	**0.891**	0.701	0.672	0.297	0.464	0.546	0.225	-0.180	0.283	0.275
Cloud Computing**	0.534	**0.825**	0.563	0.489	0.046	0.203	0.375	0.188	-0.085	0.140	0.223
Continuous Delivery**	0.735	0.624	**0.928**	0.831	0.263	0.358	0.526	0.174	-0.186	0.285	0.387
Dev and Ops Sinergy**	0.774	0.756	**0.936**	0.857	0.302	0.385	0.575	0.273	-0.229	0.268	0.276
Cooperation**	0.757	0.700	0.846	**0.912**	0.298	0.356	0.538	0.229	-0.188	0.315	0.329
Fail**	0.647	0.529	0.754	**0.881**	0.332	0.366	0.494	0.204	-0.214	0.396	0.293
Innovation**	0.743	0.629	0.860	**0.929**	0.290	0.340	0.514	0.242	-0.210	0.377	0.238
DT.AWR01	0.280	0.224	0.308	0.339	**0.895**	0.656	0.264	0.098	-0.033	0.225	0.162
DT.AWR02	0.090	0.137	0.206	0.230	**0.826**	0.613	0.248	0.126	-0.047	0.225	0.126
DT.TRK01	0.315	0.375	0.390	0.372	0.566	**0.857**	0.361	0.090	-0.039	0.297	0.182
DT.TRK02	0.277	0.369	0.319	0.315	0.567	**0.806**	0.327	0.042	-0.114	0.269	0.219
DT.TRK03	0.204	0.239	0.275	0.261	0.637	**0.752**	0.286	0.109	-0.062	0.331	-0.003
DT.TRK04	0.239	0.296	0.280	0.288	0.624	**0.796**	0.271	0.070	-0.118	0.288	0.081
Cultural Capability**	0.431	0.424	0.540	0.540	0.231	0.296	**0.840**	0.322	-0.100	0.277	0.253
Governance Capability**	0.401	0.457	0.464	0.418	0.250	0.360	**0.881**	0.254	-0.215	0.174	0.237
Leadership Capability**	0.384	0.445	0.502	0.501	0.249	0.337	**0.839**	0.435	-0.195	0.190	0.164
Market Capability**	0.508	0.478	0.441	0.447	0.220	0.297	**0.792**	0.345	-0.119	0.205	0.203
Operational Capability**	0.502	0.514	0.546	0.500	0.261	0.404	**0.867**	0.250	-0.164	0.202	0.281
People and Expertise Capability**	0.545	0.474	0.589	0.527	0.206	0.290	**0.878**	0.275	-0.158	0.131	0.207
Strategic Capability**	0.489	0.515	0.501	0.500	0.312	0.378	**0.902**	0.264	-0.190	0.249	0.150
Technology Capability**	0.402	0.435	0.458	0.455	0.320	0.323	**0.866**	0.330	-0.097	0.233	0.219
SD.LTT01	0.129	0.205	0.075	0.098	0.183	0.107	0.237	**0.666**	0.118	0.241	0.100
SD.LTT02	0.175	0.194	0.267	0.264	0.061	0.062	0.329	**0.906**	-0.037	0.320	0.288
SD.OSR02	-0.076	-0.067	-0.151	-0.168	0.002	-0.018	-0.109	0.101	**0.678**	0.080	-0.057
SD.OSR03	-0.176	-0.164	-0.185	-0.174	-0.063	-0.121	-0.160	-0.045	**0.829**	0.016	0.088
SD.REI02	0.223	0.234	0.228	0.307	0.129	0.209	0.172	0.323	0.045	**0.787**	0.302
SD.REI03	0.179	0.189	0.258	0.345	0.286	0.380	0.221	0.268	0.049	**0.855**	0.219
SD.SSA01	0.186	0.263	0.297	0.280	0.168	0.134	0.165	0.243	-0.012	0.284	**0.822**
SD.SSA02	0.175	0.285	0.333	0.242	0.151	0.158	0.248	0.307	0.055	0.259	**0.877**
SD.SSA03	0.246	0.173	0.247	0.274	0.102	0.098	0.204	0.100	0.035	0.240	**0.802**

*All factor loadings are significant at 1%; ** First-order constructs.

3.7. Control variables and common method bias

As research control, variables collected from respondents during the application of the online survey were defined *a priori*: size of the organization by number of employees, size of the organization by revenue, sector of the economy where the organization operates, and the role occupied by the respondent in the organization. None of the control variables were statistically significant (p-value > 0.05) when correlated to the model's LV, except for the size of the organization by number of employees in relation to the TD Awareness (Size_Employee -> Awareness, $\beta = 0.228$, p-value = 0.029). The test was performed with all LVs, both exogenous and endogenous.

A measured latent marker variable (MLMV) was used as a technique to control the CMB (Podsakoff et al., 2003, 2012), which occurs when there are variations in the responses resulting from the research instrument, rather than from the real predispositions of respondents (Chin et al., 2013). The instrument can introduce bias in variances that will be subsequently analyzed, and in this case, the research can present distortions that must be addressed.

To assess the possible distortions of the CMB, the MLMV was added to the investigation (Yoshikuni and Albertin, 2020), with the intention of having the lowest possible correlation with the measured model.

Table 7 - Measurement models and CMB control

	Model 1		Model 2 (MLMV)		Difference	
Structural relation	**β**	**R^2**	**β**	**R^2**	**$\beta(1) - \beta(2)$**	**$R^2(1) - R^2(2)$**
Latest Technology and Tools -> Digital Maturity	0.253		0.222		0.031	
Tracking -> Digital Maturity	0.215	0.404	0.223	0.434	-0.008	-0.030
Delivery Approach -> Digital Maturity	0.449		0.416		0.033	
Delivery Approach -> Awareness	0.304	0.085	0.289	0.081	0.015	0.004
Delivery Approach -> Latest Technology and Tools	0.241	0.051	0.182	0.081	0.059	-0.030
Delivery Approach -> Obsolescence Risk	-0.223	0.042	-0.155	0.086	-0.068	-0.044
Delivery Approach -> Replacement Intention	0.296	0.081	0.239	0.118	0.057	-0.037
Delivery Approach -> System Support Availability	0.354	0.119	0.338	0.12	0.016	-0.001
Delivery Approach -> Tracking	0.399	0.153	0.383	0.149	0.016	0.004
Culture -> Delivery Approach	0.664		0.654		0.01	
Managerial Methodologies -> Delivery Approach	0.160	0.853	0.157	0.857	0.003	-0.004
Technology Enablers -> Delivery Approach	0.169		0.174		-0.005	

Legend: β = structural coefficient; R^2 = square root of AVE; MLMV - measured latent marker variable

Table 8 presents the MLMV included in the model to estimate and remove the CMB effect. In Model 2, it is added as explained in Chin et al. (2013), and the results presented are the standardized structural coefficients after removing the CMB effect. The R^2 values and the difference between the models were also added.

3.8. Results of the structural model

To examine the hypotheses defined in the study, the structural model was analyzed with PLS-PM. As recommended in the two-step approach, the first-order constructs calculated in the measurement model were transformed into indicators, and the structural model was then analyzed. A bootstrap analysis with 10,000 iterations was performed and the structural model presented the results of the effect size coefficient (f^2), correlation coefficient (ϭ), and structural coefficient (R^2) along with the standard deviations, t-values, and p-values. The model's degree of prediction (Q^2) was generated from a blindfold test. All results can be observed in Table 7.

Table 8 - (a) Structural model results (n=134)

Structural relation	Structural coefficient (ϐ)	Hypothesis	R^2 adjusted	f^2	Q^2	VIF*	Sample mean	Standard error	t-value	p-value **
Latest Technology and Tools -> Digital Maturity	0.253	H3(+)	0.404	0.094	0.310	1.215	0.259	0.087	2.904	0.004
TD Tracking -> Digital Maturity	0.215			0.032		2.551	0.216	0.103	2.091	0.037
Delivery Approach -> Digital Maturity	0.449	H1(+)		0.247		1.445	0.447	0.106	4.227	0.000
Delivery Approach -> TD Awareness	0.304	H4(+)	0.085	0.102	0.060	1.000	0.310	0.083	3.670	0.000
Delivery Approach -> Latest Technology and Tools	0.241		0.051	0.062	0.015	1.000	0.247	0.102	2.369	0.018
Delivery Approach -> Obsolescence Risk	-0.223		0.042	0.052	0.018	1.000	-0.236	0.086	2.601	0.009
Delivery Approach -> Replacement Intention	0.296		0.081	0.096	0.045	1.000	0.303	0.083	3.555	0.000
Delivery Approach -> System Support Availability	0.354		0.119	0.143	0.077	1.000	0.362	0.074	4.780	0.000
Delivery Approach -> TD Tracking	0.399		0.153	0.189	0.096	1.000	0.407	0.079	5.077	0.000
Culture -> Delivery Approach	0.664	-	0.853	1.081	0.732	2.834	0.661	0.061	10.814	0.000
Managerial Methodologies -> Delivery Approach	0.160			0.054		3.332	0.160	0.069	2.330	0.020
Technology Enablers -> Delivery Approach	0.169			0.084		2.355	0.172	0.054	3.151	0.002

* VIF < 5 indicates no critical levels of collinearity; ideally, VIF should be close to 3 or lower (Hair et al., 2017).
** p-values estimated by bootstrapping with 10,000 repetitions.
Legend: f^2 = effect size of Cohen (1988); VIF = variance inflation factor; ϐ = structural coefficient; R^2 = square root of AVE.

Table 8 - (b) Latent variables correlation

Structural relation	Structural coefficient	Hypothesis	Sample mean	Standard error	t-value	p-value
Replacement Intention -> TD Awareness	0.260	H2(+)	0.260	0.084	3.093	0.002
TD Tracking -> Replacement Intention	0.366		0.366	0.080	4.595	0.000

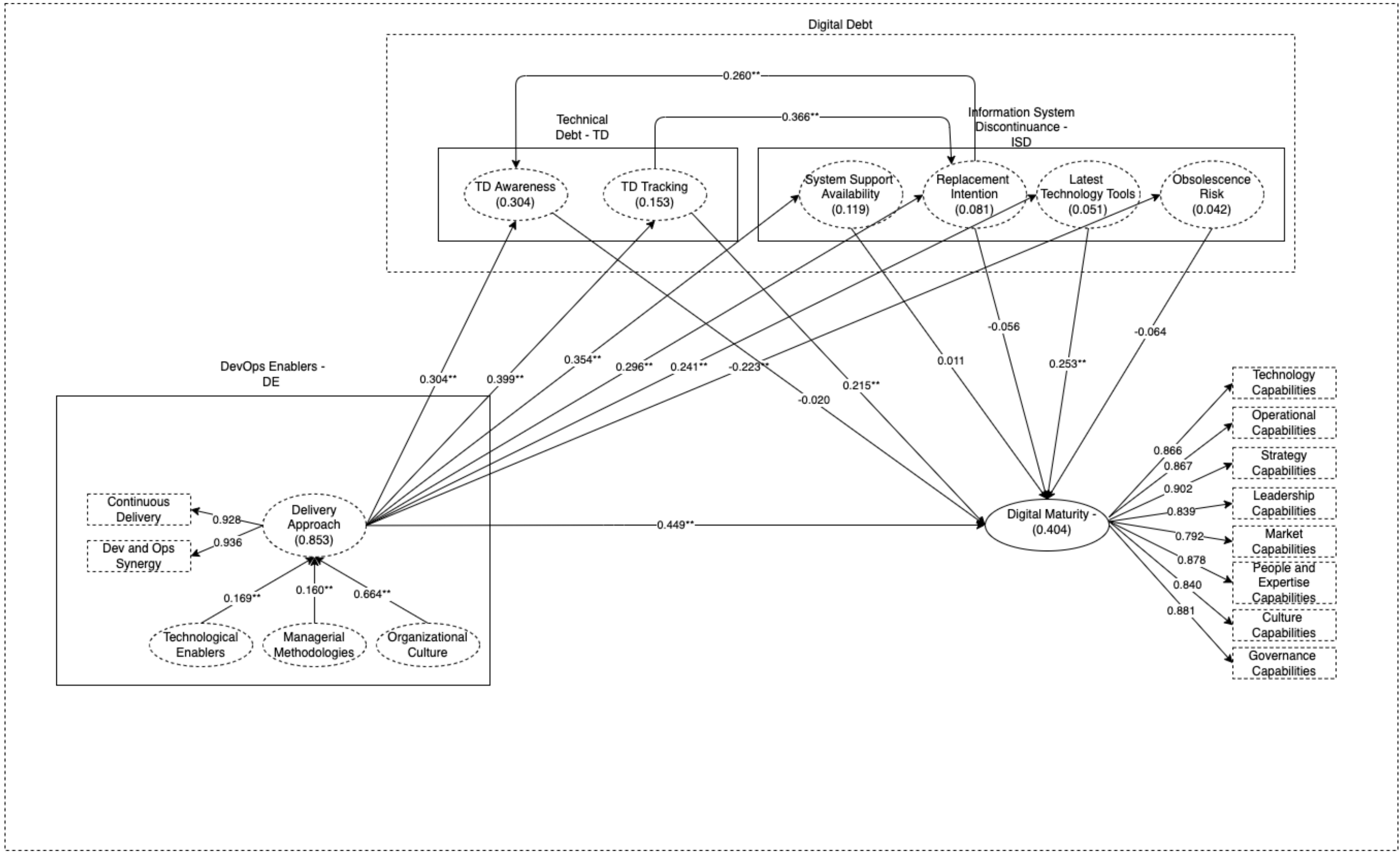

Fig. 2 Research model formatted with SmartPLS tool

4. Discussion and conclusions

The results of the final research model provide important evidence and insights for organizations seeking high levels of DM. In 2018, McKinsey and Company conducted a survey on DT projects in organizations; only 16% of its respondents reported that DT projects successfully improved performance. Moreover, the survey presented that success rates differed by company size: organizations with fewer than 100 employees were 2.7 times more likely to report success with DT than those with more than 50,000 employees (de la Boutetière et al., 2018).

