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INFORMATION TECHNOLOGY CAPABILITY AND INNOVATION CAPABILITY EFFECTS ON ORGANIZATIONAL AGILITY AND FIRM PERFORMANCE

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AUTHORSHIP STATEMENT

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SUMMARY

Purpose – The business value of information technology poses theoretical and business challenges. That is noted especially with emerging new technologies, markets, and threats. IT governance plays a critical role in managing IT resources and capabilities that influence organizational agility. It also provides a stable platform for different innovative approaches. We aim to examine how IT governance can impact organizational agility under turbulent environmental conditions mediated by IT and innovation capabilities.

Design/methodology/approach – Our research employs a survey method as we collected data from senior business managers in different industries. We tested the model and hypotheses utilizing data from 132 firms via partial least squares - structural equations modeling methodology.

Findings – Our study demonstrates that IT governance exerts its impact on organizational agility mediated by IT and innovation capabilities and has no direct influence on organizational agility. The results indicate mixed effects of market turbulence on the relationships between information technology capability, innovation capability, and organizational agility. However, there is a weak effect of technological turbulence.

Originality/value – Our research examines and demonstrates how the two theories, RBV and DCV combined, can explain the relationship between IT governance on organizational agility under environmental turbulence. We showed that IT governance positively influences IT and innovation capabilities when facing turbulent conditions. The management control imposed through IT governance mechanisms will ensure that IT and innovation capabilities enable the desired organizational agility state.

Keywords

IT governance, IT capability, Innovation capability, Organizational agility, Environmental turbulence, IT business value

POVZETEK

Namen – Poslovna vrednost informacijske tehnologije postavlja teoretične in poslovne izzive. To je še posebej opazno pri nastajajočih novih tehnologijah, trgih in grožnjah. Upravljanje IT igra ključno vlogo pri upravljanju virov in zmogljivosti IT, ki vplivajo na organizacijsko agilnost. Zagotavlja tudi stabilno platformo za različne inovativne pristope. Naš cilj je preučiti, kako lahko upravljanje IT vpliva na organizacijsko agilnost v turbulentnih okoljskih razmerah, ki jih posredujejo IT in inovacijske zmogljivosti.

Zasnova/metodologija/pristop – Naša raziskava uporablja metodo ankete, saj smo zbrali podatke višjih menedžerjev v različnih panogah. Model in hipoteze smo testirali z uporabo podatkov 132 podjetij z metodologijo modeliranja delnih najmanjših kvadratov - strukturnih enačb.

Ugotovitve – Naša študija dokazuje, da upravljanje IT vpliva na organizacijsko agilnost, ki jo posredujejo IT in inovacijske zmogljivosti, in nima neposrednega vpliva na organizacijsko agilnost. Rezultati kažejo mešane učinke tržnih turbulenc na razmerja med zmogljivostjo informacijske tehnologije, inovativnostjo in organizacijsko agilnostjo. Vendar pa obstaja šibek učinek tehnološke turbulence.

Izvirnost/vrednost – Naša raziskava preučuje in prikazuje, kako lahko obe teoriji, RBV in DCV skupaj, pojasnita razmerje med upravljanjem IT na organizacijsko agilnost v okoljskih turbulencah. Pokazali smo, da upravljanje IT pozitivno vpliva na IT in inovacijske zmogljivosti v turbulentnih razmerah. Nadzor upravljanja, uveden z mehanizmi upravljanja IT, bo zagotovil, da bodo IT in inovacijske zmogljivosti omogočile želeno stanje organizacijske agilnosti

ključne besede
Upravljanje IT, zmogljivost IT, zmogljivost inovacij, organizacijska agilnost, Okoljska turbulenca, poslovna vrednost IT

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LIST OF ABBREVIATIONS

Abbreviation	Definition
1G	First-generation statistical techniques
2G	Second-generation statistical techniques
ABC	Activity-Based Costing
ABS	Association of Business Schools
AIS	Association for Information Systems
AJG	Academic Journal Guide
AVE	Average Variance Extracted
BoE	AIS Basket of Eight Journals
BSC	Balanced Scorecard
CA	Cronbach's Alpha
CABS	Chartered Association of Business Schools
CB-SEM	Covariance-Based Structure Equation Modeling
CFA	Confirmatory Factor Analysis
CMB	Common Method Bias
CMMI	Capability Maturity Model Integration
COBIT	Control Objectives for Information Technology
CR	Composite Reliability
DC	Dynamic Capabilities
DCV	Dynamic Capabilities View
DSF	Dynamic Strategic Fit
DV	Dependent Variable
EM	Eisenhardt & Martin, 2000
EN	Environmental turbulence
FP	Firm Performance
GoF	Goodness-of-Fit
GS	Google Scholar
HCM	Hierarchical Component Models
HOC	Higher-Order Component
HTMT	Heterotrait-Monotrait Ratio
IC	Innovation Capability
IDR	Interdisciplinary Research
ISACA	Information Systems Audit and Control Association

IT	Information Technology
IT BSC	IT Balanced Scorecard
ITC	Information Technology Capability
ITCB	ITC-IT Business Spanning Capability
ITCI	ITC-IT Infrastructure Capability
ITCP	ITC-IT Proactive Stance
ITG	Information Technology Governance
ITGC	ITG-Communication Approach
ITGD	ITG-Decision-Making Structure
ITGF	ITG-Formal Process
ITGI	Information Technology Governance Institute
ITIL	Information Technology Infrastructure Library
ITO	IT and Organization
IV	Independent Variable
LOC	Lower Order Component
LR	Literature Review
LVs	Latent Variables
MIS	Management Information Systems
MT	Market Turbulence
MV	Mediating Variable
MVs	Manifest Variables
NLR	Narrative Literature Review
OA	Organizational Agility
OAM	OA-Market Capitalizing Agility
OAO	OA-Operational Adjustment Agility
OC	Organizational Capability
PLS	Partial Least Squares
PLS-SEM	Partial Least Squares - Structure Equation Modeling
PMS	Performance Management System
R^2	Coefficient of Determination
RBV	Resource-Based View
SAM	Strategic Alignment Model
SCA	Sustainable Competitive Advantage
SEM	Structure Equation Modeling

SLR	Systematic Literature Review
TPS	Teece, Pisano, & Shuen, 1997
TT	Technological turbulence
VHB (de)	Verband der Hochschullehrer für Betriebswirtschaft
VHB (en)	The German Academic Association of Business Research
VIF	Variance Inflation Factor
VRIN	Valuable-Rare-Inimitable-Non-substitutable
VRIO	Valuable-Rare-Inimitable-Organization
VUCA	Volatility, Uncertainty, Complexity, and Ambiguity

INTRODUCTION

This chapter starts with the background for the study as it lays the foundation for the research. It outlines the domains of the research topic and the contribution of each one to the study, i.e., IT governance, organizational agility, IT capability, innovation capability, environmental turbulence, and firm performance. Then, it highlights the purpose of the study by defining the motivation for conducting the research and outlines the research questions.

With the purpose of the study explained and the research questions posed, it proceeds to the conceptual framework that links the research questions to the theories used and the research's outcome. The proposed research model draws upon both the resource-based view of the firm and the dynamic capabilities view and investigates the relationship between IT governance, IT capability, innovation capability, organizational agility, and firm performance. It also examines the effect of environmental turbulence on this relationship.

Next, we discuss the research design, which describes the steps followed in conducting the dissertation. It reviews the exploratory phase highlighting its role in validating the gap. Then, we explain our research design methodology. This step includes the instrument development, sampling strategy, and the research method used. The last section provides an overview of the research execution, e.g., the pilot study, data collection method, data analysis techniques, and analysis and discussion of the findings. Finally, we present the contribution of the study. It focuses on the research impact on academic research and management practice.

Background of the Study

Many authors regard information technology (IT) as a critical foundation for organizational success. That is because it influences how firms create and capture the value and outperform competitors (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014; Grover, Chiang, Liang, & Zhang, 2018; Hair Jr, Hult, Ringle, & Sarstedt, 2016). IT governance is crucial in enhancing the business value of IT, as it influences the management of IT resources and capabilities and further provides a stable and safe platform for different innovative approaches. As a result, IT governance helps sustain the competitive advantage by promoting organizational agility. Previous studies on the business value of IT have examined the determinants of IT governance success (Buchwald, Urbach, & Ahlemann, 2014) and the role of IT governance in supporting organizational performance (Chau, Ngai, Gerow, & Thatcher, 2020; Harguem, 2021; Zhang, Zhao, & Kumar, 2016), project performance (Sirisomboonsuk, Gu, Cao, & Burns, 2018), and business reporting (Haouam, 2020). Nevertheless, how IT governance interacts in a turbulent environment and what is its influence on organizational agility is under-studied and limited research is available to investigate that role.

In the early 2000s, many corporate scandals emerged, such as Enron, Global Crossing, and WorldCom, indicating that lack of corporate governance was the primary cause (Green,

2004). That led to the release of a United States federal law named the Sarbanes-Oxley Act (SOX) for corporate governance and the SOX 404 section for internal controls. SOX 404 influenced the IT governance framework and had a powerful impact on implementing management controls in organizational practice (Karanja & Zaveri, 2014).

The research in IT governance evolved over the years into different paths, which many expected because of the changes in the management approach and dynamic market requirements and expectations. In addition, information technology developments and innovations, incremental or disruptive, have contributed markedly to new market requirements and ever-changing customer preferences. Unfortunately, academic research didn't grow as much in the IT governance domain despite its significant impact on academia and professional practice (Liang, Chiu, Wu, & Straub, 2011). IT governance oversees the design, development, deployment, and maintenance of IT capability that automates and facilitates business procedures, including outsourcing (Kim, Lee, Koo, & Nam, 2013). IT governance also supports exploring and developing innovations and exploiting the current system to increase organizational efficiency under changing environmental conditions (Andersen, Svejvig, & Heeager, 2017).

Organizations conduct a long-term process to develop organizational agility through IT and innovation (Lowry & Wilson, 2016; Teece, Peteraf, & Leih, 2016). The IT governance framework ensures the strategic alignment of the objectives of IT with the business objectives of the organization (Gregory, Kaganer, Henfridsson, & Ruch, 2018). That would enhance and improve organizational agility (Gregory, Kaganer, Henfridsson, & Ruch, 2018; Wu, Straub, & Liang, 2015) and the firm's performance (Chau, Ngai, Gerow, & Thatcher, 2020).

Effective IT governance mechanisms enable organizations to leverage their IT resources and capabilities and manage innovative practices. IT capability can prepare the firm for environmental turbulence, and this depends primarily on the IT decision-making process (Benitez-Amado & Walczuch, 2012; Mithas, Ramasubbu, & Sambamurthy, 2011). IT capability needs periodic or even continuous assessment to check for its suitability to opportunities and threats encountered or anticipated by the firm. That may result in upgrading and reconfiguring IT resources and capabilities enabling companies to survive in a highly competitive environment with many changing environmental conditions. When facing such uncertainties, the dynamic capabilities provide the needed abilities to sustain the competitive advantage (Teece D. J., 2007).

In the information systems (IS) literature, IT competence and innovation capability are usually considered critical capabilities for developing organizational agility (Chakravarty, Grewal, & Sambamurthy, 2013; Ravichandran, 2018; Tallon, Queiroz, Coltman, & Sharma, 2019). Organizations show heterogeneity in their IT resources, such as IT infrastructure, human IT skills, and the ability to leverage IT for intangible benefits (Bharadwaj A. S., 2000; Ray, Muhanna, & Barney, 2005). These organizations that achieve competitive advantage

through IT recognized the need to effectively combine their IT resources to create an overall IT capability.

IT capability has been very supportive in different aspects of organizational practice. Researchers found that IT capability enables product innovation (Chen, Wang, Nevo, Benitez-Amado, & Kou, 2015) and service innovation (Chen & Tsou, 2012) with improved firm performance. IT capability also enables the digital transformation of companies (Nwankpa & Roumani, 2016) and influences the development of digital platforms over time (Tan, Pan, Lu, & Huang, 2015). Thus, they can provide more engagement for social media and e-commerce customers (Braojos, Benitez, & Llorens, 2019). IT capability can improve firm performance directly or indirectly through mediators such as organizational agility (Felipe, Leidner, Roldán, & Leal-Rodríguez, 2020; Sambamurthy, Bharadwaj, & Grover, 2003; Lu & Ramamurthy, 2011). Furthermore, it enables business development and innovation, and it also provides the needed flexibility to facilitate both exploring and exploiting different market opportunities. That, in turn, leads to a better firm response and the ability to sustain its competitive advantage under turbulent environmental conditions (Benitez, Llorens, & Braojos, 2018).

While IT capability provides organizations with the opportunities to be agile, capturing these opportunities could depend on the organization's ability to innovate, among other factors (Ravichandran, 2018). Research has long considered innovation capability a crucial capability that drives organizational change (Linder, Jarvenpaa, & Davenport, 2003). Innovative organizations, such as Amazon, Google, and Facebook, continuously experiment with many aspects of their business model and processes to be agile (Rindova & Kotha, 2001). Such continuous transformation characterizes agile firms (Rindova & Kotha, 2001). Therefore, innovative organizations are more likely to make such adaptations, and hence innovation capability is a critical complementary capability that could explain the variance in organizational agility (Ravichandran, 2018).

A firm innovation capability means the ability of the firm to generate and adopt new ideas that move away from old working practices. That indicates the ability to change the old ways of conducting business and try untested ideas such as new management practices, new marketing concepts, and new corporate strategies (Camisón & Villar-López, 2014; Menguc & Auh, 2006). Firms with innovation capability can be reactive or proactive depending on the environmental turbulence encountered. The same company may react differently based on its IT capability at the time. They also may select a radically innovative approach or prefer to be incremental. That depends on the nature of the product or service changes required.

Researchers consider organizational agility a manifestation of higher-order organizational capabilities. Thus, it will enable the firm to manage its resources efficiently and effectively and create value in response to internal and external conditions (Teece, Peteraf, & Leih, 2016; Overby, Bharadwaj, & Sambamurthy, 2006). The dynamic capabilities determine how

an organization integrates, builds, and reconfigures internal and external competencies to address changing business environments (Teece D. , 2018).

Both the resource-based view (RBV) and the dynamic capabilities view (DCV) are two views that explain how firms can achieve organizational agility using resources and capabilities. However, RBV does not explain the response to market turbulence (Eisenhardt & Martin, 2000). Market turbulence can precipitate rapid and unpredictable changes in customers' needs and preferences (Jaworski & Kohli, 1993). These changes can be continuously dynamic and thus become a challenging threat to the competitive state of the organization. With unpredictable environmental changes, the dynamic capabilities can enable firms to build and reconfigure their resource base, thus, helping them manage emerging opportunities or impending threats. The dynamic capabilities highlight how firms can use their internal resources and external capabilities to sustain their agility in a dynamically unpredictable environment. The DCV extends the RBV explaining how dynamic capabilities can govern when faced with turbulent environmental conditions (Teece, Peteraf, & Leih, 2016).

Environmental turbulence creates an unpredictable state that is continuously dynamic and can pose a critical threat to the competitive state of the firm. Market and technological turbulence are two aspects of environmental turbulence that pose the risk of unanticipated changes, which entails both opportunities and threats (Jaworski & Kohli, 1993). The speed and unpredictability associated with technology change require innovative exploration or exploitation based on the opportunities and threats encountered. Also, the rate of change in customers' preferences and their new demands require continuous efforts by the firm to innovate in their lines of products and services enabled by IT capability to respond quickly and effectively. IT governance provides the framework of management controls that provides a reasonable assurance for a successful transformation of the firm from one state to another. Firms with established dynamic capabilities have a better performance than their competitors, manifested by increasing market share, higher sales growth, and overall profitability (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014).

We surveyed senior business managers from mixed industries in 132 firms. The objective is to study the influence of IT governance mechanisms on organizational agility and investigate the mediating role of IT capability and innovation capability on this relationship. We also examined the moderating role of environmental turbulence when organizational agility is much needed. We also investigated the impact of organizational agility on firm performance. We tested the proposed conceptual model with a sample of senior business managers in medium-to-large firms, and the empirical analysis supports our theory.

Our study demonstrates that IT capability and innovation capability fully mediate the effect of IT governance on organizational agility. In addition, our results also show the strong impact of IT governance and IT capability on organizational agility when associated with

high market turbulence. However, the effect of innovation capability on organizational agility is high when market turbulence is low.

Using the RBV lens, our model explains how IT governance, innovation capability, and IT capabilities are potential sources for organizational agility. We extended RBV with DCV to illustrate how IT governance can impact IT capability, innovation capability, and organizational agility. It also shows how changing environmental conditions can influence that impact.

Research Purpose

The business value of information technology (IT) still poses a significant theoretical and practical challenge, especially with the emergence of new technologies, new markets, and the threats encountered (Bharadwaj A. S., 2000; Bhatt & Grover, 2005; Chen, Wang, Nevo, Jin, Wang, & Chow, 2014; Melville, Kraemer, & Gurbaxani, 2004; Shea, Dow, Chong, & Ngai, 2019). In today's volatile and fast-paced competitive environment, IT is widely regarded as a critical foundation for organizational success, influencing how they create and capture value and outperform competitors (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014; Grover, Chiang, Liang, & Zhang, 2018; Lu & Ramamurthy, 2011; Popovič, Hackney, Tassabehji, & Castelli, 2018).

Previous research recognized the role of many resources in generating business value from IT, such as specific types of IT (Aral & Weill, 2007), organizational capabilities (Sambamurthy, Bharadwaj, & Grover, 2003), resource complementarity (Nevo & Wade, 2010), and internal fit (Sharma, Yetton, & Zmud, 2008). IT governance is crucial in enhancing the business value of IT, as it influences the management of IT resources and capabilities and further provides a stable and safe platform for different innovative approaches. Previous studies on the business value of IT have examined the determinants of IT governance success (Buchwald, Urbach, & Ahlemann, 2014) and the role of IT governance in supporting organizational performance (Chau, Ngai, Gerow, & Thatcher, 2020; Zhang, Zhao, & Kumar, 2016).

Nevertheless, how IT governance interacts in a turbulent environment and what is its influence on organizational agility is under-studied and limited research is available to investigate that role. Furthermore, there are scarce studies that examine the moderating influence of environmental turbulence on such a relationship. The significance of that impact is essential and critical with new and emerging technologies and the innovative practice in implementing them. Effective management of IT and innovation capabilities can provide the firm with needed agility and higher performance under different environmental conditions.

Organizations conduct a long-term process to develop organizational agility through IT and innovation (Lowry & Wilson, 2016; Teece, Peteraf, & Leih, 2016). Effective IT governance enables organizations to effectively use their IT resources and capabilities and manage innovative practices. The IT governance mechanisms ensure the strategic alignment of the objectives of IT with the business objectives of the organization (Gregory, Kaganer, Henfridsson, & Ruch, 2018). That would enhance and improve organizational agility (Gregory, Kaganer, Henfridsson, & Ruch, 2018; Wu, Straub, & Liang, 2015) and the firm's performance (Chau, Ngai, Gerow, & Thatcher, 2020).

We propose in our study that IT governance can influence organizational agility, either directly or indirectly. It can exert a powerful influence on IT capability, and it is hard to imagine how IT capability can act without such consideration. Having IT governance as an antecedent may explain the dynamic impact of IT capability on organizational agility. Furthermore, IT governance is more about stability and standards, while innovation capability is more about flexibility and out-of-the-box solutions. It is imperative to achieve strategic innovation to realize the business value of IT in supporting the innovation process (Peterson, 2004). The management control imposed through IT governance ensures the modular IT infrastructure will support the desired innovative practice. There is a paradox in the relationship between IT governance and innovation capability. Thus, we need to understand the critical role of IT governance on organizational agility and if it has IT and innovation capabilities as mediators for such an impact. Thus, we ask the following **research questions**:

(i) How does IT governance influence organizational agility?
(ii) How does IT governance help develop the IT capability and innovation capability, and how do these capabilities contribute to organizational agility?
(iii) How does environmental turbulence affect IT governance, IT capability, and innovation capability on organizational agility?

Conceptual Framework

Both the resource-based view of the firm (RBV) and the dynamic capabilities view (DCV) are two views that enable us to understand how firms can achieve organizational agility using resources and capabilities. The RBV emphasizes that firms have valuable, rare, inimitable, and non-substitutable (VRIN) resources that help maintain agility over a predictable and sustained period (Barney J. , 1991). However, the dynamic capabilities emphasize how firms can use their internal resources and external capabilities to sustain their agility in a dynamically unpredictable environment (Teece, Pisano, & Shuen, 1997). A Nobel laureate in economic sciences, Oliver E. Williamson, argued that the best efficient approach to business strategy is the resource-based or dynamic capabilities as they deal with the core business issues. He even implied the possibility of combining them (Williamson, 1991, p. 76).

As the dynamic capabilities view (DCV) extends the resource-based view (RBV) of the firm, it explains how dynamic capabilities govern in such a changing turbulent environment (Teece, Peteraf, & Leih, 2016). These dynamic capabilities include sensing, responding, and transforming resources to enable the firm to explore and exploit market opportunities and manage new unpredictable threats.

Extending the RBV with the DCV explains how IT governance can impact IT capability, innovation capability, and organizational agility and how environmental turbulence can influence that impact. With environmental changes, the dynamic capabilities can enable firms to build and reconfigure their resource base, thus, helping them manage emerging opportunities or impending threats. Although ordinary capabilities enable new process innovation, the dynamic capabilities are the ones that help to identify new products and services (Helfat & Raubitschek, 2018). Furthermore, they can support the firm in monitoring environmental changes and assessing the viability of the current business model with the potential of creating new business models.

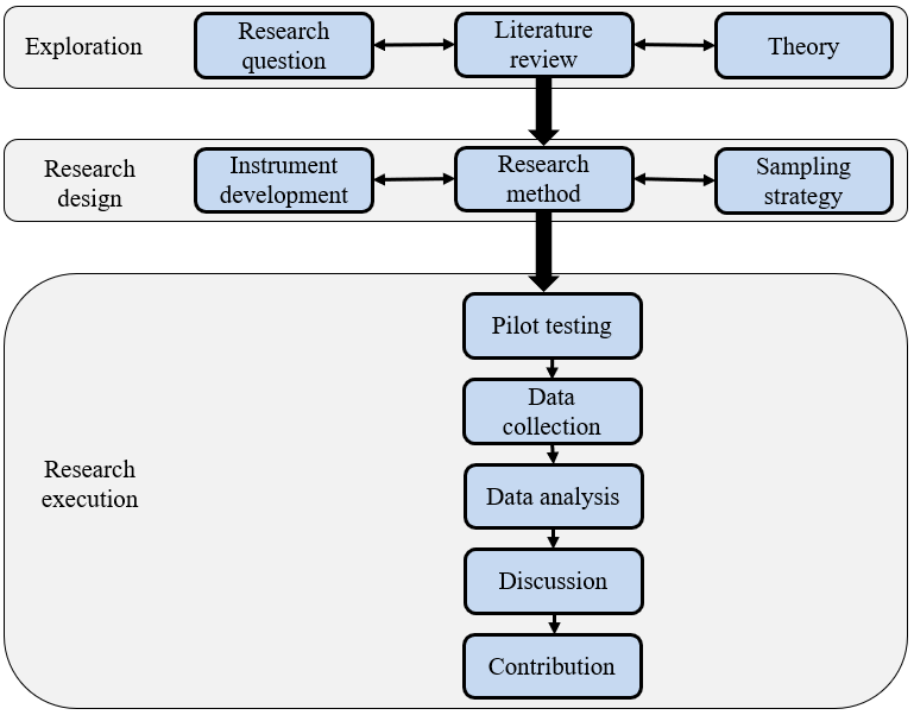
Using the RBV lens, our model explains how IT governance, innovation, and IT capabilities are potential sources for organizational agility. Among the different resources of the firm, IT resources and capabilities have the most significant role, especially with emerging Industry 4.0 technologies. In such a competitive environment, the resource-based view of the firm (RBV) is the theory that can explain and predict the business value of IT and how IT resources as part of firm resources can provide the firm with a competitive advantage (Cao, Duan, & Cadden, 2019). We extended RBV with DCV to explain how IT governance can impact IT capability, innovation capability, and organizational agility. It also shows how changing environmental conditions can influence that impact.

Research Design

Our research started with our notion that IT governance is crucial to developing organizational agility. We propose that IT governance can exert a powerful impact on IT and innovation capabilities and thus can influence organizational agility. If the results of our empirical study can prove our postulation, the study will have a profound effect on both academic research and management practice. Our research journey passed through three steps (*Figure **1***).

First, we explored the literature and validated the gap that we identified. We identified our research questions and posed the theories that can explain the answers to them. **Second**, we planned our research design by identifying our survey instruments and sampling strategy. We prepared our online survey accordingly. **Third**, we collected our data and analyzed it. We then presented our findings and discussed how the results contribute to academic research and management practice.

Figure 1: Our research process



Source: adapted from Bhattacherje (2012)

Exploration

We conducted an exploratory search to identify and validate the research gap that may need further investigation. Hence, a literature review helped to identify and confirm the gap. It also helped refine and validate the research questions and link them to theory. Our research questions provide an insight into what the study will investigate, and they emphasize the scope by defining what the study will answer. We postulated that RBV and DCV would explain the answers to our research questions, and they were linked as early as possible to them.

Design

Our plan for the research design contains different components. They include identifying the survey instrument, defining the nature of the study, outlining our sampling strategy, and determining our research method. The nature of the study refers to whether it is a cross-sectional or longitudinal one. We employed a cross-sectional survey to test the research model, and we used the firm as the unit of analysis. Our research method is a quantitative approach. In survey research strategy, we often associate quantitative research with questionnaires. We conducted our study to investigate and demonstrate causal relationships between our proposed variables.

Execution

Our target organizations in this study were firms in Brazil. We collected data using an online survey of senior executives in medium to large firms (private and public) that are not industry-specific, i.e., mixed-industry. The unit of analysis is the firm. We conducted pilot testing using a sample that is a small subset of the target population. It can detect potential problems in the research design or the instruments used. As some questions may not be suitable for the targeted sample, it was crucial to ensure that the measurement instruments used are reliable and valid and measure the constructs of the study. Then, we conducted our survey and received 132 responses, which exceeded the recommended requirements.

We tested our research model using the structural equation modeling – partial least squares (PLS-SEM). The software we used is SmartPLS version 3.3.2 for data analysis (Ringle, Wende, & Becker, 2015). We used PLS-SEM in this study for the following reasons. **First**, as we have IT governance as a formative construct, PLS-SEM will allow us to model constructs with formative indicators (Goo, Kishore, Rao, & Nam, 2009; Hair Jr, Hult, Ringle, & Sarstedt, 2016). **Second**, it is the recommended technique when little theory is available and predictive accuracy is required, as applied to our study (Teo, Wei, & Benbasat, 2003; Garson, 2016, p. 8).

We conducted data analysis in our model by conducting a measurement model assessment (reflective and formative constructs) and a structural model assessment (Hair Jr, Hult, Ringle, & Sarstedt, 2016; Hair, Risher, Sarstedt, & Ringle, 2019). Finally, we presented our findings and discussed how the results contribute to academic research and management practice (next section).

Major Areas of Contributions

Even though there is limited literature that considers the relationships between IT governance and IT capability and innovation capability, the area of research between organizational agility and IT governance has even fewer studies. To address that gap, we investigated the effects of IT governance on organizational agility, whether directly or indirectly. We postulated our research questions that drove this study. Our study attempts to answer our posed research questions by developing a theoretical model and empirically testing it. We proposed in our research model that IT governance is an antecedent to organizational agility. We also posited that IT and innovation capabilities mediate that relationship. The collected survey data from 132 senior business managers support our proposed research model, thus validating our theoretical development for the research.

Scholarly contributions

Our research contributes to the IS discipline in several ways. **First**, it examines and demonstrates how the theories, RBV and DCV combined, can explain the impact of IT governance on organizational agility under changing environmental conditions.

Second, we showed that IT governance plays an important role when facing the moderating influence of environmental turbulence. While IT capability needs flexibility and the ability to transform and respond quickly to environmental changes, IT governance demands standardization and stability. Thus, the model enabled us to understand the paradox in this relationship. The significance of such an impact seems essential and critical with new and emerging technologies and the innovative practice in implementing them. Firms possessing more effective IT governance are likely to have more effective and efficient IT capability. Effective management of IT capability can provide the firm with higher performance under different environmental conditions.

Third, in our study, we demonstrated that IT governance positively influences organizational agility mediated by the IT capability of the firm. IT governance can enhance organizational agility indirectly through mediation by IT capability. That is indeed a new relevant stream of research that influences organizational agility.

Fourth, it is challenging to achieve strategic innovation without realizing the business value of IT in supporting or driving the innovation process (Peterson, 2004). The management control imposed through IT governance mechanisms will ensure that information technology will enable the desired innovative practice. That will enhance exploring innovations or exploiting the current system to increase organizational efficiency (Andersen, Svejvig, & Heeager, 2017).

Fifth, our study shows that IT governance acts indirectly on organizational agility mediated by IT and innovation capabilities. That is a significant step toward a better understanding of antecedents of a firm's agility and represents a deviation from the current stream of research. Effective IT governance also provides a credible assurance for maintaining business continuity and innovation continuity when threatened by environmental changes. Our study shows that IT governance operates indirectly on organizational agility through mediation by innovation capability.

Sixth, our study confirms previous findings on the role of organizational agility in improving the performance of firms (Chakravarty, Grewal, & Sambamurthy, 2013; Ravichandran, 2018; Sambamurthy, Bharadwaj, & Grover, 2003; Tallon & Pinsonneault, 2011). Agile organizations can detect and seize market opportunities quickly and effectively. Agility also enables firms to reconfigure their assets and become more capable of managing environmental turbulence leading to superior performance.

Managerial contributions

Managers may need to consider the appropriate IT governance mechanisms best suited for their practice to ensure alignment between IT and business objectives, including the desired agility. That will enable both IT and innovation capabilities to contribute positively to business objectives in a turbulent environment. This study provides several practical insights to senior management, IT executives, and IT auditors.

First, IT governance mechanisms enhance managing firms' IT resources and capabilities in the best suitable way. Our study shows that effective IT governance has a significant impact on developing or acquiring new IT resources and capabilities. That is a step required to achieve organizational agility.

Second, in our study, we demonstrated that IT governance positively influences organizational agility mediated by the IT capability of the firm. IT governance can enhance organizational agility indirectly through mediation by IT capability.

Third, the study provided evidence that IT governance is a critical antecedent for stability in innovative practice. Thus, IT governance acts more as an enabler than a barrier to creativity. IT governance mechanisms provide a governed path for innovation capability to achieve desired organizational agility.

Fourth, IT governance mandates the approval of senior business managers for the deployment of the assigned IT management controls. IT auditing is a significantly effective management control exercised by the board and senior management over IT resources and capabilities. IT auditors need to emphasize the importance of IT governance mechanisms that oversee the preparation of IT and innovation capabilities for turbulent environmental conditions and the need for enhanced management control to guard against these unpredictable changes.

Fifth, effective IT governance provides a reasonable assurance for maintaining business continuity and in-effect innovation continuity when threatened by environmental changes. Exploiting or exploring innovative practices requires imposing management control dynamically to render any digital transformation as safe and smooth as possible.

Sixth, our study shows that organizational agility positively influences firm performance. When encountering environmental turbulence, organizational agility enables the firm to sense and seize market opportunities better than its competitors. Further, it allows the firm to reconfigure its resources and quickly respond to unpredictable changes. Thus, it will enable the firm to sustain its competitive advantage.

Organization of the Dissertation

We organize the remainder of the dissertation as follows. First, we identify the research background for the dissertation. Then, we review the literature and identify the knowledge gap in the domains of interest. We then describe the theoretical perspective of the hypotheses of the study.

Further, we present our research design and hypotheses development. We outline the research methodology and the procedures we took. Then, we provide the findings and discuss the result. Finally, we summarize the findings and contributions of the study and provide our conclusion.

1 RESEARCH BACKGROUND

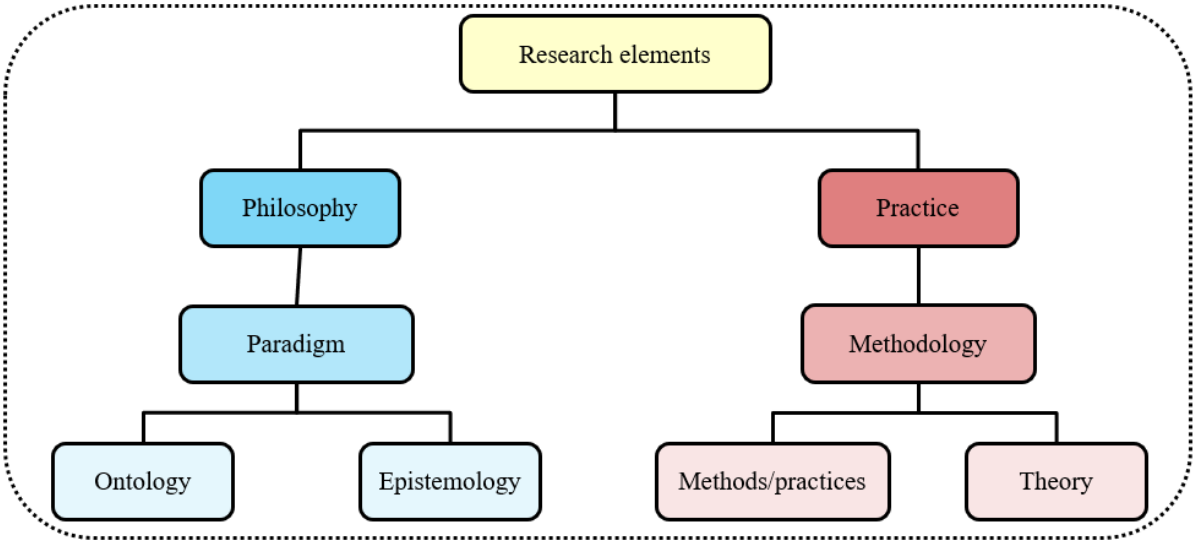
In this chapter, we present the research background that influenced our study. We highlight some of its elements to explain our approach, e.g., the research philosophy and practice. We define the research philosophy and some of the common types. However, we emphasize the post-positivism philosophy that influenced the current study. Within the context of the research philosophy, we discuss the paradigm that has ontology and epistemology components. Then, we discuss the methodology that has both theory and methods components.

Next, we discuss the nature of research in information systems and highlight the status of the information systems domain as a reference discipline. The current research joins three areas of interest: information systems, management science, and organizational science. We explain how multiple domains can affect our approach.

1.1 Overview of the Research Philosophy

Our beliefs are important because they impact how we think, see, and act regarding the nature of the social world, social life, research practice, valued knowledge, and how we come to know. Many researchers regard the main research elements as having three general categories (Leavy, 2017, p. 11): philosophy, practice, and ethics. We provide a brief overview of two of them, as shown in *Figure 2*, revealing their relevance and impact on the current study.

Figure 2: Research elements



Source: adapted from Leavy (2017)

The research philosophy includes a strategy for the research, problem formulation, data collection, and analysis. In other words, it is the development of research assumptions and knowledge. Researchers often have their worldview as a foundational set of beliefs that they call paradigms (epistemology and ontology). These beliefs guide and shape their research activities. However, their disciplines often influence their worldview and guide their approach, e.g., quantitative, qualitative, or mixed-method research (*Figure 3*). There are four common philosophical approaches: post-positivism, constructivism, transformative, and pragmatism (*Figure 3*) (Creswell & Creswell, 2018). In quantitative information systems research, the popular philosophy is post-positivism which we adopted (*Figure 4*).