DT in organizations is difficult to implement and sustain, and our findings show that DevOps and digital debt should be viewed as factors that, if well-managed, increase the odds of success. In our findings, organization size by number of employees was not statistically significant, except in TD awareness, implying that factors such as DevOps and digital debt impact all types of organizations (size by number of employees, size by revenue and industries).

The current study shows that DevOps and digital debt act as an enabler and barrier for DT, respectively, as we will discuss in the following four key findings.

1 – **DevOps acts as a digital transformation enabler**. The analysis of the model shows that the DA has a moderate to high effect on the DM indices of organizations, supporting the hypothesis that DevOps practices play a significant role in the DT process of organizations (Table 7).

The structural model indicates that DevOps positively influence the DM of organizations. In the model, the constructs of culture, MM, and TE act on the DA of organizations which, in turn, establish a positive correlation with the DM of the organization, supporting the H1 hypothesis.

DevOps changes the way organizations approach the SDLC and enables both IT operations and IT development teams to cooperate and align with each other (Tessem and Iden, 2008; Wiedemann et al., 2020), obtaining gains in productivity (Silva et al., 2018) and quality (Mishra and Otaiwi, 2020). DM represents a systematic approach as an organization digitally transforms its business model (Teichert, 2019), and DevOps enhances the digital delivery capability of the organization, creating an automated continuum delivery approach for digital products.

The changes, enabled by technological, managerial, and cultural factors, affects the IT outcomes (Cogo, 2019) and more, as we can see from our research model (Fig. 3). This improve the odds of success (Bughin et al., 2019) by enhancing the DM of the company and helps the organization become a digital master; they are 26% more profitable than their competitors and can generate 9% higher revenue from their physical assets (Mugge et al., 2020).

Eisenhardt and Martin (2000) identified product development as one of the main processes that create value in a company because it leads the organization's resources to operate in dynamic markets. Achieving agility and speed by exploiting digital technologies is the main focus of organizations that need to change their business model digitally (Li et al., 2021). DevOps can be a tool to improve the organization delivery process to achieve the speed of today's business and market agility (Accenture, 2016).

The results of this research indicate the need for organizations to prioritize DevOps culture, management, and technology practices to support a new software delivery approach. The synergy of IT development and IT operations is essential for organizations to improve their DM and business results.

2 –**TD and IS discontinuance influence each other.** Hypothesis H3 was supported by the positive correlations of the RI and TD awareness constructs and by the correlation of TD tracking with RI. Although the IS discontinuance constructs show the strongest evidence for CMB, as shown in Table 8, it is observed that the TD management constructs have an influence on an organization's intention to replace IS and a significant influence on TD monitoring strategies.

Replacement is a particular form of IS discontinuance with two main processes running in parallel: discontinuance of an incumbent IS and adoption of a new one as an alternative (Soliman and Rinta-Kahila, 2020). In many cases, this replacement is preceded by an IS migration strategy that can introduce risks (McConnell and Walker, 2019) and challenges to the organization (Gholami et al., 2017; Hainaut et al., 2008). As seen in Table 7, the intention to replace IS increases when an organization is aware of the existing TD. Furthermore, when the intention to replace IS increases, the organization increases its TD monitoring.

In a recent report based on a survey of 521 corporate IT decision makers, Outsystems, in partnership with Lucid Research, found that 69% of chief information officers believe that TD limits their company's ability to innovate, and 61% state that it significantly impacts the company's business performance. Consistent with our findings, the higher priority problems presented in this survey are turnover of IT development teams, high number of development technologies and frameworks, and outdated development technology (Outsystems and Lucid, 2021).

The growth of new technologies and features, pressures of the digital market, and low budget for eliminating outdated IS contribute to the silent accumulation of TD, which is compounded through a variety of seemingly small decisions; these may become significant issues that prevent organizations from investing resources into current activities, innovation, and future development (Berent-Spillson, n.d.; Fernández-Sánchez et al., 2017; Lenarduzzi et al., 2021; Mumtaz et al., 2021). Often, these outcomes depend on reckless or convenient decisions aimed at "delivering a product/service quickly" rather than "doing things properly" or "delivering for the future" (Outsystems and Lucid, 2021). This amount of TD impacts the quality of IS, reducing the expected lifetime and increasing the decision-making team's tendency to replace IS.

Another relevant point revealed in the results of the structural model is that the number of employees in the organization has an impact on TD awareness, which is an interesting factor for leaders and managers. Multidisciplinary teams are better able to identify and be aware of the obstacles that arise from their technical decisions, especially in a DT environment (Verhoef et al., 2021; Yli-Huumo et al., 2016). It is important to emphasize that no statistical significance was observed for the size of a company in terms of its turnover. Higher turnover does not increase the business awareness of its TD.

3 – **Digital debt acts as a barrier to digital transformation.** Barriers hinder organizations from obtaining the potential advantages of DT; when these barriers are rapidly recognized, executives can adopt countermeasures to address them (Vogelsang et al., 2019). As seen in Table 7, the H4 hypothesis was supported by the positive correlation of TD tracking and LTT constructs with the DM of the organization.

Agility and speed cannot afford reckless and misguided decisions that cause TD to grow in the organization's digital solutions portfolio (Ampatzoglou et al., 2020; Farias et al., 2020; Sierra et al., 2019). Moreover, TD is associated with significant negative impacts on future firm performance, measured as gross profit scaled by beginning-of-year total assets, and this negative association increases over time (Banker et al., 2021). In addition, Queiroz et al. (2018) argued that an organization can enhance its performance by developing the ability to refresh its application portfolio through a process of building, buying, and retiring IT application; they call it an IT application orchestration dynamic capability.

It is also important to notice that new disruptive technologies, as well as new features and technological advances, are recurrently being introduced to the market. To attain competitive advantage, the organization must achieve agility in its business processes and innovation (Tallon et al., 2019), develop the culture to search for LTT, evaluate alternatives to use non-ownership services (Wittkowski et al., 2013), and be prepared for a continuous transformation.

The accumulated digital debt directly impacts an organization's capacity for innovation and transformation (Rolland et al., 2018). It restricts the organization's technological capabilities (Yli-Huumo and Smolander, 2017), impacts the productivity of IT teams (Besker et al., 2018b, 2019), and demands management and monitoring efforts (Lenarduzzi et al., 2021; Martini et al., 2018; Yli-Huumo et al., 2016). We show that a well-managed digital debt can improve the DM of an organization, developing a state of advantage for the organization in a digital market.

4 – **DevOps reduces the barriers imposed by digital debt.** The structural model (Table 7) shows that DA has a positive correlation with digital debt management constructs such as TD awareness, TD tracking, LTT, and SSA; moreover, it has an inverse correlation with OR. This supports the H3 hypothesis.

DevOps reduces the digital debt impact on organizations, increases business awareness of TD and its monitoring, and positively contributes to the organizational adoption of the most modern technologies and tools in the market. It is a culture of change, searching for the new, transforming internal processes, and overcoming what Vial (2019) calls "corporate inertia" to create value.

The continuum characteristics of DevOps practices, such as continuous maintenance, continuous delivery, and continuous integration (B. Fitzgerald and Stol, 2014; Mikkonen et al., 2018; Pang and Hindle, 2017), change the organizational dynamics, establish a culture of change, transform, and deliver new business value. The technology OR reduces with DevOps practices as it enhances the LTT of the organization, as we can see in Table 7. This search for modern technologies contributes to the DM of the organization. Furthermore, the DA has a role in reducing the risk of obsolescence of the organization's assets, which reflects on its internal capabilities.

The new dynamics of present markets pressure organizations with new technology; even if the organization has adequate systems and software to fulfill its requirements, new technology can substantially change the way processes are executed, and create new features that increase productivity, reduce costs, and improve digital experience (Furneaux and Wade, 2017). A culture that absorbs these changes, reduces the inertia, and rapidly adapts to the new is a competitive advantage for the organization.

As a contribution to the studies in the field of IS, a final research model is highlighted. The model contributes to the exploration of three highly complex phenomena, whose correlations are based on constructs established in the literature. This model is shown in Fig. 3.

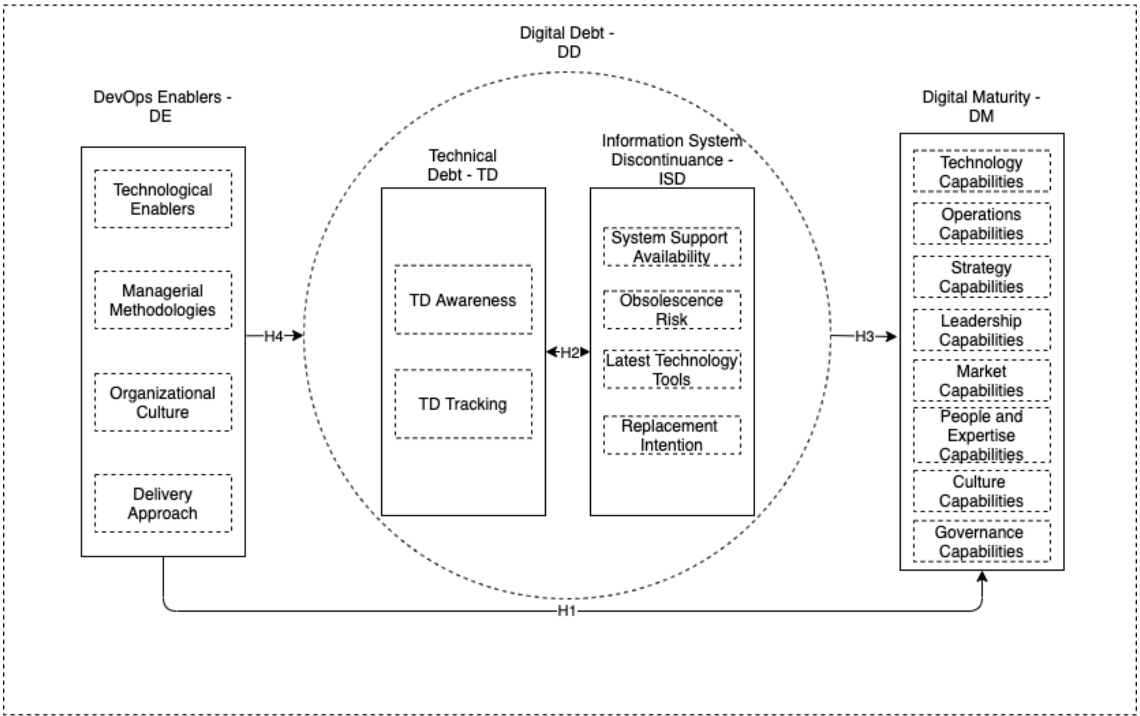

Fig. 3 Final research model

The study also starts a discussion on the concept of digital debt. Although the exploratory study focuses on an organization's technological deficiencies arising from TD and the IS discontinuance, it is natural that the concept of digital debt extends to other dimensions of the organization, such as marketing, decision-making, and user experience.

A company may present digital deficiencies when it does not adopt multiple service channels, invest in its customer relationship, or collect enough data to deliver an integrated physical and digital experience. Here, we presented a perspective focused on an internal and technical view of the phenomenon; however, new investigation approaches are welcome to further the understanding.