Table 1: Researcher‘s view of positivism

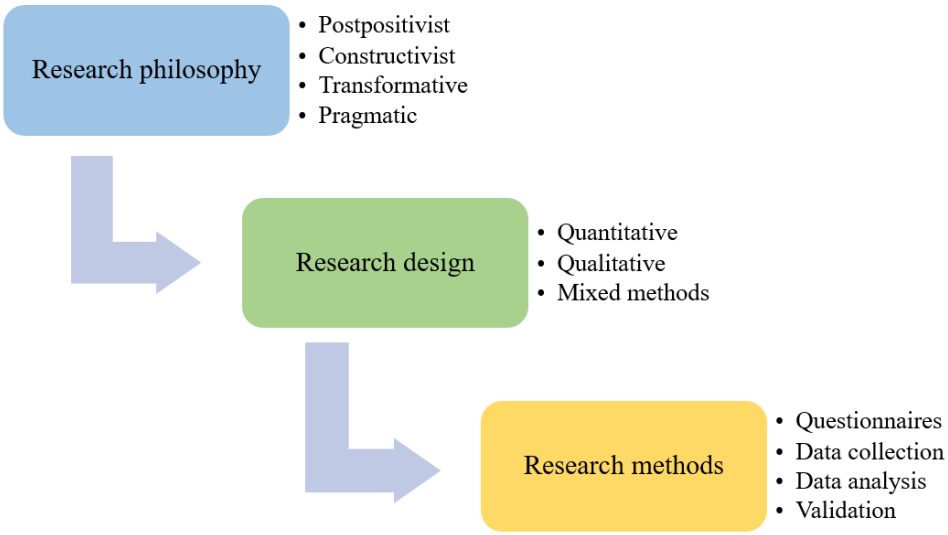
	Researcher's view	**Positivism**
Ontology	What is the nature of reality?	It is objective, where researchers and reality are separate and independent.
Epistemology	What is acceptable knowledge?	Only observable phenomena can provide credible data.
Data collection	What are the techniques researchers often use?	Data is highly structured and usually quantitative, although researchers can use qualitative data.
Validity		Data is a reflection of reality and researchers can measure it.
Reliability		Researchers can reproduce the results.

Source: adapted from Weber (2004); Saunders, Lewis, & Thornhill (2012)

Post-positivism takes its roots in positivism. Positivism holds that science should rely only on what we can observe and measure, as shown in *Table 1*. It tends to rely exclusively on theories that we can directly test. The frustration with positivism led to the emergence of post-positivism, where we can reasonably infer from a phenomenon by combining empirical observations with logical reasoning. Some researchers call it by different names, e.g., the scientific method, positivist/post-positivism research, empirical science, or simply post-

positivism (Creswell & Creswell, 2018). It challenges the notion of the absolute truth of knowledge endorsed in the positivist philosophy.

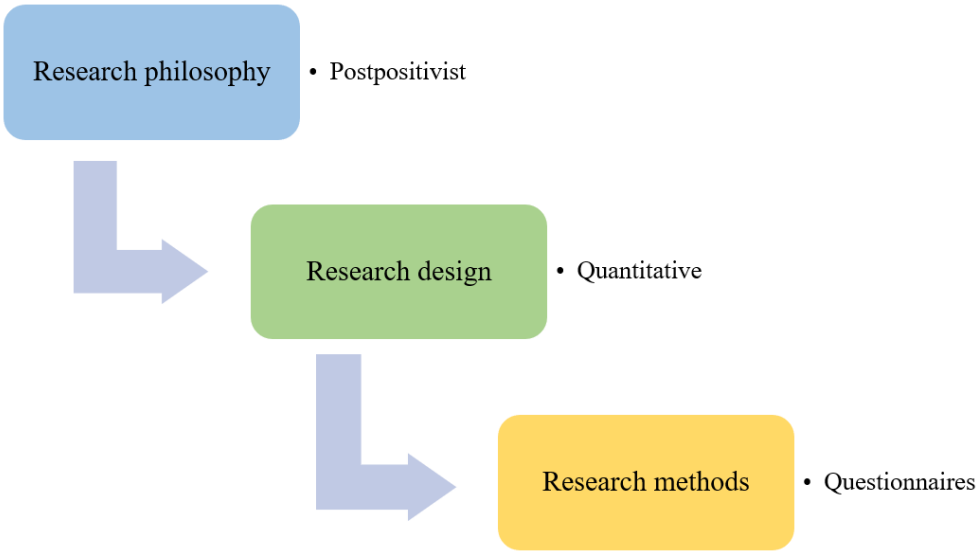
Figure 3: Philosophy-design-methods relationship



Source: own work

Post-positivist researchers view science as probabilistic with no certainty. Researchers commonly use post-positivism in the domain of social and behavioral sciences. Thus, the research involves making and testing the claims regarding the causal relationships, such as A causes B or A causes B under certain conditions. Further, in post-positivist research, many theories guide our studies and are employed deductively to predict the expected relationships between variables. Theory selection in research relies on prior studies of the topic of interest within its discipline (Leavy, 2017, p. 92).

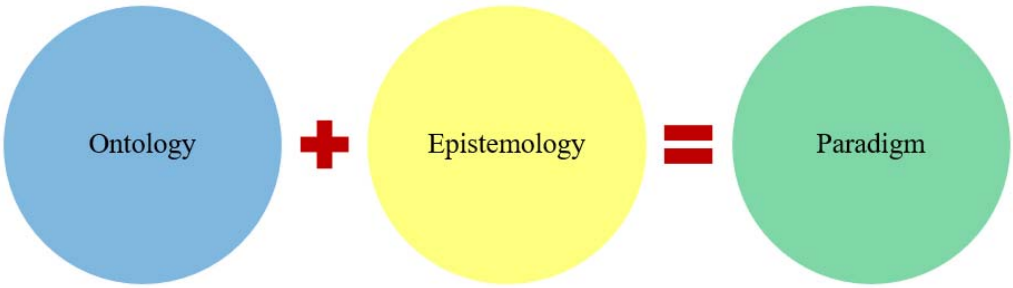
Figure 4: Philosophy-design-methods relationship for our study



Source: own work

In our study, we proposed a causal relationship. We posited that IT governance has a causal relationship with organizational agility. We also claimed that this relationship might have IT capability and innovation capability as mediators. That will lead to either rejecting or supporting the hypotheses but not proving them. Researchers will employ theories deductively to predict what to find regarding how certain variables relate to each other. As mentioned earlier, prior topic research in the discipline of study will most likely determine the specific theory or theories.

Figure 5: Paradigm components



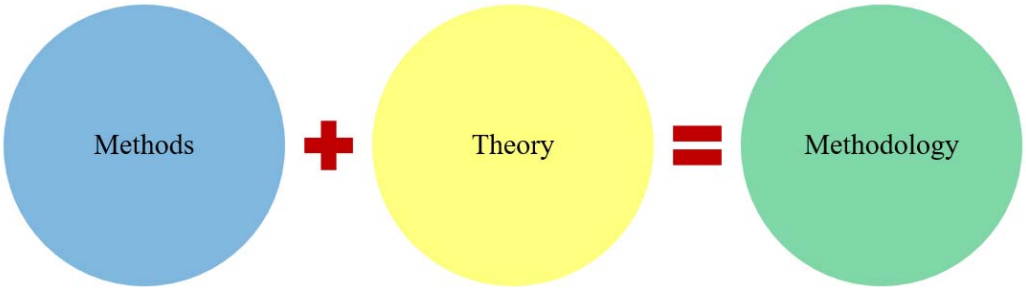
Source: adapted from Leavy (2017)

The paradigm helps to define the research philosophy. It is our mental model that provides a foundational viewpoint for our assumptions. That will guide our research process for the topics under study (Leavy, 2017). In other words, our paradigms act as if we are wearing colored glasses that define our views of the world and how we think about that. Thus, they are the lenses we use to design and execute our research, even though they are often difficult to see. Both ontological and epistemological belief systems combine in paradigms, as shown in *Figure 5*.

Ontology is the science of what is. That includes the kinds and structures of many things, e.g., objects, properties, events, processes, and relations in every area of reality (Leavy, 2017). Ontology attempts to provide a definitive and comprehensive classification of entities in all aspects of being. It concerns itself with conceptualizations and the description of corresponding domains of objects (concepts) (Smith, 2004).

Epistemology is the philosophy of knowledge and how we come to know (Leavy, 2017). It refers to our assumptions about what knowledge is and how research proceeds, e.g., do we need to use an objective or subjective approach to examine social reality. That leads to acquiring what can be considered valid knowledge (Hirschheim, 1985).

Figure 6: Methodology components



Source: adapted from Leavy (2017)

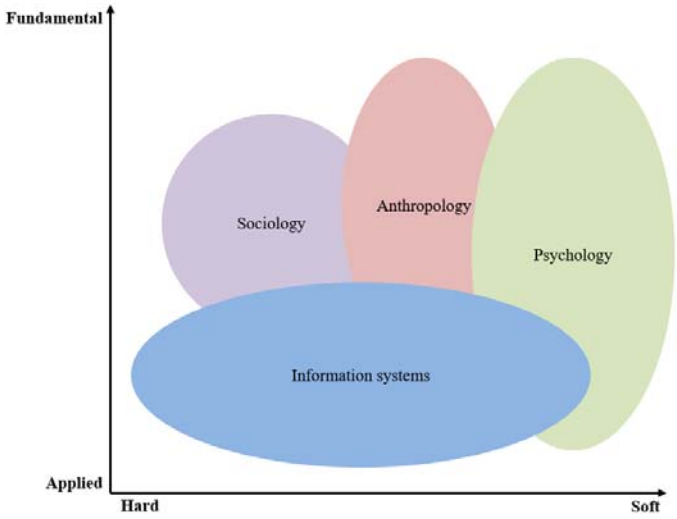
Besides research philosophy, the other element is the research practice. It refers to our way of conducting research and the tools we use to do it. We develop a methodology when we combine these tools to conduct the research study. Epistemology and methodology have strong interrelationships. They both share the same concern with how we come to know. However, the latter is more practical. The research design refers to the methods or tools we use to collect data as outlined in chapter six: Research Design. In practice, a methodology stems from combining both methods and theory (*Figure 6*). It is the plan for how the research will proceed. We discuss the "Theoretical Background" in chapter three and “Research Design” in chapter five.

1.2 The Nature of Research in Information Systems

Research is a practice where somebody uses resources to achieve and deliver something that has implications for an entity (Ågerfalk & Karlsson, 2020). Information systems research aims at studying the interaction between information technology, organization, business, and society. However, the theoretical boundaries are not well-defined due to the interactions with different scientific fields such as management science, organizational studies, economic science, and social sciences. Although management science was in a dominant position serving as a reference discipline, this decreased lately due to the growth of other domains such as strategy, marketing, and many others (Bernroider, Pilkington, & Córdoba, 2015).

Researchers argue that the information systems discipline is an applied science that has reached maturity since it can serve as a foundation for more IS research (Avison & Elliot, 2006). However, they also argue that IS discipline focuses on technology applications instead of the fundamental technologies and theories (*Figure 7*) (Avison & Elliot, 2006). There is less emphasis on the technologies themselves (the hard ones). *Figure 7* shows the focus of the different disciplines, although that doesn’t reflect the amount of work conducted or their contribution.

Figure 7: Differentiating IS from other social science disciplines



Source: adapted from Avison & Elliot (2006)

Because the emphasis in IS research is on the soft aspect, that may suggest it is more on the social science side than on the engineering. Nevertheless, in other social science domains, they don't share the emphasis on applying technology to organizations or society. Although there is considerable overlap between these disciplines, there are differences in the focus, purpose, and associated activities (Avison & Elliot, 2006).

As information systems research has many fundamental and valuable reference disciplines, some researchers argue that it can now provide reference discipline for others (Baskerville & Myers, 2002). However, other researchers doubt that it has reached that status (Wade, Biehl, & Kim, 2006). We support the argument that IS research can serve as a foundation for further IS research, indicating discipline maturity (Baskerville & Myers, 2002). IS research has become a healthy system where competition is between ideas rather than a central direction (Tiwana A. , 2019).

The interdisciplinary nature of information systems research

Some researchers claim that information system research emerged from three foundational fields: computer science, management science, and organizational science (Culnan & Swanson, 1986). They also agree that it is an interdisciplinary field and the IS researchers have different academic backgrounds (Benbasat & Zmud, 2003).

In interdisciplinary research (IDR), different disciplinary perspectives join to provide a systemic outcome. That is in contrast to multidisciplinary research, where each discipline works separately (*Figure 8*) (Huutoniemi, Klein, Bruun, & Hukkinen, 2010). The IDR nature of the IS discipline has the objective of studying the interaction between technology and

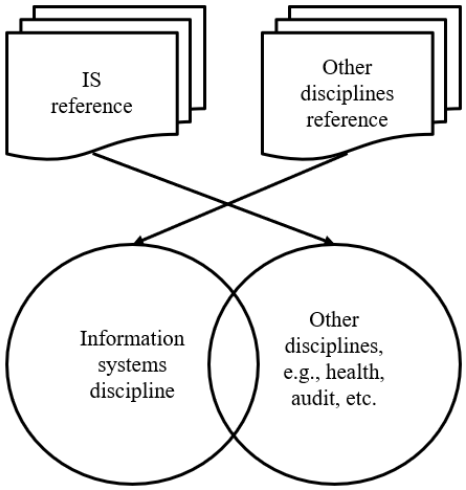
human actors. That explains the need to explore new theoretical and methodological research guidelines (Cordella & Mola, 2008).

Figure 8: Interdisciplinary vs. multidisciplinary research

Source: own work

We define IDR as a conceptual model that employs the integration of theoretical frameworks from different disciplines (Aboelela, Bakken, Carrasquillo, Formicola, Glied, & Gebbie, 2007). Its study design and methodology are not limited to any specific field. Further, it requires perspectives and skills of the integrated disciplines in all the phases of the research process. Furthermore, the output of the integration process should result in new and transformative to the fields under study and serves to solve a problem (MacLeod & Nagatsu, 2018). That should result in new concepts and practices with a better reflection and understanding of the set of phenomena that was the target of the research (Aboelela, Bakken, Carrasquillo, Formicola, Glied, & Gebbie, 2007; MacLeod & Nagatsu, 2018).

Figure 9: Interdisciplinary research (IDR)



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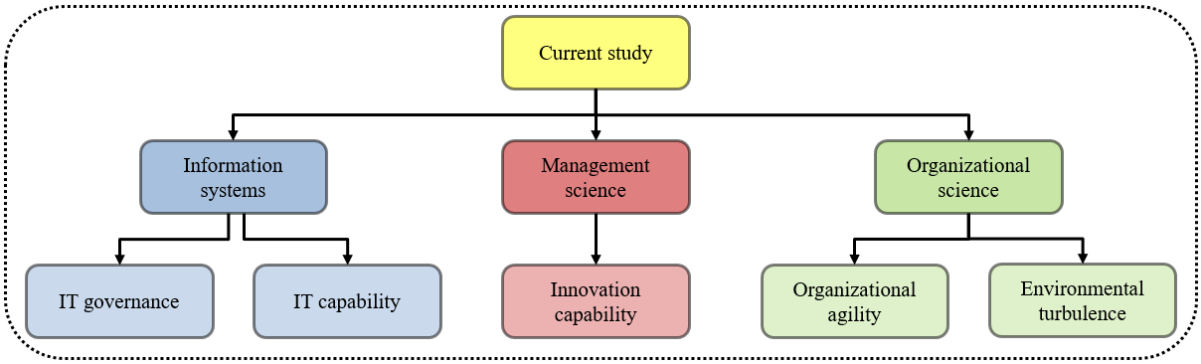
IDR poses different challenges to the information systems discipline (*Figure 9*). One is to expand the discipline boundary of information systems topics. Another is interacting with other domains to explain information systems-enabled phenomena (Tarafdar & Davison, 2018). The theoretical boundaries of information systems are becoming less defined due to

the interactions among management science, organizational studies, social sciences, and economic science. That reflects on the approaches to studying the interaction between information technologies, organizations, and society (Cordella & Mola, 2008). Most theory contributions in the interdisciplinary field try to explain, extend, or apply existing theories in newly relevant ways.

Figure 10: The interdisciplinary nature of the current study



Source: own work

The interdisciplinary nature of our study (*Figure 10*) has implications both from the theoretical perspective and in the literature review methodology. In chapter three, we discuss the impact on theory selection. In the following chapter, we discuss the impact on the literature review.

2 LITERATURE REVIEW

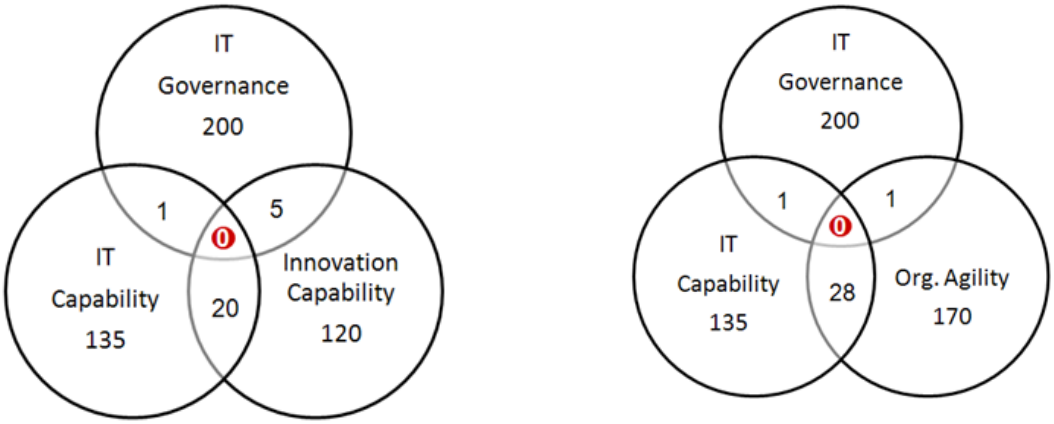
We outline in this chapter the methods used for the literature review, such as narrative and systematic literature review, and what we did. We explain the difficulties encountered in our study because of the research's multiple domains. We discuss how we conducted the phases of our literature review, and we present the results reached.

Then, we review the six domains of our research: IT governance, organizational agility, IT capability, innovation capability, environmental turbulence, and firm performance. We discuss these topics from selected papers, many of them from the basket of eight journals focused on information systems research. We examine how they relate to each other and how they provide the rationale for the model of this study.

2.1 Literature Review Phases

Literature reviews are one of the ways to acknowledge that researchers are standing on the shoulders of giants. The process of conducting a literature review faces many challenges. One is the rapidly increasing number of publications. Another is access to these publications. Finally, we have the task of assessing their qualities for selection and inclusion in the review report.

Figure 11: Literature review results



Source: own work

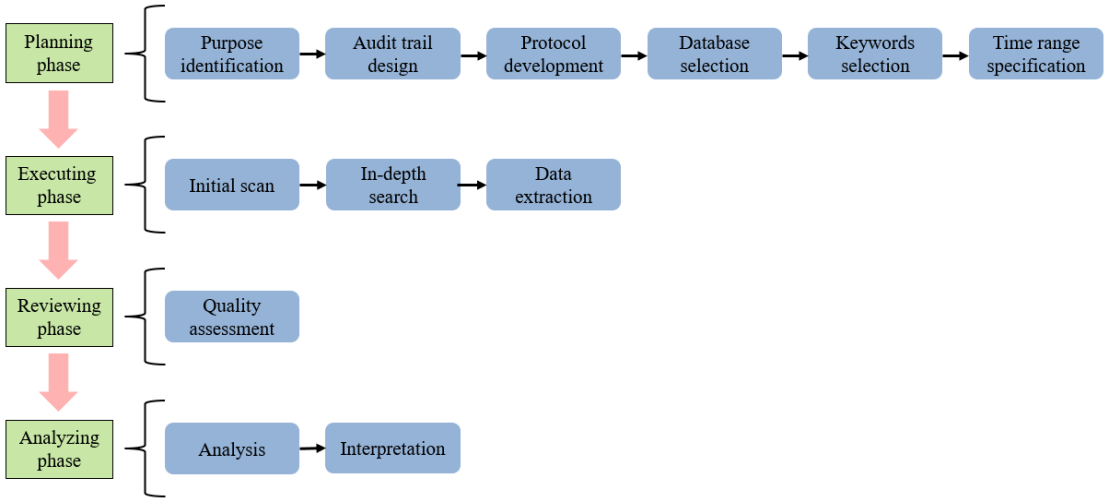
A literature review can serve many purposes. Some researchers use it to create standalone papers, while others use it as a background for research. We used it in our study to serve as a review section in a dissertation (Vom Brocke, Simons, Riemer, Niehaves, Plattfaut, & Cleven, 2015). It helped us cover the publications in the different fields of our study: information systems, innovation, and organizational agility. That provided a solid foundation for the current research dissertation. It emphasized our motivation and documented the research gap that confirmed our study's originality (*Figure 11*).

At the beginning of our research in 2018, there were no studies to examine the relationships between the IT governance and capability side and innovation capability or organizational agility on the other side (*Figure 11*). We argue that such relationships are crucial to understanding the antecedents of organizational agility. We claim that IT governance can play a vital role in developing and maintaining organizational agility, whether directly or through mediators such as innovation and IT capabilities. Because there were limited studies to examine such relationships, that indicated a gap that is highly relevant academically and professionally and necessitated investigation. IT governance mechanisms can provide the management control that can strongly influence developing and sustaining organizational agility, especially under turbulent environments.

The literature review explained the necessity of having different coverage approaches in the research domains. In short, the literature review process helped us to manage knowledge diversity for specific academic research. It enabled us to assess the existing knowledge areas and develop a research question to advance further.

Literature review analyzes and synthesizes previous knowledge on topics of interest, delineating biases and gaps, and then proposes future research directions (Rowe, 2014). The extent of having relevant coverage is perhaps the most distinct aspect of the literature review (Boote & Beile, 2005). However, these topics may have different completeness and quality assessment levels (Grant & Booth, 2009). Thus literature review does not have to integrate all the knowledge extracted into a coherent, logical conclusion (Rowe, 2014).

Figure 12: Literature review phases



Source: own work

There are different methodologies to conduct a literature review based on the purpose, e.g., narrative, systematic, and critical (Grant & Booth, 2009). We used the narrative review in the current study. It was practically difficult to conduct SLR for multiple disciplines, especially when we could not find any publications that link them together. So, we borrowed many steps from the systematic review process (*Figure 12*) to improve the quality of the narrative one and reduce bias (Ferrari, 2015). Narrative literature review methodology is perhaps the most common, but it received a lot of criticism because of the potential of implicit biases in the selection process. That led the medical profession to pursue an evidence-based medicine approach to improve the review process quality by systematically analyzing research (Guyatt, 1992). Medical researchers argue that medical literature reviews need to be more effective in guiding the change in the medical practice. It will enable the decision-makers to become better informed about health care delivery. The resulting impact will lead to a paradigm shift (Guyatt, 1992). Even though systematic literature review has its roots in evidence-based medicine (Boell & Cecez-Kecmanovic, 2015), its practice has moved into other disciplines such as management and information systems (Tranfield, Denyer, & Smart, 2003).

Researchers argue that systematic literature reviews are domain-based, theory-based, or method-based (Paul & Criado, 2020). That shows the challenges faced when having multiple domains in conducting our research. That also explains our approach for conducting a narrative review supplemented by systematic literature review procedures. We define systematic literature review (SLR) as a protocol-based approach with explicit steps (Okoli &

Schabram, 2010). The systematic approach ensures that the literature review is objective and replicable (*Figure **12***). Researchers primarily use it to answer the research question, with the evidence for that answer. Part of the protocol is to define the inclusion and exclusion criteria. Such criteria provide the possibility for replication of the review with less reliance on the researcher's interpretation. That would minimize subjectivity and eliminate bias. However, that may or may not include quality assessment. In short, the systematic literature review provides the strength of the critical review, comprehensive searching, and practice recommendations.

We conducted the literature reviews in four phases (*Figure **12***). They are the planning, executing, reviewing, and analyzing.

Planning phase

First, the planning phase includes the essential components required to perform the systematic review effectively. It has purpose identification, audit trail design, protocol development, database selection, keywords selection, and time range specification (*Figure 13*).

Figure 13: Planning phase steps

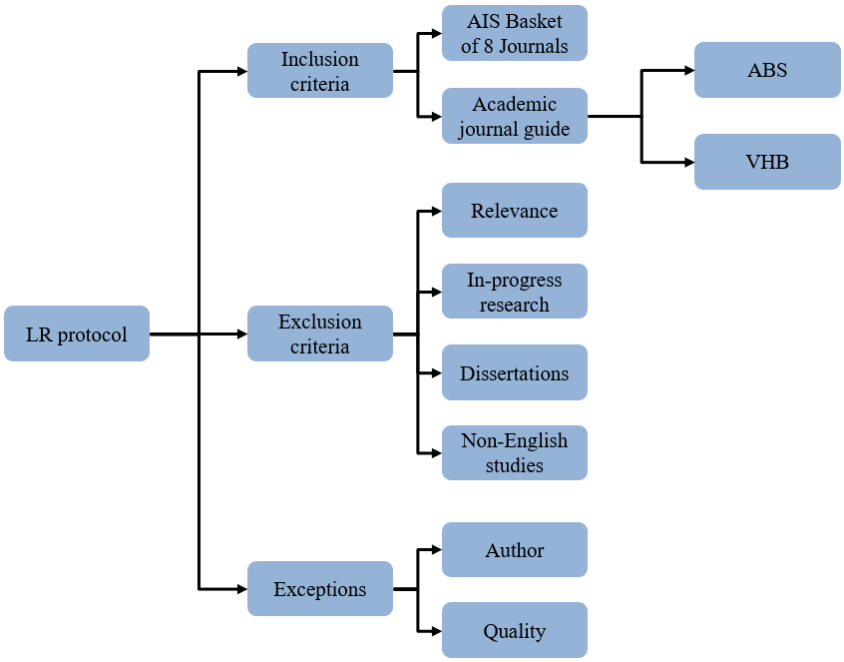
Source: own work

Purpose identification refers to the research question, and it is perhaps the most critical step that will influence the validity of the literature review. The research question in the study examines the relationship between three separate disciplines, as explained earlier. To set the boundaries for the purpose, we defined the search scope. The search scope guided us to outline the basic features of the review. It depends on four elements: process, sources, coverage, and techniques (Vom Brocke, Simons, Riemer, Niehaves, Plattfaut, & Cleven, 2015). The plan for our search process is to be iterative to enable reviewing and analyzing continuously. It needs to be comprehensive for IT governance and to include relevant publications as much as possible. That will also validate the existence of any relationships between that domain and the other domains. In doing so, we relied on different publications covering seminal works and leading articles. We selected relevant studies for the rest of the research domains that support the current research.

We created **an audit trail** to demonstrate all the steps we used (Randolph, 2009). Thus, we can support the evidence interpreted and provide objectivity and a defined replicable process. We developed an information system to store and manage the audit trail requirements. It allows us to code the articles using different approaches. One is to have high-level coding categories, e.g., ITG, OA, ITC, IC, FP, TT, and MT. Keyword tagging for the articles

provides the needed flexibility to assign different labels besides categories and sub-categories. For example, innovation capability is a category that has different sub-categories such as product innovation, service innovation, process innovation, etc. It is also possible to add other keywords, e.g., supply chain agility, PLS-SEM, and RBV. The information system also allows us to have excerpts from the articles cited in the dissertation. It also includes the paraphrased version that exists in the dissertation.

Figure 14: Literature review protocol



Source: own work

We developed a **protocol** to outline the inclusion and exclusion criteria and the rules for exceptions (*Figure 14*). That will support validity and reproducibility. Our inclusion criteria range from articles published in journal articles, conference proceedings, and books to relevant scientific and management magazines. We used the Academic Journal Guide (AJG) (2015, 2018, and now the 2021 version) published by the Association of Business Schools (ABS[1]). We also used the journal guide published by The German Academic Association of Business Research (VHB[2]). They have different scoring rankings for some journals, as shown in the sample list for both guides in Appendix 6. The scoring guide and the number of citations for published articles helped prepare the prioritization list for review (*Table 2*). We included articles published in IS conference proceedings, e.g., ICIS, ECIS, PACIS, AMCIS, HICSS, but only the VHB has a scoring system for these conferences (*Table 3*). The included articles have both conceptual and empirical ones. Because of the nature of the IDR, we included quantitative, qualitative, and case studies.

[1] Now, it is called the Chartered Association of Business Schools (CABS)
[2] VHB: https://vhbonline.org/en/

We excluded in-progress research, dissertations, and studies not written in English. We didn't discard any article that is either not listed in both journal guides or has low-scoring rankings. We only discard it if checked and proved that it doesn't meet the relevance required. The checking included the title, the abstract, quality of the full article. There were exceptions as we kept those with relevant, high-quality content, even with a low-scoring ranking, e.g., Tallon P. P., 2008. We also retained some that are not in both journal guides. For example, we cited the Journal of American Medical Association (JAMA) and the British Medical Journal (BMJ) because of their relevant content and high-quality standards. That also applied to other publications by different recognized organizations such as Information Systems Audit and Control Association (ISACA) and Forrester Research.

Table 2: The scoring system used in the inclusion criteria

The scoring system used in the inclusion criteria			
ABS		VHB	
4*	A world elite journal	A+	World leading
4	A top journal	A	Leading
3	A highly regarded journal	B	Important and respected
2	A well-regarded journal	C	Recognized
1	A recognized journal	D	Peer-reviewed

Source: Harzing (2021)

Table 3: VHB scoring system for IS conferences

IS conferences	VHB score
ICIS	A
ECIS	B
PACIS	C
HICSS	C
AMCIS	D

Source: VHB

We based our search strategy for **database selection** on employing Google Scholar (GS). Researchers argue that GS is the most comprehensive academic search engine for publications and citations. Furthermore, it is free (Gusenbauer, 2019; Harzing, 2019; Martín-Martín, 2021). However, the candidate faced the challenge of existing different citation versions for the same article in Google Scholar search results. In some cases, that required going through all of them to get the appropriate and complete one. When it wasn't possible to find the correct citation, it was necessary to go to the publishing source for citation verification.

Keywords selection can be tedious work. However, we used different keywords for the used domains of information systems, business, theory, and methodology. Information systems keywords included IT governance, Information Technology governance, IT capability, and information technology capability. Business keywords covered innovation capability,

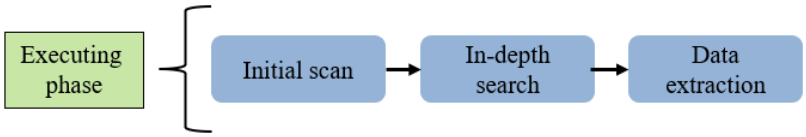
innovation capacity, organizational agility, business agility, business process agility, enterprise agility, market turbulence, and environmental turbulence, among many others.

There were **no time restrictions** on any study for any of the main domains of research. When searching for theories such as resource-based review and dynamic capabilities view, it was mandatory to go back in time to check some old articles.

Executing phase

The second phase is executing the plan outlined earlier. It has three components: the initial scan, in-depth search, and data extraction (*Figure 15*). During execution, we returned to the planning phase to make necessary adjustments. That explains the iterative nature of the reviewing process.

Figure 15: The executing phase

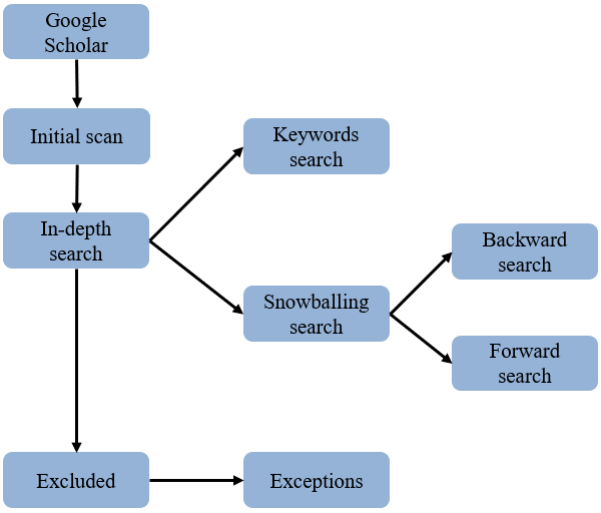


Source: own work

The **initial scan** is what we call a preliminary literature review. The objective of the initial scan was to understand the topics of interest and describe the relationships that may exist between them. It relies on screening the title, the abstract, and the introduction (if needed). It was also essential for us to check the research models in the target disciplines and review their conceptualization. We conducted the scan on each domain separately and then in combinations of twos and threes. Meantime, having a comprehensive search for IS part should reveal any link to other disciplines.

We performed the literature search based on the lines of the narrative review search. However, it included features from the systematic review methodology (Figure 16). Our **in-depth search strategy** employed two approaches: keywords and snowballing search (Greenhalgh & Peacock, 2005). In the **keyword search**, we used different keywords as mentioned earlier, e.g., IT governance, Information Technology governance, etc. The **snowballing approach** consists of backward and forward searches (Webster & Watson, 2002). First, we conducted a **backward search** (reference tracking) by going backward in time based on the references listed in the articles retrieved. We followed this by having a **forward search** (citation tracking) by checking publications that cited these articles. Citation tracking also helps identify articles published in unknown journals (Greenhalgh & Peacock, 2005). However, for a comprehensive literature search, we always risk the inability to collect all selected publications. We faced these challenges when the search results had books, some old articles, and priced articles. The total number of articles retrieved at the time for all the domains reached 625 publications (*Table 4*). However, the results for the combined ones are in *Table 5*.

Figure 16: Literature review search strategy



Source: own work

The in-depth search revealed the limited publications for the combined two domains. However, it is worth noting that there were no publications when combining the information systems discipline, represented by IT governance and IT capability, with either organizational agility or innovation capability (*Figure 11*) and (*Table 5*). The result confirmed the gap status that no prior research exists to explain the role of IT governance in the rest of the domains. Although IT governance is critical for IT capability in professional practice, only one academic article was available to study that relationship. Furthermore, there were no prior studies on the impact of the combined two IS components on the other two domains. That provided strong motivation to pursue the scope of research, considering that while business value is the driver, IT is the enabler (Henderson & Venkatraman, 1999). We used the in-depth step to review the relevance of the collected articles, the conceptualization of the research model, the methodology used, and the contribution.

Table 4: Search results for the domains of the study

Domain of research	Number of articles reviewed
OA	170
ITG	200
ITC	135
IC	120
Total	625

Organizational agility (OA), Information technology governance (ITG), Information technology capability (ITC), Innovation capability (IC)

Source: own work

Table 5: Search results for combined domains

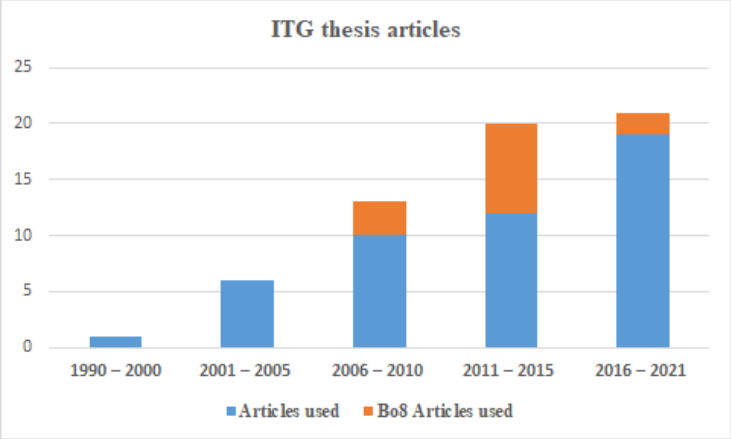
Information systems	OA	IC
ITG	1*	5
ITC	28	20
Combined ITG and ITC	0	0

*Published in 2021 in the International Journal of Accounting Information Systems

Source: own work

It is worth noting that the AIS[3] basket of eight journals may have a higher impact on information systems research. Yet, for example, in IT governance, we found that the number of relevant articles published in other journals was significantly higher than in the basket of eight journals (*Table 6*). We cited IT governance studies that include selected relevant ones from different journals in *Table 7* and *Figure 17*. Only 13 articles from a total of 48 are BoE publications.

Figure 17: ITG articles cited in the dissertation



Source: own work

Table 6: Number of published IT governance articles

ITG articles – time range	Number of articles	Number of articles in BoE[4]*
1990 – 2000	10	5
2001 – 2005	27	1
2006 – 2010	43	4
2011 – 2015	83	14
2016 – 2021	70	2
Total number of articles	233	26

*BoE=AIS Basket of Eight Journals

Source: own work

Table 7: Number of cited IT governance articles in the study

ITG used articles – time range	Number of articles	Number of BoE articles
1990 – 2000	1	0
2001 – 2005	6	0
2006 – 2010	10	3
2011 – 2015	12	8
2016 – 2021	19	2
Total number of articles used in the study	48	13

Source: own work

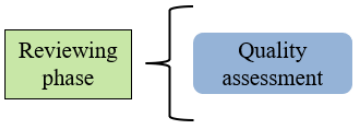
[3] AIS: Association of Information Systems

[4] BoE is not a standard abbreviation for the basket of eight journals. The candidate developed it for easier textual reference.

After finishing the search and identifying the relevant articles, we proceeded with systematic data extraction of the desired information from them. *Table 8* includes a sample of extracted data from some selected studies. The research question in the protocol provided the basis for the type of extracted data.

Reviewing phase

Figure 18: The reviewing phase



Source: own work

In the reviewing phase, we assessed the quality of the selected articles (*Figure 18*). Some scholars refer to the **quality assessment** as a screening process for further exclusion (Okoli & Schabram, 2010). We used relevance, conceptualization, methodology, and contribution as criteria for quality appraisal. We also added the journal scoring system to refine our quality assessment. That resulted in defining which articles we will cite and reference in the dissertation.

Analyzing phase

Figure 19: The analyzing phase

Source: own work

In the analysis phase (*Figure 19*), we used matrix tables to review extracted data and **analyze** the research components across different articles (*Table 8*). Data extraction depends on the purpose of the review. It can range from overview, study type (quantitative, qualitative, case, conceptual, etc.), research models, theoretical perspectives, research design, contribution, etc.

For example, we checked the statistical analysis model, model justification, and sample size in selected quantitative studies relevant to our case to validate our research design (Table 8). We linked in our analysis the data extracted to the journal name and its score for quality enhancement. We used matrix data to review and interpret the findings and contributions in relevant articles. These selected studies are quantitative, having firm as the unit of analysis, and cross-sectional. Most of them have mixed-industry sectors. However, some researchers used hospitals (Bradley, Byrd, Pridmore, Thrasher, Pratt, & Mbarika, 2012), manufacturing companies (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014), and auditors who are members of a local ISACA chapter (Ali & Green, 2012). Most of the studies used PLS-SEM as the statistical approach of choice justified because of having formative constructs, small sample

size, or complex relationships in the research model. The literature review we conducted served its purpose and supported our plan for pursuing the current dissertation.

Table 8: Analysis of selected quantitative studies

DO	Selected reference	Journal	Scoring	Stat	Reason	Size
OA	Chen, Y. et al. (2014).	European Journal of Information Systems	BoE 3/A	CFA	R	214
	Felipe, C. M. et al.(2016).	Journal of Business Research	3/B	PLS	Prediction	172
	Lowry, P. B. et al.. (2016).	Journal of Strategic Information Systems	BoE 3/A	PLS	F	400
	Queiroz, M. et al. (2018).	Journal of Strategic Information Systems	BoE 3/A	PLS	F	120
	Ravichandran, T. (2018).	Journal of Strategic Information Systems	BoE 3/A	PLS	F	129
ITG	Ali, S. et al. (2012).	Information Systems Frontiers	3/B	SEM	R	110
	Bradley, R. V., et al. (2012).	Journal of Information Technology	3/A	PLS	F	164
	Héroux, S. et al. (2018).	Information Systems Management	2/C	PLS	Small size	66
	Tiwana, A. et al. (2010).	Information Systems Research	3/B	PLS	F	223
	Wu, et al. (2015).	MIS Quarterly	BoE 4/A+	PLS	F	136
ITC	Benitez, J. et al. (2018).	Information and Management	3/B	PLS	F	203
	Lu, Y. et al. (2011).	MIS Quarterly	BoE 4/A+	CFA	R	128
	Mikalef, P. et al. (2017).	Journal of Business Research	3/B	PLS	F	274
	Pavlou, P. A. et al. (2010).	Information Systems Research	3/B	PLS	Complex	386
	Roberts, N. et al. (2012).	Journal of Management Information Systems	BoE 4/A	CFA	F	188
IC	Camisón, C. et al. (2014).	Journal of Business Research	3/B	PLS	F	144
	Jiménez-Jiménez, D. et al. (2011).	Journal of Business Research	3/B	SEM	R	451
	Menguc, B. et al. (2006).	Journal of the Academy of Marketing Science	4/A	CFA	F	242
	Ngo, L. V. et al. (2019).	Journal of Business Research	3/B	PLS	Small size	150

DO=Domain, OA=Organizational agility, ITG=IT governance, ITC=IT capability, IC=Innovation capability, R=Reflective construct, F=Formative construct

Source: own work

2.2 IT Governance

IT governance emerged as a new concept with a significant positive impact on information technology (De Haes & Van Grembergen, 2005). Many authors reviewed the many definitions of IT governance in so many articles (Aasi, Rusu, & Vieru, 2020; Leo & Panetta, 2018; Turedi & Zhu, 2019; Vejseli & Rossmann, 2017; Wu, Straub, & Liang, 2015; Lee & Lee, 2009; Levstek, Hovelja, & Pucihar, 2018). A recent article has cited 35 definitions for IT governance used (Gregory, Kaganer, Henfridsson, & Ruch, 2018). These many definitions of IT governance indicate a lack of a common unified definition among academics since information systems is a relatively new domain that stems from diversified other domains such as social science and computer science (Webb, Pollard, & Ridley, 2006). Still, IT governance is also a relatively new sub-domain. However, in practice, only the definition of the IT Governance Institute (Guldentops, et al., 2003) prevails and is the one most widely adopted by IT professionals and IT auditors. That definition also serves as a popular base definition in academic research and the definition used in this paper.

According to the IT Governance Institute (ITGI), IT governance is the management control exercised by the board and senior management to achieve the business objectives under normal or turbulent environmental conditions (Guldentops, et al., 2003). This control is communicated and exercised through the organizational structure and its processes. Some organizations do not have a board of directors to supervise IT governance implementation and practice. However, for example, firms operating in the US need to exercise IT

governance, complying with US law. That shows in different IT practices, such as submission of accurate and transparent financial reports, and assurance of security and privacy practices, among many other requirements. IT systems, such as enterprise resources planning (ERP), commonly generate financial documents, and as such, they must also comply with management controls.

IT governance is about the strategic direction of IT at the board level with the needed control to align IT objectives with business objectives to realize the business value of IT and mitigate the IT risks encountered. The integration of the strategic plans of IT and business is a crucial factor for achieving business objectives. While the business strategy is the driver, the IT strategy is the enabler (Henderson & Venkatraman, 1999). IT governance provides the management control for IT resources and capabilities, including the outsourced ones (Lioliou, Zimmermann, Willcocks, & Gao, 2014), although these controls still show limitations in current practice (Aubert & Rivard, 2020). Further, poor or lack of IT governance will often demonstrate poor acquisition, development, and utilization of IT resources and eventually poor IT capability and performance. The impact will be over-budget projects, unjustified rising operating costs, and exposure to unnecessary risks with unplanned responses (Ali & Green, 2012).

Firms that have more effective IT governance showed 25% more profits, and effective IT governance is considered the single most significant predictor of the business value of IT (Weill & Ross, 2004). For example, benefits realization from ERP investments is more rewarding in organizations with effective IT governance (Bernroider, 2008). IT is more than a tool to support business; it is a resource that, when managed effectively, can lead to a higher competitive advantage for the firm, and it is a critical factor in determining whether organizations are getting acceptable value from their IT investments (Weill & Ross, 2004). Organizations that succeed where others fail have one thing in common, effective IT governance.

Research in the IT governance domain went through different streams from its beginning in the mid-1990s till now (Musson, 2009). One stream relied on the relationship between IT governance and the audit process. IT auditing is a management control practice exercised by the board and senior management over IT resources and capabilities. The purpose of this stream is to enable effective and efficient IT management through the implementation of different frameworks such as Control Objectives for Information Technology (COBIT), Information Technology Infrastructure Library (ITIL), and Capability Maturity Model Integration (CMMI), among others. However, COBIT, released by the Information Systems Audit and Control Association (ISACA), is the de facto framework that provides best practices for IT management and control (Joshi, Bollen, Hassink, De Haes, & Van Grembergen, 2018). COBIT also defines different IT controls that cover SOX 404, a subsection of the Sarbanes-Oxley Act, and more to provide reasonable assurance to meet business objectives. However, the role of IT auditors is different from that of IT managers,

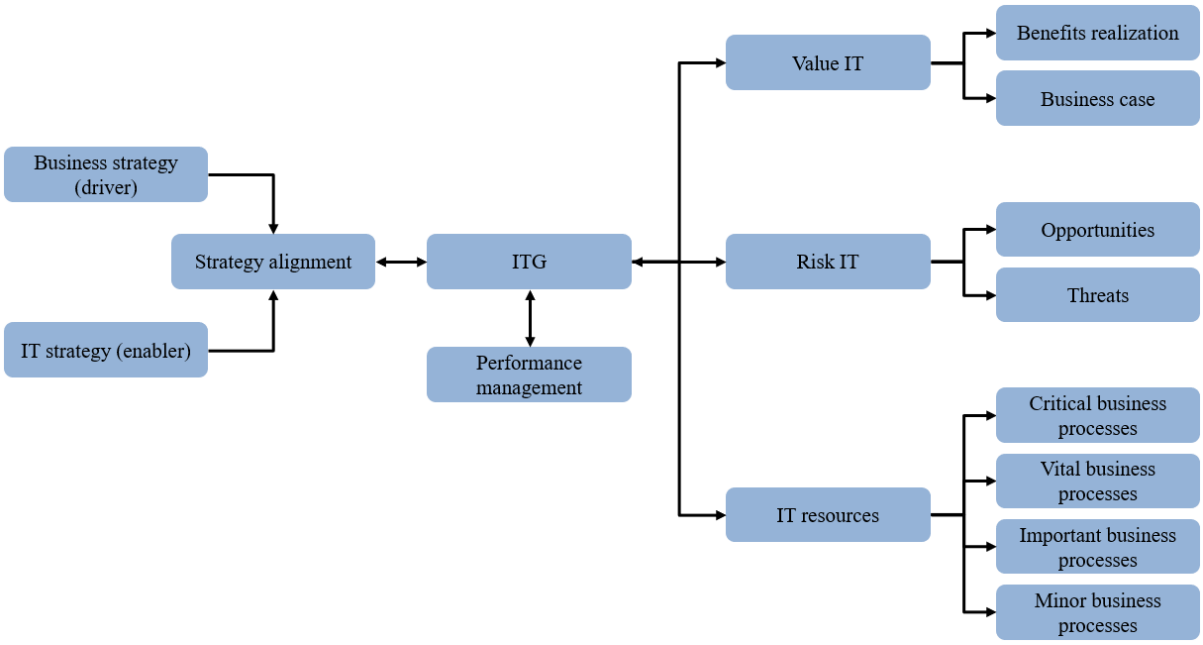
who, for example, may lower their perception of IT risks due to a false perception of managerial control (Nuijten, Keil, van der Pijl, & Commandeur, 2018).

The audit stream seemed to work on its own for quite some time, but then it became under the umbrella of corporate governance. That occurred after so many scandals in corporate management, and it has become a requirement for effective corporate governance. It is hard to assume that the IT department would start an expensive implementation of IT controls that can affect most, if not all, business units, especially the core ones, without any support from senior management of these business units. As IT governance has a significant influence on business units, directly and indirectly, it also has strong communication and two-way interactions with them. Simply put, it can't function without the approval of senior business managers for these IT controls.

Senior management may need to communicate these controls to the designated staff along the hierarchy vertically and across business units horizontally. They may also need to interact externally when relevant, e.g., with customers and suppliers. That requires active communication with most business units, including the IT department, regardless of the IT structure, processes, and communication mechanisms. These controls need to serve the business objectives at the level of each business unit individually to align with the organization's strategy. They also need to support the firm as a whole. There is a need to have IT governance mechanisms to oversee many activities and their controls, e.g., design, development, outsourcing, and implementation. That necessitates having a proper structure (e.g., IT steering committee), the needed processes (e.g., cost/benefit/risk analysis), and communication processes (e.g., shared understanding of business/IT objectives). The discussion of these mechanisms will be in the following section.

Another stream of research is having the board of directors for IT governance as the primary focus. However, as mentioned earlier, not all companies have a board of directors which may explain the variations in implementing IT governance in different companies (Huang, Zmud, & Price, 2010). IT governance is the responsibility of the board of directors and senior management. Board-level IT governance is an entity that is separate from managerial-level IT governance (IT management). Board-level IT governance is responsible for monitoring and controlling managerial IT decisions and implementing IT governance mechanisms over IT resources and IT investments (Benaroch & Chernobai, 2017; Jewer & McKay, 2012; Ali S. , Green, Robb, & Masli, 2021). The board and senior management exercise their assigned responsibilities through management control over practices. Some researchers argue that such an effect is partially mediated through IT operational capabilities that influence a firm's financial performance (Turel, Liu, & Bart, 2019).

Figure 20: ITG domains

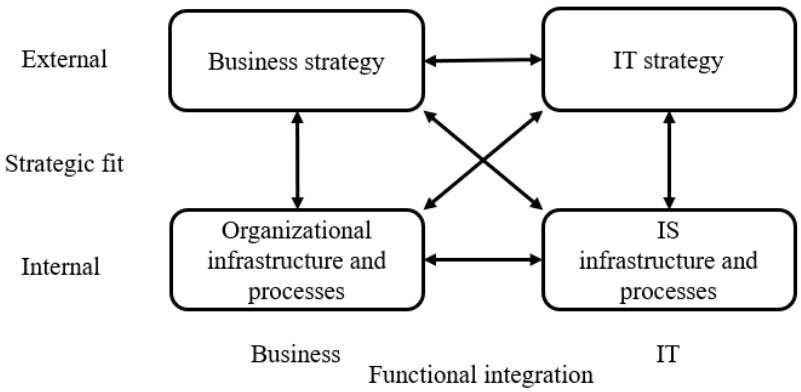


Source: own work

The IT governance mechanisms provide IT strategic direction to achieve business objectives with proper management. They maintain a balance between IT value, IT risks, and utilization and optimization of IT resources and capabilities. These mechanisms provide a framework for implementing organizational structures, processes, and communication, which, in turn, will enable realizing business objectives under normal or turbulent environmental conditions (Guldentops, et al., 2003).

Recently, there has been an interest in key focus areas of IT governance identified by ITGI (*Figure 20*) as the outcome of effective IT governance (Guldentops, et al., 2003). They include strategic alignment of business and IT, realizing the planned IT business value, managing IT risk, and efficient management of IT resources (Lunardi, Maçada, Becker, & Van Grembergen, 2017; Buckby, Best, & Stewart, 2009).

Figure 21: Strategic alignment model (SAM)



Source: adapted from Henderson & Venkatraman (1999)

We identify the relationship between business and IT in the strategic alignment model (SAM) (Henderson & Venkatraman, 1999). The model serves to conceptualize the area of strategic management of IT. It has two components: strategic fit and functional integration (*Figure 21*) (Henderson & Venkatraman, 1999; De Haes S. , Van Grembergen, Joshi, & Huygh, 2020). The first component is the strategic fit, which refers to what extent the organization can align its resources and capabilities to the opportunities in the environment externally. It also indicates how the IT infrastructure should be managed and configured internally (Auster, Basir, & Ruebottom, 2016). So, companies must have the resources and capabilities to accomplish their strategy and enhance their competitive status. However, researchers emphasize a dynamic strategic fit (DSF) because of the dynamic changes encountered by the organizations (Zajac, Kraatz, & Bresser, 2000). Thus, the dynamic strategic fit is highly valuable when companies face unpredictable conditions. Failing to change will put the strategy at risk of becoming obsolete. When an organization develops more or less than the required change, it is considered a dynamic misfit.

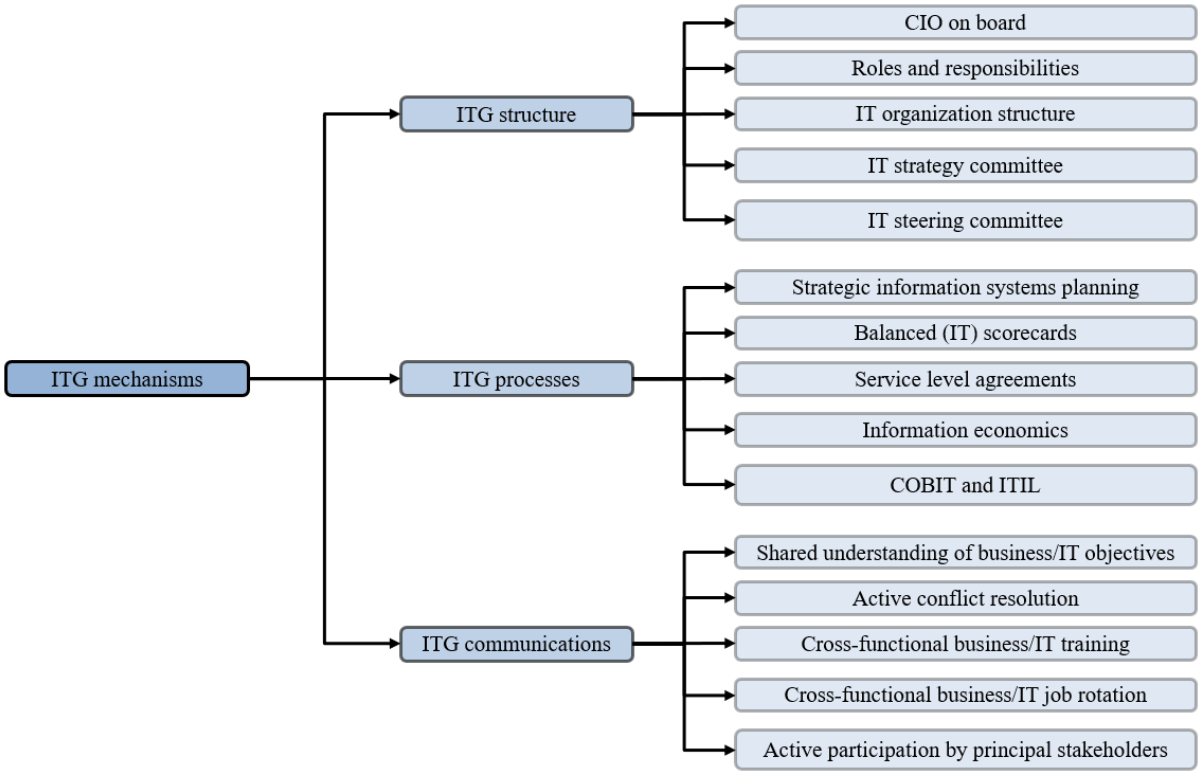
The second component is functional integration, which refers to strategic and operational integration. Strategic integration connects the business strategy and IT strategy, and it is crucial when IT is a source of external strategic advantage. On the other hand, operational integration is more concerned internally within the organization as it links the infrastructure and processes of business and IT.

IT Governance Mechanisms

Three core IT governance mechanisms contribute to effective IT governance (Ali & Green, 2012; Bradley, Byrd, Pridmore, Thrasher, Pratt, & Mbarika, 2012; De Haes & Van Grembergen, 2005; Weill & Ross, 2004; De Haes & Van Grembergen, 2009; De Haes S. , Van Grembergen, Joshi, & Huygh, 2020). These mechanisms are considered unique to the organizations and indicate their roots are in the RBV. Each organization will select the appropriate IT practices relevant to its business objectives and industry standards (*Figure 22*). Accordingly, they have them reviewed and audited regularly for compliance. These mechanisms impose the necessary control to align IT objectives with business objectives.

The first mechanism is the ITG structure which defines the roles, responsibilities, and accountability for IT decisions, including those involved with the IT investment process. Some researchers prefer to categorize ITG structure into reporting relationships, governance-specific positions, and committees (Symons, 2005). As the CIO reports to the CEO, this enhances the effectiveness of IT governance structures. Furthermore, the IT leadership positions at the top of the IT organizational structure, such as the chief information officer (CIO) and the chief digital officer (CDO), are involved in board meetings. They define the vision and mission for information technology's role in the company and share it with all relevant parties. Job positions that are governance-specific include ITG officers reporting to the CIO and IT auditors reporting to the audit committee.

Figure 22: Examples of ITG mechanisms



Source: own work

The board of directors fulfills their governance responsibilities through committees, such as the IT strategy committee, which enables them to consider the criticality of IT. The IT strategy committee has strong relationships with other board and management committees. These result in guiding, reviewing, and facilitating the aligned business and IT strategies.

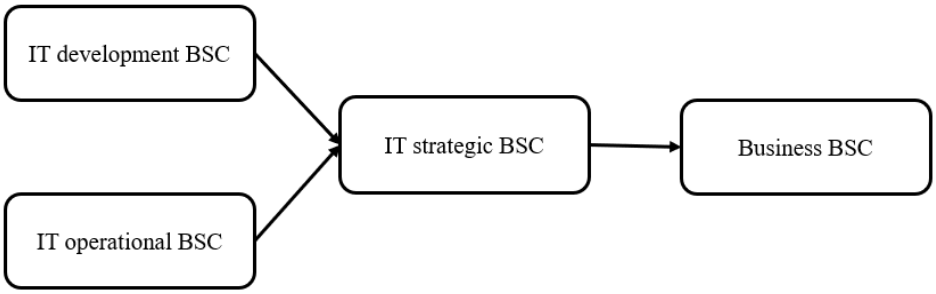
As mentioned earlier, there is no best structure, and each company usually plans its own that is suitable for its business, industry sector, firm size, and organizational culture. For example, small companies might find implementing the control separation of duties difficult because of the limited number of employees. In such cases, they may manage by having compensating controls to mitigate such risk. Compensating controls are internal controls intended to minimize the risk of an existing control weakness.

The second mechanism is ITG processes responsible for monitoring IT operations practice based on the policies and procedures approved by the board and senior management. IT professionals use different tools and techniques to perform these processes, such as COBIT, ITIL, etc. They cover many tasks, such as IT balanced scorecard analysis and cost/benefit/risk analysis.

COBIT helps define **what** management can do, and ITIL provides the **how** for service management activities. Organizations use COBIT at the highest level of IT governance to implement a management control framework. COBIT includes management guidelines, e.g.,

maturity models processes and their scorecards which can assist organizations in achieving IT governance. COBIT control objectives support IT governance mechanisms, and management can implement them using ITIL.

Figure 23: The cascade of IT balanced scorecards (BSC)



Source: adapted from Van Grembergen & Saull (2001)

For example, senior management can implement a business and IT alignment using a cascade of balanced scorecards (*Figure 23*). The balanced scorecards cascade has an IT development scorecard and an IT operational scorecard. They are enablers for the strategic IT balanced scorecard, which is the enabler of a business balanced scorecard (BSC). The linking of the business BSC and the IT BSC results in a supportive mechanism for IT governance (Van Grembergen & Saull, 2001).

The third mechanism is ITG communication. It is responsible for advocating and communicating IT governance principles, policies, and procedures. These include a shared understanding of business/IT objectives and active participation among the key stakeholders. Business and IT must understand each other. Effective IT governance is two-way communication and requires a motivated collaboration between the people of business and IT. There should be an ongoing sharing of knowledge across business units to sustain the business-IT alignment. Using different communication mechanisms can achieve that, e.g., career crossover, cross-training, and continuous education.

Table 9: Sample of selected IT governance articles

Reference	Journal	Scoring	Study	Nature	Unit	Model	Reason	Industry	Sample size
Ali et al. (2012)	Information Systems Frontiers	3/B	Quan	Cross-sectional	Firm	SEM	Reflective	Auditors	110
Bradley et al. (2012)	Journal of Information Technology	3/A	Quan	Cross-sectional	Hospital	PLS	Formative	Health	164
Héroux et al. (2018)	Information Systems Management	2/C	Quan	Cross-sectional	Firm	PLS	Small sample	Mixed	66
Tiwana et al. (2010)	Information Systems Research	BoE 4/A+	Quan	Cross-sectional	Firm	PLS	Formative	NA	223
Wu et al. (2015)	MIS Quarterly	BoE 4/A+	Quan	Cross-sectional	Firm	PLS	Formative	Mixed	136

Source: own work

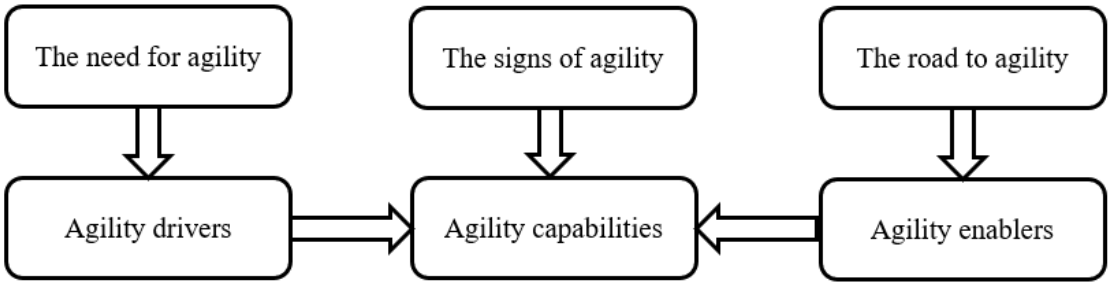
As part of the literature review of IT governance articles, Table 9 shows a sample of relevant ITG articles. They indicate the methodology, the nature of the study, the unit of analysis, the sample size, the industry, and the statistical approach.

2.3 Organizational Agility

Organizational agility is a state of readiness enabling the firm to sustain its competitive advantage under turbulent environmental conditions by empowering the firm to sense and respond quickly and effectively against such unpredictable changes (Overby, Bharadwaj, & Sambamurthy, 2006; Tallon & Pinsonneault, 2011; Van Oosterhout, Waarts, & Van Hillegersberg, 2006). Firms that possess high levels of agility are often operationally successful in turbulent conditions (Vázquez-Bustelo, Avella, & Fernández, 2007).

Agility is considered a strategic capability and a manifestation of high-order capabilities (Teece, Peteraf, & Leih, 2016; Chakravarty, Grewal, & Sambamurthy, 2013). The term "agile" came up at Iaccoca Institute at Lehigh University in 1991 when some researchers used it (Yusuf, Sarhadi, & Gunasekaran, 1999). When the environment is turbulent and unpredictable, firms face opportunities and threats. They need to respond quickly and effectively to environmental changes to sustain their competitive advantage and have superior performance. They need to be agile and renew their existing resources and reconfigure them. Past research argued that information technology and innovation capability assist firms' reconfiguration and transformation (Ravichandran, 2018).

Figure 24: Core organizational agility framework



Source: adapted from Sharifi & Zhang (2001); Eshlaghy, Mashayekhi, Rajabzadeh, & Razavian (2010)

Some researchers use flexibility and agility interchangeably (Conboy, 2009)**.** However, they do not communicate the same meaning in our study. One differentiating feature is the nature of the situations encountered. While managers can plan flexible changes in response to known cases, agile changes are unplanned responses to unpredictable changes, e.g., market or customers' preferences (Bernardes & Hanna, 2009). That means that agility encompasses flexibility. The agility concept entails both speed and flexibility. Organizations must respond

quickly and flexibly to environmental changes to sustain their competitive advantage (Breu, Hemingway, Strathern, & Bridger, 2002). With organizational agility, firms can change business and processes quickly beyond their ordinary flexibility level to manage unpredictable changes effectively (Van Oosterhout, Waarts, & Van Hillegersberg, 2006). That mostly requires the deployment of new information technology capabilities.
We outline a core framework for organizational agility in *Figure 24*. We base it on three components: agility drivers, agility enablers, and agility capabilities (Sharifi & Zhang, 2001; Van Oosterhout, Waarts, & Van Hillegersberg, 2006; Eshlaghy, Mashayekhi, Rajabzadeh, & Razavian, 2010). The posed framework will help us answer three central questions to emphasize the significance of organizational agility in our study. The questions are: **why** do some firms need to be agile? **How** can an organization become agile? And lastly, **what** are the signs of agility?

The need for agility – agility drivers

On the first question (**why**), firms need to become agile to achieve and sustain their competitive advantage. Some leading firms focused on organizing from an outside-in. In other words, instead of working on their value chain, they shifted their attention to the needs of their customers and innovative market opportunities. An outside-in mindset requires new creative management roles, policies, procedures, and practices in contrast to the prevailing hierarchical bureaucracies (Denning, 2013). It requires a firm-wide capability for responding to unexpected shifts in customer preferences and expectations. Some firms continued to follow mass-production methods with the focus on saving (e.g., economies of scale) or eliminating waste (e.g., lean methods), or on Six Sigma (e.g., quality control). These approaches share some characteristics with agility (e.g., increased flexibility), yet, their primary focus is on improved efficiency and cost-cutting, while organizational agility focuses on adding values.

When companies face turbulent conditions, they need to sustain their competitive advantage. Unpredictable conditions can pose varying degrees of threats or opportunities. These conditions act as drivers for agility. They indicate the need to be agile to encounter these conditions. These agility drivers pressure organizations to adapt to the changing environment, thus maintaining or gaining a competitive advantage (Sharifi & Zhang, 2001). They indicate the changes required for the business and motivate the company to pursue either to capitalize on an opportunity or to minimize undesirable risks. The impact of the agility drivers varies from one company to another. It can even have different changes in the same company depending on the situation encountered and the company's status at the time (Sharifi & Zhang, 1999).

The need for change is often associated with the company's vision and strategy to sustain its competitive advantage. Consequently, the need for a change dictates the need to become agile. Several drivers promote such an attitude, e.g., market, customer, competition, and

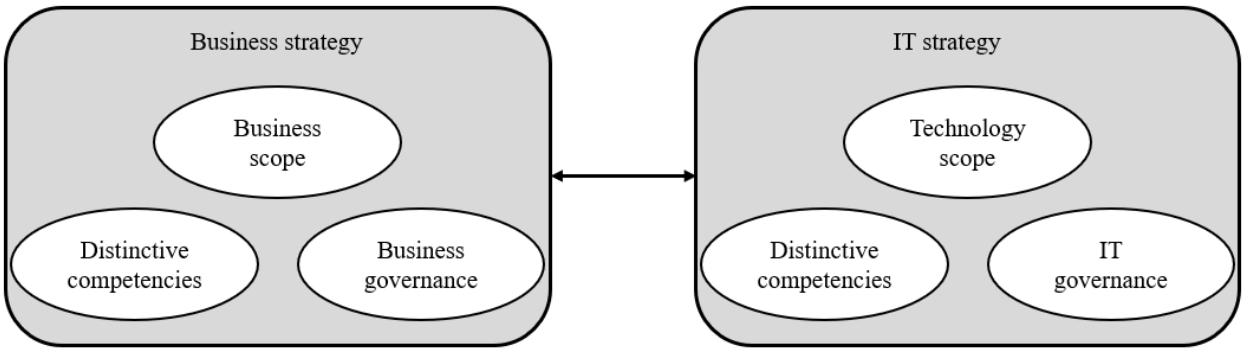
technology (Eshlaghy, Mashayekhi, Rajabzadeh, & Razavian, 2010). Market changes include growth of the niche market or shrinkage of a product lifetime. Customers may switch their preferences by demanding more individualized products and services, expecting increased quality and quick delivery time. With fierce competition, there can be increased pressure on cost or an increasing rate of innovation. Technology can be a crucial agility driver, especially when introducing new technologies, whether software or technical methods. Finally, another driver is the social factors, such as environmental pressures or workforce expectations.

The road to agility – agility enablers

In answering the second question (**how**), firms usually require agility enablers to achieve their desired agility level. We will present some of these enablers and their reflections on our study. However, we need to emphasize again the role of IT governance in the strategic alignment as it reflects on the agility enablers and the context of the study.

IT governance shines in the strategic alignment domain between business and IT, as outlined in the strategic alignment model (SAM) (*Figure 25*). It ensures that the IT strategy aligns with the business strategy, as mentioned in section 2.2 of IT governance (*Figure 21*). Because business strategy is the driver and IT strategy is the enabler, management often explores how IT can enhance the existing business strategies or replace them with new ones (Henderson & Venkatraman, 1999). We will discuss the points relevant to our study and highlight the relationships that provide the desired agility in the study's context.

Figure 25: Strategic alignment as an agility enabler



Source: adapted from Henderson & Venkatraman (1999)

Agility enablers include technology, processes, human resources, and network (Vázquez-Bustelo, Avella, & Fernández, 2007; Van Oosterhout, Waarts, & Van Hillegersberg, 2006). Some researchers argue that agility can be relevant to the organization and its business network (Van Oosterhout, Waarts, & Van Hillegersberg, 2006). They claim that when the network around an organization is agile, that will facilitate and may even require the

organization to become agile. If the organization is the only one having agility in the network, it will not act appropriately. In general, networks should be flexible and adaptable, whether internal or external. Internal networks require teamwork and knowledge sharing. External networks include suppliers, partners, and contractors.

Processes should be able to sense and respond to environmental changes with the necessary speed and effectiveness. Human resources should have the skills to be proactive and adaptable. They need to take the required initiatives on their own and respond effectively to unexpected changes. The structure should be flexible and not carved into stone. It should be possible to modify it and make it responsive to external and internal agility drivers (Vázquez-Bustelo, Avella, & Fernández, 2007). Lastly, the technology, which is a crucial enabler for agility, we will discuss in more detail in the agility capabilities section.

The signs of agility – agility capabilities

In answering the third question (**what**), we can see the signs of agility in a brave, new, agile world (not written by Aldous Huxley). Agility capabilities are the fundamental capabilities companies need to respond positively by exploiting and exploring unpredictable changes and thus realize superior performance (Sharifi & Zhang, 2001). They include speed, flexibility, competency, and responsiveness (Sharifi & Zhang, 1999). One capability is responsiveness, which is the ability to sense changes and respond quickly to them, either reactively or proactively, in an attempt at recovery. Competency is another capability that refers to the effectiveness and efficient ability in achieving business objectives. Flexibility, the third capability, is the ability to manage variable products and achieve different business objectives with the same resources. Finally, quickness is the speed of carrying out tasks in the shortest time possible.

Organizations manifest agility capabilities in different ways (*Table 10*). One way is related to the firm's customer agility (Roberts & Grover, 2012). It pertains to the firm's ability to sense and respond quickly to customer-related opportunities for innovation and competitive action. Innovation is perhaps a shared component in all roads to agility. Firms compete to give better customer experiences with more innovations to provide higher value to their products or services (Ravichandran, 2018).

Another way is to become strategically agile since it allows the firm to have an efficient and effective response to changing market conditions (Fink & Neumann, 2007). However, their responses need to be quick and aligned with their business objectives to have a better competitive advantage (Lu & Ramamurthy, 2011; Tallon & Pinsonneault, 2011). Other researchers argue that the conceptualization of agility encompasses strategic flexibility (Ravichandran, 2018; Rindova & Kotha, 2001). They claim that strategic flexibility allows the firm to respond to market changes quickly and change its business model.

However, others regard strategic capability as a sign of organizational agility (Chakravarty, Grewal, & Sambamurthy, 2013). They argue that firms must sense opportunities for competitive interventions and the need to seize them. Firms can do that by balancing two options. One is to have entrepreneurial agility that allows them to create new products, services, or even new business models. That will sustain their competitive advantage. Another is having adaptive agility that enables them to respond to environmental changes, whether market or technological.