4.1. Limitations and future research

Despite this study presenting important insights into an organization's strategy to achieve DM, there are several limitations that will require further research. First, the exploratory analyses of the research model are based on responses from IT professionals, mostly executives and analysts. Although these respondents have certain knowledge about the companies they are working for, there is a limit to an individual's knowledge about the entire value process of the organization, especially regarding strategic factors of digital and business transformation and their correlations with the operational factors of the organization, based on its internal SDLC, TD management, and IS lifecycle. Therefore, a larger number of respondents from the same company, although with different functions, may provide a more reliable result.

Second, because of the complexity in obtaining responses from Brazilian companies, the study's data sample from important sectors of the economy such as agribusiness or industry is limited. Conducting research in countries with different levels of economic development and digital innovation can also add new insights.

A third point is the need to develop modern constructs to analyze the phenomenon of digital debt, considering DT. The study of these factors is fundamental to understanding the impact of these barriers in the new digital age of organizational competitiveness. Future studies can develop new scales for measuring digital debt in its multiple facets.

Finally, the research presents a gap in terms of the need for a longitudinal study to help organizations in the development of their skills and the reduction of barriers to DM over time.

References

Accenture. (2016). *DevOps: Delivering at the speed of today's business*. 1–8. https://www.accenture.com/t20171211T085809Z__w__/hk-en/_acnmedia/PDF-13/Accenture-DevOps-Brochure-Final.pdf#zoom=50

Albukhitan, S. (2020). Developing Digital Transformation Strategy for Manufacturing. *Procedia Computer Science*, *170*, 664–671. https://doi.org/10.1016/j.procs.2020.03.173

Allison, P. D. (2001). Missing data. In *Sage University Papers Series on Quantitative Applica- tions in the Social Sciences*. Sage. http://dx.doi.org/10.1007/978-981-10-7826-2_9

Ampatzoglou, A., Ampatzoglou, A., Chatzigeorgiou, A., & Avgeriou, P. (2015). The financial aspect of managing technical debt: A systematic literature review. *Information and Software Technology*, *64*, 52–73. https://doi.org/10.1016/j.infsof.2015.04.001

Ampatzoglou, A., Mittas, N., Tsintzira, A. A., Ampatzoglou, A., Arvanitou, E. M., Chatzigeorgiou, A., Avgeriou, P., & Angelis, L. (2020). Exploring the Relation between Technical Debt Principal and Interest: An Empirical Approach. *Information and Software Technology*, *128*(August), 106391. https://doi.org/10.1016/j.infsof.2020.106391

Avgeriou, P., Kruchten, P., Ozkaya, I., & Seaman, C. (2016). Managing Technical Debt in Software Engineering. *Dagstuhl Reports*, *6*(4), 110–138. http://www.dagstuhl.de/16162

Babakus, E., & Mangold, W. G. (1992). Adapting the Servqual Scale to a Private Hospital Emergency Services: An Empirical Investigation. *HSR: Health Services Research*, *26*(6). https://doi.org/10.17265/1537-1506/2014.05.001

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models Cite this paper. *Journal of the Academy of Marketing Science*, 74–94.

Bahaa, A., Mostafa, Y., & Mahmoud, -. (2017). Enhancing Lean Software Development by using Devops Practices. *International Journal of Advanced Computer Science and Applications*, *8*(7), 267–277. https://doi.org/10.14569/ijacsa.2017.080736

Banica, L., Radulescu, M., Rosca, D., & Hagiu, A. (2017). Is DevOps another Project Management Methodology? *Informatica Economica*, *21*(3/2017), 39–51. https://doi.org/10.12948/issn14531305/21.3.2017.04

Banker, R., Liang, Y., & Ramasubbu, N. (2021). Technical debt and firm performance. *Management Science*, *67*(5), 3174–3194. https://doi.org/10.1287/mnsc.2019.3542

Baptista, J., Stein, M. K., Klein, S., Watson-Manheim, M. B., & Lee, J. (2020). Digital work and organisational transformation: Emergent Digital/Human work configurations in modern organisations. *Journal of Strategic Information Systems*, *29*(2). https://doi.org/10.1016/j.jsis.2020.101618

Barclay, D., Thompson, R., dan Higgins, C. (1995). The Partial Least Squares (PLS) Approach to Causal Modeling: Personal Computer Adoption and Use an Illustration. *Technology Studies, 2*(2), 285–309.

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Benbasat, I., & Barki, H. (2007). Quo vadis, TAM? *Journal of the Association for Information Systems*, *8*(4), 211–218. https://doi.org/10.17705/1jais.00126

Berent-Spillson, N. (n.d.). *Drowning in technical debt? Worse: You're trapped in a Ponzi scheme | TechBeacon*. TechBeacon. Retrieved November 10, 2021, from https://techbeacon.com/app-dev-testing/drowning-technical-debt-worse-youre-

trapped-ponzi-scheme
Berent-Spillson, N. (2019, December). *Drowning in technical debt? Worse: You're trapped in a Ponzi scheme | TechBeacon*. Tech Beacon. https://techbeacon.com/devops/drowning-technical-debt-worse-youre-trapped-ponzi-scheme
Berman, S. J. (2012). Digital transformation: Opportunities to create new business models. *Strategy and Leadership*, *40*(2), 16–24. https://doi.org/10.1108/10878571211209314
Besker, T., Ghanbari, H., Martini, A., & Bosch, J. (2020). The influence of Technical Debt on software developer morale. *Journal of Systems and Software*, *167*. https://doi.org/10.1016/j.jss.2020.110586
Besker, T., Martini, A., & Bosch, J. (2017). The pricey bill of Technical Debt - When and by whom will it be paid? *Proceedings - 2017 IEEE International Conference on Software Maintenance and Evolution, ICSME 2017*, *October*, 13–23. https://doi.org/10.1109/ICSME.2017.42
Besker, T., Martini, A., & Bosch, J. (2018a). Managing architectural technical debt: A unified model and systematic literature review. *Journal of Systems and Software*, *135*, 1–16. https://doi.org/10.1016/j.jss.2017.09.025
Besker, T., Martini, A., & Bosch, J. (2018b). Technical debt cripples software developer productivity: A longitudinal study on developers' daily software development work. *Proceedings - International Conference on Software Engineering*, *June*, 105–114. https://doi.org/10.1145/3194164.3194178
Besker, T., Martini, A., & Bosch, J. (2019). Software developer productivity loss due to technical debt—A replication and extension study examining developers' development work. *Journal of Systems and Software*, *156*, 41–61. https://doi.org/10.1016/j.jss.2019.06.004
Bharadwaj, A., El Sawy, O. A., Pavlou, P. A., & Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. *MIS Quarterly: Management Information Systems*, *37*(2), 471–482. https://doi.org/10.25300/MISQ/2013/37:2.3
Bharadwaj, A. S. (2000). A resource-based perspective on information technology capability and firm performance: An empirical investigation. *MIS Quarterly: Management Information Systems*, *24*(1), 169–193. https://doi.org/10.2307/3250983
Bido, D. de S., & Da Silva, D. (2019). SmartPLS 3: especificação, estimação, avaliação e relato. *Administração: Ensino e Pesquisa*, *20*(2), 488–536. https://doi.org/10.13058/raep.2019.v20n2.1545
BNDES. (2021). *Guia do financiamento*. https://www.bndes.gov.br/wps/portal/site/home/financiamento/guia/porte-de-empresa
Boikos, S. (2020). Capital utilization, obsolescence and technological progress. *Journal of Economic Asymmetries*, *22*(May), e00170. https://doi.org/10.1016/j.jeca.2020.e00170
Bovaird, J. a, Kupzyk, K. a, Maikranz, J., Dreyer, M., & Steele, R. (2007). Missing data and standard errors with partial least squares. *115th Annual Meeting of the American Psychological Association*, 1.
Brislin, R. W. (1970). Back-Translation for Cross-Cultural Research. *Journal of CrossCultural Psychology*, *1*(185–216). https://doi.org/https://doi.org/10.1177/135910457000100301
Brock, J. M., Payne, E. R., Collopy, P. D., & Brown, O. C. (2019). Considering

obsolescence in system design. *Procedia Computer Science*, *153*, 317–324. https://doi.org/10.1016/j.procs.2019.05.085

Brooke, C. (2000). A Framework for Evaluating Organizational Choice and Process Redesign Issues. *Journal of Information Technology*, *15*(1), 17–28. https://doi.org/10.1177/026839620001500103

Brown, N., Cai, Y., Guo, Y., Kazman, R., Kim, M., Kruchten, P., Lim, E., MacCormack, A., Nord, R., Ozkaya, I., Sangwan, R., Seaman, C., Sullivan, K., & Zazworka, N. (2010). Managing technical debt in software-reliant systems. *Proceedings of the FSE/SDP Workshop on the Future of Software Engineering Research, FoSER 2010*, 47–51. https://doi.org/10.1145/1882362.1882373

Bughin, J., Deakin, J., & O'beirne, B. (2019). Digital transformation: Improving the odds of success. *McKinsey Quarterly*, *October*, 1–5.

Calicchio, N., & Fiorini, R. (2020). Brazil 2020 Opportunity Tree. *McKinsey & Company*, 231.

Carvalho, L. M. de, & Souza Jr., J. R. de C. (2021, August). *Previsões macroeconômicas | Carta de Conjuntura*. IPEA. https://www.ipea.gov.br/cartadeconjuntura/index.php/tag/previsoes-macroeconomicas/

Catlin, T., Scanlan, J., & Willmott, P. (2013). Raising your Digital Quotient. *McKinsey Quarterly*, 1–13.

Chae, H. C., Koh, C. E., & Park, K. O. (2018). Information technology capability and firm performance: Role of industry. *Information and Management*, *55*(5), 525–546. https://doi.org/10.1016/j.im.2017.10.001

Chanias, S., Myers, M. D., & Hess, T. (2019a). Digital transformation strategy making in pre-digital organizations: The case of a financial services provider. *Journal of Strategic Information Systems*, *28*(1), 17–33. https://doi.org/10.1016/j.jsis.2018.11.003

Chanias, S., Myers, M. D., & Hess, T. (2019b). Digital transformation strategy making in pre-digital organizations: The case of a financial services provider. *Journal of Strategic Information Systems*, *28*(1), 17–33. https://doi.org/10.1016/j.jsis.2018.11.003

Chen, Y., Wang, Y., Nevo, S., Jin, J., Wang, L., & Chow, W. S. (2014). IT capability and organizational performance: The roles of business process agility and environmental factors. *European Journal of Information Systems*, *23*(3), 326–342. https://doi.org/10.1057/ejis.2013.4

Chin, W. W., Thatcher, J. B., Wright, R. T., & Steel, D. (2013). Controlling for Common Method Variance in PLS Analysis: The Measured Latent Marker Variable Approach. *Springer Proceedings in Mathematics and Statistics*, *56*, 231–239. https://doi.org/10.1007/978-1-4614-8283-3_16

Ciancarini, P., & Russo, D. (2020). The Strategic Technical Debt Management Model: An Empirical Proposal. *IFIP Advances in Information and Communication Technology*, *582 IFIP*, 131–140. https://doi.org/10.1007/978-3-030-47240-5_13

Cogo, G. S. (2019). Understanding DevOps: From its Enablers to Impact on IT Performance. In *Texas Tech University* (Issue August 2019).

Cohen, J. (1992). A power primer. (power analysis) (Quantitative Methods in Psychology). *Psychological Bulletin*, *112*(1), 155.

Conrad, A., Oberc, H., Wannöffel, M., & Kuhlenkötter, B. (2020). Interdisciplinary scientific study program "digital transformation" for workers´ representatives. *Procedia Manufacturing*, *45*, 331–336. https://doi.org/10.1016/j.promfg.2020.04.026

Creswell, J. W. (2003). *Research design Qualitative quantitative and mixed methods approaches* (Sage Publications (ed.)).