Then, we have operational agility signs where firms can pursue operational adjustment agility, focusing on their ability to match the market's changing needs quickly and effectively by having efficient business processes. Some researchers claim that this approach is a relatively reactive response (Lu & Ramamurthy, 2011). They also argue that firms need market capitalizing agility. Market capitalizing agility emphasizes a firm's ability to continuously sense market changes and respond quickly by improving or transforming its products and services to satisfy customers' expectations. Such an aggressive change may change the existing business model into a new one. That is indeed an entrepreneurial mindset at the strategic level of the firm (Lu & Ramamurthy, 2011).

Table 10: Examples of the relationship between IT and organizational agility

Study	IT enablers examples	Signs of agility capabilities
Van Oosterhout et al. (2006)	IT infrastructure Agile application software Dynamic control and governance of the business network	Enterprise agility
Fink et al. (2007)	IT infrastructure capability	IT-dependent information agility IT-dependent strategic agility IT-dependent system agility
Tiwana et al. (2010)	IT architecture modularity	IT agility IT alignment
Lu et al. (2011)	IT infrastructure capability IT business spanning capability Proactive IT stance	Market capitalizing agility Operational adjustment agility
Tallon et al. (2011)	Strategic IT alignment IT flexibility	Firm agility
Roberts et al. (2012)	Web-based customer infrastructure	Customer-sensing capability Customer-responding capability
Chakravarty et al. (2013)	IT competencies IT infrastructure	Entrepreneurial agility Adaptive agility
Chen et al. (2014)	IT infrastructure IT business partnerships IT business process integration IT management Business IT strategic thinking External IT linkage	Business process agility
Lowry et al. (2016)	IT service quality	IT-dependent information agility IT-dependent strategic agility IT-dependent system agility
Queiroz et al. (2018)	IT application orchestration capability	Process agility
Ravichandran (2018)	Digital platform capabilities IT infrastructure flexibility Application platform scope	Customer responsiveness Operational flexibility Strategic flexibility

Source: own work

Then another sign is business process agility. It refers to how firms can change their business processes with ease and speed when facing market turbulence (Tallon P. P., 2008; Chen,

Wang, Nevo, Jin, Wang, & Chow, 2014). Process agility provides the firm with operational flexibility and thus, adapts quickly and responds to customer needs increasing the firm's revenues and reducing costs (Queiroz, Tallon, Sharma, & Coltman, 2018; Sambamurthy, Bharadwaj, & Grover, 2003).

In summary, we discussed the relevance of organizational agility and sample roads to achieve it. Firms always try to sustain their competitive advantage and improve their performance even under turbulent environmental conditions. However, to pursue any of the roads to agility, firms need to have valuable information technology and innovation capabilities that enable their transformation into agile ones.

2.4 IT Capability

Researchers have indicated that IT capability is an essential organizational capability (Wade & Hulland, 2004). Firms can achieve a competitive advantage by acquiring or developing organizational capabilities. Organizational capabilities have a hierarchy with lower-order capabilities that help them build higher-order capabilities (Rai, Patnayakuni, & Seth, 2006). IT capabilities are described as lower-order capabilities that enable the development of higher-order ones (Chakravarty, Grewal, & Sambamurthy, 2013; Lu & Ramamurthy, 2011; Roberts & Grover, 2012). When firms take full advantage of their existing IT capability, they can enhance their competitive advantage and performance (Bhatt & Grover, 2005; Santhanam & Hartono, 2003; Chen, Wang, Nevo, Jin, Wang, & Chow, 2014). IT capability enables the firm to build on its existing resources and the associated knowledge and skills. The emphasis is more on the exploitation side of technology (Nwankpa & Datta, 2017). The dynamic side of IT capability enables exploring technological opportunities and incorporating them with the existing resources base.

Based on the resource-based view (RBV), combining IT capability with the resources and capabilities of the firm can provide the needed competitive advantage (Bharadwaj A. S., 2000). IT capability is the ability of the firm to acquire and implement the required IT-dependent resources to achieve its business objectives. Some researchers argue that business processes are considered the basic units for the firm to gain competitive advantages (Ray, Muhanna, & Barney, 2005; Doherty & Terry, 2009; Gu & Jung, 2013; Ray, Barney, & Muhanna, 2004). Hence, IT resources and capabilities that serve and support critical processes share the same state, and they require the needed focus to gain the desired competitive advantage (Trkman, 2010).

IT capability reflects how a firm manages its IT resources to support its business objectives. Effective management includes aligning business and IT strategies to deliver value, capitalize on opportunities, and minimize threats. There are several dimensions to consider for IT capability. These dimensions have a significant impact on organizational agility. *Table 10*

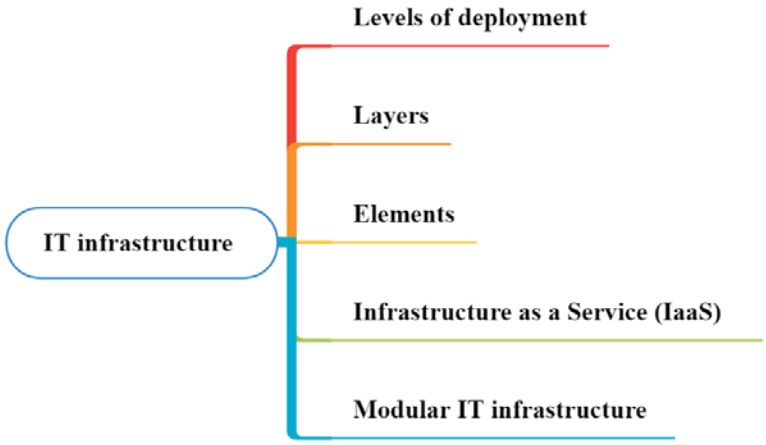
shows selected studies published in the "basket of eight" IS journals. These studies highlight the influence of different IT dimensions on organizational agility.

IT infrastrucre capability

One of the dimensions is the **IT infrastructure capability** (Chakravarty, Grewal, & Sambamurthy, 2013; Chen, Wang, Nevo, Jin, Wang, & Chow, 2014; Fink & Neumann, 2007; Lu & Ramamurthy, 2011; Ravichandran, 2018; Roberts & Grover, 2012; Van Oosterhout, Waarts, & Van Hillegersberg, 2006). Some researchers claim that IT infrastructure capability has two components: knowledge-based and process-based (Roberts & Grover, 2012). Other researchers argue that research on IT infrastructure capability has two main streams (Fink & Neumann, 2007). One stream emphasizes the IT architecture such as the platform, network, and applications and is static (*Figure **29***). The other stream focuses on shared services and is more concerned with supporting business processes (*Figure **29***). However, both streams emphasize the sharing of IT across the organization. The sharing of real-time information will result in quick and effective decision-making. It also supports market scanning to sense early changes in market needs and customers' preferences. Early sensing will enable the firm to respond to unexpected changes effectively (Park, El Sawy, & Fiss, 2017). When the firm uses modular information systems architecture, it can rapidly produce new, innovative IT-based products and services to cope with unexpected market changes (Tiwana & Konsynski, 2010).

IT infrastructure capability is one of the specific IT resources. It has a shared information delivery base, and managers regard it as a critical business resource that provides a long-term advantage (Bharadwaj A. S., 2000). It enables different business activities, e.g., cross-functional processes and cross-selling opportunities.

Figure 26: IT infrastructure capability characteristics



Source: own work

When the IT infrastructure capability is fragmented and lacking system compatibility, the company suffers from limited options in taking new business initiatives. Companies opt to develop an integrated IT infrastructure through committing time and acquiring professional

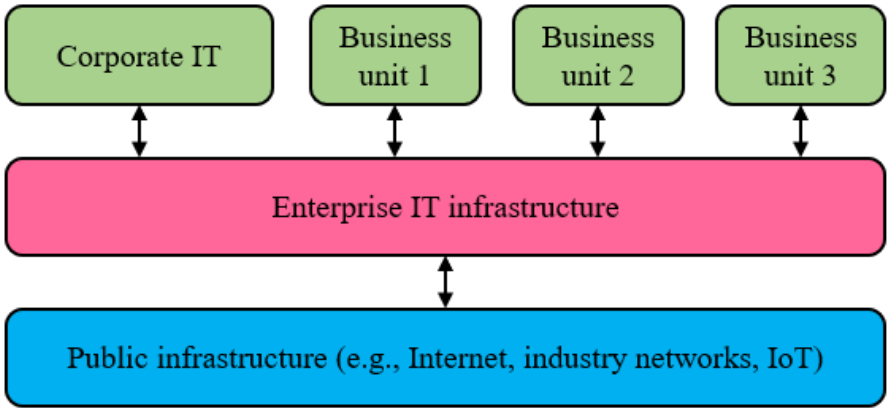
expertise to avoid a fragmented status. That process is tailored to the company's strategic goals, which entails redesigning its products and services based on exploiting its IT infrastructure capability.

The integrated IT infrastructure has different components, e.g., levels of deployment, layers, elements, and modularity (*Figure 26*). The unique components of the IT infrastructure enable the firm to implement the proper applications at the right time. As the integrated infrastructure provides the needed resources to make innovations feasible, it offers synergetic benefits. That result in minimizing the cost and increasing the business value of the technological innovations compared to the competitors. Hence, the IT infrastructure will enable the firm to identify and deploy core applications successfully in a short time and share the information across products, services, and branches. It will also stimulate the firm to exploit synergetic opportunities between different business units (*Figure 27*).

IT infrastructure levels of deployment

Management must decide the place of the IT infrastructure capability. It can be at the enterprise-wide level or business unit level (*Figure 27*). It is a strategic decision that may result in either centralized or decentralized management of IT. Each has its own merits and disadvantages. The enterprise-wide IT infrastructure often links to public IT infrastructure (e.g., Internet, industry, and IoT).

Figure 27: IT infrastructure levels of deployment



Source: adapted from Weill, Subramani, & Broadbent (2002)

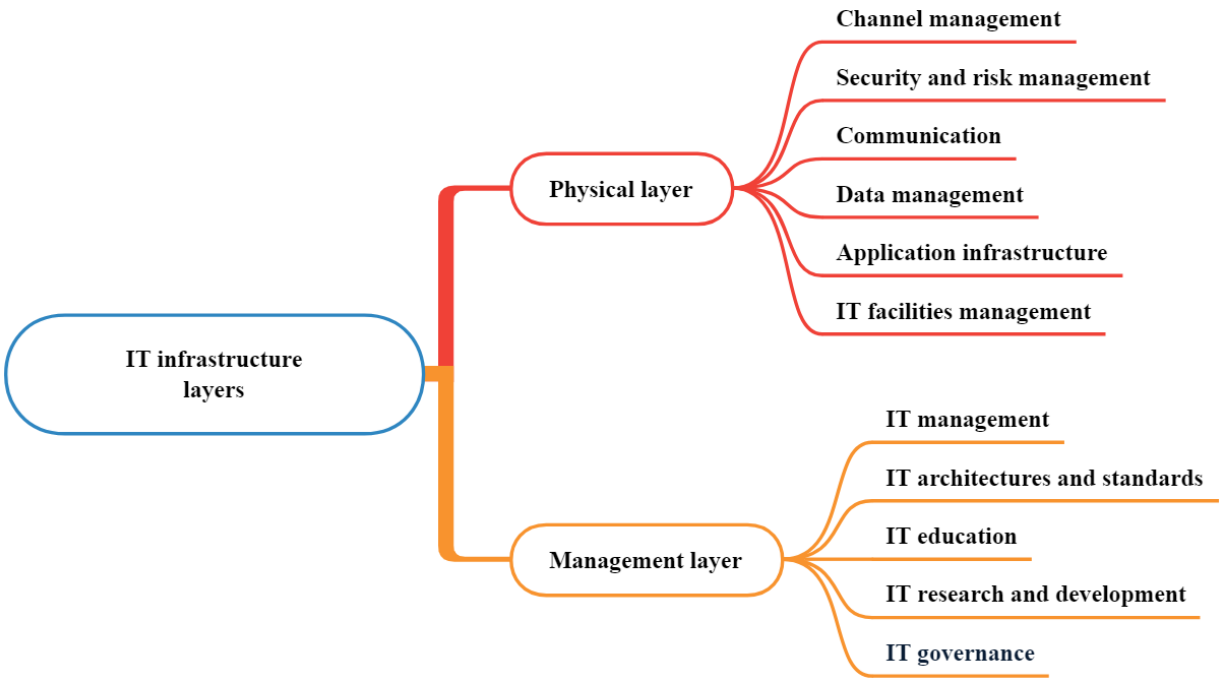
Deploying on the enterprise level requires information integration from the different business units. That will enable customers, suppliers, and partners to communicate across business units and participate in business services crucial for them and the enterprise. That will create valuable business opportunities for all parties involoved.

IT infrastructure layers

IT infrastructure has two crucial layers: physical and management layers. The physical layer has different components (*Figure 28*). They are channel management, security and risk management, communication, data management (including big data), application infrastructure, and IT facilities management.

First, channel management links to customers, suppliers, and partners via electronic channels. Second, security and risk management protect the enterprise's assets. Management must balance the acceptable risk against the cost and to ensure business continuity. Third, communication links all points within an enterprise. Fourth, data management (including big data) has data assets independent of applications to become available enterprise-wide. Fifth, application infrastructure supports shared services such as accounting, human resource management, and budgeting, e.g., enterprise resource planning (ERP). Sixth, IT facilities management coordinates the physical infrastructure layers. It adds value by integrating the other physical infrastructure layers and thus optimizing operations.

Figure 28: IT infrastructure layers



Source: adapted from Weill, Subramani, & Broadbent (2002)

The management layer also has different components. They are IT management, IT architectures and standards, IT education, IT research and development, and IT governance. First, the IT management (e.g., IS planning and project management) is responsible for coordinating the integrated enterprise infrastructure and managing the relationships with the business units. Second, the IT architecture and standards span the physical layers and interact

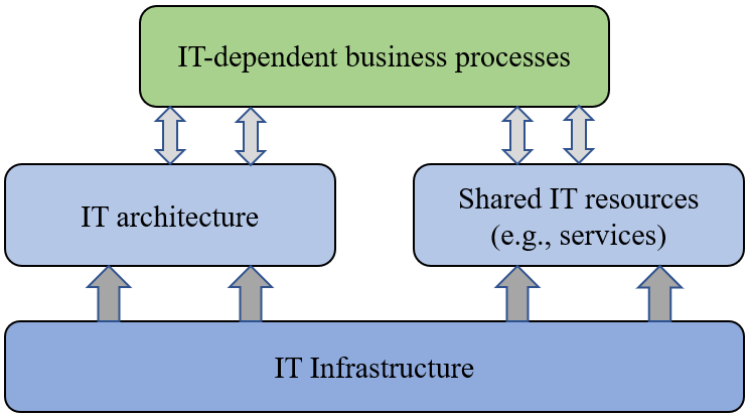
directly with IT management and IT research and development. Third, the IT education includes training on using the enterprise's specific technologies and systems. Fourth, IT research and development examine new ways to create and increase the business value of IT. Finally, IT governance imposes management controls to realize the business objectives.

IT infrastructure elements

Two key elements constitute the IT infrastructure (*Figure 29*) (Broadbent, Weill, Brien, & Neo, 1996). The first element is the base layer based on the IT infrastructure, including computers and communications technologies.

The second element is a set of shared IT resources and services and the IT architecture. The shared IT resources support business processes (e,g., the management of data processing (Park, El Sawy, & Fiss, 2017).

Figure 29: IT infrastructure elements



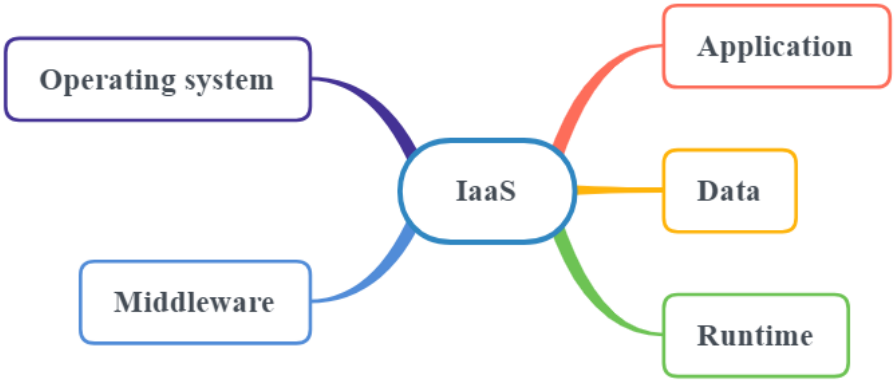
Source: adapted from Broadbent, Weill, Brien, & Neo (1996)

The IT architecture links various software applications and subsystems. It is relatively static (e.g., platform, network, and applications) (Fink & Neumann, 2007; Tiwana & Konsynski, 2010).

Infrastructure as a Service (IaaS)

Cloud computing provides a shared set of computing services, e.g., applications, storage, development, and deployment platforms. Many companies use a combination of public and private cloud services. They use different methods based on their business requirements and integrate these services.

Figure 30: Infrastructure as a Service (IaaS)



Source: own work

Companies can now have IT infrastructure as a Service (IaaS) in the cloud (*Figure 30*). In a private IaaS, the IT organization creates an infrastructure to provide resources on-demand to internal users and selected partners. In public IaaS, companies can control operating systems, storage, and deployed applications and they can have limited control over some networking components, e.g., host firewalls (Mell & Grance, 2011).

Modular IT infrastructure

IT architecture modularity refers to the decomposition degree of the firm's IT portfolio into loosely coupled subsystems communicating through standardized interfaces (Tiwana & Konsynski, 2010). Because components are coupled loosely with each other, having changes in one will have little effect on the existence or performance of another. It also means that alternative implementations that provide the same services can replace it.

IT business-spanning capability

The second dimension of IT capability is the **IT business-spanning capability**. It refers to the management ability of the firm to forge strategic planning between business and IT (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014; Lu & Ramamurthy, 2011; Tallon & Pinsonneault, 2011). That necessitates having clear business objectives and a vision for the role of IT to achieve these objectives.

As discussed in the IT governance section, that alignment leads to a better understanding of the business objectives in the IT unit and how IT can take an active role to achieve these objectives. The alignment becomes a form of synergy that leads to more added IT business value (Tallon & Pinsonneault, 2011; Tiwana & Konsynski, 2010). The synergy effect will lead to better collaboration at the business process level. That results in a quick and effective response to market changes, such as innovative, radical process changes (Mitchell & Zmud, 1999).

IT proactive stance

The third dimension of IT capability is the **IT proactive stance**. It is the proactive approach toward IT innovations, whether exploiting existing IT resources or exploring new ones (Lu & Ramamurthy, 2011; Ravichandran, 2018). That gives the firm business opportunities to manage market changes that provide business values or minimize threats.

As will be discussed in the innovation capability section, the proactive participation of IT in the innovation process allows quick and effective reconfigurations in response to market changes. That will reflect on the other dimensions, such as having a more flexible and modular IT infrastructure that can dynamically integrate with data and business processes. That can also lessen the state of lock-in technology, commonly cited as the IT paradox debating its role as an enabler or disabler of organizational agility (Van Oosterhout, Waarts, & Van Hillegersberg, 2006).

2.5 Innovation Capability

In the current study, the firm's innovation capability means the ability of the firm to generate and adopt new ideas that move away from old working practices (Lawson & Samson, 2001). Innovation capability may reflect the number of innovations adopted or implemented by the firm successfully (Hurley & Hult, 1998). That indicates the capability to change the old ways of conducting business and try untested ideas such as new management practices, new marketing concepts, and new corporate strategies (Camisón & Villar-López, 2014; Menguc & Auh, 2006). Firms with innovative management practices can enhance their performance (Mol & Birkinshaw, 2009).

Innovation is a process that can turn emerging opportunities into new ideas that can be explored or exploited and put into practice (Tidd, 2001). Firms possessing innovation capability can be reactive or proactive depending on the environmental turbulence encountered. They may select a radically innovative approach or prefer to be incremental depending on the product or service changes required. When relevant IT can absorb external knowledge from different sources, such as customers, it can influence innovation (Saldanha, Mithas, & Krishnan, 2017). Thus, IT can enhance the firm's ability to detect opportunities for innovation (Héroux & Fortin, 2018).

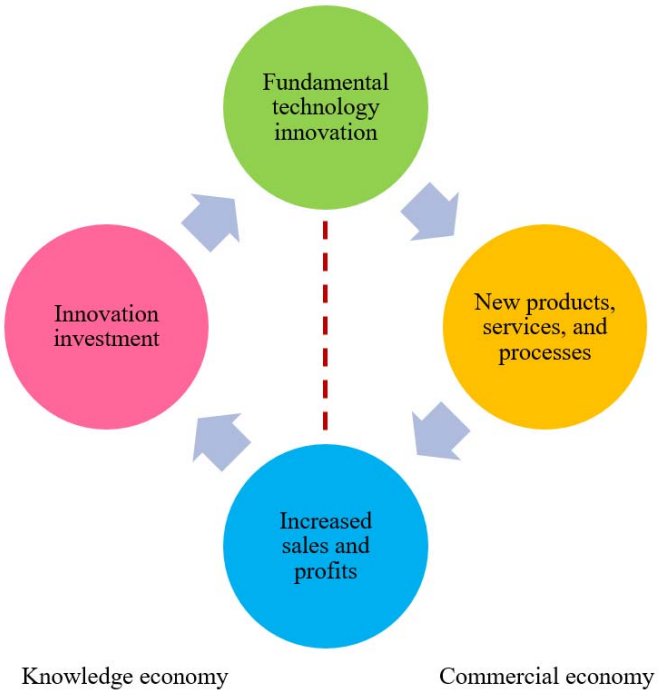
Many researchers regard RBV as the theoretical framework that facilitates the analysis of innovation and its link to performance (Camisón & Villar-López, 2014; Mol & Birkinshaw, 2009). Some researchers state that innovation capability is an ordinary capability that can directly create value through new products and services (Camisón & Villar-López, 2014). However, other researchers argue that it is a higher-order one with the ability to manage and integrate many other capabilities (Lawson & Samson, 2001). They claim that a firm's innovation capability is a powerful component of its dynamic capabilities (Menguc & Auh,

2006; Lawson & Samson, 2001) and essential to managing uncertainty generated by environmental turbulence (Teece, Peteraf, & Leih, 2016). I'll discuss this in a later sub-section. Many firms' failures are attributed to weak innovative responses when facing environmental changes (Staw, Sandelands, & Dutton, 1981).

The innovation ecosystem

To discuss innovation capability, we first need to put it in its context, i.e., the innovation ecosystem. That will explain its relationships with knowledge and business. That relationship is relevant to our study and enables us to answer one of the research questions: How do these capabilities contribute to organizational agility? How does environmental turbulence affect innovation capability on organizational agility?

Figure 31: The innovation ecosystem



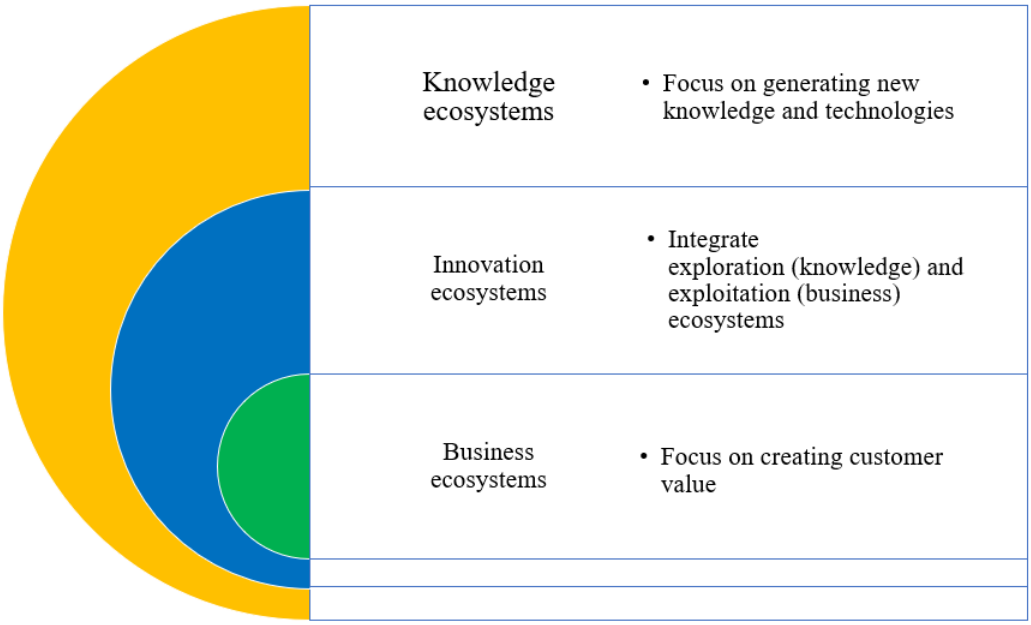
Source: adapted from Jackson (2011)

Generally, an ecosystem has all the organisms and the physical environment with which they interact. The innovation ecosystem consists of loosely linked companies with shared and evolving capabilities around shared technologies and knowledge. However, they work in cooperation and competition to develop new products and services (Granstrand & Holgersson, 2020).

The innovation ecosystem is usually strategically developed around a specific technology. It has two distinct economies, the knowledge economy, driven by fundamental research, and the commercial economy, driven by the marketplace (*Figure 31*). The best way for economic

growth is by facilitating the efficient actualization of innovations from the knowledge economy into the commercial economy (Jackson, 2011). Further, the resources available to the knowledge economy if, ideally coupled with the resources generated by the commercial one, the two economies (knowledge and commercial) exist in a balanced equilibrium. For example, when a company invests in developing software for its usage, it must balance the innovation investment and the ability to use it profitably by having a reasonable benefits/cost ratio (BCR) and total cost of ownership (TCO).

Figure 32: Linking business, innovation, and knowledge ecosystems



Source: adapted from Valkokari (2015)

Creating new technologies is a manifestation of knowledge economy, while developing IT capability is a manifestation of commercial economy. Thus, each company can develop its own unique IT capability based on its business objectives (*Figure 31*). While innovation can bring new technologies and knowledge, it is the innovative usage and deployment of these technologies that can bring competitive advantage and superior firm performance.

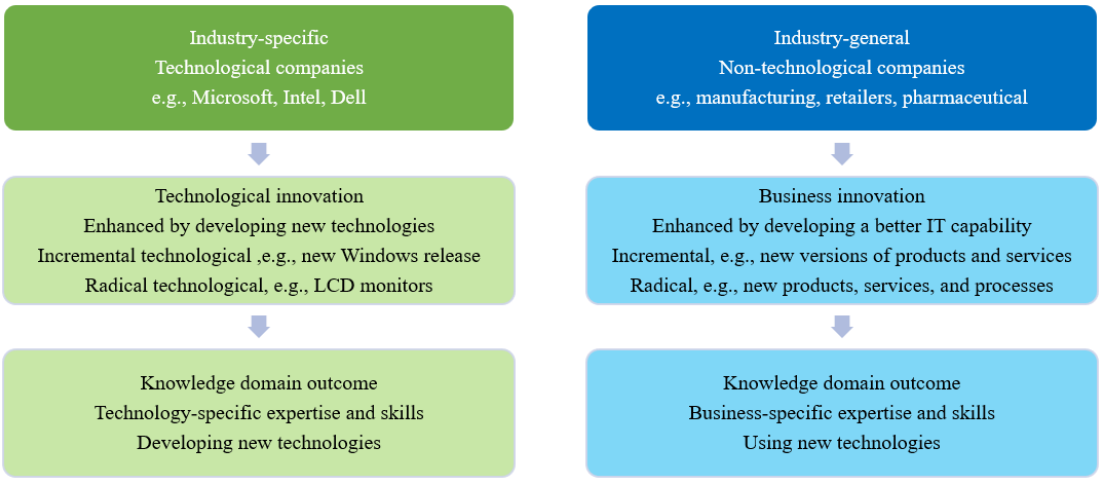
In technological companies, the knowledge ecosystem focuses on generating new knowledge and technologies (*Figure 32*). For example, IT companies target any of the four components of IT: hardware, software, network, and telecommunication. So, their main knowledge areas focus on generating new knowledge and creating new technologies. They can build on existing technologies, e.g., a new release of the Windows operating system (incremental), or they can come up with disruptive technology, e.g., Liquid Crystal Display (LCD) monitors (radical) that replaced Cathode Ray Tube (CRT). However, companies can share the knowledge produced by technological companies, thus enabling its usage in their business

context. Knowledge sharing largely depends on the innovative approach of business companies to using these technologies.

In the business ecosystem, companies focus on value creation for the customer. For example, companies in the after-sales services use mobiles and tablets to provide field services and increase their value proposition for their customers. So, companies focus on value creation for their customers by creatively using newly invented devices such as mobiles and tablets. They use, for example, field services software on mobiles and tablets to have instant access to data and provide output to their customers, e.g., Amazon delivery systems, where customers sign on the company's mobile.

Innovation ecosystem bridges the gap between business and knowledge as it integrates both of them (*Figure 32*). The business objective of non-technological companies focuses on the efficient and effective utilization of their IT resources and developing their IT capability (Figure 33). A company can use its acquired technologies to change its products, service, or processes, even when faced with unpredictable conditions. So, as mentioned earlier, business is the driver, while technology is the enabler. While technology companies invent new hardware, e.g., mobiles and tablets, other companies may use them innovatively to create or transform their products, services, processes or even their business models as will be discussed later.

Figure 33: Business-innovation-knowledge relationship



Source: own work

Innovation capability and the risk of environmental turbulence

The turbulent changes and the competitive rivalry demand the firms focus on innovation capabilities (Breznik & Hisrich, 2014). So, firms have to respond fast when facing environmental changes or take a proactive approach to influence the environment. The business activity relies on a combination of resources, and the firm's ability to modify its resource base will allow a continuous adaption to change. Dynamic capabilities usually

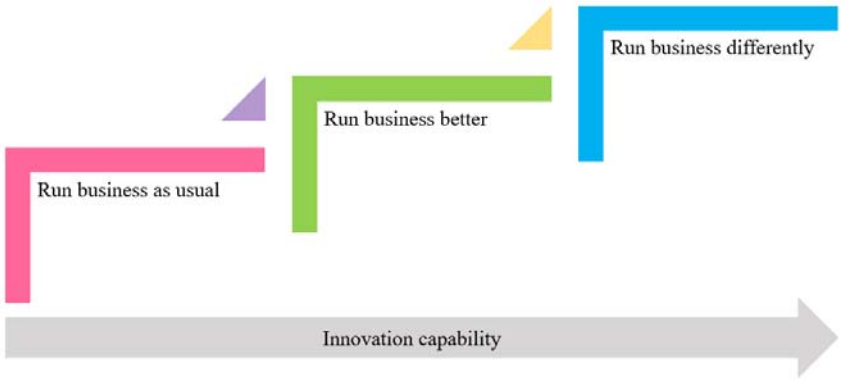
emerge in innovation-based competition, where competitive advantage results from the creative destruction of the current operational capabilities. That, in turn, leads to reconfigured superior operational ones (Pavlou & El Sawy, 2010).

A firm must always be innovative to survive in a turbulent environment (Calantone, Cavusgil, & Zhao, 2002; Jiménez-Jiménez & Sanz-Valle, 2011). Firms need to learn new knowledge and develop expertise on an ongoing basis to sustain their innovation progress (Wang & Dass, 2017). Innovative changes happen when current organizational procedures fail. They find a need to deviate from traditional solutions, and the decision-makers will be more risk-seeking, proactive, and more on the explorative side (Mone, McKinley, & Barker III, 1998). Firms affected by environmental turbulence need to revitalize their status with more innovative products, services, and processes to respond to the external environment (McKinley, Latham, & Braun, 2014). It is far easier for innovative firms that enjoy flexible resources to develop new activity systems or even new business models (Ravichandran, 2018). Both explorations of new possibilities and exploitations of old certainties are essential in the face of environmental turbulence, even though they compete for whatever resources the firm has (March, 1991).

Innovation capability and the power of dynamic capabilities

Companies can run their business as usual or run it better by creating changes or even reinventing their business and running it differently. Innovation capability is at the heart of these three events (*Figure 34*).

Figure 34: Innovation capability and business transformation



Source: own work

However, innovation doesn't work on its own. It acts in combination with other capabilities, e.g., the dynamic capabilities. The nature of the relationship between innovation and the dynamic capabilities is always the subject of study among researchers.

Figure 35: Innovation capability vs. dynamic capabilities

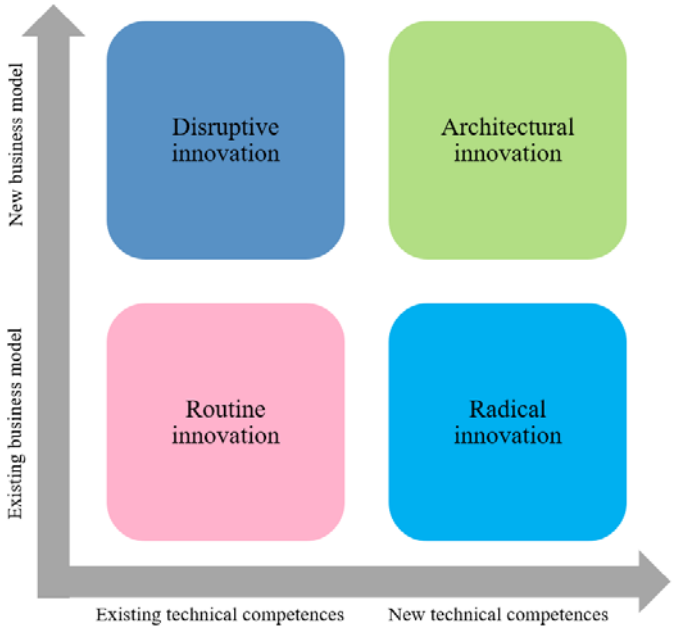
Source: own work

Some researchers reviewed the relationships between innovation and dynamic capabilities (Breznik & Hisrich, 2014). They concluded that this relationship has different shapes and effects. However, in the context of our study, we support the notion that when innovation capability helps to operate, administer, and govern, it acts as an ordinary capability. Then, it can be a dynamic capability when it helps sense, seize, and transform (*Figure 35*).

Innovation strategy

As discussed earlier in the IT governance section, good strategy promotes alignment between business and IT helping clarify objectives and priorities. The same rules apply to innovation strategy. Without an aligned business-innovation strategy, innovation practices will lose the power of innovation capability that the company needs and left with what is called best practices.

Figure 36: The innovation landscape map



Source: adapted from Pisano (2015)

Researchers study innovation in different approaches, most notably product, service, or process, and radical or incremental (Damanpour, 1991). However, any approach depends on the company's innovation strategy. Some researchers argue that innovation has two dimensions: the degree of a change in technology and the business model, and both will

reflect on the innovation strategy (Pisano, 2015). An innovation landscape map explains the strategic options for companies (*Figure 36*). At one end, they can keep or modify their business models. On the other end, companies need to reinvent their business models (Pisano, 2015).

One of the innovation strategic options is routine innovation. It builds on existing technological competencies and business models. Then, another option is the disruptive innovation that requires a new business model, although it may not be associated with a technological breakthrough. For example, Microsoft's Internet Explorer browser and Google's Android operating system are free. A third option is radical innovation, where the challenge is technological. Finally, the fourth option is the architectural innovation which combines the disruption of technology and business model, and perhaps this is the most challenging. Companies should specify their innovation strategy on how the different innovation types will fit into the business strategy and what resources the company will allocate for each.

For example, innovation capabilities for products, services, and supporting resources and capabilities generally reside at the organizational level (Helfat & Raubitschek, 2018). They are usually represented in routines when used with tangible and intangible resources. A well-crafted innovation strategy serves as a critical input for having innovation capability. That is noted, especially in turbulent market conditions, because it offers a vision for the types of ideas needed in the context of the firm within its market boundaries (Kock & Georg Gemünden, 2016).

Then, exploitative innovation uses existing capabilities and has its primary concern in securing a desirable position in the marketplace. That requires committing the needed resources to ensure competitiveness (Auh & Menguc, 2005). That often leads to developing new products and services that are more satisfactory to the customers. Exploitative innovation uses existing knowledge as a foundation to extend existing products and services for current customers (Jansen, Van Den Bosch, & Volberda, 2006; Enkel, Heil, Hengstler, & Wirth, 2017). When focusing on exploitative innovations, firms often risk being disrupted by new entrants (Ngo, Bucic, Sinha, & Lu, 2019).

On the other side, explorative (radical) innovations are more concerned with challenging the predominant concepts and ideas with innovative and entrepreneurial approaches (Auh & Menguc, 2005). They usually focus on using new or disruptive technologies to create new products and markets (He & Wong, 2004). That indicates risk probability is higher in exploration activities than in exploitation ones (O'Reilly & Tushman, 2013). Engaging in exploratory innovation requires acquiring new knowledge or departure from existing knowledge and developing new products and services. That is targeting emerging markets or new customers. When they rely on explorative innovation, they risk losing the leverage of their existing capabilities (Ngo, Bucic, Sinha, & Lu, 2019).

Innovation capability and IT capability

There is limited research that examines the relationships between IT and innovation capabilities. We analyzed selected articles that investigated these relationships (*Table 11*), including our study. We found three types: mediating, moderating, and parallel relationships.

Table 11: Selected IT and innovation capabilities studies

References	Main theory	ITC	IC	Relationships
Cepeda-Carrion, G. et al. (2012).	Absorptive capacity	IS capability	Organizational innovativeness	Innovation capability indirectly mediates IS capability
Chen, J. S. et al. (2012).	*RBV	IT capability	Service process innovation	Service process innovation mediates IT capability on firm performance
Kathuria, A. et al (2016).	RBV	Information management capability	Innovation capability	Innovation capability mediates the relationship between Information management capability and firm performance moderated by environmental turbulence
Kmieciak, R. et al. (2012).	RBV	IT capability	Innovativeness	IT capability does not moderate the relationship between innovativeness and firm performance
Soto-Acosta, P. et al. (2018).	**TOE and KBV	IT capability	Innovation ambidexterity	Innovation capability mediates IT capability on firm performance
Our study (2022)	RBV and DCV	IT capability	Innovation capability	Both innovation capability and IT capability act in parallel to enhance organizational agility

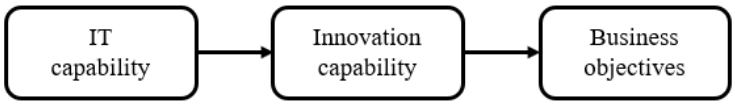
*RBV=Resource-based view, **TOE=Technology–Organization–Environment theory, KBV=Knowledge-based view

Source: own work

The mediation relationship between IT and innovation capabilities

Researchers argue that companies should maintain knowledge within the organization and make it accessible for employees, especially those who will exploit the company's resources. Companies always face the risk of losing valuable knowledge due to the turnover of employees and the passage of time. IT capability is crucial in preserving and using that knowledge (Cepeda-Carrion, Cegarra-Navarro, & Jimenez-Jimenez, 2012). Thus, IT capability positively impacts innovation capability and its effect on firm performance.

Figure 37: IT and innovation capabilities mediation relationship



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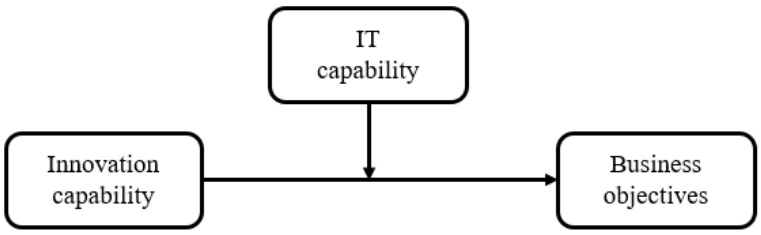
Further, innovation capability enjoys valuable interaction with IT capability. Some researchers claim that both are critical drivers of the company's success (Kathuria, Saldanha, Khuntia, & Andrade Rojas, 2016). They also claim that innovation capability mediates the relationship between IT capability and firm performance (*Figure 37*). Still, others argue that firms with more IT resources have a high degree of innovation (Chen & Tsou, 2012). That especially shows in product innovation because of its interdisciplinary nature (Chen, Wang, Nevo, Benitez-Amado, & Kou, 2015). Other researchers argue that exploitative and explorative ambidextrous innovation mediate IT capability. They state that the most successful firm can balance exploitative and explorative innovation (Soto-Acosta, Popa, & Martinez-Conesa, 2018).

The moderation relationship between IT and innovation capabilities

Other researchers examined the moderating role of IT capability on the relationship between innovation capability and firm performance (Kmieciak, Michna, & Meczynska, 2012). Their findings showed that IT capability exerts no significant moderation on that relationship (*Figure 38*).

Figure 38: IT and innovation capabilities moderation relationship



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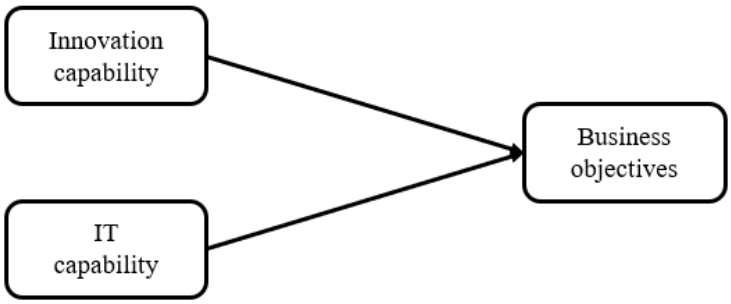
The parallel relationship between IT and innovation capabilities

In our study, we took a different approach. We designed our research model based on a parallel relationship between IT capability and innovation capability to create a synergetic effect on organizational agility (*Figure 39)*. That is probably one of the first studies to evaluate such a parallel relationship. Our results showed that both capabilities have a positive impact on organizational agility.

Figure 39: IT and innovation capabilities parallel relationship



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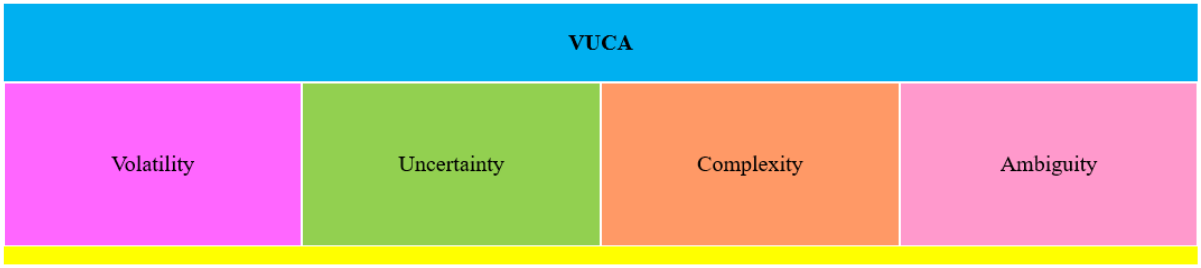
2.6 Environmental Turbulence

Turbulent times had the acronym VUCA, which stands for volatility, uncertainty, complexity, and ambiguity (*Figure 40*) (Whiteman, 1998). Later, it found its place in business for organizations facing a turbulent environment, but fortunately, only a few firms may encounter a VUCA environment daily (Bennett & Lemoine, 2014; Schoemaker, Heaton, & Teece, 2018). This turbulent environment is a dynamic state of turmoil with varying

unpredictability and uncertainty (Glazer & Weiss, 1993). However, the risk of unanticipated changes in environmental turbulence can provide both opportunities and threats.

Figure 40: The VUCA world



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Volatility has relatively unstable changes, but the information is available, and the situation is understandable. However, there are frequent changes, and sometimes they are unpredictable. Organizations need to have the power of agility to cope with volatility. Uncertainty indicates a lack of the needed knowledge about the consequences of an event. However, the cause and effect are known, but the magnitude of that effect is unknown. Organizations need to acquire new sources of information to reduce uncertainty. Complexity often makes the companies uncertain as they find it hard to respond with the necessary innovations and thus will face a decline in their performance (Arrive & Feng, 2018). Complexity has many interconnected parts. However, that doesn't necessarily mean having any changes. Organizations need to restructure their internal operations to match external complexity. Ambiguity has a lack of knowledge about the cause and effect. Organizations need to experiment intelligently to outline appropriate strategies to reduce ambiguity.

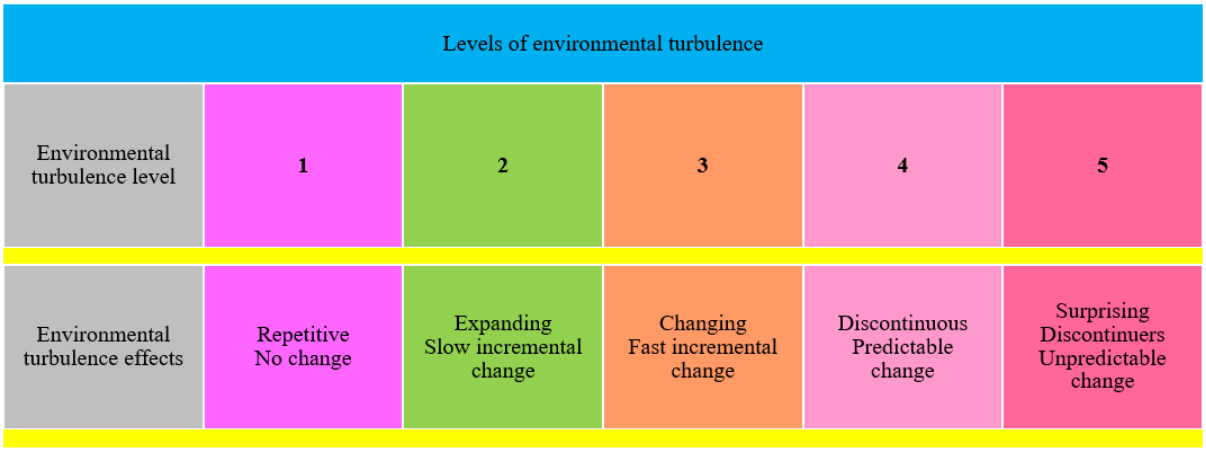
While researchers use VUCA to descirbe turbulent times, they also state that environmental turbulence creates an unpredictable state that is continuously dynamic and can pose a critical threat to the competitive state of the firm. Market and technological turbulence are two aspects of environmental turbulence that pose the risk of unanticipated changes, which entails both opportunities and threats (Jaworski & Kohli, 1993). In the context of the resource-based theory, researchers argue that environmental factors can neutralize or even evaporate a resource's comparative advantage (Teece, Pisano, & Shuen, 1997). The creative response plays a pivotal role in such a turbulent environment.

Environmental turbulence levels

In the twentieth century, many researchers examined environmental turbulence across different business activities using different turbulence types. The motivation was always how to maintain firm success in turbulent environmental conditions. Some researchers argued that a firm should align its strategic behavior with its environment to optimize its profits and achieve a better firm performance (Ansoff & Sullivan, 1993). They investigated environmental turbulence based on the degree of changeability and predictability of the

firm's environment. They described five different turbulence levels based on the complexity of the event, familiarity with the consecutive event, the rapidity of the event, and finally, the predictability of event consequences (*Figure 41*).

Figure 41: Environmental turbulence levels



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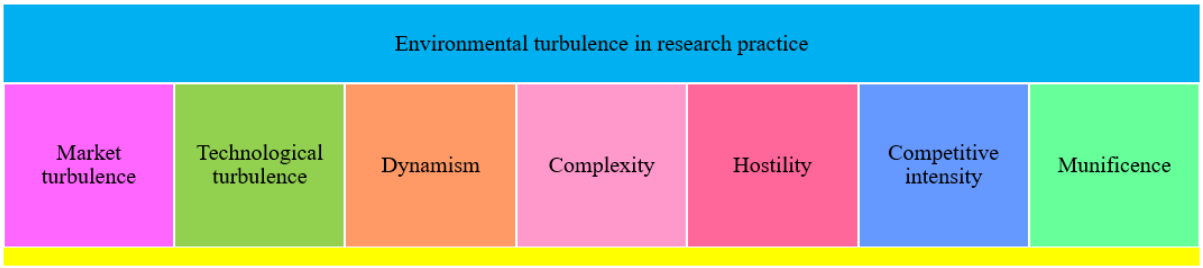
In summary, the first turbulence level has no change. However, in level 2, there is a slow incremental change. Then, it becomes fast incremental in turbulence level 3. In turbulence level 4, it becomes exceedingly fast and discontinuous with a partially predictable future. Finally, level 5 is full of surprises, where the change is so fast, and no company can predict the future.

Environmental turbulence types

Different types of environmental turbulence offer a variety of opportunities and threats for firms. Thus, a broad conceptualization of environmental turbulence may not reveal relevant insights for managers (Tsai & Yang, 2013). Business research often focuses on different factors under environmental turbulence, e.g., market turbulence, technological turbulence, dynamism, complexity, hostility, competitive intensity, and munificence (*Figure 42*). We reviewed selected articles that examined different types of environmental turbulence in their research (*Table 12*) that may shed some light on a topic relevant to our study. It is not intended to be a comprehensive list of all the types but is a sample of the common ones used in research. Many researchers believe that turbulent environments provide an umbrella for these common types. However, there is limited research on the level of turbulence for each of these types. Further, all the studies in *Table 12* used environmental turbulence as a moderator.

Figure 42: Environmental turbulence types in research practice



Source: own work

Table 12: Sample of environmental turbulence studies

Reference	**Dependent variable**	**Environmental turbulence**
Auh, S. et al. (2005)	Firm performance	Competitive intensity
Pavlou, P. A. et al. (2006)	Competitive advantage	MT, TT
Stoel, M. D. et al. (2009)	Firm performance	Dynamism, Munificence
Chakravarty, A. et al. (2013)	Firm performance	Dynamism
Tsai, K. H. et al. (2013)	Business performance	TT, Competitive intensity
Chen, Y. et al. (2014)	Organizational performance	Dynamism, Complexity, Hostility
Chavez, R. et al. (2015)	Firm performance	TT
Wang, G. et al. (2015)	Financial performance	MT
Chan, H. K. et al. (2016)	Firm profitablitiy	Dynamism
Kock, A. et al. (2016)	Agility	MT, TT
Soto-Acosta, P. et al. (2018)	Firm performance	Dynamism
Ashrafi, A., et al. (2019)	Firm performance	MT, TT
Turulja, L. et al. (2019)	Business performance	MT, TT, Competitive intensity
Zhou, J. et al. (2019)	Financial performance	MT
Our study (2022)	Firm performance	MT, TT

MT=Market turbulence, TT=Technological turbulence

Source: own work

There is a need for relevant information quickly in turbulent times. Firms that enjoy superior technical capabilities would have the IT systems and applications ready to support such requirements. Furthermore, as firms may need to modify their business processes or even change their business models, IT capability would provide the means to act as desired. In the meantime, IT governance would provide IT assurance for a smooth transformation from one state to another. Hence, firms with superior technical capabilities would gain more profits in such an environment (Lee & Wong, 2011). They would respond to these unpredictable changes quickly and effectively compared to other firms. However, some may also need innovative exploitation, exploration, or both. They can exploit existing technologies and markets through incremental improvement, efficiency, and control. They can also explore new technologies and markets where experimentation and flexibility are needed. They can choose to do both exploiting and exploring and thus, become ambidextrous organizations (O'Reilly & Tushman, 2013).

Technological Turbulence

Technological turbulence is defined as the rate and unpredictability associated with technology change which requires innovative exploration, exploitation, or both, based on the analysis of the opportunities and threats encountered (Jaworski & Kohli, 1993). It arises due to changes in existing technologies of products or services and their rate of obsolescence (Kandemir, Yaprak, & Cavusgil, 2006). When technology changes rapidly within an industry, firms need to sense and detect them early. Technology changes can affect the existing technology used to develop current products or services. They can even create an undetermined performance of the new products and services. Companies may need to update existing technologies or even replace them before they become obsolete (Kandemir, Yaprak, & Cavusgil, 2006). That often exists in industries with a short and fast cycle of technological innovation.

Market Turbulence

Market turbulence is another significant environmental change (Eisenhardt & Martin, 2000). Market turbulence may inflict quick and severe changes in customer needs and preferences (Jaworski & Kohli, 1993). That poses a high risk for current business processes and the technology used. With market turbulence, firms may have to change their business model. They need to act faster to modify their business processes, even the core ones, before their competitors (Xue, Liang, & Boulton, 2008). That may require investing more in IT to improve operational efficiency to sustain firms' competitive advantage. Furthermore, more efficient utilization of resources, e.g., IT through sharing and better coordination across different business units, would support the business more (Xue, Ray, & Gu, 2011).

Although market changes can bring more opportunities, firms can quickly lose their competitive status if they don't keep up with the market (Zhou, Mavondo, & Saunders, 2019). Market turbulence requires relevant information to become available quickly to enable firms to have their ordinary capabilities match the market changes (Baum & Wally, 2003). Firms operating in highly turbulent markets need to modify their products, services, and even processes more often (Jaworski & Kohli, 1993). They need to satisfy the dynamic preferences of their customers as quickly as demanded.

Further, when customers' demands change, firms will rely on their creativity to modify their products and services (Tsai & Yang, 2013). They also need to adjust their operations continuously. So, creative firms will develop innovative strategies to exploit or explore the changes in customers' demands. Thus, innovativeness enables firms to reconfigure their resources in new ways and build dynamic capabilities to neutralize threats and exploit opportunities in turbulent markets.

Environmental dynamism

Dynamism refers to the rate and unpredictable environmental changes, e.g., changes in customers' preferences and fluctuations in the supply of materials. It describes the degree of market instability over time and the turbulence caused by the relationships between organizations (McArthur & Nystrom, 1991). The higher the rate of environmental changes, the higher the environment becomes dynamic, reflecting the speed and strength of change. That will impose different requirements on the information processing capability, thus necessitating a superior IT capability to perform efficient market operations.

Environmental complexity

It is the number of inputs and outputs that any organization requires to perform its operations. It also refers to the number and types of suppliers, customers, and competitors (Wade & Hulland, 2004). Environmental complexity makes it difficult for companies to identify the key performance drivers. That leads to more difficulty for competing firms to identify critical resources. Thus, firms operating in a complex environment must have efficient and effective systems to manage performance and knowledge. They should have superior IT capability to collect and analyze market information better than competitors.

Environmental hostility

Environmental hostility refers to external forces existing in firms' business environment, thus making it more unfavorable. Firms in these conditions may not make better decisions, e.g., choosing products that satisfy customers' demands. That can occur even with superior IT capability because they are less likely to use their IT capability to enhance their agility. Researchers attribute hostility to many factors, e.g., resource shortage (materials, financial), competition (price, product), declining market trends (economic trends, customer loyalty), and restrictiveness (political, social). Thus, hostile environments increase the failure rate among companies (Calantone, Schmidt, & Di Benedetto, 1997). Successful firms recognize and respond to a hostile environment as early as possible using a prospector strategy by exploiting market or product opportunities and establishing an early and strong presence in market development with a flexible organizational structure.

Competitive intensity

Competitive intensity is the degree of competition in an industry, and in such a competitive context, organizations are likely to have zero-sum relations with one another, directly or indirectly (Barnett, 1997). The level of competitive intensity relates to the activities of competing firms, e.g., price competition (Cui, Griffith, & Cavusgil, 2005). Competitive intensity usually arises from resource constraints, the presence of many competitors, and the lack of opportunities to grow (Tsai & Yang, 2013). However, differentiation can decrease

competition threats. Innovative firms are prone to create differentiation advantages and provide solutions that win the competition.

Munificence

It is the extent to which a business environment can support sustained growth (Wade & Hulland, 2004). With low mnuificence, there is often a fierce competition. In that case, firms work hard to maintain profits by focusing on increasing its internal efficiency. Markets that are munificent tend to support organizational growth even if firms don't enjoy perfect strategy (Wade & Hulland, 2004).

2.7 Firm Performance

Table 13: IT-related organizational agility and firm performance measures

Study	IT	Organizational agility	Firm performance measures
Tallon et al. (2011)	Strategic IT alignment IT flexibility	Firm agility	1. Return on assets (ROA) 2. Net margin 3. The ratio of operating income to assets (OI/A)
Chakravarty et al. (2013)	IT competencies IT infrastructure	Entrepreneurial agility Adaptive agility	1. Return on investment relative to objective. 2. Sales relative to objective. 3. Profit relative to goals. 4. Growth relative to objective. 5. General success.
Chen et al. (2014)	IT infrastructure IT business partnerships IT business process integration IT management Business IT strategic thinking External IT linkage	Business process agility	1: Our profitability has been substantially better. 2: Our return on investment has been substantially better. 3: Our growth in market share has been substantially better. 4: Our sales growth has been substantially better.
Queiroz et al. (2018)	IT application orchestration capability	Process agility	a. We are more profitable than our competitors. b. Our sales growth exceeds that of our competitors. c. Our revenue growth exceeds that of our competitors. d. Our market share growth exceeds that of our competitors. e. Overall, our performance is better than our competitors.
Ravichandran (2018)	Digital platform capabilities IT infrastructure flexibility Application platform scope	Customer responsiveness Operational flexibility Strategic flexibility	(1) Improvement in market share in major product markets (2) Cost (3) Productivity (4) Profitability (5) Overall financial performance compared to competitors

Source: own work

Previous research has shown that organizational agility positively influences firm performance (Ravichandran, 2018; Tallon & Pinsonneault, 2011). Agile firms with established dynamic capabilities can achieve far better performance than their competitors, manifested by different measures, such as increasing market share, higher sales growth, overall profitability, and return on investment (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014). A firm's market growth indicates changes in its market share and can represent the growth rate of its total sales in the principal market segment of a business unit (Gebauer,

2008). This outcome represents an important indicator for the firm's products and services in specific markets and its market position.

Organizational agility influences firm performance that is mostly noted during turbulent environmental conditions. Different studies examined and confirmed the positive impact of different forms of organizational agility on firm performance. Many of these studies also investigated the role of IT on organizational agility and how this will reflect on firm performance. These studies used firm performance measures that are not related to IT (*Table 13*).

Firms can enjoy a competitive advantage under normal conditions. However, under turbulent environments, sustaining such an advantage may prove difficult. Current research indicates that dynamic capabilities can influence firm performance under unstable environments. Agility, a manifestation of dynamic capabilities, enables firms to detect changes in market and technology and hence the ability to reconfigure their resources effectively and quickly in response to such potentially risky conditions. Sensing market changes can, in effect, improve firm performance (DeGroote & Marx, 2013). Thus, agility plays a significant role in sustaining the competitive advantage under different circumstances and enables firms to exploit and explore opportunities while minimizing undesired risks. Furthermore, different types of agility can influence firm performance, e.g., customer agility, supply chain agility, and IT agility (Roberts & Grover, 2012; DeGroote & Marx, 2013; Tiwana & Konsynski, 2010).

Firm performance management systems in practice

A performance management system (PMS) has different measures that target the company's business activities, including, but not restricted to, profitability. First, the company defines its strategy. Second, we present the criteria needed to have a successful PMS. Finally, we highlight relevant main approaches for having a PMS in practice (*Figure 43*).

Figure 43: Firm performance management phases

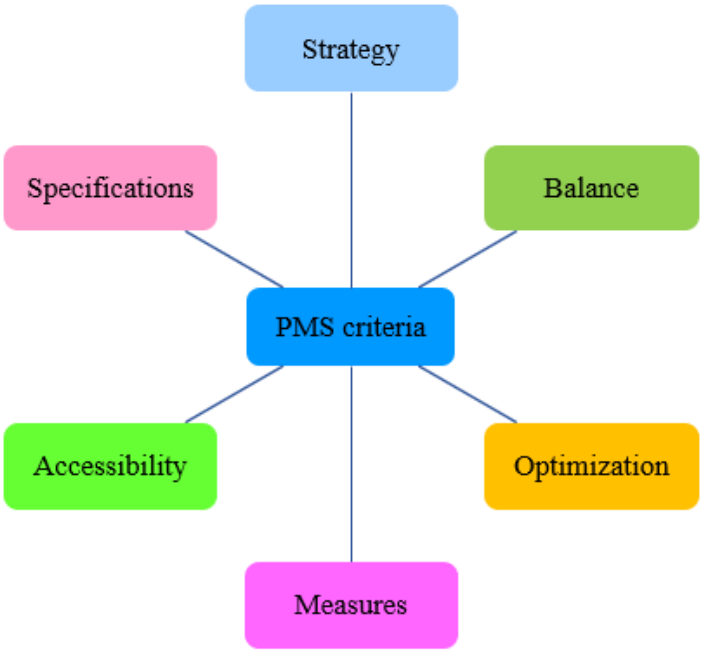
Source: own work

Firm performance management system criteria

A performance management system (PMS) should have criteria that enable it to be an effective performance measuring system for the company (*Figure 44*).

Strategy
As the firm's strategy provides the base for PMS, the PMS must reflect it at all times. In other words, when some strategy parts of the firm change, the relevant performance measures should also change. That requires having a flexible performance management system to adapt to these changes.

Figure 44: Performance management system criteria



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Balance
A PMS must include other performance measures apart from financial ones. The other performance measures should balance all relevant aspects representing the company's activities, including short and long-term objectives.

Optimization
A PMS must establish a transparent and clear linking top management of the company to the lowest operational level without having bias or sub-optimization by employees at the different levels of management. That will ensure having employees' behavior aligned with the company's goals.

Measures
A reliable PMS should have a limited number of performance measures to avoid a long analysis time. It should have only the necessary information, the purpose, and the cost of producing it against the value retrieved from it.

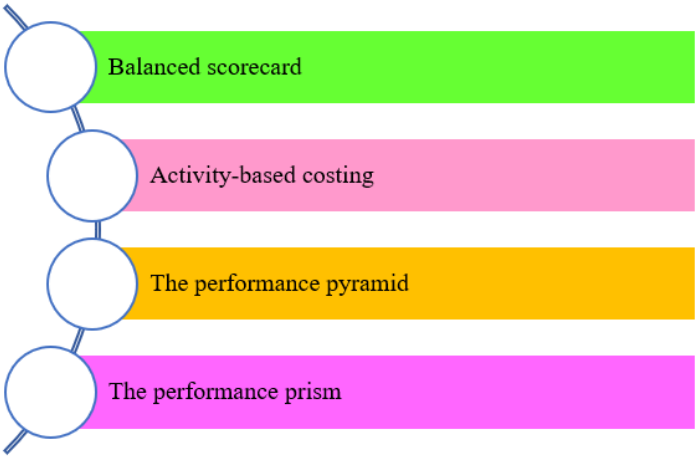
Accessibility
A PMS must be easily accessible to give the needed information at the right time to the right employee. In addition, it should present the information in a manner easily understood by those who need it.

Specifications
A PMS must have comprehensible specifications with a clear purpose and the details of the life cycle of the measure. The measure life cycle includes who will use each one, who will collect the data, and at what frequency.

Firm performance management approaches

In the industrial era, traditional financial performance measures worked well. However, that doesn't work anymore. We will present some popular approaches that address the limitations of depending only on financial performance measures (*Figure 45*).

Figure 45: Examples of firm performance management approaches



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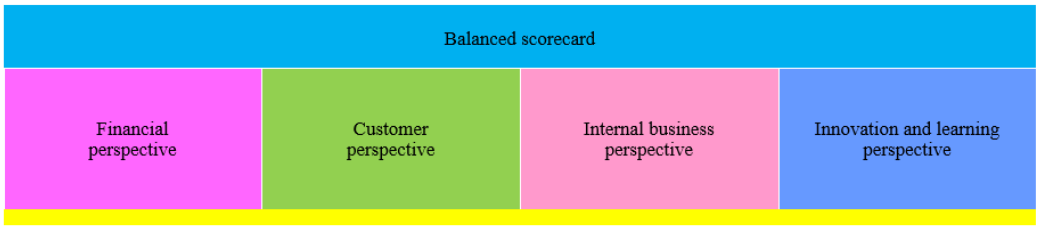
Balanced scorecard (BSC)
The BSC is a strategic performance management framework that allows organizations to measure and manage their strategic objectives (Kaplan & Norton, 1992). The balanced scorecard provided managers the framework to look at the business from four crucial perspectives (*Figure 46*). It also minimizes information overload by limiting the number of measures used. It consists of four perspectives: financial, customer, internal business, and innovation and learning.

Figure 46: The balanced scorecard



Source: own work

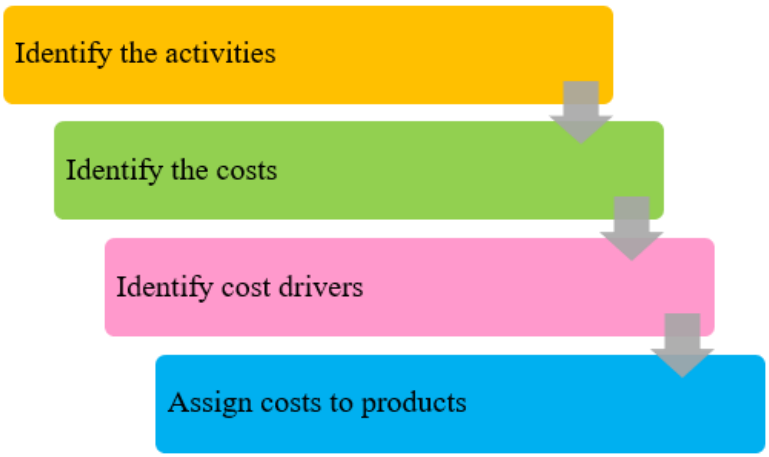
Financial performance measures monitor the profits and if the company is getting its return on investment and satisfying the shareholder value. That indicates if the company's strategy contributes to its success.

The customer perspective monitors the company's value to its customers and measures customer satisfaction with its products or services. It often lies in four categories: lead time, quality, performance and service, and cost.
The internal business perspective requires companies to focus on critical internal operations that are highly relevant to customer satisfaction. That also includes the core competencies and technologies that ensure market leadership.

The innovation and learning perspective serves the company to measure its ability to create new products and services, thus, creating more value for its customers. That also will increase its operational efficiency enabling it to penetrate new markets and increase its revenues.

Activity-based costing (ABC)
It is an approach to measuring the cost of activities within a company (Tangen, 2004). It analyzes the indirect costs within a company to discover the activities that cause those costs. These activities are called cost drivers, and they are used to apply the overhead cost to specific products.

Figure 47: Activity-based costing process



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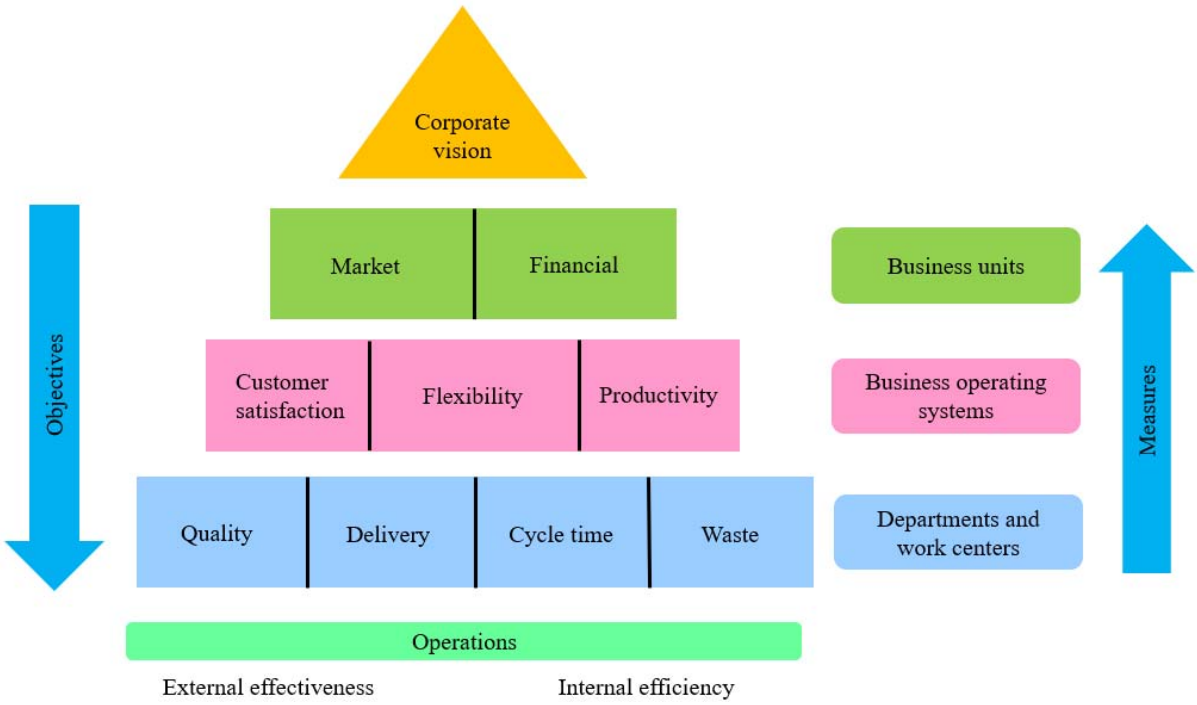
The process of activity-based costing has four steps (*Figure 47*). It starts with identifying the activities and the direct and indirect costs for each activity. It then identifies the factors affecting these costs, called cost drivers. It calculates the cost driver rate to allocate the activity cost to the total product cost.

The performance pyramid

The performance pyramid links the company's strategy across its different hierarchical levels, i.e., from the strategic objectives to operations (Tangen, 2004). That means translating the business objectives from the top-down and the measures from the bottom up. The pyramid has four levels that address the company's external effectiveness (left side) and internal efficiency (right side) (*Figure 48*). At the first and highest level, there is the definition of the corporate vision. Managers translate the vision into individual business unit objectives.

Figure 48: The performance pyramid



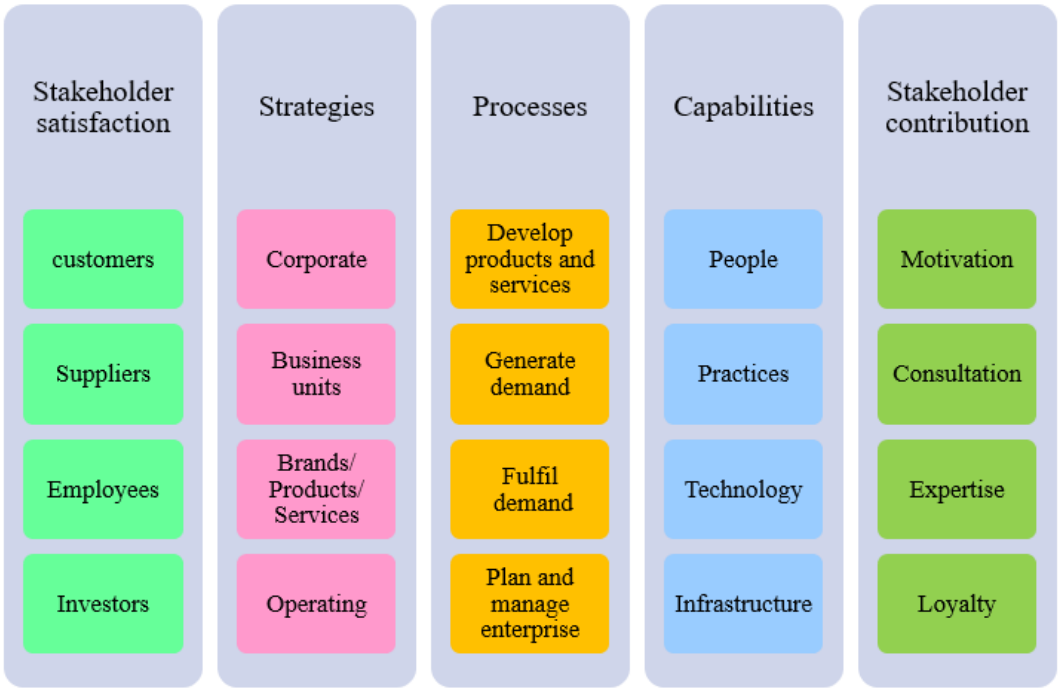
Source: own work

At the second level, the business units set the short-term (cash flow and profitability) and long-term goals (growth and market position, e.g., market, financial). The third level is the business operating system that connects the top level with the day-to-day operational measures (e.g., productivity, customer satisfaction, flexibility). Then, at the lowest level, there are four key performance indicators (quality, delivery, cycle time, and waste). The department and work centers use these measures daily.