Crotty, J., & Horrocks, I. (2017). Managing legacy system costs: A case study of a meta-assessment model to identify solutions in a large financial services company. *Applied Computing and Informatics*, *13*(2), 175–183. https://doi.org/10.1016/j.aci.2016.12.001

da Silva Neto, V. J., & Chiarini, T. (2021). Technological progress and political systems: Non-institutional digital platforms and political transformation. *Technology in Society*, *64*(November 2020). https://doi.org/10.1016/j.techsoc.2020.101460

De Goeij, M. C. M., Van Diepen, M., Jager, K. J., Tripepi, G., Zoccali, C., & Dekker, F. W. (2013). Multiple imputation: Dealing with missing data. *Nephrology Dialysis Transplantation*, *28*(10), 2415–2420. https://doi.org/10.1093/ndt/gft221

de la Boutetière, H., Montagner, A., & Reich, A. (2018). Unlocking success in digital transformations. *McKinsey & Company*, *October*, 1–14. https://www.mckinsey.com/business-functions/organization/our-insights/unlocking-success-in-digital-transformations

Dehning, B., & Richardson, V. J. (2002). Returns on Investments in Information Technology: A Research Synthesis. *Journal of Information Systems*, *16*(1), 7–30. https://doi.org/10.2139/ssrn.302139

Dieffenbacher, S. (2022). *What is Digital Maturity, why it matters, and how to measure it*. Digital Leadership. https://digitalleadership.com/blog/digital-maturity/#Key_Takeaways

Diel, E., Marczak, S., & Cruzes, D. S. (2016). Communication challenges and strategies in distributed DevOps. *Proceedings - 11th IEEE International Conference on Global Software Engineering, ICGSE 2016*, 24–28. https://doi.org/10.1109/ICGSE.2016.28

Diller, M., Asen, M., & Späth, T. (2020). The effects of personality traits on digital transformation: Evidence from German tax consulting. *International Journal of Accounting Information Systems*, *37*. https://doi.org/10.1016/j.accinf.2020.100455

Dong, Y., & Peng, C. Y. J. (2013). Principled missing data methods for researchers. *SpringerPlus*, *2*(1), 1–17. https://doi.org/10.1186/2193-1801-2-222

Duffy, C. (2019). *How every company could become a "tech" company*. CNN Business. https://edition.cnn.com/2019/11/10/tech/microsoft-satya-nadella-tech-transformation/index.html

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic Capabilities: What are They? *Strategic Management Journal*, *21*(10/11), 1105–1121.

Erdfelder, E., FAul, F., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods*, *41*(4), 1149–1160. https://doi.org/10.3758/BRM.41.4.1149

Erdős, G., Paniti, I., & Tipary, B. (2020). Transformation of robotic workcells to digital twins. *CIRP Annals*, *69*(1), 149–152. https://doi.org/10.1016/j.cirp.2020.03.003

Etikan, I. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1. https://doi.org/10.11648/j.ajtas.20160501.11

Fan, L., & Suh, Y. H. (2014). Why do users switch to a disruptive technology? An empirical study based on expectation-disconfirmation theory. *Information and Management*, *51*(2), 240–248. https://doi.org/10.1016/j.im.2013.12.004

Farias, M. A. de F., Neto, M. G. de M., Kalinowski, M., & Spínola, R. O. (2020). Identifying self-admitted technical debt through code comment analysis with a contextualized vocabulary. *Information and Software Technology*, *121*(January). https://doi.org/10.1016/j.infsof.2020.106270

Fenwick, N. (2015). Digital Predator Or Digital Prey? *Forrester Research, Inc*, 1–23. www.forrester.com

Fernández-Rovira, C., Álvarez Valdés, J., Molleví, G., & Nicolas-Sans, R. (2021). The digital transformation of business. Towards the datafication of the relationship with customers. *Technological Forecasting and Social Change*, *162*(September 2020). https://doi.org/10.1016/j.techfore.2020.120339

Fernández-Sánchez, C., Garbajosa, J., Yagüe, A., & Perez, J. (2017). Identification and analysis of the elements required to manage technical debt by means of a systematic mapping study. *Journal of Systems and Software*, *124*(November 2017), 22–38. https://doi.org/10.1016/j.jss.2016.10.018

Filotto, U., Caratelli, M., & Fornezza, F. (2021). Shaping the digital transformation of the retail banking industry. Empirical evidence from Italy. *European Management Journal*, *39*(3), 366–375. https://doi.org/10.1016/j.emj.2020.08.004

Fischer, M., Imgrund, F., Janiesch, C., & Winkelmann, A. (2020). Strategy archetypes for digital transformation: Defining meta objectives using business process management. *Information and Management*, *57*(5). https://doi.org/10.1016/j.im.2019.103262

Fitzgerald, B., & Stol, K. J. (2014). Continuous software engineering and beyond: Trends and challenges. *1st International Workshop on Rapid Continuous Software Engineering, RCoSE 2014 - Proceedings*, *June*, 1–9. https://doi.org/10.1145/2593812.2593813

Fitzgerald, M., Kruschwitz, N., Bonnet, D., & Welch, M. (2013). Embracing Digital Technology: A New Strategic Imperative. *MIT Sloan Management Review*, *55*(1), 1–13. https://www.capgemini-consulting.com/SMR

Fletcher, G., & Griffiths, M. (2020). Digital transformation during a lockdown. *International Journal of Information Management*, *55*(June), 10–12. https://doi.org/10.1016/j.ijinfomgt.2020.102185

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50.

Forsgren, N., & Kersten, M. (2017). DevOps metrics. *Queue*, *15*(6). https://doi.org/10.1145/3178368.3182626

Fowler, M. (2009, October 14). *Technical Debt Quadrant*. Martinfowler.Com. https://martinfowler.com/bliki/TechnicalDebtQuadrant.html

Fuchs, C., & Hess, T. (2018). Becoming agile in the digital transformation: The process of a large-scale agile transformation. *International Conference on Information Systems 2018, ICIS 2018*, *January 2019*.

Furneaux, B., & Wade, M. (2010). The End of the Information System Life: A Model of IS Discontinuance. *Data Base for Advances in Information Systems*, *41*(2), 45–69. https://doi.org/10.1145/1795377.1795381

Furneaux, B., & Wade, M. (2011). An exploration of organizational level information systems discontinuance intentions. *MIS Quarterly: Management Information Systems*, *35*(3), 573–598. https://doi.org/10.2307/23042797

Furneaux, B., & Wade, M. (2017). Impediments to Information Systems Replacement: A Calculus of Discontinuance. *Journal of Management Information Systems*, *34*(3), 902–932. https://doi.org/10.1080/07421222.2017.1373013

Gholami, M. F., Daneshgar, F., Beydoun, G., & Rabhi, F. (2017). Challenges in migrating legacy software systems to the cloud — an empirical study. *Information*

Systems, *67*, 100–113. https://doi.org/10.1016/j.is.2017.03.008

Gong, Y., Yang, J., & Shi, X. (2020). Towards a comprehensive understanding of digital transformation in government: Analysis of flexibility and enterprise architecture. *Government Information Quarterly*, *37*(3). https://doi.org/10.1016/j.giq.2020.101487

Google, M. (2019). Índice de Maturidade Digital. *Isobar Brasil*, *Imd*. http://www.abranet.org.br/doc/maturidade-digital-2019 .pdf

Guyon, E., & Pommeret, D. (2011). Imputation by PLS regression for linear mixed models. *Journal de La Société Française de Statistique*, *152*(4), 30-46–46.

Hadjielias, E., (Lola) Dada, O., Discua Cruz, A., Zekas, S., Christofi, M., & Sakka, G. (2021). How do digital innovation teams function? Understanding the team cognition-process nexus within the context of digital transformation. *Journal of Business Research*, *122*(September 2020), 373–386. https://doi.org/10.1016/j.jbusres.2020.08.045

Haftor, D. M., & Climent, R. C. (2021). CO2 reduction through digital transformation in long-haul transportation: Institutional entrepreneurship to unlock product-service system innovation. *Industrial Marketing Management*, *94*(xxxx), 115–127. https://doi.org/10.1016/j.indmarman.2020.08.022

Hainaut, J. L., Cleve, A., Henrard, J., & Hick, J. M. (2008). Migration of legacy information systems. *Software Evolution*, 105–138. https://doi.org/10.1007/978-3-540-76440-3_6

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Hair, J., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A primer on Partial Least Square Structural Equation Modeling (PLS-SEM)* (SAGE Publications (ed.); 3nd ed.).

Hansen, D. (2021). *DevOps and Digital Transformation: Now and Future*. Cio.Com. https://www.cio.com/article/189303/devops-and-digital-transformation-now-and-future.html

Hemon-Hildgen, A., Rowe, F., & Monnier-Senicourt, L. (2020). Orchestrating automation and sharing in DevOps teams: a revelatory case of job satisfaction factors, risk and work conditions. *European Journal of Information Systems*, *October*, 474–499. https://doi.org/10.1080/0960085X.2020.1782276

Henley, M. (2019, November 27). *Digital Transformation by the Numbers*. CMS WiRE. https://www.cmswire.com/digital-workplace/digital-transformation-by-the-numbers/

Heredia, J., Geldes, C., Flores, A., & Heredia, W. (2020). The new strategy to the legitimation of informal firms. The effects of the signals and biases on decisions about crowdfunding digital transformation. *Journal of Technology Management and Innovation*, *15*(4), 54–62. https://doi.org/10.4067/s0718-27242020000400054

Hermes, S., Riasanow, T., Clemons, E. K., Böhm, M., & Krcmar, H. (2020). The digital transformation of the healthcare industry: exploring the rise of emerging platform ecosystems and their influence on the role of patients. *Business Research*, *13*(3), 1033–1069. https://doi.org/10.1007/s40685-020-00125-x

Hinterhuber, A., & Nilles, M. (2021). DIGITAL transformation, the HOLY GRAIL and the disruption of business models. *Business Horizons*. https://doi.org/10.1016/j.bushor.2021.02.042

Holotiuk, F., & Beimborn, D. (2017). Critical Success Factors of Digital Business Strategy. *13th International Conference on Wirtschaftsinformatik*, 991–1005.

Holvitie, J., Licorish, S. A., Spínola, R. O., Hyrynsalmi, S., MacDonell, S. G., Mendes, T. S., Buchan, J., & Leppänen, V. (2018). Technical debt and agile software development practices and processes: An industry practitioner survey. *Information and Software Technology*, *96*(September 2016), 141–160. https://doi.org/10.1016/j.infsof.2017.11.015

Hoxmeier, J. A., & Dicesare, C. (2000). System Response Time and User Satisfaction : An Experimental Study of Browser-based Applications. *Proceedings of the Association of Information Systems Americas Conference*, *2*, 10–13. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.99.2770&rep=rep1&type=pdf

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic Management Journal*, *20*(2), 195–204. https://doi.org/10.1002/(sici)1097-0266(199902)20:2<195::aid-smj13>3.0.co;2-7

IBM, C. (2020). *IBM SPSS Statistics for Macintosh, Version 27.0*. IBM Corp.

Iivari, N., Sharma, S., & Ventä-Olkkonen, L. (2020). Digital transformation of everyday life – How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care? *International Journal of Information Management*, *55*(June). https://doi.org/10.1016/j.ijinfomgt.2020.102183

Isaac, M., & Frenkel, S. (2021). *Facebook, Instagram, WhatsApp Were Down: Here's What to Know - The New York Times*. The New York Times. https://www.nytimes.com/2021/10/04/technology/facebook-down.html

Jabbari, R., Ali, N. Bin, Petersen, K., & Tanveer, B. (2016). What is DevOps? A systematic mapping study on definitions and practices. *ACM International Conference Proceeding Series*, *24-May-201*. https://doi.org/10.1145/2962695.2962707

Jain, G., Paul, J., & Shrivastava, A. (2021). Hyper-personalization, co-creation, digital clienteling and transformation. *Journal of Business Research*, *124*(November 2020), 12–23. https://doi.org/10.1016/j.jbusres.2020.11.034

Kane, G. C., Palmer, D., Phillips, A. N., Kiron, D., & Buckley, N. (2017). Achieving Digital Maturity. *MIT Sloan Management Review*, *Summer*, 5,6. http://sloanreview.mit.edu/digital2017

Kapur, A. (2019). Is your portfolio ready for digital transformation ? *Mergers and Acquisitions*.

kesharwani, S., & Tomar, K. S. (2021). Has COVID -19 Pandemic altered the Volatility Spillover and Connectedness based on Size of Market Portfolios? *Global Journal of Enterprise Information System*, *12*(3 SE-View Point (VP)), 74–83. https://doi.org/10.18311/gjeis

Khan, M. R., Manoj, J., Singh, A., & Blumenstock, J. (2015). Behavioral Modeling for Churn Prediction: Early Indicators and Accurate Predictors of Custom Defection and Loyalty. *Proceedings - 2015 IEEE International Congress on Big Data, BigData Congress 2015*, 677–680. https://doi.org/10.1109/BigDataCongress.2015.107

Kim, G., Behr, K., & Spafford, G. (2013). The Phoenix Project: A Novel About IT, DevOps, and Helping Your Business Win. In *Journal of Chemical Information and Modeling* (Vol. 53, Issue 9).