The performance prism

The performance prism advocates that a PMS should have five connected dimensions of performance (*Figure 49*) (Neely, Adams, & Crowe, 2001). The first dimension is stakeholder satisfaction. It outlines who the stakeholders are and what their needs are. This dimension is broader than that of the balanced scorecard view of stakeholders, which presents only shareholders and customers and doesn't mention suppliers, alliance partners, or intermediaries. The second dimension is the strategies, and it should come only after identifying the stakeholders and their needs. After that, it is possible to define strategies for the stakeholders' satisfaction.

Figure 49: The performance prism



Source: own work

The third dimension is the processes, especially those needed to deliver the strategies. These processes should have specific measures that will allow management to monitor any relevant issues attributed to them. The fourth dimension is the capabilities which are the foundation that enables any organization to compete. They are the people, practices, technology, and infrastructure, and they work in combination so that the organization can execute its business processes. The fifth dimension is the stakeholder contribution. It acknowledges the fact that value delivery is two-way. As much as organizations should deliver value to their stakeholders, the relationship between stakeholders and the organization should also allow the stakeholders to contribute value to the organization.

Summary

In summary, we faced the challenges of having a systematic literature review of multiple domains. Thus, we used the narrative review with borrowed many steps from the systematic review process to improve the quality of the narrative one and reduce bias. We developed a protocol-based approach with explicit phases to conduct it. We defined inclusion and exclusion criteria that offer the possibility of review replication. That helped cover the publications in the different fields of study: information systems, innovation, and organizational agility, and to have a solid foundation for the current research dissertation. The impact of IT governance in professional practice is undeniably significant and required by law in some countries. Finally, the review outcome confirmed the gap indicating limited research publications exist to explain the role of IT governance in the rest of the domains.

3 THEORETICAL BACKGROUND

This chapter presents the theoretical perspective of the study. It starts with an overview of postulating a theory. It discusses the requirements of a good one and how this will reflect on our research.

Then, it delves into the nature of theory in information systems research. In that section, we outline the four goals of theorizing in information systems research and explain how combining these goals will lead to five different types of theory. That will clarify the conceptualization proposed in our study.

The following section will discuss the resource-based view of the firm as the first theory that explains the proposed research model considering the primary resources used in the study, such as IT capability and IT governance.

Then, the following section will discuss the dynamic capabilities view, which is the second theory that explains the needed theoretical support for parts of the model. It helps us understand how organizational agility, supported by its resources and capabilities, enables the firm to respond when faced with environmental turbulence.

Next, we discuss the concept of organizational capabilities and how they impact organizational agility as an outcome of the study.

Finally, we discuss the selection of theory for our study and how we needed to combine two to explain the research model proposed.

Our study needs a good theory

The current research needed a theory that satisfies the requirements of being a good one. We set the environment for theorizing our research by outlining theorizing in general, then in information systems research. Then, we define our theories and their potential to explain and predict the answer to the research questions postulated in our study.

A theory focuses on the nature of causal relationships, and the strong one emphasizes the underlying processes to explain the reasons for occurrence or nonoccurrence (Sutton & Staw, 1995). A theory has concepts connected with statements of relations bounded by assumptions and constraints (Bacharach, 1989). It has a set of logically interwoven arguments that can explain and predict. However, many researchers safely state that references, data, variables, diagrams, and hypotheses don't represent a theory.

A good theory requires the logical consistency of its building blocks. That includes the theoretical construct, propositions, assumptions, and boundary conditions. It also requires the power to explain or predict better than rival ones. The explanation provides the substantive meaning of constructs, variables, and relationships. The prediction will test that meaning by comparing it to empirical evidence (Bacharach, 1989). That means testing it empirically with the potential to falsify it but with no ability to prove it. Finally, it should be parsimonious. Parsimony indicates how much we can explain the phenomenon with few variables. It takes roots in Occam's razor, which states that the most simplistic theory, with fewer variables or fewest assumptions, is the most sufficient usually to explain the observed evidence. That allows parsimonious theories to be more easily generalized (Bacharach, 1989).

Table 14: The differences between variance theory and process theory

	Variance theory	Process theory
Role of time	Irrelevant Necessary and sufficient conditions can occur in any order	Crucial The time ordering in which necessary conditions combine is consequential
How to "read" the theory	The cause is necessary and sufficient for the outcome	Causation consists of necessary conditions in sequence; chance and random events play a role
Assumptions	The outcome will invariably occur when necessary and sufficient conditions are present	The outcome may not occur (even when conditions are present)
Outcome	A variable	A discrete occurrence
Logical form	If X, then Y; if more X, then more Y	If not X, then not Y; can't be extended to "more X" or more "Y"

Source: adapted from Markus & Robey (1988); Soh & Markus (1995)

The logical structure of a good theory indicates the relationship between the antecedents and the outcomes. It identifies the variance theory and the process theory. About 80% of the articles in major IS journals used a variance theory, while 20% used a process theory (Paré, Bourdeau, Marsan, Nach, & Shuraida, 2008). Our research is of the variance type that

focuses on the properties of entities and their varying values. The entities will not change over time; only their values can vary. The relationships between entities are assumed to be unidirectional and constant. But on the other side, the process type focuses on entities participating in the events (called focal actors) or affected by them. The entities change over time. The relationships between entities are assumed to be related to the sequence of events (discrete states). A summary of the differences between variance theory and process theory is in *Table 14*.

Finally, the theory should contribute to academic research. However, theoretical contributions are not of the same magnitude. Improving a single element of an existing one is rarely sufficient. The focus should be on multiple components to add completeness and thoroughness. There must be significant evidence, whether logical or empirical. In short, the theory should propose either corrections or other options to consider (Whetten, 1989).

3.1 The Nature of Theory in Information Systems

The goal of a theory is to guide our understanding of complicated and conflicting real-world phenomena. It acts as a lens to help us focus on our research questions while minimizing the interference others may cause (Truex, Holmström, & Keil, 2006). Some researchers argue that there are four primary goals for theories in information systems research (Gregor, 2006). They are analyzing, explaining, predicting, or prescribing. In **analysis**, the goal is to describe the phenomena of interest and analyze the relationship among the constructs. In **explanation**, our goal is to explain how, why, and when. It relies on causality that will enable a better understanding of the phenomenon under study. Then, the third goal is **predicting** probable future events that can happen under certain preconditions. Lastly, the fourth goal is **prescription** trying to describe the method or the structure or both for an artifact construction.

Table 15: Theory types in information systems research

	Research question	Prediction	Testable propositions	Causal explanations
Analysis	What is	No	No	No
Explanation	How, why, when, where	No	No	Yes
Prediction	What is and what will be	Yes	Yes	No (weak if any)
Explanation and prediction	How, why, when, where, what is, and what will be	Yes	Yes	Yes
Design and action	How	No	No	No

Source: adapted from Gregor (2006)

The combinations of these goals lead to the five types of theories outlined in *Table 15* (Gregor, 2006). The five theory types have a common ground as they are all used to advance the current state of knowledge, thus adding to cumulative theory (Truex, Holmström, & Keil, 2006).

First, **analysis theory** answers the question of what is. It is the most basic type, and it describes attributes of individuals, groups, or events by summarizing the commonalities found in collected observations. A theory that describes and analyzes is valuable if the knowledge available is scarce about the phenomena of interest. However, it doesn't go beyond analysis and description with no causal relationships or predictions.

Second, an **explanation theory** answers how, why, when, and where. It can be labeled theory for understanding as it often emphasizes explaining how and why events happened as they did. That will enable a different perception of how things are and potentially answer the why. However, it doesn't predict or offer testable propositions.

Third, a **prediction theory** answers what is and what will be but does not answer the why. The discovery of correlations that allow prediction can be interesting if these were unknown before. The correlations between two variables do not necessarily imply a causal relationship. Although this type can provide predictions and testable propositions, there are no well-developed causal explanations.

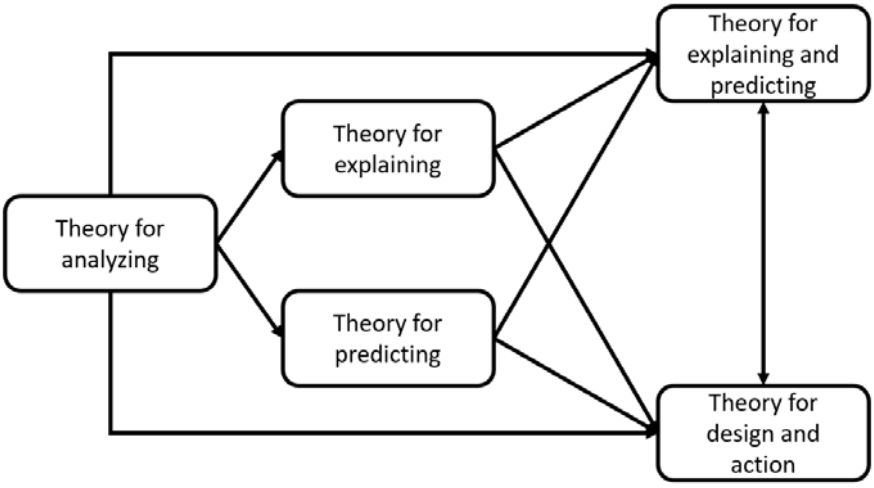
Fourth, **explanation and prediction theory** answers what is, how, why, when, and what will be, as in the previous two types. It provides an understanding of the underlying causes and predictions. It can also describe the theoretical constructs and the existing relationships among them. Thus, it offers predictions, testable propositions, and a causal explanation. That can contribute to either theory building or theory testing. Our research belongs to this group, as we described the theoretical constructs for our model and the proposed relationships among them, which we had tested empirically. The model explained the relationships between IT governance and organizational agility and the proposed mediators and moderators. Thus, it provided a better understanding of the antecedents and the predicted outcome.

Fifth, **design and action theory** is about the way of doing something and building an artifact, such as the principles of forms, functions, methods, and the theoretical knowledge that justifies such usage in IS development.

There are interrelationships among theory types as the most basic analytic theory is needed to develop the other types, as shown in *Figure 50*. That requires clear construct conceptualization and definition in all theory formulations. However, some researchers argue that theories for analysis are typologies rather than theories (Weber R. , 2012). They regard typologies as a type of description that is a source of material but not as theoretical statements (Bacharach, 1989). They also consider theories for explanation are models rather than theories, and researchers often use them within interpretivism research. They also argue that even theories postulated for prediction do not always provide a clear account of constructs association (Weber R. , 2012). Finally, they consider theories for design and actions are rather models due to the lack of some attributes that are essential in theory (Weber R. , 2012).

However, the categorization is helpful if the theory has the quality attributes of a good one, as described earlier.

Figure 50: Theory types interrelationships



Source: adapted from Gregor (2006)

The research in the information systems domain is primarily within two paradigms: behavioral science and design science (Hevner, March, Park, & Ram, 2004). The behavioral science paradigm focuses on developing and verifying theories that explain or predict human or organizational behavior. It is rooted in the business school culture in the Anglo-Saxon world. The design-science paradigm focuses on extending human and organizational capabilities, thus creating new and innovative artifacts. It is rooted in business and information systems engineering in German-speaking countries and Scandinavia. In Germany, the term 'Wirtschaftsinformatik' means business and information systems engineering, which is considered equivalent to IS research in the Anglo-Saxon world (Österle, et al., 2011). However, both paradigms study people, organizations, and technology.

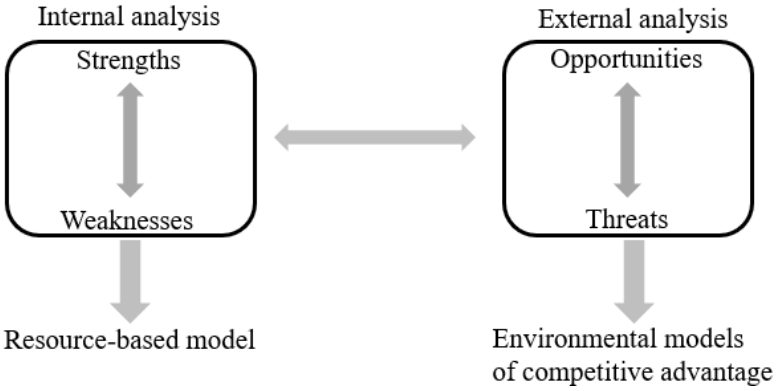
Information systems are one of the primary sources of organizational resources and capabilities. The design and implementation of information systems and the management of IS professionals require careful consideration of the behavioral aspect. That is essential to have more effective IS capabilities. It explains the need to adopt behavioral science research standards such as theory-based research questions and proper methodology to achieve these capabilities. Furthermore, in quantitative studies, we use theory deductively or, in other words, we test or verify it rather than developing it. We collect the data, analyze it, and reflect on the result, whether confirming or rejecting it. The theory is a framework for the study, and it provides an organizing model for the research questions or hypothesis. In our research, we combined RBV and DCV to help us understand the research model and answer the research questions.

3.2 Resource-Based View (RBV)

Researchers argue that the resource-based view of the firm (RBV) has roots in different theories that explain sustained competitive advantage and economic rents (profits), e.g., Ricardian rents and Schumpeterian rents (Dagnino, 1996). They also argue that this can happen through owning assets, capabilities, and internal resources (Miller, 2019). Ricardian rent happens when resources/capabilities are rare (Parayitam & Guru, 2010; Peteraf, 2018; Sautet, 2018). Schumpeterian rent occurs when imitators can not imitate the innovation while the entrepreneur continues earning the profits (Sautet, 2018). The rents (profits) appear when innovations are new and disappear when the imitators can imitate the innovations (Dagnino, 1996; Parayitam & Guru, 2010).

RBV is one of the best strategy options when firms formulate their own. Firms need to understand the relationships between resources, capabilities, competitive advantage, and economic rent. RBV argues that competing firms may enjoy functional differences due to their resources and capabilities. According to RBV, resources are the firm's assets (tangible or intangible), and if valuable, they enable the firm to develop and implement its strategies by lowering costs or increasing revenues. So, these differences can explain their significant impact on performance (Xiao, Arikan, & Barney, 2018).

Figure 51: Resource-based model vs. environmental model



Source: adapted from Barney (1991)

Research revealed that firms sustain their competitive advantage by focusing on strategies that exploit their internal strengths in response to environmental opportunities (Barney J. , 1991). At the same time, they also focus on strategies that minimize their external threats and avoid their internal weaknesses (Barney J. , 1991). So, researchers often compare the traditional environmental model and the RBV model (*Figure 51*). The environment model of competitive advantage has two assumptions (Barney J., 1991). First, firms within an industry can have similar strategically relevant resources and goals. Second, if resource heterogeneity should develop, it will be temporary because resources are assumed to be highly mobile.

However, based on the RBV model, other researchers argue that firms within an industry may have and control heterogeneous strategic resources. They also assume that such resources may not have the free mobility to be moved across firms indicating that heterogeneity can be long-lasting (Barney J., 1991). In other words, the resource-based view (RBV) assumes that resources are heterogeneous and imperfectly mobile across firms.

That explains why the resource-based view (RBV) has become one of the most influential theories used in management for describing, explaining, and predicting organizational relationships (Kraaijenbrink, Spender, & Groen, 2010; Barney, Ketchen Jr, & Wright, 2011). It has a dominant role in explaining the firm performance differences in the strategic management domain. However, its resource-based logic also influences theoretical and empirical studies in other fields, such as management information systems. It states how firms operate and how they use their internal sources to sustain their competitive advantage. Sustainable competitive advantage (SCA) relies on having a firm-specific resource(s). RBV assumes that sustainable competitive advantage is the desired goal for firms as this will allow them to earn economic rents (Fahy & Smithee, 1999). RBV argues that firms must have unique resources to achieve this goal.

Figure 52: VRIO

Source: own work

The firm-resource must have the following four attributes (VRIN): (1) valuable; (2) rare; (3) inimitable; (4) non-substitutable (Barney J. , 1991), but later, Barney updated the VRIN by combining inimitability and substitutability, and adding a fourth factor the organization (VRIO) to exploit the resources (Barney J. B., 1995). The organization (O) must be capable of absorbing and applying them, as shown in *Figure 52*. Valuable resources enable the firm to exploit opportunities and alleviate threats in its environment (i.e., rent-producing) (Hart, 1995). When a firm possesses a valuable resource that many firms also own, these firms have the same opportunity to implement that same strategy for competitive advantage. That also applies to a bundle of valuable resources. If firms have available valuable resources, they can achieve competitive parity. That is because no single firm enjoys a competitive advantage.

Firms with valuable but rare resources often become strategic innovators, as they can design and implement strategies contrasting with other firms lacking such relevant resources (e.g., first-mover advantages). However, for firms possessing such valuable and rare resources, if they need to keep their competitive advantage, there should be no possibility for other firms without these resources to obtain them.

Researchers attribute different factors to the state of imperfectly imitable. One factor is the unique historical conditions that influence the ability to get the resources, e.g., physical

capital and individual human capital. Another is the causally ambiguous relationship between the resources and the firm's sustained competitive advantage (e.g., assets based on learning-by-doing reached by experience and enhanced by practice but not visible) (Hart, 1995). Lastly, resource generation is socially complex (e.g., organizational culture).

Further, there aren't strategically equivalent valuable resources (non-substitutable). Substitutability may have more than one form. First, a firm may not have an identical resource, but it can substitute it with a comparable one achieving similar strategies. Also, firms may have very different resources, yet they can serve as strategic substitutes. When committed to its existing competency base, the firm might find it increasingly difficult to obtain new resources or capabilities. Thus, the challenges posed by environmental changes are one of the main reasons to develop a new resource base (Hart, 1995). We will discuss these challenges in the dynamic capabilities view section.

RBV in information systems research

The resource-based view has been used in information systems research to explain how IT business value can provide a competitive advantage (Bharadwaj A. S., 2000). Researchers argue that RBV is highly useful in information systems research citing many factors for their arguments (Wade & Hulland, 2004). RBV shows how information systems can strongly link to a firm's strategy. As such, it provides a valuable framework to evaluate the strategic value of IS resources. Furthermore, it helps differentiate the various types of information systems and how each one can influence performance. Finally, it enables researchers to compare the value between IS and non-IS resources. Information systems resources exert influence through complementary relationships with other firm assets and capabilities to provide strategic benefits.

Among the different resources of the firm, IT resources and capabilities have the most significant role, especially with emerging Industry 4.0 technologies. In such a competitive environment, the resource-based view of the firm (RBV) is the theory that can explain and predict the business value of IT and how IT resources as part of firm resources can provide the firm with a competitive advantage (Cao, Duan, & Cadden, 2019). The RBV highlights how firm resources such as IT resources can be the main predictors of a firm's performance (Barney J. , 1991). It explains how IT resources can be highly differentiating factors in a firm's strategies, and if they are difficult to replicate, they can sustain competitive advantage (Bharadwaj A. S., 2000). IT resources can become a differentiating factor if they are valuable, rare, inimitable, and non-substitutable (VRIN) (Bharadwaj A. S., 2000). However, the effect may be temporary if environmental changes affect the existing resource base of the company. That is also true when changing conditions necessitate building a new resource base (Barney J. , 1991). Furthermore, researchers sometimes combine RBV with major extensions that include a dynamic capabilities view (DCV) and a knowledge-based view of the firm (KBV) to explain their research model (Miller, 2019).

We used RBV theory to study the relationship between innovation capability, IT capability, IT governance, organizational agility, and firm performance. Looking through the RBV lens, our model explains how IT governance, innovation, and IT capabilities are potential sources for organizational agility.

Criticisms of RBV

Although RBV emphasizes the need to develop and obtain VRIN resources, it doesn't show how firms can do it. Some authors would explain that as a tension between descriptive and prescriptive theorizing (Lado, Boyd, Wright, & Kroll, 2006). However, RBV's focus is never on managerial prescriptions.

Some authors claim that RBV supports the notion that firms must acquire higher-order capabilities (Kraaijenbrink, Spender, & Groen, 2010). They argue that higher-order ones have a more suitable structure to innovate products better. Thus, they will become more valuable than lower ones in product innovation. However, others argue that there is no need to treat higher-order capabilities as superior to lower ones. Instead, there is a need to manage the interactions between them.

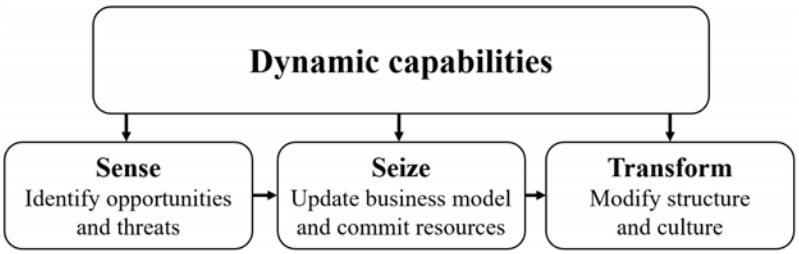
RBV can hold its position as long as an industry's environment remains relatively fixed. However, this can change when there is an unpredictable environment, where the market changes with drastic fluctuations in the resources' value. That would necessitate going beyond RBV.

Finally, the definitions of a resource can be problematic if it is inclusive. One reason is that they don't differentiate between the resources as inputs and the output after organizing such inputs. That needs further consideration when discussing dynamic capabilities, as in our study. The definition should separate the resources used and the dynamic capabilities that resulted from these resources. RBV treats all types of resources as one type which needs further review.

3.3 Dynamic Capabilities View (DCV)

Researchers argue that dynamic capabilities are the preferred path to a long-lasting competitive advantage, and firms need to acquire the skills that enable them to build these capabilities. DCV has its roots in three theories: the resource-based view of the firm, the Schumpeterian rent, and organizational learning (Dagnino, 1996; Parayitam & Guru, 2010). The Austrian school and Schumpeter emphasize the creative destruction and the role of entrepreneurs in disrupting the equilibrium, especially during uncertainty. Then, we have organizational learning, which focuses on studying organizational routines and the decision-making processes.

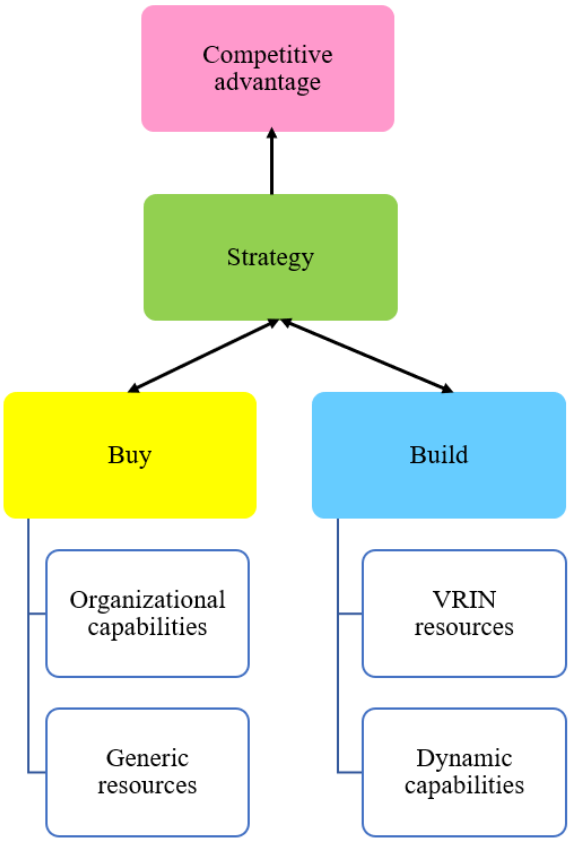
Figure 53: Dynamic capabilities



Source: adapted from Teece (2019)

The dynamic capabilities view (DCV) extends the resource-based view (RBV) of the firm by explaining how dynamic capabilities govern in such a changing turbulent environment (Teece, Peteraf, & Leih, 2016). These capabilities include sensing, responding, and transforming resources to enable the firm to explore and exploit market opportunities and manage new unpredictable threats (*Figure 53*).

Figure 54: Dynamic capabilities framework



Source: adapted from Teece (2019)

However, the capabilities required to achieve these objectives are not routine organizational capabilities. They are a different set of higher-order nature that enables quick and effective rearrangement of existing resources or the creation of new ones, and they are difficult to be

imitated. They can also explain why some firms can develop a competitive advantage in volatile markets more than others. Researchers regard these high-order capabilities as dynamic capabilities (*Figure 54*). Hence, extending the RBV with the DCV will explain how IT governance can exert its strong impact on IT capability, innovation capability, and organizational agility and how this impact can be influenced by environmental turbulence, as shown in *Figure 55*.

With market changes, the dynamic capabilities can enable firms to build and reconfigure their resource base, thus, helping them manage emerging opportunities or impending threats. For example, ordinary capabilities enable new process innovation, while dynamic capabilities enable identifying new products and services (Helfat & Raubitschek, 2018). Furthermore, they can support the firm in monitoring market changes and assessing the viability of the current business model with the potential of creating new business models.

Dynamic capabilities play a significant role in governing the rate of change of an organization's ordinary capabilities. They are unique for each organization and built rather than bought (*Figure 54*). Some researchers consider dynamic capabilities heterogeneous across different firms because of their unique characteristics and specific processes (Teece, Pisano, & Shuen, 1997) (also known as TPS). However, other researchers argue that dynamic capabilities show commonalities across firms (Eisenhardt & Martin, 2000) (also known as EM), and they are extensions or modifications of an organization's ordinary capabilities (Winter, 2003). Table 13 summarizes some fundamental differences between the two conceptualizations (Peteraf, Di Stefano, & Verona, 2013).

However, both streams of research agree that dynamic capabilities have a significant role in developing competitive advantage and sustaining it in turbulent conditions. Dynamic capabilities are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die (Daniel, Ward, & Franken, 2014). Researchers regard dynamic capabilities as processes or routines that enable the firm to integrate and configure its resources and related ordinary capabilities. That is marked, especially when encountering a turbulent market (Daniel, Ward, & Franken, 2014).

Table 16: Differences in dynamic capabilities conceptualization

	Teece, Pisano, & Shuen, 1997 (TPS)	Eisenhardt & Martin, 2000 (EM)
Boundary conditions	The framework applies to environments of rapid technological change	The framework encounters a boundary condition in such environments
Competitive advantage	Dynamic capabilities can be a source of competitive advantage	Dynamic capabilities can be a source of only limited competitive advantage
Sustainable advantage	Dynamic capabilities can be a source of sustainable advantage under certain conditions	Dynamic capabilities can't be a source of sustainable advantage under any conditions

Source: adapted from Peteraf, Di Stefano, & Verona (2013)

In summary, DCV is one of the significant theories in the study of information systems research (Schilke, 2014; Lim, Saldanha, Malladi, & Melville, 2013). It extends the RBV and explains how the organization can maintain its competitive environment under changing market conditions (Eisenhardt & Martin, 2000; Peteraf, Di Stefano, & Verona, 2013). RBV is limited to a static environment and doesn't explain the response to rapid and unpredictable market conditions (Eisenhardt & Martin, 2000). That led to shifting the emphasis from within the organization internally to the environment externally, focusing on acquiring a new resource base or reconfiguring existing ones. While RBV emphasizes the selection of resources (VRIN), DCV highlights resource renewal and reconfiguration. Dynamic capabilities enable sensing, seizing, and reconfiguring resources (*Figure **53***). In other words, RBV does not emphasize the role of turbulent market conditions, and DCV fills this gap (Pavlou & El Sawy, 2011).

Criticisms of DCV

Dynamic capabilities faced two primary criticisms (Collis & Anand, 2018; Collis & Anand, 2021)**.** The first limitation indicated a lack of clear definition that resulted in some gaps and initiated different interpretations. That early definition relied on the ability of the firm to build and reconfigure its competencies when facing turbulent environmental conditions. Unfortunately, that definition didn't include the nature of these abilities and their sources.

The VRIN test exposes the first limitation, where any organizational capability needs to pass the tests of sustainable competitive advantage (Collis & Anand, 2018; Collis & Anand, 2021). First, is the TPS capability valuable? The answer would be "yes" because it allows a firm to adapt to external changes. It can update its positioning by accommodating new demands. Furthermore, it is flexible and can respond to imitation, substitution, or saturation. Second, is the TPS capability rare? The answer would be "maybe" because a firm must be better than other competitors. Possessing the ability to respond flexibly to changing circumstances is not enough. Third, is the TPS capability inimitable? The answer would be "yes" because organizational capabilities have ambiguous nature and hence, are hard to imitate. Finally, is the TPS capability non-substitutable? The answer would be "maybe" because any firm can build its inimitable version of TPS capability.

The second limitation emphasizes that firms can't build a TPS capability by conducting a tradeoff with their lower-level capabilities because they can lose out to their competitors. For example, while a first mover has advantages in a new market, a later entrant with lower TPS capability may copy and takeover the first mover if it has superior-lower order capabilities.

3.4 Organizational Capabilities Perspective

An organizational capability indicates the ability of the firm to perform a coordinated set of activities using its resources to fulfill a specific outcome (Helfat & Peteraf, 2003).

Capabilities can influence the firm through different mechanisms, but unfortunately, their contribution has limited theorizing (Drnevich & Kriauciunas, 2011).

Some researchers define organizational capabilities as the socially complex routines by which firms physically transform inputs into outputs with the designated efficiency (Collis D. J., 1994). Organizational capabilities can meet the conditions formulated by the resource-based view of the firm as a source of sustainable competitive advantage. However, they are exposed to the threats of erosion, substitution, or surpassed by a higher-order capability. *Table **17*** shows a summary of the comparison between ordinary and dynamic capabilities.

Organizational capabilities are valuable but not always sources of sustainable competitive advantage. They are part of the routines, and they are a product of the entire system that includes structures, processes, culture, and employee relations. Inside the firm, they transform physical inputs into outputs. They represent resources accumulated over time, or in other words, they are built rather than bought. Therefore, they can contribute to the competitive advantage. However, researchers argue that ordinary capabilities that generate competitive advantage today will not last (Collis D. J., 1994). They claim that they can suffer from erosion when the firm adapts to market changes, a different one can replace them, or a better one can surpass them.

Ordinary capabilities have also been called zero-level. Researchers argue that they are high-level routines, where repeating them can cause learned behavior. They link to specific objectives rather than innovative improvisation (Winter, 2003). Ordinary capabilities enable the firm to survive in its present time, as they describe how firms earn their living now and how they produce and sell the same product on the same scale to the same customers over time. Ordinary capabilities can improve the quality of existing processes, services, and products. That can increase the firm's revenue and reduce the costs associated with providing services (Drnevich & Kriauciunas, 2011). Without these capabilities, the firm will not generate the revenue needed to buy inputs to repeat the whole process. These capabilities generally have three categories: administration, operations, and governance (Teece D. J., 2014).

Researchers consider strong ordinary capabilities exist in the firm when it has performed best practices and where its employee base has the relevant skilled people and advanced equipment. However, having best practices alone is insufficient to sustain competitive advantage, except in weak competitive environments, because the knowledge behind ordinary capabilities is available through consultants or investments in training. These capabilities achieve technical efficiency in the core business functions of operations, administration, or governance.

Table 17: Comparison between ordinary and dynamic capabilities

	Ordinary capabilities	Dynamic capabilities
Purpose	Technical efficiency in business functions	Achieving harmony with customer needs and with technological and business opportunities
	Competing today	Future-oriented
	Enable a firm to make a living in the present	Enable a firm to alter how it currently makes its living
Mode of attainability	Buy or build (learning)	Build (learning)
Tripartite schema	Operate, administrate, and govern	Sense, seize, and transform
Key routines	Best practices	Signature processes
Managerial emphasis	Cost control	Entrepreneurial asset orchestration and leadership
Priority	Doing things right	Doing the right things
	The ability to execute day-to-day activities	Modify ordinary capabilities
	The ability to solve current problems	The ability to change the way the firm solves its problems
Imitability	Relatively imitable	Inimitable
Result	Technical fitness (efficiency)	Evolutionary fitness (innovation)
Example	New product development capabilities	The ability to reform the way the firm develops new products

Source: adapted from Teece (2014); Zhou, Mavondo, & Saunders (2019)

Table 17 summarizes the main differences between ordinary and dynamic capabilities. Dynamic capabilities can change ordinary ones and modify resources and capabilities (Winter, 2003) in preparation or response to market changes (Daniel, Ward, & Franken, 2014). Dynamic capabilities exist partly in the signature of the organizational processes. That resides in the firm's experience, and investment strategy, among others making it hard for competitors to imitate. In other words, the dynamic capabilities make it possible for the firm to sustain its competitiveness while facing changing market conditions (Winter, 2003).

Dynamic capabilities have three foundational capabilities that help the firm during turbulent environments: sensing the change, seizing opportunities, and transforming the firm (Schoemaker, Heaton, & Teece, 2018). Early sensing of market changes under unpredictable environmental conditions before the firm's competitors will allow them to detect market shifts and how these changes can affect them. The firm must analyze the warning signs and test them thoroughly to understand what lies ahead, whether opportunities or threats. Nevertheless, sensing may not be enough, as firms need to act rapidly to seize opportunities and explore them innovatively. However, firms may find incremental response insufficient, and they must transform and implement radical changes that may even involve their business models to compete in a brave new world.

3.5 Theory Selection for the Study

In information systems research, many theories compete to explain a given phenomenon. When joining information systems and organizations research, as in this study, theorizing needs to explain and predict in both domains. The resource-based view is second to the technology acceptance model among the theories used in information systems research (Lim,

Saldanha, Malladi, & Melville, 2013). However, in IT and organization (ITO), RBV ranks first, followed by the dynamic capabilities view, as shown in *Table 18*.

To explain our research model, we draw on the resource-based view of the firm (RBV) and the dynamic capabilities view (DCV). We used both the RBV and the DCV to provide a foundation and validity for our study. We used them as statements of relationships among constructs to test our research model empirically. Both RBV and DCV are two views that allow us to understand how firms can achieve organizational agility using resources and capabilities. The RBV emphasizes that firms have valuable, rare, inimitable, and non-substitutable resources that allow them to maintain their agility state over a predictable and sustained period. We used RBV theory to study the relationship between innovation capability, IT capability, IT governance, and organizational agility. Using the RBV lens, the model explains how IT governance, innovation, and IT capabilities are potential sources for organizational agility. However, as RBV is limited to a static environment, it does not explain the response to rapid and unpredictable market conditions (Eisenhardt & Martin, 2000). RBV does not emphasize the role of turbulent environmental conditions and DCV fills this gap (Pavlou & El Sawy, 2011).

DCV extends RBV by explaining how dynamic capabilities govern when facing a changing turbulent environment (Teece, Peteraf, & Leih, 2016). The dynamic capabilities emphasize how firms can use their internal resources and external capabilities to sustain their agility in a dynamically unpredictable environment. These capabilities include sensing, responding, and transforming resources to enable the firm to explore and exploit market opportunities and manage new unpredictable threats. Extending RBV with DCV will explain the strong impact of IT governance on IT capability, innovation capability, and organizational agility and how environmental turbulence can influence this impact. With environmental changes, the dynamic capabilities can enable firms to build and reconfigure their resource base, thus, helping them manage emerging opportunities or impending threats.

Table 18: Theories used in IT and organization (ITO) research

Theory	Percentage
Resource-based view	16
Dynamic capabilities view	7
Organizational learning theory	6
Transaction cost theory	5
Absorptive capacity theory	4
Others	62
Total	100

Source: adapted from Lim, Saldanha, Malladi, & Melville (2013)

Selected articles relevant to the current study show that the dominant theory is the resource-based view (*Table 19*). From the resources perspective, some authors consider IT capabilities

as practices that complement IT (Wu, Straub, & Liang, 2015). They state that if IT capabilities are valuable, rare, inimitable, and non-substitutable (VRIN), they support competitive advantage to the organization if having such resources (Bradley, Byrd, Pridmore, Thrasher, Pratt, & Mbarika, 2012). They argue that these capabilities require successful management control. They recognize the contribution of IT governance in the management control of the vital IT assets of the organization. They consider IT governance as human IT resources that complement IT in delivering business value and that IT governance mechanisms are unique to the organization (Wu, Straub, & Liang, 2015).

Table 19: Theories used in selected articles in the study

Domain	Reference	Theory
IT governance	Bradley et al. (2012)	RBV
	Wu et al. (2015)	RBV
IT capability	Chen et al. (2014)	RBV
	Lu et al. (2011)	Structuration theory
Innovation capability	Menguc et al. (2006)	RBV, DCV
	Ravichandran (2018)	DCV
Organiztional agility	Felipe et al. (2016)	RBV, DCV
	Queiroz et al. (2018)	DCV

Source: own work

Combining Theories for the Study

The complexity of IS discipline often requires explanations that can parallel its complexity. That commonly requires combinations from multiple-lens perspectives to provide answers uniquely suited to IS. Some authors call that combination of theories as "theoretical triangulation" (Hoque, Covaleski, & Gooneratne, 2013). It is critical to reflect the reality of IS in our theorizing to overcome the tendency to create fragmented areas of knowledge that reflect specialization. Having such multiple-lens perspectives can help to provide coherence for the fragmented knowledge areas. That can emphasize complementarity areas, overlap, or contradiction. Thus, this can lead to theoretical integration.

Researchers argue that there are two significant dimensions for the relationship between theories (Okhuysen & Bonardi, 2011). These are theories' proximity in terms of the phenomena they explain and the agreement of their underlying assumptions. First, proximity is the conceptual distance between these phenomena that the lenses address in their original conception. Second, there is the assumptions compatibility. When theories have common underlying assumptions, they are compatible, but when these assumptions are very different, they are incompatible. We attempted in the current dissertation to have coherent knowledge that can explain the research model. The knowledge areas stem from diverse disciplines, mainly information systems, management science, and organizational science. For theoretical triangulation, we integrated two theories that can explain the coherent knowledge reached.

A Nobel laureate in economic sciences, Oliver E. Williamson, argued that the best efficient approach to business strategy is the resource-based or dynamic capabilities as they deal with

the core business issues. He even implied the possibility of combining them (Williamson, 1991, p. 76).

To explain our research model, we draw on the resource-based view of the firm (RBV) and the dynamic capabilities view (DCV). Both RBV and DCV are two views that allow us to understand how firms can achieve organizational agility using resources and capabilities. The RBV emphasizes that firms have valuable, rare, inimitable, and non-substitutable resources that allow them to maintain their agility state over a predictable and sustained period.

Researchres have used RBV in information systems research to explain how IT business value can provide a competitive advantage (Bharadwaj A. S., 2000). Among the different resources of the firm, IT resources and capability have the most significant role, especially with emerging industry 4.0 technologies. In such a competitive environment, the resource-based view of the firm (RBV) is the theory that can explain and predict the IT business value and how IT resources can provide a firm with a competitive advantage (Cao, Duan, & Cadden, 2019; Wade & Hulland, 2004). The RBV underlines how firm resources such as IT resources can be the main predictors of a firm's performance (Barney J., 1991). We use RBV theory to study the relationship between innovation capability, IT capability, IT governance, and organizational agility. Using the RBV lens, the model explains how IT governance, innovation capability, and IT capabilities are potential sources for organizational agility.

However, the dynamic capabilities emphasize how firms can use their internal resources and external capabilities to sustain their agility in a dynamically unpredictable environment. DCV extends RBV by explaining how dynamic capabilities govern when facing a changing turbulent environment (Teece, Peteraf, & Leih, 2016). These capabilities include sensing, responding, and transforming resources to enable the firm to explore and exploit market opportunities and manage new unpredictable threats. Extending RBV with DCV will explain the strong impact of IT governance on IT capability, innovation capability, and organizational agility and how environmental turbulence can influence this impact. With environmental changes, the dynamic capabilities can enable firms to build and reconfigure their resource base, thus, helping them manage emerging opportunities or impending threats.

As RBV is limited to a static environment, it does not explain the response to rapid and unpredictable market conditions (Eisenhardt & Martin, 2000). That led to shifting the emphasis from within the organization internally to the environment externally, focusing on acquiring a new resource base or reconfiguring existing ones. While RBV emphasizes the selection of resources (VRIN), DCV highlights resource renewal and reconfiguration. Dynamic capabilities enable sensing, seizing, and reconfiguring resources. In other words, RBV does not emphasize the role of turbulent environmental conditions, and DCV fills this gap (Pavlou & El Sawy, 2011).

4 RESEARCH MODEL and HYPOTHESIS DEVELOPMENT

This chapter describes the research model and the hypotheses in the study. It starts with the research model, which delineates the relationships and impact of the variables. The model has the proposed constructs and how they relate to each other. IT governance can exert its influence directly on organizational agility. However, it can also act indirectly through mediation by innovation capability and IT capability. Then, the environmental turbulence variable acts as a moderator on the three variables. It impacts their influence on organizational agility. Finally, organizational agility exerts a positive influence directly on the firm's performance.

Then, we will discuss our hypotheses. We hypothesize the positive role of IT governance on organizational agility. IT governance exerts its influence, either directly or indirectly, through innovation and IT capabilities. We also hypothesize that environmental turbulence moderates these relationships. Finally, we posit that organizational agility positively influences firm performance.

4.1 Research Model

Among the different resources that firms have, IT resources and capabilities are among the most significant, especially in Industry 4.0 era, where IT plays a dominant role. In such a competitive environment, the resource-based view of the firm (RBV) is the theory that can explain the business value of IT and how IT resources as part of firm resources can provide the firm with a competitive advantage (Cao, Duan, & Cadden, 2019). The RBV highlights how firm resources such as IT resources as the main predictors of firm performance (Barney J. , 1991), and IT resources are considered significant differentiating factors in firm strategies. If they are difficult to replicate, they can sustain a competitive advantage (Bharadwaj A. S., 2000). If IT resources influence firm strategies and play a differentiating factor, they need to be valuable, rare, inimitable, and non-substitutable (VRIN) (Bharadwaj A. S., 2000). However, this might be temporary, notably when environmental changes affect either the existing resource base owned by the company or if there are changing conditions that necessitate building a new resource base (Barney J. , 1991).

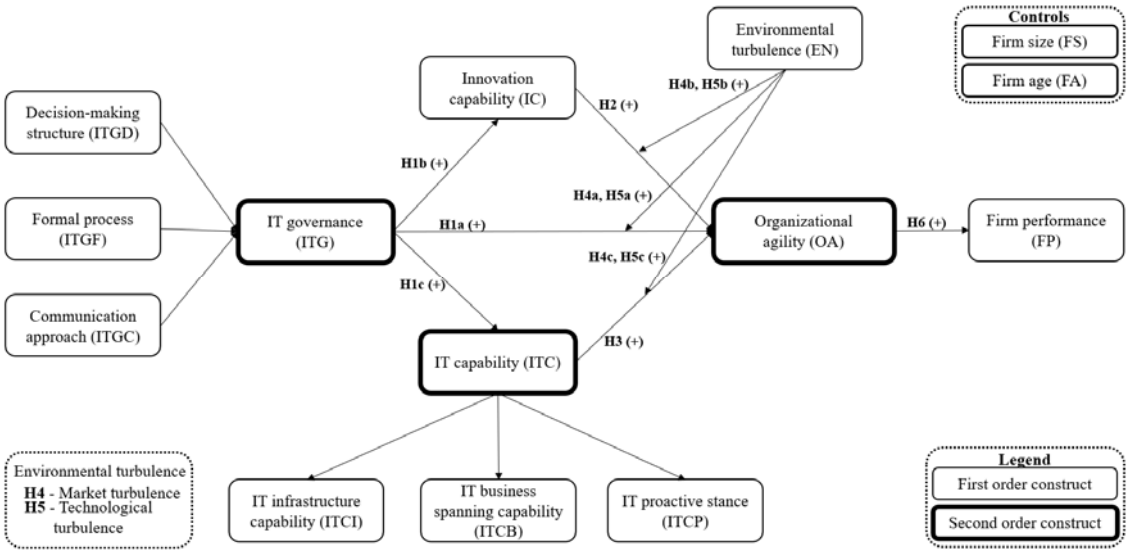
The dynamic capabilities view (DCV) extends the resource-based view (RBV) of the firm by explaining how dynamic capabilities govern in such a changing turbulent environment (Teece, Peteraf, & Leih, 2016). These capabilities include sensing, responding, and transforming resources to enable the firm to explore and exploit market opportunities and manage new unpredictable threats. However, the capabilities required to achieve these objectives are not routine organizational capabilities. They are a different set of higher-order nature that enables quick and effective rearrangement of existing resources or creation of new ones, and they are difficult to be imitated. Researchers call these high-order capabilities the dynamic capabilities.

Hence, extending the RBV with the DCV allows us to explain how IT governance can exert its strong impact on IT capability, innovation capability, and organizational agility and how this impact can be influenced by environmental turbulence, as shown in Figure 55. It also explains the influence of organizational agility on a firm's performance. With environmental changes, the dynamic capabilities can enable firms to build and reconfigure their resource base, thus, helping them manage emerging opportunities or impending threats. Ordinary capabilities enable new process innovation, but the dynamic capabilities help identify new products and services (Helfat & Raubitschek, 2018). Furthermore, they can support the firm in monitoring environmental changes and assessing the viability of the current business model with the potential of creating new business models.

Combined RBV and DCV can explain the relationships between the proposed constructs and the result of the study. We postulate in our research model that IT governance and the two capabilities (innovation capability and IT capability) act as resources to enable the organization's strategic pursuit of agility. IT and innovation capabilities mediate the relationship between IT governance and organizational agility, while environmental turbulence moderates the governance-agility and capabilities-agility relationships and can affect the strength of the relationship. We also propose that organizational agility can influence the firm's performance (Figure 55).

Organizations with effective IT governance often succeed, while others without it often fail (Weill & Ross, 2004). IT capability can't function effectively and efficiently to serve the business needs without effective IT governance. IT governance provides the framework for management control to align IT objectives with business objectives to achieve an aligned strategy. The framework would also enable the efficient acquisition, maintenance, and update of IT resources and capabilities. In addition, it provides a smooth transition for the changes imposed by environmental turbulence.

Figure 55: Research model and hypotheses



Source: own work

IT governance ensures the strategic alignment between business and IT objectives (Alreemy, Chang, Walters, & Wills, 2016). It is a challenge for any company to achieve strategic innovation without the needed service infrastructure and the realization of the business value of IT in supporting or driving the innovation process (Peterson, 2004). IT governance supports exploring and exploiting emerging opportunities to capture value or minimize threats (Andersen, Svejvig, & Heeager, 2017). The management controls imposed through IT governance ensure that the IT resources will facilitate the desired innovation objectives (Tiwana & Konsynski, 2010). IT governance also reasonably assures business continuity and innovation continuity when threatened by undesirable changing conditions.

Senior management may prefer to make different choices when leveraging innovation for organizational agility. Some prefer to act proactively and explore new approaches that enable early detection and rapid response ahead of competitors. Others may be more cautious about developing new products or services quickly because of their risk aversion. Organizations use new technologies and practices innovatively to generate new products and services. That will impact the desired organizational agility (Ashrafi, Ravasan, Trkman, & Afshari, 2019).

4.2 Hypothesis Development

We propose that IT governance exerts a positive effect on organizational agility. That effect is either directly or indirectly. The indirect impact is through its positive influence on innovation and IT capability. We also hypothesize that environmental turbulence affects these relationships. Finally, we posit that organizational agility positively influences firm performance.

IT governance complements traditional dynamic capabilities (Rai, Patnayakuni, & Seth, 2006; Sarker, Sarker, Sahaym, & Bjørn-Andersen, 2012; Khalil & Belitski, 2020). As dynamic capabilities facilitate enhanced IT-business alignment, some researchers argue that IT governance is, in essence, one of the dynamic capabilities since it can provide organizations with the ability to sense and respond quickly and effectively (Héroux & Fortin, 2018).

IT governance assures the strategic alignment of business and IT objectives which enhances the innovation objectives of the company. The board and senior management may choose different decisions when using innovation for organizational agility (Asensio-López, García, & Álvarez, 2019). Having IT aligned with the business objectives, then IT governance can enhance exploring and exploiting innovative practices leading to increased organizational efficiency (Andersen, Svejvig, & Heeager, 2017). When organizations use new technologies and practices innovatively and develop new products and services, that will impact the desired organizational agility (Ashrafi, Ravasan, Trkman, & Afshari, 2019). We argue that IT governance can exercise a powerful impact on organizational agility through its influence on the innovative practice of the firm. IT governance mechanisms provide the management with

controls that help have a reliable dynamic IT infrastructure that enables the desired innovation practice (Tiwana & Konsynski, 2010).

As IT governance mechanisms ensure a strategic alignment between IT and business objectives, that would result in having the desired IT capability that serves the business objectives. IT governance provides better management control and efficient utilization of IT capability, making IT capability flexible and ready to respond to any needed changes in unpredictable conditions. Thus, firms having more effective IT governance are more likely to have more efficient IT capability (Peterson, 2004). Firms that enjoy better IT capability usually outperform their competitors (Bharadwaj A. S., 2000) because they would be able to sense and respond to unpredictable environmental conditions (DeGroote & Marx, 2013). They can do so by monitoring the environment, and making quick and effective decisions, thereby reconfiguring their internal processes and achieving the desired readiness state (Lu & Ramamurthy, 2011). We argue that IT governance can exert a powerful impact on organizational agility mediated by its influence on IT capability.

The role of IT governance

IT governance mechanisms provide the necessary management control to align IT objectives with business objectives. One of these mechanisms is the structure that defines clear roles, responsibilities, and accountability for IT decisions. The high integration between business and IT decisions enforces implementing the required IT capability to achieve and maintain the selected state of organizational agility (Peterson, Parker, & Ribbers, 2002). That assures identifying and selecting IT business cases based on business prioritization and evaluation of IT decisions. Communication is another mechanism for IT governance concerned with a shared understanding of business/IT objectives, including organization agility. Reaching the state of an agile organization will depend on the joined collaboration of senior management, including the IT leadership, to review the main requirements and proposals from different business units, hence, rendering the decision-making process more agile (Aghina, De Smet, & Weerda, 2015). Senior management plays a principal role in sensing environmental changes and formulating an organizational response to these changes (Park, El Sawy, & Fiss, 2017). Furthermore, IT governance enhances the effective usage of IT resources and capabilities that improve organizational agility (Zhen, Xie, & Dong, 2021). We posit that:
H1A IT governance is positively associated with organizational agility.

IT governance and innovation have a relationship influenced by the impact of the board of directors or senior management on the innovation process (Asensio-López, García, & Álvarez, 2019). While some senior managers prefer to take a proactive and exploring approach to stay ahead of the competition, other managers prefer risk-averse and take a reactive and exploiting approach to maintain their competitive status (Ashurst, Freer, Ekdahl, & Gibbons, 2012). However, in either case, it is challenging to achieve strategic innovation

without the needed service infrastructure and the realization of the business value of IT in supporting or driving the innovation process (Peterson, 2004).

IT governance assures the strategic alignment of business and IT objectives which are considered the most significant success factor in many studies (Alreemy, Chang, Walters, & Wills, 2016). That would enhance the innovation objectives of the company, either in the current practice or the upcoming plans. That will have the advantage that exploring and exploiting the core organizational resources would stimulate the innovation process (Tallon & Pinsonneault, 2011).

IT governance will support exploring and developing innovations (exploration) or exploiting the current system based on the business objectives. That will increase organizational efficiency (exploitation) (Andersen, Svejvig, & Heeager, 2017). IT governance mechanisms notably increase the business value of IT both in-house and in an outsourced context. The management controls implemented through IT governance ensure that the modular IT infrastructure will facilitate the desired innovation practice (Tiwana & Konsynski, 2010). It also provides a reasonable assurance for assuming business continuity and in-effect innovation continuity when threatened by risks. We posit that:

H1B IT governance is positively associated with innovation capability.

A significant concern of IT governance is having efficient management of the firm's IT resources and capabilities (Lee & Lee, 2009). IT governance enables choosing among different options of IT resources and capabilities and hence, having management controls that lead to a smooth transformation from one IT capability state to another. IT governance enables us to do the right thing while doing things right. That is the expected behavior under normal conditions and more in a turbulent environment.

IT governance and dynamic capabilities enable the firm to become more flexible and agile when using digital technologies, whether adapting, reconfiguring, or implementing new technologies, systems, and applications. Hence, IT governance provides effective management and utilization of IT resources and capabilities, making them flexible and ready for any required changes in unpredictable conditions. Firms having more effective IT governance are likely to have more effective and efficient IT capability. As IT governance complements traditional dynamic capabilities (Rai, Patnayakuni, & Seth, 2006; Sarker, Sarker, Sahaym, & Bjørn-Andersen, 2012; Khalil & Belitski, 2020), it would enable the firm to mitigate the risks in the digital environment (Helfat & Peteraf, 2003). Because dynamic capabilities facilitate enhanced IT-business alignment, some scholars argue that IT governance is, in essence, one of the dynamic capabilities since it can provide organizations with the ability to sense and respond quickly and effectively (Héroux & Fortin, 2018).

Not only IT governance has a dynamic aspect, as mentioned earlier, but researchers also investigated IT capability for that same aspect. Other researchers studied the potential

dynamic capabilities of IT using different terms. For example, they used dynamic IT capabilities (Li & Chan, 2019), IT-enabled dynamic capabilities (Mikalef & Pateli, 2017), and IT application orchestration capability (Queiroz, Tallon, Sharma, & Coltman, 2018). They share common attributes, e.g., the ability to sense and respond quickly and effectively to environmental changes. We propose that IT governance has a powerful impact on IT capability, as it provides the framework that allows the needed control for proper development, acquisition, maintenance, and update for IT capability. We assert that:
H1C IT governance is positively associated with IT capability.

The role of innovation capability

The board and senior management have different options to decide when using innovation for organizational agility. Some lean toward an exploratory and proactive approach leading to early detection and rapid response well ahead of the competition. Others may prefer to be more cautious about developing new products or services quickly because of their risk aversion. In either case, the ability of management to use new technologies and practices innovatively to offer new products and services will impact the expected organizational agility (Ashrafi, Ravasan, Trkman, & Afshari, 2019). Many companies prefer to create a separate business unit to practice innovations. These units can be linked to the core business as new initiatives are explored or leveraged.

For example, one of the leading manufacturers in Powder Metallurgy, GKN, created a separate unit outside its existing organizational structure. The company wanted to stay ahead of the competition in using 3D printing. The company realized its business goal by incorporating the new separate entity into a start-up company called 3YOURMIND (3YD), which has the required expertise in 3D printing (Wildhirt, Seidel, Bub, & Kühr, 2019). KAESER, as another example, is one of the leading manufacturers of compressed air systems. It has developed a new service-based operator model. In its business model, customers do not pay for air compressors but pay a monthly fee only for the compressed air they use. KAESER also created a new business unit to implement this innovative practice (Bock, Wiener, Gronau, & Martin, 2019). Both companies employed new technologies innovatively to realize their business goals. They also created new business units, allocated resources, and successfully accommodated the innovative practice with new technologies in response to anticipated market changes. We argue that:
H2 Innovation capability is positively associated with organizational agility.

The role of IT capability

Many researchers investigated the direct effects of IT capability on organizational agility. Recent research is also trying to understand the underlying factors of these effects, including what influences IT capability and what moderates it (Lu & Ramamurthy, 2011; Chen, Wang, Nevo, Jin, Wang, & Chow, 2014). Firms that maintain a higher IT capability usually exceed

their competitors (Bharadwaj A. S., 2000) because they would be in a better state to sense and respond to changing environmental conditions (DeGroote & Marx, 2013). They can do so by monitoring the environment, and making quick and effective decisions, thereby reconfiguring their internal processes and achieving the desired readiness state (Lu & Ramamurthy, 2011).

Some researchers argue that firms realizing the full benefits of their IT capability have a better opportunity to become agile and sustain their competitive advantage (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014). IT capability practice provides value to firms through complementing IT (Aral & Weill, 2007; Melville, Kraemer, & Gurbaxani, 2004).

However, some researchers claim that IT capability may not be an enabler of business objectives (Chae, Koh, & Park, 2018; Chae, Koh, & Prybutok, 2014). Some even claim that IT capability may act as a disabler to becoming agile and thus, hinder the anticipated response in facing different environmental conditions, especially in SMEs (Neirotti & Raguseo, 2017). However, we argue that IT governance mechanisms shift the balance towards a positive influence of IT capability on organizational agility. We posit that:
H3 IT capability is positively associated with organizational agility.

The role of market turbulence

Market turbulence poses a challenge and different types of pressures that affect the governance of the decision-making processes as this will impose new resources and capabilities requirements on the organization (Xue, Liang, & Boulton, 2008). The response may require improving operational efficiency with more IT investment (Philip, 2007). Such pressure would also mandate the company to rely on its specialized business units, such as IT, which controls IT resources and capabilities that support critical business processes. Acting under pressures, such as abiding by market regulations imposed by the government or imitating successful competitors, requires early sensing and anticipating market changes. It will also demand an early and quick response. That means a proper transformation process that aligns IT objectives with business objectives. The decision-making process has a delicate balance between the IT and the business unit that can tip in either direction (Queiroz, Tallon, Sharma, & Coltman, 2018). We assert that:
H4A Market turbulence positively moderates the relationship between IT governance and organizational agility.

Innovation capability can counteract the threat of competitive innovation, including emerging opportunities for innovation (Helfat & Raubitschek, 2018). It enables the firm to be alert and aware of market turbulence early, hence its significance as an enabler for long-term success, especially in continuously changing markets (Jiménez-Jiménez & Sanz-Valle, 2011). The sensing of early market changes and the speedy innovative response enables the firm to deal with unforeseen threats and capitalize on emerging opportunities. Creative responses range

from changing business processes to creating new business models. In addition, innovative approaches for developing new products and services in response to customer preferences are becoming increasingly realistic. Firms unable to do so will quickly lose the market to their competitors (Zhou, Mavondo, & Saunders, 2019). We posit that:

H4B Market turbulence positively moderates the relationship between innovation capability and organizational agility.

Companies that enjoy higher IT capability tend to outperform their competitors (Bharadwaj A. S., 2000) because they can sense and respond quickly and effectively to market changes better than competitors. They can reconfigure and transform their internal processes and even change their business model. KAESER, a leading manufacturer of compressed air systems, developed a new business model that requires customers to pay a monthly fee only for the compressed air they use rather than selling air compressors (Bock, Wiener, Gronau, & Martin, 2019). Companies willing to transform a core business process or change the business model in response to market turbulence require having appropriately skilled personnel, critical resources, and the ability of current IT systems to adapt within acceptable costs (Lu & Ramamurthy, 2011; Ravichandran, 2018). We assert that:

H4C Market turbulence positively moderates the relationship between IT capability and organizational agility.

The role of technological turbulence

A critical challenge for IT governance is to provide reasonable assurance that the technological turbulence will not seriously affect the existing IT capability. That requires having a balanced and well-managed portfolio of technologies that can achieve the firm's objectives and the desired form of agility even when faced with rapid technological development (Autry, Grawe, Daugherty, & Richey, 2010). The IT department needs to exercise effective control over IT capabilities that support critical business processes. That is regardless of being developed in-house, acquired from third-party vendors, or outsourced to other parties. The emphasis is on having a delicate balance in the decision-making process between the IT unit and the business unit. We assert that:

H5A Technological turbulence positively moderates the relationship between IT governance and organizational agility.

As mentioned earlier, innovation capability can counteract the threat of competitive innovation, including emerging opportunities for innovation (Helfat & Raubitschek, 2018). Firms need to become alert and have an early awareness of technological changes that may impact their existing resources and capabilities. Early sensing of these changes and the speedy innovative response enables the firm to modify its resources. Hence, they can capitalize on emerging opportunities. In addition, innovative approaches using these technologies to provide new products and services can become a significant factor in

improving organizational agility (Song, Droge, Hanvanich, & Calantone, 2005). Those unable to do so will quickly have their technologies obsolete, unable to compete, and lose the market to their competitors (Zhou, Mavondo, & Saunders, 2019). We posit that:

H5B Technological turbulence positively moderates the relationship between innovation capability and organizational agility.

Companies that enjoy higher IT capability tend to outperform their competitors because they often have better knowledge and skills (Chakravarty, Grewal, & Sambamurthy, 2013). They can modify their technology base quicker and more effectively and reach the desired organizational agility. Transforming existing information technologies can occur through developing, acquiring, or outsourcing the needed resources in response to technological turbulence. However, it requires that companies have appropriately skilled personnel, critical resources, and the ability of current IT systems to adapt within acceptable costs. We assert that:

H5C Technological turbulence positively moderates the relationship between IT capability and organizational agility.

The role of organizational agility

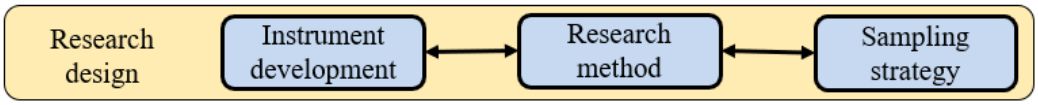
Firms work hard to win their competitive advantage under normal conditions. However, under turbulent environments, they need to struggle harder. Some firms may even struggle to survive. Current research indicates that dynamic capabilities can influence firm performance under these changing conditions. Organizational agility is a dynamic capability that enables firms to sense and detect early changes in the market and technology (Sambamurthy, Bharadwaj, & Grover, 2003). Hence, agile firms can reconfigure their resources in response to such potential risky conditions effectively and quickly. Agility plays a critical role in sustaining the competitive advantage under different circumstances and enables firms to exploit and explore opportunities while minimizing undesired risks. Agile firms often achieve higher performance than their competitors, manifested by increasing market share, sales growth, and overall profitability. We posit that:

H6 Organizational agility is positively associated with firm performance.

5 RESEARCH DESIGN

Our research design is the focus of this chapter (*Figure 56*). We discuss the survey instruments used, including their definitions and sub-dimensions, if any. Then, we outline our sampling strategy selected for the study. It includes defining the target population, the unit of analysis, the nature of the survey, and the method used for estimating our sample size. Finally, we outline the data collection and the data analysis techniques.

Figure 56: Research design phase



Source: own work

First, we discuss the survey instrument used to measure the used constructs of the model. We explain the difference between unidimensional and multidimensional constructs, as the study has both types. We also outline the differences between reflective and formative constructs and how that influenced our selection of the statistical technique. We end this section by describing the scales for all the constructs used in our study.

Then, we present our sampling strategy, which depends on three elements. First, we defined the target population for our study and the unit of analysis. The level of analysis distinguishes entities as the focus of the study (Markus & Robey, 1988), as it defines the target of our theorizing (Makadok, Burton, & Barney, 2018). Then, we discuss our sample size estimation technique. The second element is the sampling frame. We employed a cross-sectional survey to test the research model. Finally, the third element is the sampling technique, as we used an online survey to collect the data.

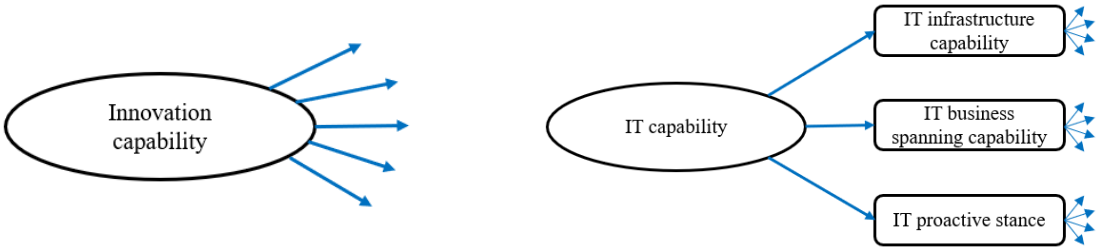
Next, in the data collection section, we describe the process and how we managed the common method bias (CMB). In the data analysis technique section, we outline the statistical techniques and then define the one used in the study. We explain the differences between CB-SEM and PLS-SEM and the reason for selecting the PLS-SEM approach.

5.1 Survey Instrument

A construct is an abstract concept representing a phenomenon. It can be a simple idea (unidimensional construct) as the construct of innovation capability in our study. Others can be related ideas combined (multidimensional), e.g., IT capability and IT governance constructs (*Figure 57*). We conceptualize our constructs at the theoretical level, while indicators operate at the operational level (*Figure 58*). Furthermore, each of these indicators may have several attributes representing values. The variable can be independent (e.g., IT governance), dependent (e.g., firm performance), mediating (e.g., IT capability, innovation capability), or moderating (e.g., market turbulence).

Unidimensional constructs are often simple as they focus only on one conceptual space. That helps to minimize measurement error and enhances theoretical accuracy. However, relevant to our study, we used multidimensional constructs. They have more than one dimension, where each one can be measured using either reflective or formative indicators (Petter, Straub, & Rai, 2007).

Figure 57: Unidimensional and multidimensional constructs

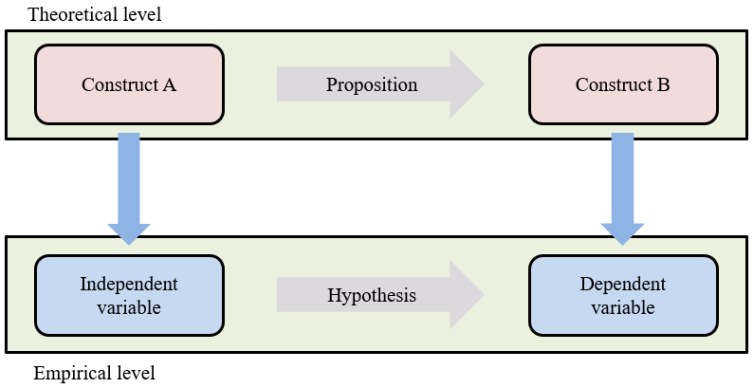


Unidimensional construct Multidimensional construct

Source: own work

To build a theory, we need to have well-defined constructs, and it is mandatory to have clear statements to have a well-defined construct (Suddaby, 2010). Furthermore, a clear definition of constructs is essential to communicate the relationships among constructs, as will be discussed in the instrument development section (Bacharach, 1989).

Figure 58: Theoretical and empirical levels

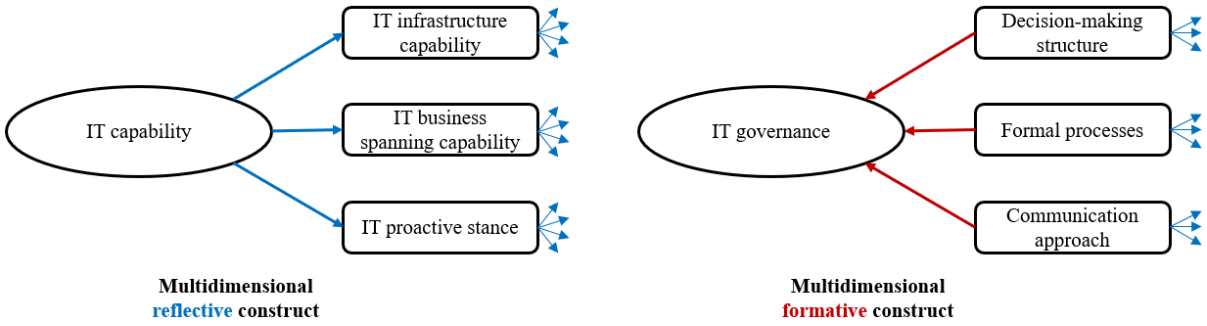


Source: adapted from Bhattacherjee (2012)

Once we defined a construct, we delineated its scope to outline its boundaries and context and what it would conceptually represent and indicate the differences between it and other related constructs. This step was essential to ensure a clear semantic relationship with other related constructs. We examined the logical consistency to support the intended theory. We followed the core steps to avoid different error types that can have undesired consequences resulting in doubtful results and having our study rejected.

When the construct lacks a proper definition, its measures don't represent its domain as precisely as required. Furthermore, when designing a study, the focus of the research is often on the structural paths between constructs. Unfortunately, the relationships between constructs and measures don't have the same emphasis (Petter, Straub, & Rai, 2007). That would lead to the inaccurate specification of the construct's relationship to its measurements. The measurement model is the nature of the relationship between the construct and its measures. After defining the construct, there is the operationalization process to develop the indicators or items to measure the construct.

Figure 59: Measurement models (reflective and formative)



Source: adapted from Jarvis, MacKenzie, & Podsakoff (2003)

Generally, the measurement relation model can be a reflective or formative indicator measurement model (*Figure 59*). The reflective indicators are considered the effects of the latent variables (LVs), e.g., IT capabilities. They all measure the same concept under study, and they change and correlate positively whenever the LVs change (internal consistency). The reflective model indicates the flow of causality from the construct to the measures.

Then, we have the formative indicators, where there is no direct causal relationship between the LV and the formative indicators. They cause the latent variable (LV), e.g., IT governance, and indicate the flow of causality from the measures to the construct. Thus, LV's formative indicators do not need to correlate. Complex or hierarchical component models (HCM) that consist of formative (causal) and reflective (consequent) constructs are becoming very common in social science (*Figure 60*). *Table 20* compares the differences between both types of indicators.

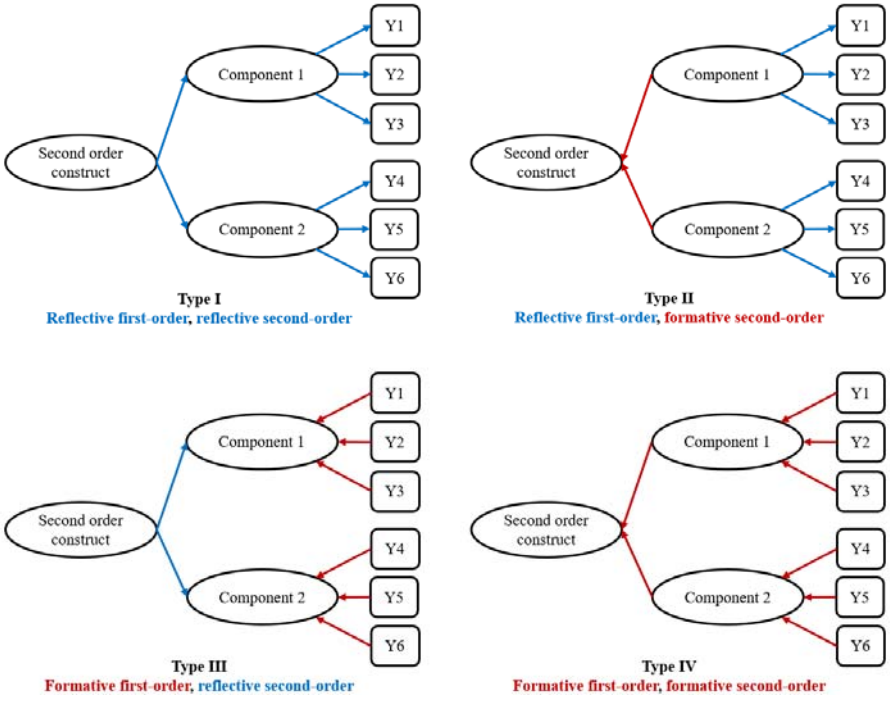
Table 20: Reflective and formative constructs differences

	Reflective model	Formative model
Causal priority	From construct to indicators	From indicators to construct
Construct	Changes in the construct do cause changes in the indicators	Changes in the construct don't cause changes in the indicators
Indicators	Manifestations of the construct	Characteristics of the construct
	Changes in the indicator shouldn't cause changes in the construct	Changes in the indicator should cause changes in the construct
Measurement error	Measurement error at the item level	Measurement error at the construct level
Internal consistency	Indicators should possess internal consistency	Internal consistency is not implied
Correlations	Measures are to correlate	No correlation
Measurement interchangeability	Dropping an indicator shouldn't alter the conceptual domain of the construct	Dropping an indicator may alter the conceptual domain of the construct
Nomological net of the construct indicators	Nomological net of the indicators shouldn't differ	Nomological net of the indicators may differ
	Indicators are required to have the same antecedents and consequences	Indicators are not required to have the same antecedents and consequences

Source: adapted from Jarvis, MacKenzie, & Podsakoff (2003); Urbach & Ahlemann (2010)

In our study, we have hierarchical component models (HCM) that have two layers of constructs, a higher-order component (HOC) and a lower-order one (LOC), e.g., IT capabilities and IT governance. The lower-order one makes up the higher-order one (Hair, Hollingsworth, Randolph, & Chong, 2017). Generally, there are four main types of HCMs (*Figure 60*) based on different relationships between the LOCs and the HOCs and between the indicators and their constructs (Jarvis, MacKenzie, & Podsakoff, 2003).