Kirkpatrick, D. (2011). *Now Every Company Is A Software Company*. Forbes. https://www.forbes.com/sites/techonomy/2011/11/30/now-every-company-is-a-software-company/?sh=2f965e5df3b1

Kiselicki, M., Josimovski, S., Pulevska Ivanovska, L., & Kirovska, Z. (2020). Digital

Transformation of Learning Process Due To Covid-19 Crisis in the Republic of North Macedonia. *Journal of Sustainable Development (1857-8519)*, *10*(25), 53–66. http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=147898824&lang=pt-br&site=eds-live&scope=site

Klippert, M., Marthaler, F., Spadinger, M., & Albers, A. (2020). Industrie 4.0 - An empirical and literature-based study how product development is influenced by the digital transformation. *Procedia CIRP*, *91*, 80–86. https://doi.org/10.1016/j.procir.2020.02.152

Kolahdouz-Rahimi, S., Lano, K., Sharbaf, M., Karimi, M., & Alfraihi, H. (2020). A comparison of quality flaws and technical debt in model transformation specifications. *Journal of Systems and Software*, *169*, 110684. https://doi.org/10.1016/j.jss.2020.110684

Kraus, S., Schiavone, F., Pluzhnikova, A., & Invernizzi, A. C. (2021). Digital transformation in healthcare: Analyzing the current state-of-research. *Journal of Business Research*, *123*, 557–567. https://doi.org/10.1016/j.jbusres.2020.10.030

Kruchten, P., Nord, R. L., & Ozkaya, I. (2012). Technical Debt : From Metaphor. *IEEE Software*, 18–22.

Kunkel, S., & Matthess, M. (2020). Digital transformation and environmental sustainability in industry: Putting expectations in Asian and African policies into perspective. *Environmental Science and Policy*, *112*(February), 318–329. https://doi.org/10.1016/j.envsci.2020.06.022

Lawler, R., & Heath, A. (2021). *Facebook is back online after a massive outage that also took down Instagram, WhatsApp, Messenger, and Oculus - The Verge*. The Verge. https://www.theverge.com/2021/10/4/22708989/instagram-facebook-outage-messenger-whatsapp-error

Leite, L., Rocha, C., Kon, F., Milojicic, D., & Meirelles, P. (2019). A survey of DevOps concepts and challenges. *ACM Computing Surveys*, *52*(6). https://doi.org/10.1145/3359981

Lenarduzzi, V., Besker, T., Taibi, D., Martini, A., & Arcelli Fontana, F. (2021). A systematic literature review on Technical Debt prioritization: Strategies, processes, factors, and tools. *Journal of Systems and Software*, *171*, 110827. https://doi.org/10.1016/j.jss.2020.110827

Li, H., Wu, Y., Cao, D., & Wang, Y. (2021). Organizational mindfulness towards digital transformation as a prerequisite of information processing capability to achieve market agility. *Journal of Business Research*, *122*(October 2019), 700–712. https://doi.org/10.1016/j.jbusres.2019.10.036

Lim, E., Taksande, N., & Seaman, C. (2012). A balancing act: What software practitioners have to say about technical debt. *IEEE Software*, *29*(6), 22–27. https://doi.org/10.1109/MS.2012.130

Llopis-Albert, C., Rubio, F., & Valero, F. (2021). Impact of digital transformation on the automotive industry. *Technological Forecasting and Social Change*, *162*(September 2020). https://doi.org/10.1016/j.techfore.2020.120343

Locsin, R. C., Soriano, G. P., Juntasopeepun, P., Kunaviktikul, W., & Evangelista, L. S. (2021). Social transformation and social isolation of older adults: Digital technologies, nursing, healthcare. *Collegian*, *28*(5), 551–558. https://doi.org/10.1016/j.colegn.2021.01.005

Lunardi, G. L., Maçada, A. C. G., Becker, J. L., & Van Grembergen, W. (2017). Antecedents of IT governance effectiveness: An empirical examination in Brazilian firms. *Journal of Information Systems*, *31*(1), 41–57.

https://doi.org/10.2308/isys-51626
Luz, W. P., Pinto, G., & Bonifácio, R. (2018). Building a collaborative culture: A grounded theory of well succeeded devops adoption in practice. *International Symposium on Empirical Software Engineering and Measurement*. https://doi.org/10.1145/3239235.3240299
MacCormack, A., & Sturtevant, D. J. (2016). Technical debt and system architecture: The impact of coupling on defect-related activity. *Journal of Systems and Software*, *120*, 170–182. https://doi.org/10.1016/j.jss.2016.06.007
Markus, M. L., & Rowe, F. (2018). Is it changing the world? Conceptions of causality for information systems theorizing. *MIS Quarterly: Management Information Systems*, *42*(4), 1255–1280. https://doi.org/10.25300/MISQ/2018/12903
Martini, A., Besker, T., & Bosch, J. (2018). Technical Debt tracking: Current state of practice: A survey and multiple case study in 15 large organizations. *Science of Computer Programming*, *163*, 42–61. https://doi.org/10.1016/j.scico.2018.03.007
Martini, A., Bosch, J., & Chaudron, M. (2014). Architecture technical debt: Understanding causes and a qualitative model. *Proceedings - 40th Euromicro Conference Series on Software Engineering and Advanced Applications, SEAA 2014*, *September*, 85–92. https://doi.org/10.1109/SEAA.2014.65
Matarazzo, M., Penco, L., Profumo, G., & Quaglia, R. (2021). Digital transformation and customer value creation in Made in Italy SMEs: A dynamic capabilities perspective. *Journal of Business Research*, *123*(February 2020), 642–656. https://doi.org/10.1016/j.jbusres.2020.10.033
Matthess, M., & Kunkel, S. (2020). Structural change and digitalization in developing countries: Conceptually linking the two transformations. *Technology in Society*, *63*. https://doi.org/10.1016/j.techsoc.2020.101428
McConnell, P., & Walker, M. (2019). Strategic technology risk: Core systems replacement. *Journal of Risk Management in Financial Institutions*, *12*(4), 384–400.
Mellal, M. A. (2020). Obsolescence – A review of the literature. *Technology in Society*, *63*(April), 101347. https://doi.org/10.1016/j.techsoc.2020.101347
Melville, N., & Kraemer, K. (2004). REVIEW: INFORMATION TECHNOLOGY AND ORGANIZATIONAL PERFORMANCE: AN INTEGRATIVE MODEL OF IT BUSINESS VALUE. *Mis Quartely*, *28*(2), 283–322.
Mensah, S., Keung, J., Svajlenko, J., Bennin, K. E., & Mi, Q. (2018). On the value of a prioritization scheme for resolving Self-admitted technical debt. *Journal of Systems and Software*, *135*, 37–54. https://doi.org/10.1016/j.jss.2017.09.026
Mezak, S. (2018). *The Origins of DevOps: What's in a Name? - DevOps.com*. DevOps.Com. https://devops.com/the-origins-of-devops-whats-in-a-name/
Mikkonen, T., Lassenius, C., Männistö, T., Oivo, M., & Järvinen, J. (2018). Continuous and collaborative technology transfer: Software engineering research with real-time industry impact. *Information and Software Technology*, *95*(May 2017), 34–45. https://doi.org/10.1016/j.infsof.2017.10.013
Mishra, A., & Otaiwi, Z. (2020). DevOps and software quality: A systematic mapping. *Computer Science Review*, *38*. https://doi.org/10.1016/j.cosrev.2020.100308
Mugge, P., Abbu, H., Michaelis, T. L., Kwiatkowski, A., & Gudergan, G. (2020). Patterns of Digitization: A Practical Guide to Digital Transformation. *Research Technology Management*, *63*(2), 27–35. https://doi.org/10.1080/08956308.2020.1707003
Mumtaz, H., Singh, P., & Blincoe, K. (2021). A systematic mapping study on architectural smells detection. *Journal of Systems and Software*, *173*, 110885.

https://doi.org/10.1016/j.jss.2020.110885
Neuman, W. L. (2011). Social Research Methods: Qualitative and Quantitative Approaches. In *Pearson Education*.
Nord, R. L., Ozkaya, I., Kruchten, P., & Gonzalez-Rojas, M. (2012). In search of a metric for managing architectural technical debt. *Proceedings of the 2012 Joint Working Conference on Software Architecture and 6th European Conference on Software Architecture, WICSA/ECSA 2012*, 91–100. https://doi.org/10.1109/WICSA-ECSA.212.17
Nyati, R. (2020). Legacy Systems - A barrier in digital transformation journey of your organization. *CXO Insights*, *August*.
OECD. (2020). Going digital in Brazil. *OECD Reviews of Digital Transformation*, *OECD Publi*(Paris). https://doi.org/https://doi.org/10.1787/e9bf7f8a-en
Outsystems, & Lucid. (2021). The growing threat of technical debt. *Www.Outsystems.Com*, *May*, 1–10.
Overby, S. (2021). *Digital transformation: 10 ways DevOps helps*. The Enterprisers Project. https://enterprisersproject.com/article/2021/6/digital-transformation-10-ways-devops-helps
Pang, C., & Hindle, A. (2017). Continuous maintenance. *Proceedings - 2016 IEEE International Conference on Software Maintenance and Evolution, ICSME 2016*, 458–462. https://doi.org/10.1109/ICSME.2016.45
Pantano, E., Iazzolino, G., & Migliano, G. (2013). Obsolescence risk in advanced technologies for retailing: A management perspective. *Journal of Retailing and Consumer Services*, *20*(2), 225–233. https://doi.org/10.1016/j.jretconser.2013.01.002
Parker, G., Van Alstyne, M. W., & Jiang, X. (2016). Platform Ecosystems: How Developers Invert the Firm. *SSRN Electronic Journal*, *41*, 255–266. https://doi.org/10.2139/ssrn.2861574
Ping-Ju Wu, S., Straub, D. W., & Liang, T.-P. (2015). Training Solutions for Business and Industry B usiness and i nformation t echnology. *MIS Quarterly*, *39*(2), 497–518.
Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879
Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2012). Sources of method bias in social science research and recommendations on how to control it. *Annual Review of Psychology*, *63*, 539–569. https://doi.org/10.1146/annurev-psych-120710-100452
Polites, & Karahanna. (2012). Shackled to the Status Quo: The Inhibiting Effects of Incumbent System Habit, Switching Costs, and Inertia on New System Acceptance. *MIS Quarterly*, *36*(1), 21. https://doi.org/10.2307/41410404
Porter, M. E. (1980). *Competitive strategy : techniques for analysing industries* (Free Press (ed.)).
Porter, M. E. (1985). *Competitive advantage : creating and sustaining competitive performance* (Free Press (ed.)).
Pureur, P. (2022). *Sustainable architectures in a world of Agile, DevOps, and cloud*. Stack Overflow Blog. https://stackoverflow.blog/2022/02/24/sustainable-architectures-in-a-world-of-agile-devops-and-cloud/
Qualtrics. (2021). *Qualtrics* (current Month(s) and year(s) of use). https://www.qualtrics.com

Queiroz, M., Tallon, P. P., Sharma, R., & Coltman, T. (2018). The role of IT application orchestration capability in improving agility and performance. *Journal of Strategic Information Systems*, *27*(1), 4–21. https://doi.org/10.1016/j.jsis.2017.10.002

Ramasubbu, N., & Kemerer, C. F. (2014). Managing technical debt in enterprise software packages. *IEEE Transactions on Software Engineering*, *40*(8), 758–772. https://doi.org/10.1109/TSE.2014.2327027

Recker, J. (2006). Reasoning about Discontinuance of Information System Use. *Journal of Information Technology*, *17*(1), 21–31. http://eprints.qut.edu.au/94707/

Recker, J. (2014). Towards a theory of individual-level discontinuance of information systems use. *35th International Conference on Information Systems "Building a Better World Through Information Systems", ICIS 2014*.

Ringle, C. M., Wende, S., & Becker, J.-M. (2015). SmartPLS 3. In *Bönningstedt: SmartPLS*.

Rinta-Kahila, T. (2018). Caught in between: How an organization became a prisoner of its legacy system after is change. *International Conference on Information Systems 2018, ICIS 2018*, *December*.

Rolland, K. H., Mathiassen, L., & Rai, A. (2018). Managing digital platforms in user organizations: The interactions between digital options and digital debt. *Information Systems Research*, *29*(2), 419–443. https://doi.org/10.1287/isre.2018.0788

Ross, J. (2018). *Digital Is About Speed — But It Takes a Long Time*. MIT Sloan Management. https://sloanreview.mit.edu/article/digital-is-about-speed-but-it-takes-a-long-time/

Rossmann, A. (2018). Digital maturity: Conceptualization and measurement model. *International Conference on Information Systems 2018, ICIS 2018*, *January 2019*.

Ruault, P. (2020). Digital Transformation in securities services: The BNP Paribas case study. *Journal of Securities Operations & Custody*, *12*(3), 229–236. http://proxy.lib.sfu.ca/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=143613227&site=ehost-live

Sambamurthy, V., & Zmud, R. W. (2017). Guiding the Digital Transformation of Organizations. In *Legerity Digital Press*. http://www.ldpress.com/publications/

Sandborn, P. (2013). Design for obsolescence risk management. *Procedia CIRP*, *11*, 15–22. https://doi.org/10.1016/j.procir.2013.07.073

Schumacher, S., Bildstein, A., & Bauernhansl, T. (2020). The impact of the digital transformation on lean production systems. *Procedia CIRP*, *93*, 783–788. https://doi.org/10.1016/j.procir.2020.03.066

Schwarz, A., & Chin, W. (2007). Looking forward: Toward an understanding of the nature and definition of IT acceptance. *Journal of the Association for Information Systems*, *8*(4), 230–243. https://doi.org/10.17705/1jais.00123

Sebastian, I. M., Moloney, K. G., Ross, J. W., Fonstad, N. O., Beath, C., & Mocker, M. (2017). How big old companies navigate digital transformation. *MIS Quarterly Executive*, *16*(3), 197–213. https://doi.org/10.4324/9780429286797-6

Sekaran, U., & Bougie, R. (2016). *Research Methods For Business : A Skill-Building Approach*.

Senyo, P. K., Effah, J., & Osabutey, E. L. C. (2021). Digital platformisation as public sector transformation strategy: A case of Ghana's paperless port. *Technological Forecasting and Social Change*, *162*(February 2020). https://doi.org/10.1016/j.techfore.2020.120387

Shaw, N. (2002). Capturing the Technological Dimensions of IT Infrastructure Change: A Model and Empirical Evidence. *Journal of the Association for Information*

Systems, *2*(1), 1–35. https://doi.org/10.17705/1jais.00020
Sierra, G., Shihab, E., & Kamei, Y. (2019). A survey of self-admitted technical debt. *Journal of Systems and Software*, *152*, 70–82. https://doi.org/10.1016/j.jss.2019.02.056
Silva, M. A., Faustino, J. P., Pereira, R., & da Silva, M. M. (2018). Productivity gains of DevOps adoption in an IT team: A case study. *Proceedings of the 27th International Conference on Information Systems Development: Designing Digitalization, ISD 2018*, *351*.
Singh, A., & Hess, T. (2017). How chief digital officers promote the digital transformation of their companies. *MIS Quarterly Executive*, *16*(1), 1–17. https://doi.org/10.4324/9780429286797-9
Singh, A., Klarner, P., & Hess, T. (2020). How do chief digital officers pursue digital transformation activities? The role of organization design parameters. *Long Range Planning*, *53*(3), 1–14. https://doi.org/10.1016/j.lrp.2019.07.001
Singh, P., & Sandborn, P. (2006). Obsolescence driven design refresh planning for sustainment-dominated systems. *Engineering Economist*, *51*(2), 115–139. https://doi.org/10.1080/00137910600695643
Skipper, J. (2020). *Digital transformation: Why this is a smart time to speed up | The Enterprisers Project*. The Enterprisers Project. https://enterprisersproject.com/article/2020/5/digital-transformation-how-speed-up
Sogeti Labs. (2019). *Ciphering your Digital Maturity – The DevOps Assessment playbook*. Sogeti Labs. https://labs.sogeti.com/ciphering-your-digital-maturity-the-devops-assessment-playbook/
Solberg, E., Traavik, L. E. M., & Wong, S. I. (2020). Digital Mindsets: Recognizing and Leveraging Individual Beliefs for Digital Transformation. *California Management Review*, *62*(4), 105–124. https://doi.org/10.1177/0008125620931839
Soliman, W., & Rinta-Kahila, T. (2020). Toward a refined conceptualization of IS discontinuance: Reflection on the past and a way forward. *Information and Management*, *57*(2). https://doi.org/10.1016/j.im.2019.05.002
Solomon, R., Sandborn, P. A., & Pecht, M. G. (2000). Electronic part life cycle concepts and obsolescence forecasting. *IEEE Transactions on Components and Packaging Technologies*, *23*(4), 707–717. https://doi.org/10.1109/6144.888857
Spencer, L. (2021). How Does COVID-19 Speed the Digital Transformation of Business Processes and Customer Experiences?. *Review of Business*, *41*(1), 1–14. http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=148423020&site=ehost-live
Stich, V., Zeller, V., Hicking, J., & Kraut, A. (2020). Measures for a successful digital transformation of SMEs. *Procedia CIRP*, *93*, 286–291. https://doi.org/10.1016/j.procir.2020.03.023
Szopa, Ł., & Cyplik, P. (2020). The concept of building a digital transformation model for enterprises from the sme sector. *Logforum*, *16*(4), 593–601. https://doi.org/10.17270/J.LOG.2020.497
Tallon, P. P. (2008). Inside the adaptive enterprise: An information technology capabilities perspective on business process agility. *Information Technology and Management*, *9*(1), 21–36. https://doi.org/10.1007/s10799-007-0024-8
Tallon, P. P., Queiroz, M., Coltman, T., & Sharma, R. (2019). Information technology and the search for organizational agility: A systematic review with future research possibilities. In *Journal of Strategic Information Systems* (Vol. 28, Issue 2, pp. 218–237). Elsevier B.V. https://doi.org/10.1016/j.jsis.2018.12.002
Taylor, J. (2021). *Facebook outage: what went wrong and why did it take so long to fix*

after social platform went down? | Facebook | The Guardian. The Guardian. https://www.theguardian.com/technology/2021/oct/05/facebook-outage-what-went-wrong-and-why-did-it-take-so-long-to-fix

Teece, D. J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*(13), 1319–1350. https://doi.org/10.1002/smj.640

Teece, D. J. (2018). Business models and dynamic capabilities. *Long Range Planning*, *51*(1), 40–49. https://doi.org/10.1016/j.lrp.2017.06.007

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(1991), 509–533. https://doi.org/10.1142/9789812796929_0004

Teichert, R. (2019). Digital transformation maturity: A systematic review of literature. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *67*(6), 1673–1687. https://doi.org/10.11118/actaun201967061673

Tessem, B., & Iden, J. (2008). Cooperation between developers and operations in software engineering projects. *Proceedings - International Conference on Software Engineering*, *June 2014*, 105–108. https://doi.org/10.1145/1370114.1370141

Thordsen, T., Murawski, M., & Bick, M. (2020). How to Measure Digitalization? A Critical Evaluation of Digital Maturity Models. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics): Vol. 12066 LNCS*. Springer International Publishing. https://doi.org/10.1007/978-3-030-44999-5_30

Toucinho, A. (2020). How payments drive digital transformation. *Journal of Payments Strategy and Systems*, *14*(1), 10–13.

Trategy, D. I. B. U. S., Mithas, S., Tafti, A., & Mitchell, W. (2013). HOW A FIRM'S COMPETITIVE ENVIRONMENT AND DIGITAL STRATEGIC POSTURE INFLUENCE DIGITAL BUSINESS STRATEGY. *Mis Quartely*, *37*(2), 511–536.

Turel, O. (2015). Quitting the use of a habituated hedonic information system: A theoretical model and empirical examination of Facebook users. *European Journal of Information Systems*, *24*(4), 431–446. https://doi.org/10.1057/ejis.2014.19

Van Der Heijden, H. (2004). User acceptance of hedonic information systems. *MIS Quarterly: Management Information Systems*, *28*(4), 695–704. https://doi.org/10.2307/25148660

Vassallo, C., Zampetti, F., Romano, D., Beller, M., Panichella, A., Di Penta, M., & Zaidman, A. (2017). Continuous delivery practices in a large financial organization. *Proceedings - 2016 IEEE International Conference on Software Maintenance and Evolution, ICSME 2016*, 519–528. https://doi.org/10.1109/ICSME.2016.72

Verhoef, P. C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Qi Dong, J., Fabian, N., & Haenlein, M. (2021). Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research*, *122*(September 2019), 889–901. https://doi.org/10.1016/j.jbusres.2019.09.022

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *Journal of Strategic Information Systems*, *28*(2), 118–144. https://doi.org/10.1016/j.jsis.2019.01.003

Vogelsang, K., Liere-Netheler, K., Packmohr, S., & Hoppe, U. (2019). A Taxonomy of Barriers to Digital Transformation. *14th International Conference on Wirtschaftsinformatik, February 24-27, 2019, Siegen, Germany*, *July*, 736–750.

Wade, M., & Hulland, J. (2004). Review: The resource-based view and information systems research: Review, extension, and suggestions for future research. *MIS*

Quarterly: Management Information Systems, *28*(1), 107–142. https://doi.org/10.2307/25148626
Weill, P., Broadbent, M., & Clair, D. St. (1994). I/T value and the role of I/T infrastructure investments. *Strategic Alignment*, *3675*.
Weill, P., Subramani, M., & Broadbent, M. (2002). Building IT infrastructure for: Strategic agility. *MIT Sloan Management Review*, *44*(1), 57–65.
Wessel, L., Baiyere, A., Ologeanu-Taddei, R., Cha, J., & Jensen, T. B. (2021). Unpacking the difference between digital transformation and it-enabled organizational transformation. *Journal of the Association for Information Systems*, *22*(1), 102–129. https://doi.org/10.17705/1jais.00655
Westerman, G., Bonnet, D., & McAfee, A. (2014). Leading digital : turning technology into business transformation. In *HARVARD BUSINESS REVIEW PRESS*.
Wiedemann, A., & Wiesche, M. (2018). Are you ready for Devops? Required skill set for Devops teams. *26th European Conference on Information Systems: Beyond Digitization - Facets of Socio-Technical Change, ECIS 2018*.
Wiedemann, A., Wiesche, M., Gewald, H., & Krcmar, H. (2020). Understanding how DevOps aligns development and operations: a tripartite model of intra-IT alignment. *European Journal of Information Systems*, *00*(00), 458–473. https://doi.org/10.1080/0960085X.2020.1782277
Wiengarten, F., Humphreys, P., Cao, G., & Mchugh, M. (2013). Exploring the Important Role of Organizational Factors in IT Business Value: Taking a Contingency Perspective on the Resource-Based View. *International Journal of Management Reviews*, *15*(1), 30–46. https://doi.org/10.1111/j.1468-2370.2012.00332.x
Wilkinson, D., & Birmingham. (2003). *Using Research Instruments: A Guide for Researchers* (RoutledgeFalmer (ed.)).
Wilson, S. (2020). The pandemic, the acceleration of digital transformation and the impact on cyber security. *Computer Fraud and Security*, *2020*(12), 13–15. https://doi.org/10.1016/S1361-3723(20)30128-7
Wittkowski, K., Moeller, S., & Wirtz, J. (2013). Firms' Intentions to Use Nonownership Services. *Journal of Service Research*, *16*(2), 171–185. https://doi.org/10.1177/1094670512471997
Woodard, C. J., Ramasubbu, N., Tschang, F. T., & Sambamurthy, V. (2013). Design capital and design moves: The logic of digital business strategy. *MIS Quarterly: Management Information Systems*, *37*(2), 537–564. https://doi.org/10.25300/MISQ/2013/37.2.10
World Bank. (2020). *GDP (current US$) | Data*. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?most_recent_value_desc=true
Wu, J., & Lu, X. (2013). Effects of extrinsic and intrinsic motivators on using utilitarian, hedonic, and dual-purposed information systems: A meta-analysis. *Journal of the Association for Information Systems*, *14*(3), 153–191. https://doi.org/10.17705/1jais.00325
Xu, Y. C., Yang, Y., Cheng, Z., & Lim, J. (2014). Retaining and attracting users in social networking services: An empirical investigation of cyber migration. *Journal of Strategic Information Systems*, *23*(3), 239–253. https://doi.org/10.1016/j.jsis.2014.03.002
Yli-Huumo, J., Maglyas, A., & Smolander, K. (2016). How do software development teams manage technical debt? – An empirical study. *Journal of Systems and Software*, *120*, 195–218. https://doi.org/10.1016/j.jss.2016.05.018

Yli-Huumo, J., & Smolander, K. (2017). Changes and challenges of technical debt and its management during ongoing digital transformation. *ACM International Conference Proceeding Series*, *Part F1299*(May). https://doi.org/10.1145/3120459.3120462

Yoshikuni, A. C., & Albertin, A. L. (2020). Leveraging firm performance through information technology strategic alignment and knowledge management strategy: an empirical study of ITBusiness Value. *International Journal of Research - Granthaalayah*, *8*(10), 304–318.

Zapata, M. L., Berrah, L., & Tabourot, L. (2020). Is a digital transformation framework enough for manufacturing smart products? The case of Small and Medium Enterprises. *Procedia Manufacturing*, *42*(2019), 70–75. https://doi.org/10.1016/j.promfg.2020.02.024

Zazworka, N., Seaman, C., & Shull, F. (2011). Prioritizing Design Debt Investment Opportunities Nico. *MTD '11: Proceedings of the 2nd Workshop on Managing Technical Debt*, 39–42. https://doi.org/https://doi.org/10.1145/1985362.1985372

Zazworka, N., Shaw, M. A., Shull, F., & Seaman, C. (2011). Investigating the impact of design debt on software quality. *Proceedings - International Conference on Software Engineering*, 17–23. https://doi.org/10.1145/1985362.1985366

Appendix A – Survey instrument

Phenomenon	Constructs		ID	Items in Portuguese	References
DevOps Enablers	Technological Enablers	Automation	TEC.AT01	Ferramentas de automação são implementadas na empresa.	(Cogo, 2019)
			TEC.AT02	O departamento de TI usa ferramentas de teste automatizadas no processo de desenvolvimento de software.	
			TEC.AT03	A automação de processos é encorajada dentro da empresa.	
			TEC.AT04	Ferramentas de Automação são usadas em diferentes estágios do desenvolvimento de software, tais como Construção, Teste, Implementação, Monitoramento, Recuperação e Automação da Infraestrutura.	
			TEC.AT05	A maioria das tarefas operacionais do departamento de Operações de TI são altamente automatizadas.	
		Cloud Computing	TEC.CC01	As operações da empresa são suportadas por computação em nuvem.	
			TEC.CC02	O processo de entrega de software use computação em nuvem para conseguir melhores resultados.	
			TEC.CC03	A empresa usa ferramentas de computação em nuvem, tanto no desenvolvimento de software quanto no departamento de operações da TI.	
			TEC.CC04	Computação em nuvem é uma tecnologia importante para os objetivos de TI de longo prazo da companhia.	
			TEC.CC05	Tecnologias de computação em nuvem são fundamentais para a maneira como o departamento de TI desenvolve software.	
	Managerial Methodologies	Lean Management	MAN.LM01	A empresa identifica cada passo nos processos do negócio e elimina aqueles que não criam valor.	
			MAN.LM02	A empresa sempre busca agregar mais valor usando menos recursos.	
			MAN.LM03	A empresa foca em uma abordagem de entrega de longo prazo que busca alcançar mudanças pequenas e incrementais no processo, e que criem eficiência e qualidade.	
			MAN.LM04	Existem características do Gerenciamento Enxuto (Lean) no processo de entrega de software dentro da empresa.	
			MAN.LM05	O departamento de TI usa princípios do Gerenciamento Enxuto (Lean) para suportar o gerenciamento dos processos.	
		Agile management	MAN.AG01	Desenvolvimento sustentável, onde gerentes, desenvolvedores e usuários devem manter um ritmo consistente indefinidamente, é importante para o processo de entrega de software na empresa.	
			MAN.AG02	A empresa está disposta a desviar de um plano de maneira a responder as mudanças externas.	
			MAN.AG03	Times auto-organizados e comunicação aberta são parte do processo de entrega de software da empresa.	
			MAN.AG04	Práticas da Metodologia Agile são encorajadas na empresa.	
			MAN.AG05	A empresa usa a Metodologia Agile na abordagem do desenvolvimento de software.	
	Culture	Cooperation	CUL.CO01	Existe bastante cooperação entre diferentes departamentos de TI, tais como Desenvolvimento, Operações e Controle de Qualidade.	
			CUL.CO02	Existe responsabilidade dividida para o desenvolvimento, entrega e manutenção de software.	
			CUL.CO03	A criação de times multifuncionais é algo que acontece seguidamente e que tem o suporte da empresa.	
			CUL.CO04	Qualidade, disponibilidade, confiabilidade e segurança são considerados tarefas de todos.	
			CUL.CO05	Analistas de Negócio, desenvolvedores, engenheiros de qualidade, operações, segurança e outras unidades cooperam durante todos os estágios do processo de entrega de software.	
		Fail	CUL.FA01	Quando um erro acontece, a responsabilidade é dividida entre os departamentos.	
			CUL.FA02	Quando um erro acontece, o foco maior é em resolver o problema.	
			CUL.FA03	Quando um erro acontece, a pessoa responsável não é a única culpada.	
			CUL.FA04	Quando um erro acontece, o departamento de TI não foca em achar culpados pelos fracassos.	
			CUL.FA05	Resposta as falhas foca nas condições pelas quais estas falhas acontecem.	
		Bridging	CUL.BR01	Existe encorajamento para transição entre diferentes departamentos da empresa.	
			CUL.BR02	Times diferentes são incluídos no planejamento durante todo o ciclo de entrega de software.	

Phenomenon	Constructs		ID	Items in Portuguese	References
			CUL.BR03	Times diferentes normalmente dividem o mesmo espaço de trabalho.	
			CUL.BR04	Ferramentas que suportam a transição entre departamentos são adotadas.	
			CUL.BR05	A empresa busca quebrar silos e encoraja a transição entre departamentos.	
		Innovation	**CUL.NO01**	Experimentação é uma parte essencial de todos os departamentos envolvidos no processo de entrega de software.	
			CUL.NO02	Existe apoio à novas ideias e elas são bem-vindas no ambiente de trabalho.	
			CUL.NO03	Os empregados têm tempo durante a semana de trabalho para trabalhas em novas ideias.	
			CUL.NO04	Existe incentivo para compartilhar ideias entre colegas.	
			CUL.NO05	A alta gerência apoia o compartilhamento de ideias entre os empregados.	
	Delivery Approach	**DevOps Sinergy**	**DEL.DO01**	A transição da empresa entre Desenvolvimento e Operações é feita sem atritos.	
			DEL.DO02	A empresa busca unificar diferentes departamentos de TI, tais como Desenvolvimento e Operações, em um processo de entrega de software único e coeso.	
			DEL.DO03	O relacionamento entre departamentos é vital para o processo de entrega de software.	
			DEL.DO04	A empresa tem sido efetiva em aplicar os conceitos de DevOps.	
			DEL.DO05	Desenvolvimento e Operações trabalham juntos conforme proposto pela adoção do DevOps.	
		Continuous Delivery	**DEL.CD01**	A comunicação entre os times de desenvolvimento e operações evolui constantemente.	
			DEL.CD02	O processo de entrega de software acomoda tempo para os empregados trabalharem em inovação.	
			DEL.CD03	Feedback entre diferentes departamentos de TI é rápido e eficaz.	
			DEL.CD04	O objetivo do departamento de TI da empresa é continuar melhorando constantemente.	
			DEL.CD05	Melhora contínua no processo de entrega de software é vital para a empresa.	
Technical Debt	**TD Awareness**		**DT.AWR01**	Tenho conhecimento da dimensão do Débito Técnico de nossos sistemas.	(Martini et al., 2018)
			DT.AWR02	Todos os membros do time têm conhecimento do nível de Débito Técnico que temos nos nossos sistemas.	
			DT.AWR03	Quanto do esforço global de desenvolvimento é geralmente gasto em atividades de gestão de Débitos Técnicos?	
			DT.AWR04	Quão familiar para você é o termo "Débito Técnico"?	
	TD Tracking		**DT.TRK01**	Eu rastreio (usando ferramentas, documentação, etc.) os Débitos Técnicos nos nossos sistemas.	
			DT.TRK02	Todos os membros do time participam do rastreamento de Débitos Técnicos nos nossos sistemas.	
			DT.TRK03	Eu tenho acesso aos resultados do rastreamento de Débitos Técnicos nos nossos sistemas.	
			DT.TRK04	Todos os membros do time têm acesso aos resultados dos Débitos Técnicos nos nossos sistemas.	
	ATD		**DT.ATD01**	Nossos sistemas são suscetíveis a violações de dependências (*dependency violations*).	(Martini et al., 2018; Besker et al., 2017)
			DT.ATD02	O desenho arquitetural (*architectural design*) dos nossos sistemas é complexo.	
			DT.ATD03	Nossos sistemas seguem diversificados e demasiados padrões e políticas.	
			DT.ATD04	Nossos sistemas apresentam dependência de recursos/software externos.	
			DT.ATD05	Falta reusabilidade de desenho (*design*) em nossos sistemas.	
Information System Discontinuance	**System Capability Shortcoming**		**SD.SCS01**	Os sistemas em descontinuidade na nossa empresa apresentam performance e funcionalidade bastante inadequadas.	(Furneaux & Wade, 2011)
			SD.SCS02	Os sistemas em descontinuidade na nossa empresa apresentam limitações evidentes na capacidade de atender as nossas necessidades.	
			SD.SCS03	Gostaríamos de ter várias capacidades não suportadas por nossos sistemas em descontinuidade.	
	System Support Availability		**SD.SSA01**	O suporte para os sistemas em descontinuidade na nossa empresa está prontamente disponível.	
			SD.SSA02	Não encontramos dificuldades em obter os serviços de suporte necessário para os sistemas em descontinuidade na nossa empresa.	
			SD.SSA03	Conseguimos obter facilmente os recursos de suporte necessários para continuar operando os sistemas em descontinuidade na nossa empresa.	

Phenomenon	Constructs		ID	Items in Portuguese	References
	Obsolescence Risc		SD.OSR01	É importante para a empresa minimizar o risco de obsolescência.	
			SD.OSR02	TI tem um alto risco de obsolescência.	
			SD.OSR03	Transferir o risco de obsolescência para um terceiro é vantajoso para nós.	
	Latest Technology tools		SD.LTT01	A utilização das mais novas tecnologias de informação (máximo 3 anos de idade) afetam significativamente a qualidade dos nossos produtos/serviços.	
			SD.LTT02	Utilizamos as tecnologias de informação mais recentes porque elas influenciam significativamente o nosso sucesso.	
			SD.LTT03	Precisamos substituir as nossas tecnologias de informação pelo menos a cada três anos, assim que estas se tornam ultrapassadas.	
	Replacement Intention		SD.REI01	Planejamos substituir os sistemas em descontinuidade de nossa empresa por sistemas concorrentes.	
			SD.REI02	Temos a intenção de substituir os sistemas em descontinuidade da nossa empresa por sistemas completamente diferentes.	
			SD.REI03	Vamos implementar sistemas substitutos para os sistemas em descontinuidade da nossa empresa.	
	Technical Integration		SD.TCI01	Os sistemas em descontinuidade da nossa empresa são complexos devido a suas características técnicas.	
			SD.TCI02	Os sistemas em descontinuidade da nossa empresa dependem de uma integração sofisticada de componentes tecnológicos.	
			SD.TCI03	Existe uma considerável complexidade técnica derivada dos sistemas em descontinuidade da nossa empresa.	
	System Investments		SD.SIN01	Recursos organizacionais significativos foram investidos nos sistemas em descontinuidade da nossa empresa.	
			SD.SIN02	Dedicamos tempo e dinheiro consideráveis para a implementação e a operação dos sistemas em descontinuidade da nossa empresa.	
			SD.SIN03	Foram realizados investimentos financeiros substanciais nos sistemas em descontinuidade da nossa empresa.	
Digital Maturity	Technology Capability		DM.TEC01	Nossa empresa utiliza uma grande quantidade de dados para otimizar as estratégias, os processos e os produtos.	(Rossman, 2019)
			DM.TEC02	Na nossa empresa, utilizamos ferramentas para a modelagem digital, a automação e o controle dos processos de negócio.	
			DM.TEC03	Nossa empresa implementou, em todas as áreas, os conceitos de local de trabalho digital (*Digital Workplace*). As plataformas digitais são utilizadas para a colaboração no dia a dia.	
			DM.TEC04	As tecnologias digitais são essenciais para o desenvolvimento de novos produtos e serviços.	
	Operational Capability		DM.OPC01	Para a implementação da estratégia digital da nossa empresa, contamos com recursos (tempo, pessoas, orçamento) suficientes e disponíveis.	
			DM.OPC02	Ao longo de toda a cadeia de valor, estabelecemos forte cooperação e cocriação interfuncionais (*cross-functional*) entre as partes interessadas (*stakeholders*).	
			DM.OPC03	Processos físicos e digitais estão completamente integrados por modelos de processos holísticos.	
			DM.OPC04	O ímpeto da nossa estratégia digital promove inovações na operação.	
	Strategic Capability		DM.STC01	Nossa empresa implementou uma estratégia digital.	
			DM.STC02	A estratégia digital da nossa empresa está documentada e é comunicada.	
			DM.STC03	A estratégia digital da nossa empresa influencia significativamente os modelos de negócio e de operação existentes.	
			DM.STC04	Nossa estratégia digital é continuamente avaliada e adaptada.	
	Leadership Capability		DM.LEC01	Nossos executivos apoiam a implementação da estratégia digital.	
			DM.LEC02	A estratégia digital só é implementada em áreas funcionais específicas.	
			DM.LEC03	Nossa empresa possui uma cultura de liderança baseada na transparência, cooperação e no processo de tomada de decisão descentralizado.	
			DM.LEC04	A estratégia digital da nossa empresa influencia as tarefas e os papeis dos nossos executivos.	
	Market Capability		DM.MAC01	Nossos produtos e serviços digitais integram processos e interfaces de negócio e criam um impacto perceptível na experiência do cliente (*customer experience*).	
			DM.MAC02	A digitalização progressiva dos produtos e serviços adiciona diretamente valor à empresa, por meio de, por exemplo: redução de custos, aumento da produtividade, melhor experiência do cliente (*customer experience*), diferenciação de clientes (customer differentiation).	
			DM.MAC03	Produtos e serviços digitais tem um grande impacto na performance geral de nossa empresa.	
			DM.MAC04	Nossa empresa está criando um volume significativo de vendas por meio de canais digitais.	
	People and Expertise Capability		DM.PEC01	Dentro de nossa empresa, há especialistas suficientes nas principais questões digitais (*digital core issues*).	
			DM.PEC02	Nossa empresa oferece oportunidades de capacitação relativas aos principais temas digitais.	

Phenomenon	Constructs		ID	Items in Portuguese	References
			DM.PEC03	Nossa empresa implementa medidas abrangentes para fortalecer o desenvolvimento da alfabetização digital (*Digital Literacy*).	
			DM.PEC04	Nossa empresa criou novos perfis profissionais para empregados com expertise nos principais temas digitais.	
	Cultural Capability		**DM.CLC01**	As decisões de nossa empresa são transparentes para os empregados.	
			DM.CLC02	A digitalização tem impacto na agilidade da tomada de decisão da nossa empresa.	
			DM.CLC03	Os empregados e executivos cotidianamente trocam informações sobre a transformação digital da nossa empresa.	
			DM.CLC04	Mudança contínua é parte da nossa cultura corporativa.	
	Governance Capability		**DM.GOC01**	Diretrizes para o uso de tecnologias digitais são comunicadas e utilizadas pelos empregados.	
			DM.GOC02	Nossa empresa implementa um modelo de gestão holística para a estratégia digital com métricas (*key metrics*) correspondentes.	
			DM.GOC03	As métricas (*key metrics*) da estratégia digital estão completamente integradas ao controle.	
			DM.GOC04	A estratégia corporativa e a estratégia digital estão intensamente interligadas e se complementam.	
Controll	**MLMV**		**MLMV01**	Nunca abandono o desejo de ter meu próprio negócio.	(Yoshikuni & Albertin, 2020)
			MLMV02	Tenho uma atitude positiva em relação aos outros.	
			MLMV03	Eu sempre imagino minha casa no futuro.	
			MLMV04	É fácil alcançar meus objetivos.	

Phenomenon	Constructs		ID	Items in English	References
DevOps Enablers	**Technological Enablers**	**Automation**	**TEC.AT01**	Automation tools are implemented in the company.	(Cogo, 2019)
			TEC.AT02	The IT department uses automated testing tools in the software development process.	
			TEC.AT03	Automating processes is encouraged inside the company.	
			TEC.AT04	Automation tools are used in different stages of software development, such as Build, Test, Deployment, Monitoring, Recovery, and Infrastructure Automation.	
			TEC.AT05	Most of the operational tasks in the IT Operations department are highly automated.	
		Cloud Computing	**TEC.CC01**	Cloud computing supports the organization's operations.	
			TEC.CC02	The software development process uses Cloud Computing to achieve better results.	
			TEC.CC03	The company uses cloud computing tools, both in development and in operations.	
			TEC.CC04	Cloud computing is an important technology for the software development process.	
			TEC.CC05	Cloud Computing technologies are fundamental to the way the IT department develops software.	
	Managerial Methodologies	**Lean Management**	**MAN.LM01**	Our company identifies each step in a business process and eliminates those steps that do not create value.	
			MAN.LM02	Our company is always seeking to create more value using fewer resources.	
			MAN.LM03	Our company focuses on a long-term approach to work that systematically seeks to achieve small, incremental changes in processes to increase efficiency and quality.	
			MAN.LM04	There are Lean Management characteristics in the software development process inside the company.	
			MAN.LM05	The IT department uses Lean Management principles to support management.	
		Agile management	**MAN.AG01**	Sustainable development, where sponsors, developers, and users should be able to maintain a constant pace indefinitely, is important to the software delivery process in the company.	
			MAN.AG02	The company is willing to deviate from a plan to respond to change.	
			MAN.AG03	Self-organizing teams and open communication are part of the software development process in the company.	
			MAN.AG04	Agile practices are encouraged in the company.	
			MAN.AG05	Our company uses the Agile Methodological approach towards software development.	
	Culture	**Cooperation**	**CUL.CO01**	There is a lot of cooperation between different IT departments, such as Development, Operations and Quality Assurance.	
			CUL.CO02	There is shared responsibility for building, deploying and maintaining a software.	
			CUL.CO03	The creation of cross-functional teams is something that happens often and has the support of the company.	
			CUL.CO04	Quality, availability, reliability and security are considered everyone's job.	
			CUL.CO05	Business analysts, developers, quality engineers, ops, security and other units cooperate on all stages of the software development process.	
		Fail	**CUL.FA01**	When a mistake happens, responsibility is shared between the departments.	
			CUL.FA02	When a mistake happens, the focus is on solving the problem.	
			CUL.FA03	When a mistake happens, the person responsible is not the only one held accountable.	
			CUL.FA04	When a mistake happens, the IT department does not focus on blaming individuals for failures.	
			CUL.FA05	Response to failure focuses on the conditions in which failure happens.	
		Bridging	**CUL.BR01**	There is encouragement for bridging between different departments of the company.	
			CUL.BR02	Different teams are included in the planning throughout the software development cycle.	
			CUL.BR03	Different teams usually share the same workspace.	
			CUL.BR04	Tools that support bridging between different departments are adopted.	
			CUL.BR05	Our company tries to break down silos and encourage bridging between departments.	
		Innovation	**CUL.NO01**	Experimentation is an essential part of the jobs of all departments involved in the software development process.	
			CUL.NO02	There is support for new ideas and they are welcomed in the workplace.	
			CUL.NO03	Our employees have time during the workweek to work on new ideas.	
			CUL.NO04	There is incentive to share ideas between colleagues.	
			CUL.NO05	Top management supports the sharing of ideas between employees.	
	Delivery Approach	**DevOps Sinergy**	**DEL.DO01**	Our company's transition between Development and Operations is handled seamlessly.	
			DEL.DO02	Our company aims to unify different IT departments such as Development and Operations into a cohesive software development process.	
			DEL.DO03	The relationship between departments is vital in the software development process.	
			DEL.DO04	This company has been effective in applying DevOps concepts.	
			DEL.DO05	Development and Operations work together as proposed by the adoption of DevOps.	
		Continuous Delivery	**DEL.CD01**	Communication between development and operations teams is continuously evolving.	
			DEL.CD02	The delivery process accommodates time for employees to work on innovation.	
			DEL.CD03	Feedback between different IT departments is fast and effective.	

Phenomenon	Constructs		ID	Items in English	References
			DEL.CD04	The goal for our company's IT department is to keep improving constantly.	
			DEL.CD05	Continuous improvement in the software development process is vital in our company.	
Technical Debt	TD Awareness		DT.AWR01	I am aware of how much Technical Debt we have in our system.	(Martini et al., 2018)
			DT.AWR02	All team members are aware of the level of Technical Debt in our system.	
			DT.AWR03	How much of the overall development effort is usually spent on TD management activities?	
			DT.AWR04	How familiar are you with the term "Technical Debt"?	
	TD Tracking		DT.TRK01	I track (using tools, documentation, etc.) Technical Debt in our system.	
			DT.TRK02	All team members participate in tracking Technical Debt in our system.	
			DT.TRK03	I have access to the output of the tracking of the Technical Debt in our system.	
			DT.TRK04	All team members have access to the output of Technical Debt in our system.	
	ATD		DT.ATD01	Dependency violations	(Martini et al., 2018; Besker et al., 2017)
			DT.ATD02	Complex architectural design	
			DT.ATD03	Too many different patterns and policies	
			DT.ATD04	Dependencies on external resources/software	
			DT.ATD05	Lack of reusability in design	
Information System Discontinuance	System Capability Shortcoming		SD.SCS01	The performance and functionality of this system is highly inadequate.	(Furneaux & Wade, 2011)
			SD.SCS02	There are notable limitations in the ability of this system to meet our needs.	
			SD.SCS03	We would like to have many capabilities that are not supported by this system.	
	System Support Availability		SD.SSA01	Support for this system is readily available.	
			SD.SSA02	We do not encounter difficulties in obtaining needed system support services.	
			SD.SSA03	We can easily obtain the support resources necessary to continue operating this system.	
	Obsolescence Risc		SD.OSR01	It is important to the firm to minimize obsolescence risk	
			SD.OSR02	IT has a high risk of obsolescence	
			SD.OSR03	It is beneficial for us to transfer obsolescence risk to a third party	
	Latest Technology tools		SD.LTT01	The use of the latest IT (max. 3 years old) has a significant effect on the quality of our services/products	
			SD.LTT02	We use the latest IT because it significantly influences our success	
			SD.LTT03	We need to replace our IT at least every three years, as it becomes outdated	
	Replacement Intention		SD.REI01	We plan to replace this system with a competing system.	
			SD.REI02	Our intention is to replace this system with an entirely different system.	
			SD.REI03	We will be implementing a replacement to this system.	
	Technical Integration		SD.TCI01	The technical characteristics of this system make it complex.	
			SD.TCI02	This system depends on a sophisticated integration of technology components.	
			SD.TCI03	There is considerable technical complexity underlying this system.	
	System Investments		SD.SIN01	Significant organizational resources have been invested in this system.	
			SD.SIN02	We have committed considerable time and money to the implementation and operation of this system.	
			SD.SIN03	The financial investments that have been made in this system are substantial.	
Digital Maturity	Technology Capability		DM.TEC01	Our firm uses large amounts of data to optimize strategies, processes and products.	(Rossman, 2019)
			DM.TEC02	Within our firm, we use tools for digital modeling, automation and control of business processes.	
			DM.TEC03	Our firm has implemented enterprise-wide digital workplace concepts. Digital platforms are used for day-to-day collaboration.	
			DM.TEC04	Digital technologies are the mainspring for the further development of products and services.	
	Operational Capability		DM.OPC01	There are sufficient resources (time, people, budget) available to implement the digital strategy within our firm.	
			DM.OPC02	We established a strong cross-functional cooperation and co-creation with stakeholders throughout our value chain.	
			DM.OPC03	Digital and physical processes are fully integrated by holistic process models.	
			DM.OPC04	The impetus of our digital strategy is leading to innovations in operations.	
			DM.STC01	Our firm has implemented a digital strategy.	

Phenomenon	Constructs		ID	Items in English	References
	Strategic Capability		DM.STC02	The digital strategy of our firm is documented and communicated.	
			DM.STC03	The digital strategy of our firm has a significant influence on existing business and operating models.	
			DM.STC04	The digital strategy is being continuously evaluated and adapted.	
	Leadership Capability		DM.LEC01	Our executives support the implementation of the digital strategy.	
			DM.LEC02	The digital strategy is only implemented in individual functional areas (inverse).	
			DM.LEC03	The culture of leadership in our firm is based on transparency, cooperation and decentralized decision-making processes.	
			DM.LEC04	The digital strategy of our firm has an influence on the task and role profiles of executives.	
	Market Capability		DM.MAC01	Digital products and services are embedded in our business interfaces and business processes and create a perceptible impact on customer experience.	
			DM.MAC02	There is a direct added value created by the progressive digitization of products and services of our firm (e.g., cost reductions, increased productivity, better customer experience, customer differentiation).	
			DM.MAC03	Digital products and services have a large impact on the overall performance of our firm.	
			DM.MAC04	Our firm is creating significant sales volume via digital channels.	
	People and Expertise Capability		DM.PEC01	Within our firm, there are sufficient experts on digital core issues.	
			DM.PEC02	Within our firm, further education opportunities for digital core topics are available.	
			DM.PEC03	Within our firm, comprehensive measures to strengthen digital literacy development are implemented.	
			DM.PEC04	Within our firm, new job profiles have been created for employees with expertise in digital core topics.	
	Cultural Capability		DM.CLC01	Decisions within our firm are transparent to our own employees.	
			DM.CLC02	Digitization has an impact on the decision-making agility of our firm.	
			DM.CLC03	In day-to-day business, employees and executives exchange information about the digital transformation of our firm.	
			DM.CLC04	Continuous change is part of our corporate culture.	
	Governance Capability		DM.GOC01	Guidelines for the use of digital technologies are communicated and used by employees.	
			DM.GOC02	Our firm implements a holistic management model for the digital strategy and corresponding key metrics.	
			DM.GOC03	The key metrics for the digital strategy are fully integrated into controlling.	
			DM.GOC04	The corporate strategy and the digital strategy are intensively networked and complement each other.	
Controll	MLMV		MLMV01	I would never abandon the desire to have my own business.	(Yoshikuni & Albertin, 2020)
			MLMV02	I have a positive attitude towards others.	
			MLMV03	I always imagine my house in the future.	
			MLMV04	It is easy for me to reach my goals.	