Figure 60: Hierarchical component models (HCM)



Source: adapted from Jarvis, MacKenzie, & Podsakoff (2003)

Type I is Reflective-Reflective, where the indicator measures for the first-order components are reflective, and the measures from the LOC to the HOC are reflective. **Type II** is Reflective-Formative and has reflective LOC indicators, but the LOC to the HOC is formative. **Type III** is Formative-Reflective and has formative LOC indicators, and the HOC from the LOC is reflective. The final **type IV** is Formative-Formative, where the first-order indicators are measured formative, and the measures from the LOC to the HOC are formative.

Failure to identify the most appropriate constructs for our study will lead to measurement model misspecification (Table 18). **Type I error** (a false positive by indicating that a path is significant when it is non-significant) occurs when the researcher adopts a reflective approach, even though the correct operationalization should have been formative. **Type II error** (a false negative indicating that a path is non-significant when it is significant) occurs when the researcher adopts a formative construct, even though the correct operationalization should have been reflective. Furthermore, it is impossible to have a proper theoretical

conceptualization if the construct has no clear meaning. A summary of the conditions associated with Type I and Type II errors is in *Table 21*.

Table 21: Conditions for error occurrence

Type I error	Type II error
Formative construct is endogenous	Formative construct is endogenous
Structural path originates from formative construct	Structural path leads to formative construct
Sample size is high	Sample size is low or high
Moderate to high correlation among formative measures (≥ 0.4)	High correlation among formative measures (≥ 0.7)
Can occur regardless if the model specified correctly (formative) or incorrectly (reflective)	

Source: adapted from Petter, Straub, & Rai (2007)

We adapted measurement scales from previous studies. We reviewed the literature to minimize any overlaps between the constructs. A summary of the scales used and the supporting literature is in the appendix. We measured our constructs with multiple indicators on a seven-point range scale. We conducted our pilot study before the online survey, and the number of participants was 45. The pilot results indicated the validity and reliability of the instrument.

Scale for IT governance

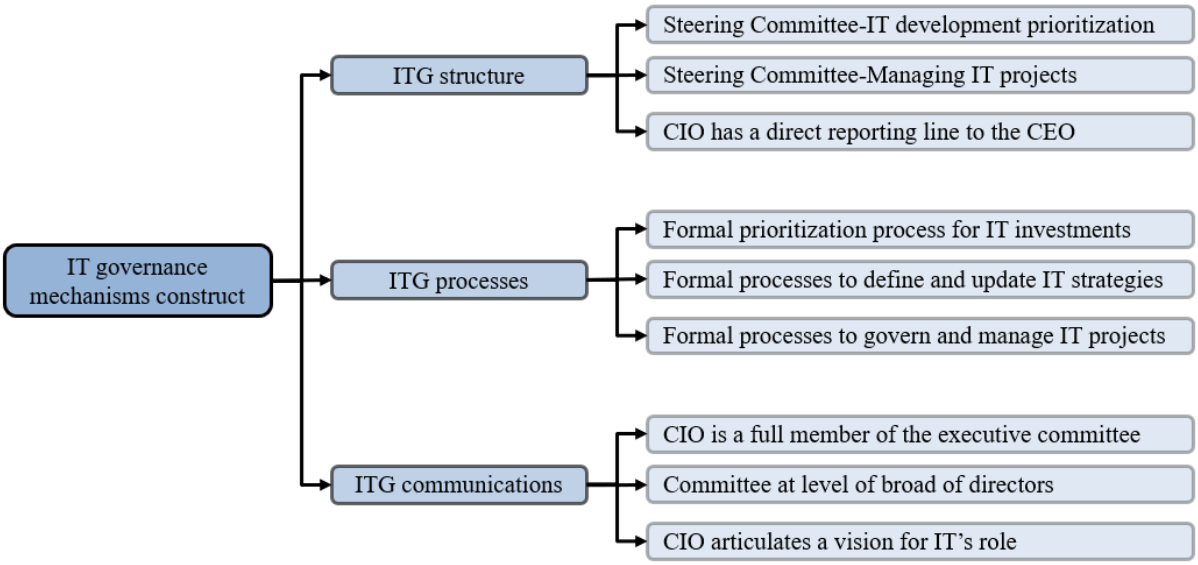
We conceptualized IT governance as a latent second-order formative-reflective type (Ringle, Sarstedt, & Straub, 2012) with three first-order dimensions: decision-making structure, formal process, and communication approach (Wu, Straub, & Liang, 2015). These dimensions measure three mechanisms implemented by organizations, and their measurement items assess the degree of well-balanced governance mechanisms (*Table 22*). These three mechanisms are unique to the organizations and contribute to effective IT governance (*Figure 61*).

Table 22: IT governance construct definition

Construct	Dimensions	Definition
IT governance mechanisms		IT governance is the ability of senior management to control the formulation and implementation of the IT strategy through organizational structures and processes. That will produce desirable behaviors and ensure that IT initiatives sustain and extend the business strategy and objectives. Three main IT governance mechanisms contribute to effective IT governance and are considered unique to the organizations.
	Decision-making structure	The first mechanism is the decision-making structure, which refers to the degree to which the organization has established organizational units and roles responsible for making IT decisions, e.g., committees.
	Formal process	The second mechanism is the formal process, which refers to how much the organization has developed a standard approach to monitor and ensure that IT policies are consistent with business needs.
	The communication approach	The third mechanism is the communication approach which refers to how much the organization has created channels that ensure appropriate communication and thus, disseminate IT governance principles.

Source: own work

Figure 61: Scale for IT governance



Source: own work

The first mechanism is the IT governance structure which defines clear roles, responsibilities, and accountability for IT decisions, such as IT managers and the IT strategy committee. IT managers have different job titles, such as the chief information officer (CIO) and the chief digital officer (CDO). They take an active role in board meetings, and they are responsible for defining the vision and mission for IT's role in the company and communicating it to all relevant parties. However, each company usually plans the structure suitable for its business, industry sector, firm size, and organizational culture. There is no best structure to apply for all companies, but the best one needs to serve the strategic alignment of business and IT.

The processes are the second mechanism for IT governance. They are responsible for monitoring IT operations, practices, and their compliance with the policies and procedures approved by the board and senior management. Some tools and techniques guide the implementation of such desirable practices, such as COBIT, ITIL, etc. The processes include different tasks such as IT balanced scorecard analysis (IT BSC) and cost/benefit/risk analysis.

The third mechanism is IT governance communication. It is concerned with advocating and communicating IT governance principles, policies, and procedures, such as a shared understanding of business/IT objectives and active participation among the key stakeholders.

Scale for organizational agility

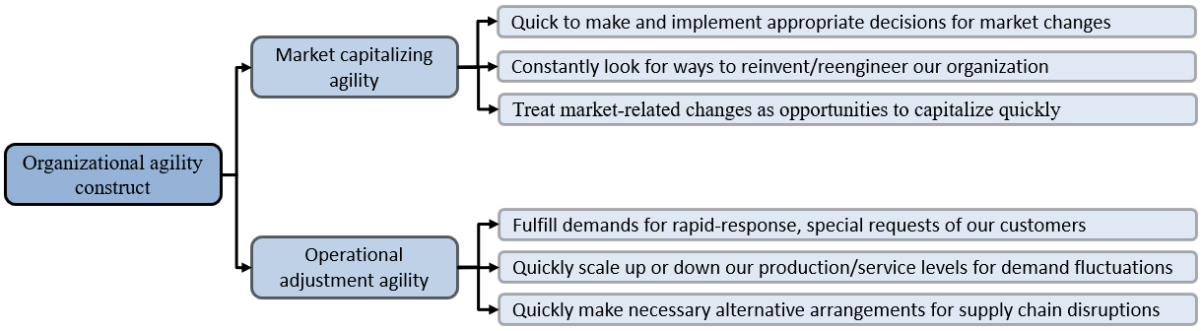
Organizational agility is highly dependent on the organization's ability to perform effectively compared with its competitors. That required having the conceptualization constructs for organizational agility expressed relative to other organizations.

Table 23: Organizational agility construct definition

Construct	Dimensions	Definition
Organizational agility		Organizational agility is the firm-wide capability to deal with changes that often arise unexpectedly in business environments via rapid and innovative responses that exploit changes as opportunities to grow and prosper.
	Market capitalizing agility	Market capitalizing agility is the firm's ability to quickly respond to and capitalize on changes through continuously monitoring and quickly improving products/services to address customers' needs.
	Operational adjustment agility	Operational adjustment agility is the firm's ability in its internal business processes to physically and rapidly cope with market or demand changes.

Source: own work

Figure 62: Scale for organizational agility



Source: own work

We conceptualized organizational agility as a high-order construct having two sub-constructs: market capitalizing agility and operational adjustment agility (*Table 23*) (Lu & Ramamurthy, 2011). We measured the market capitalizing agility construct with three items that reflect the firm's ability to respond quickly and capitalize on market changes. That is achieved by constantly monitoring and quickly improving products/services to fulfill customers' changing preferences and needs (*Figure 62*). We measured the operational adjustment agility construct with three items that reflected the firm's ability to quickly respond to market changes by relying on its internal business processes. That is critical to support innovative practices meeting market changes (*Figure 62*).

Scale for IT capability

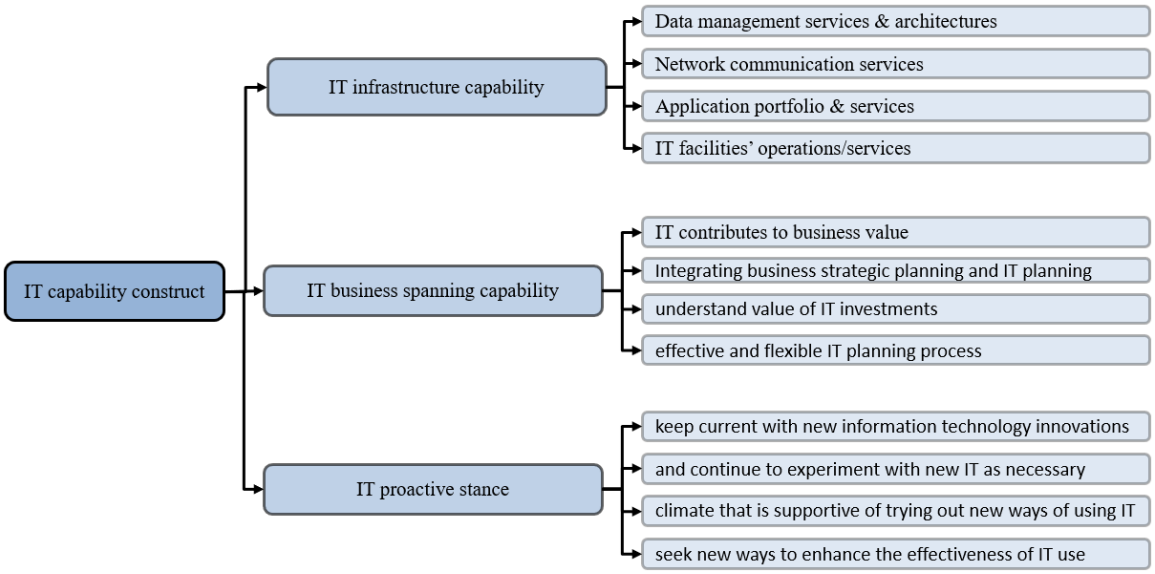
Our research model conceptualizes IT capability as a latent second-order reflective-reflective type (Ringle, Sarstedt, & Straub, 2012) with three first-order dimensions: IT infrastructure capability, IT business spanning capability, and IT proactive stance (*Figure 63*) (Lu & Ramamurthy, 2011). Below, we present the construct and its sub-dimensions (*Table 24*).

Table 24: IT capability construct definition

Construct	Dimensions	Definition
IT capability		IT capability is a firm's ability to implement and reconfigure IT resources to enable and enhance business strategies and work processes.
	IT infrastructure capability	IT infrastructure capability refers to the ability to implement shareable platforms. That indicates its proficiency in managing different activities and services, e.g., data services and architectures, network services, and application services.
	IT business spanning capability	IT business spanning capability is the management ability of the firm to exploit IT resources to enable and enhance business objectives. It reflects the extent of having a clear IT strategic vision, the integration of business and IT strategic planning, and the management's ability to understand the value of IT investments.
	IT proactive stance	IT proactive stance refers to the firm's ability to proactively search for ways to explore IT innovations or exploit existing IT resources to create business opportunities. It reflects the intent to be current with IT innovations and constantly seeks new approaches to enhance the effective use of IT. It also indicates having a culture of adopting new ways of using IT.

Source: own work

Figure 63: Scale for IT capability



Source: own work

IT infrastructure capability is the first IT capability dimension. It is the platform that integrates the processes needed to retrieve and share data as promptly and accurately as possible. The quick access to real-time data enables the firm to sense market changes early manifested in changing customers' preferences or fluctuating suppliers' performance. Furthermore, efficient IT infrastructure capability provides a platform for innovative changes considered essential to respond to environmental turbulence and achieve an efficient decision-making process.

IT business spanning capability is the second IT capability dimension. It highlights the IT-business relationship. The relationship spans from simple interaction to a partnership with a more powerful synergy. It encourages sharing knowledge between business units and IT with a better IT-business alignment at the strategic level. The synergy provides the ability to build

innovative responses that can create radical changes in core business processes or even change the business model itself, often encountered in turbulent market conditions.

A proactive IT stance is the third IT capability dimension. It emphasizes the ability of the firm to explore and exploit its IT resources. That would provide better sensing and seizing business opportunities. This responsible behavior leads to employing IT innovations better and sensing relevant IT changes, especially with new and emerging technologies. Thus, a proactive IT stance enables the firm to capitalize on IT innovations allowing a dynamic reconfiguration of its existing IT resources. That enhances the firm's ability to explore and exploit market opportunities and avoid unnecessary threats.

Scale for innovation capability

Innovation capability needs to have a new mindset in all areas of the firm to be effective. It is a means to an end. Firms that encourage their employees to be innovative are more likely to conduct higher innovative practices. However, firm innovativeness is not a simple process. It demands structural and cultural criteria such as formalization, hierarchy, and decision-making sharing (Hurley & Hult, 1998). IT governance mechanisms provide the framework that enables these criteria. Furthermore, innovation capability is not universal for all firms. It is firm-specific, which proves to be difficult to copy from one firm to another.

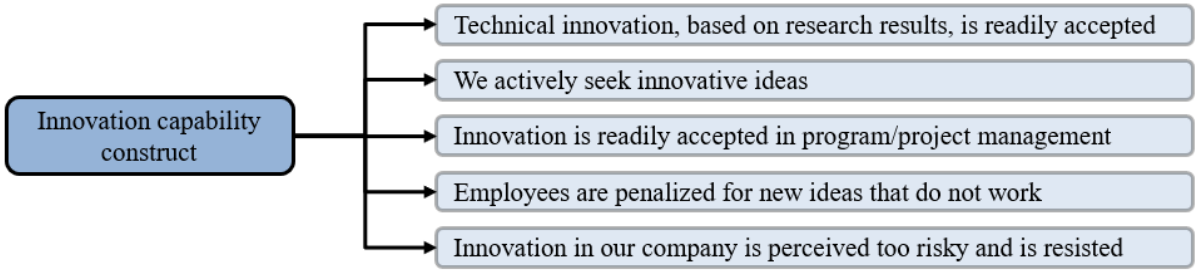
In our model, the dynamic capabilities have two focal constructs or firm-level resources: IT capability and innovation capability. We argue that IT capability will become more valuable when combined and complemented by innovation capability than when used alone (Amit & Schoemaker, 1993). We measured the firm's innovation capability with five items on a 7-point scale (*Figure 64*) (Menguc & Auh, 2006). *Table 25* highlights the construct's definition.

Table 25: Innovation capability construct definition

Innovation capability	Innovation capability is the ability of the firm to introduce new products, services, processes, and systems through the continuous transformation of its knowledge and idea.

Source: own work

Figure 64: Scale for innovation capability



Source: own work

Scale for market turbulence

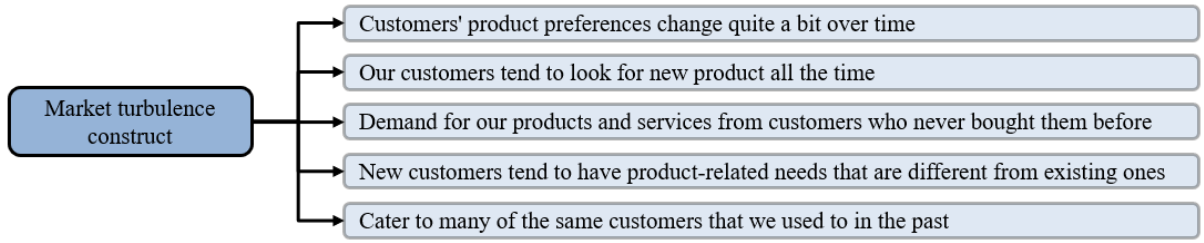
We define market turbulence as the degree and speed of change in the preferences of customers and their new demands (*Table 26*)). Firms that face more turbulent markets need to modify their products and services more often to satisfy the ever-changing demands of their customers. However, firms operating in stable markets will have relatively few modifications as the preferences do not change that much. The items for the market turbulence scale assess the changing composition of a firm's customers and their preferences over time. We measured market turbulence with a five-item scale adapted from a previous study (*Figure 65*) (Jaworski & Kohli, 1993).

Table 26: Market turbulence construct definition

Market turbulence	Market turbulence refers to the degree and speed of change in customers' preferences and their changing new demands.

Source: own work

Figure 65: Scale for market turbulence



Source: own work

Scale for technological turbulence

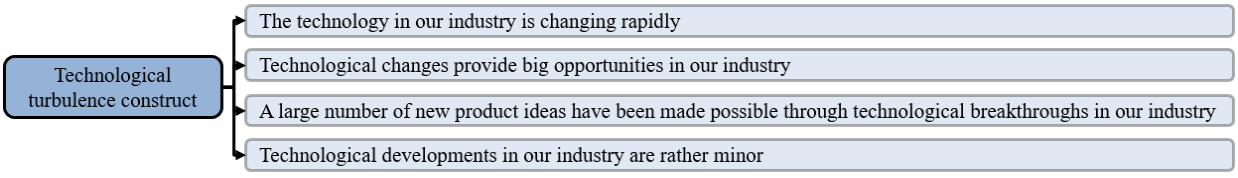
Technological turbulence is the rate and unpredictability associated with technology change which requires innovative exploration, exploitation, or both, based on the analysis of the opportunities and threats encountered (*Table 27*) (Jaworski & Kohli, 1993). When technology changes rapidly within an industry, firms need to sense and notice them early. We measured technological turbulence with a four-item scale adapted from a previous study (*Figure 66*) (Jaworski & Kohli, 1993).

Table 27: Technological turbulence construct definition

Technological turbulence	Technological turbulence refers to the rate and unpredictability associated with technology change which requires innovative exploration or exploitation or both based on the analysis of the opportunities and threats encountered.

Source: own work

Figure 66: Scale for technological turbulence



Source: own work

Scale for firm performance

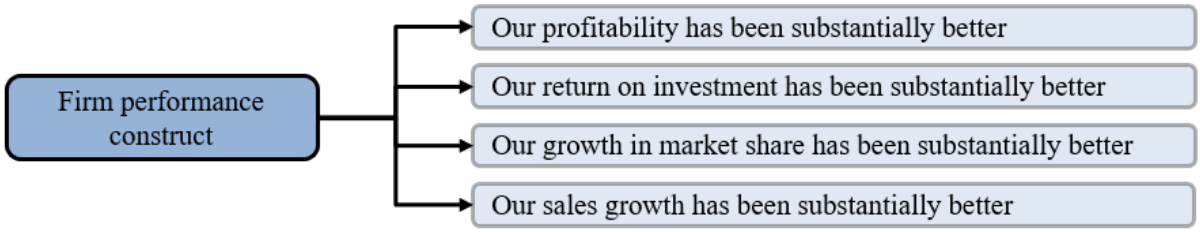
Firms can enjoy a competitive advantage under normal conditions. However, under turbulent environments, sustaining such an advantage may prove difficult. Agility plays a significant role in sustaining competitive advantage under different circumstances and enables firms to exploit and explore opportunities while minimizing undesired risks. Firms with established dynamic capabilities can achieve far better performance than their competitors manifested by increasing market share, higher sales growth, and overall profitability (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014). We measure firm performance in our study by the degree a firm has a better performance than its competitors (*Table 28*). Researchers argue that the subjective measures of firms' performance compared to competitors correlate with a high degree of reliability with objective measures. We used in our study subjective assessments of some financial performance indicators compared to competition over 2–3 years (Venkatraman & Ramanujam, 1986). We measured firm performance with a four-item scale adapted from a previous study (*Figure 67*) (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014).

Table 28: Firm performance construct definition

Firm performance	Firm performance is the degree to which a firm has superior performance relative to its competition.

Source: own work

Figure 67: Scale for firm performance



Source: own work

5.2 Sampling Strategy

Our sampling process has several steps, as will be discussed below. First, we defined the target population as senior managers in medium-to-large-sized firms. They have the attributes that the research requires for the study. The unit of analysis comprises sample people in that population that we intend to study and draw a scientific inference. We selected the firm as our unit of analysis. We used the ten times rule to estimate the sample size. Second, we defined the nature of our study, which is cross-sectional. Finally, the third element is the sampling technique, as we used an online survey to collect the data.

Sample size estimation

Insufficient sample size may not indicate a significant effect while it exists in the population. That would result in having a Type II error and may lead to significantly different results

from different samples (Hair Jr, Hult, Ringle, & Sarstedt, 2016). Several factors can influence the sample size in a structural equation model design. They are the significance level, the statistical power, the minimum coefficient of determination (R^2 values) used in the model, and the maximum number of arrows pointing at a latent variable (LV). *Table 29* shows the sample size estimation methods used in selected studies having formative constructs.

Table 29: Sample size in selected studies using formative constructs

Studies using formative constructs	Stat	Sample size estimation method	Formative construct(s)	Sample size
Tiwana, A. et al. (2010).	PLS	NA	IT architecture modularity IT governance decentralization	223
Bradley, R. V., et al. (2012).	PLS	Statistical power analysis	IT governance CIO structural power IT-business mutual participation	164
Camisón, C., et al. (2014).	PLS	NA	Organizational innovation	144
Wu, S. P. J., et al. (2015).	PLS	Statistical power analysis	IT governance mechanisms	136
Mikalef, P., et al. (2017).	PLS	Ten times rule	IT-enabled dynamic capabilities Competitive performance	274
Queiroz, M., et al. (2018).	PLS	NA	IT application orchestration capability	120
Ravichandran, T. (2018).	PLS	Statistical power analysis	Digital platform capability	129
Our study (2022).	PLS	Ten times rule	IT governance mechanisms	132

Source: own work

There are three common approaches to estimate the sample size: the ten times rule, the statistical power analysis (the minimum R^2 method), and software programs (Hair Jr, Hult, Ringle, & Sarstedt, 2016; Ringle, Sarstedt, & Straub, 2012). We used the ten times rule to estimate our sample size (Hair Jr, Hult, Ringle, & Sarstedt, 2016, p. 108). Hence, the sample size should equal ten times the highest number of formative indicators used to measure a single construct (Hair Jr, Hult, Ringle, & Sarstedt, 2016). It does not rely on the magnitude of the path coefficients in the model in estimating the minimum sample. Although it can provide a rough guideline, researchers recommended considering the sample size against the model and data characteristics (Hair Jr, Hult, Ringle, & Sarstedt, 2016, p. 47).

The second approach is statistical power analysis, where researchers use Cohen's rules of thumb in statistical power analyses (Cohen, 1992). It uses statistical power analysis based on the part of the model with the highest number of predictors to determine the sample size (*Table 30*). It has three elements. The first one is the maximum number of arrows pointing at a latent variable in a model. The second is the significance level used, and the third is the minimum R^2 in the model.

A third common approach is calculating the sample size using programs such as the G*Power to perform power analyses specific to the model setup.

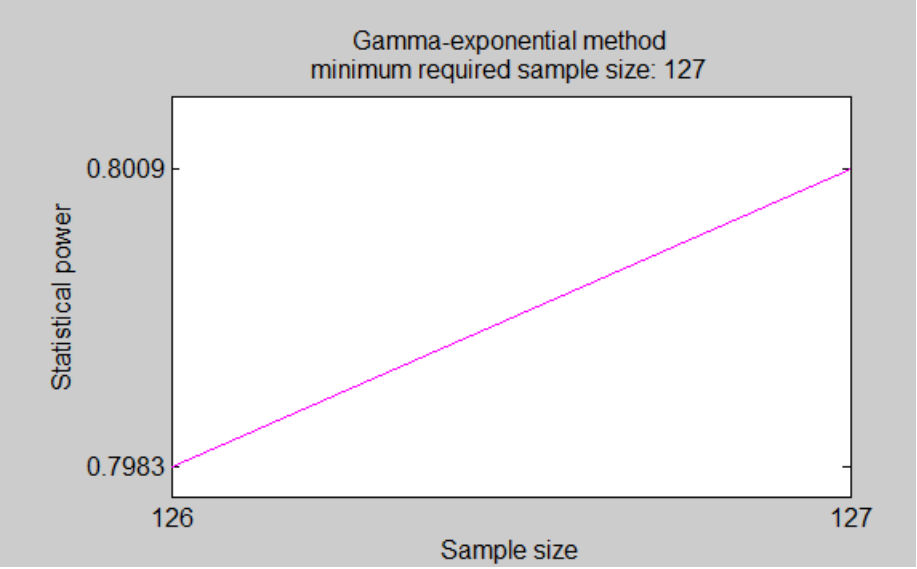
Table 30: Minimum sample size requirements

Maximum no of arrows (independent variables) pointing at a construct	Significance level											
	10%				5%				1%			
	Minimum R^2				Minimum R^2				Minimum R^2			
	0.10	0.25	0.50	0.75	0.10	0.25	0.50	0.75	0.10	0.25	0.50	0.75
2	72	26	11	7	90	33	14	8	130	47	19	10
3	83	30	13	8	103	37	16	9	145	53	22	12
4	92	34	15	9	113	41	18	11	158	58	24	14
5	99	37	17	10	122	45	20	12	169	62	26	15
6	106	40	18	12	130	48	21	13	179	66	28	16
7	112	42	20	13	137	51	23	14	188	69	30	18
8	118	45	21	14	144	54	24	15	196	71	32	19
9	124	47	22	15	150	56	26	16	204	76	34	20
10	129	49	24	16	156	59	27	18	212	79	35	21

Source: adapted from Cohen (1992) as cited in Hair, Hult, Ringle, & Sarstedt (2016)

The gamma-exponential method is a relatively new approach used to estimate the minimum sample size required (Kock N. , 2018). Our sample size estimation was 127 using the gamma-exponential method, as shown in *Figure 68*. So, all approaches supported our sample size estimation.

Figure 68: Estimating sample size using gamma-exponential method



Source: own work

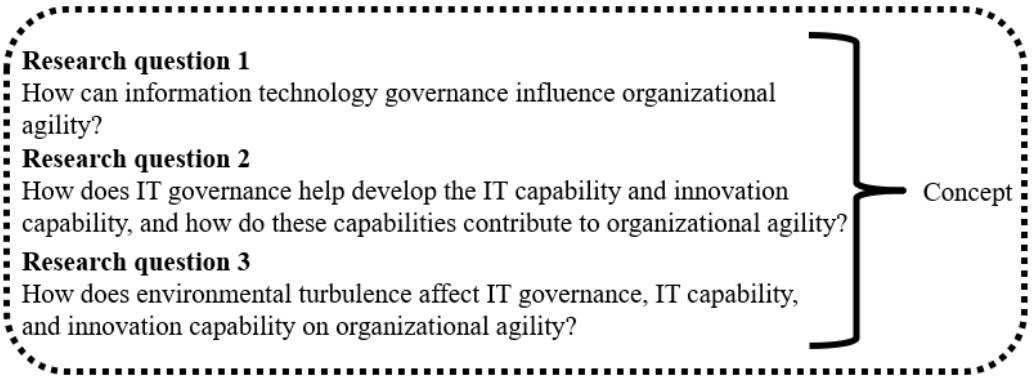
Cross-Sectional Survey Study

There are two main designs in survey research: cross-sectional and longitudinal (Leavy, 2017, p. 101). We used the cross-sectional study (snapshot time horizon) to answer our research questions. A cross-sectional design (snapshot) is perhaps the most common one in social science. It aims at finding the prevalence of a phenomenon by taking a cross-section of the population. It will enable us to study a particular phenomenon by collecting relevant data at a point in time (Kesmodel, 2018).

Online survey

Researchers often employ surveys when conducting cross-sectional studies as this will enable measuring both the independent and the dependent variables at the same point in time (Bhattacherjee, 2012; Creswell & Creswell, 2018). Survey research is one of the most common methodologies utilized in MIS research. We used the survey method to test the research model and the causal relationships. Questionnaires are the primary data collection tool in survey research, and researchers often refer to them as survey instruments.

Figure 69: Linking survey questions (items) to the concept measured



Source: own work

We proposed justifiable links between the questions (indicators) and the concepts postulated in the research model to produce a valid survey instrument (*Figure 69*) (Leavy, 2017). Our survey items (questions in the questionnaire) test our hypotheses and answer the research questions. The measured variables support the proposed model and will answer the research questions.

5.3 Data Collection

We conducted our study on the target organizations from different industries in Brazil. We collected data through an online survey of senior business managers in medium to large firms (private and public) that are not industry-specific. We collected the data in the period March-June, 2020. The unit of analysis is the firm.

We received 132 valid responses, which is more than the recommended requirement. Our sample size is more than ten times the highest number of formative indicators used to measure a single construct (Hair Jr, Hult, Ringle, & Sarstedt, 2016). We ensured both anonymity and confidentiality of the responses to the respondents. That would minimize their concerns about the management of their responses.

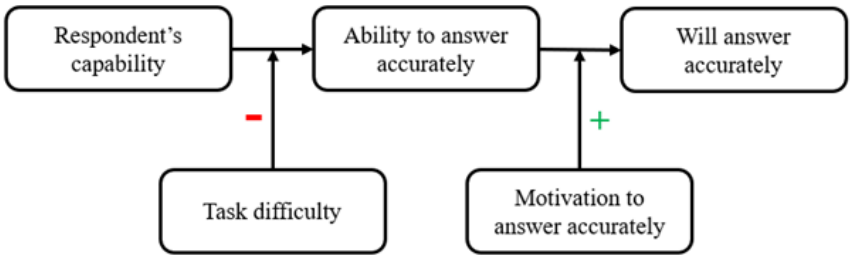
We used two controls for firm characteristics: size and age. The measure for firm size is the number of full-time employees firm-wide (*Table **43***) and the firm's age is the number of years the company has been in business (*Table **44***). The size may exercise more significant effects

on IT governance and, in addition, the ability to compete under different environmental conditions. Larger firms often have more experience and effectiveness in implementing IT governance mechanisms (Devos, Landeghem, & Deschoolmeester, 2012). The reason is due to the maturity of corporate governance and the board of directors. In the case of environmental turbulence, larger firms often have more resources than smaller firms. However, the controls showed no significant influence on any of the constructs in our research model.

Common method bias (CMB)

Self-reporting surveys can result in a common method bias. That bias is a measurement error that leads to lower reliability and validity of the constructs and the proposed relationships. The bias is attributed to the measurement method and not to the construct of interest (Eichhorn, 2014) and can happen due to plenty of CMB sources (Podsakoff, MacKenzie, & Podsakoff, 2012). One source, for example, is the use of a single rater for both independent and dependent variables, which induces a self-reporting bias. The survey instrument is another source that can affect the rater due to its complexity and ambiguity. A third source is the item's context. That can happen when the sequence of questions and their numbers affect the rater's motivation. CMB can produce systematic measurement errors that can increase or decrease the observed relationships between constructs, thus, resulting in Type I and Type II errors (Chang, 2010). Initiating CMB can happen when respondents pursue an action to comply with the minimum requirement rather than having an optimizing approach (MacKenzie & Podsakoff, 2012). However, they can provide accurate answers and support optimization if they are motivated (*Figure 70*).

Figure 70: Issues giving rise to method bias problems



Source: adapted from MacKenzie & Podsakoff (2012)

We tried to minimize any bias ex-ante and ex-post. We assured the respondents of anonymity and confidentiality of their responses ex-ante (Rogelberg & Stanton, 2007). We also designed the survey in a clear format avoiding ambiguous terms or complicated questions. We selected the measures of our study to be independent of each other and their expected outcomes. We also changed the order of our questionnaire using the scale reordering procedure (i.e., our dependent variables are after the independent variables). We conducted Harman's one-factor test on the ex-post to determine the extent of bias in our results (Podsakoff P. M., MacKenzie,

Lee, & Podsakoff, 2003; Malhotra, Kim, & Patil, 2006). The test suggests that method bias does not account for the study's results.

5.4 Data Analysis Technique

We used second-generation techniques (2G) structural equation modeling (PLS-SEM) (*Table 31*), as they are superior to the complex causal modeling that dominates current IS research (Hair Jr, Hult, Ringle, & Sarstedt, 2016). At the same time, SEM can model the relationships among multiple independent and dependent variables. That contrasts markedly with most first-generation regression models. Further, SEM assesses the structural model and evaluates the measurement model.

Table 31: Examples of statistical techniques

	Exploratory	Confirmatory
First-generation techniques (1G)	Cluster analysis Exploratory factor analysis (EFA)	Multiple regression Confirmatory factor analysis (CFA)
Second-generation techniques (2G)	Partial least square structural equation modeling (PLS-SEM)	Covariance-based structural equation modeling (CB-SEM)

Source: adapted from Hair, Hult, Ringle, & Sarstedt (2016); Lowry & Gaskin (2014)

A structural equation model supports latent variables (LVs). Using structural equation modeling (SEM) with latent variables was a game-changer in social science research. It helps distinguish between measurement and structural models and thus recognize measurement error explicitly (Henseler, Ringle, & Sinkovics, 2009). LVs are considered hypothetical constructs that enable understanding the area under study. LVs can't be observed and thus can't be measured directly. Instead, we use items or manifest variables (MVs), which are proxy variables, having the raw data. They are observable and can be empirically measured to analyze the relationships between the theoretical constructs.

Table 32: Comparison of PLS-SEM vs. CB-SEM

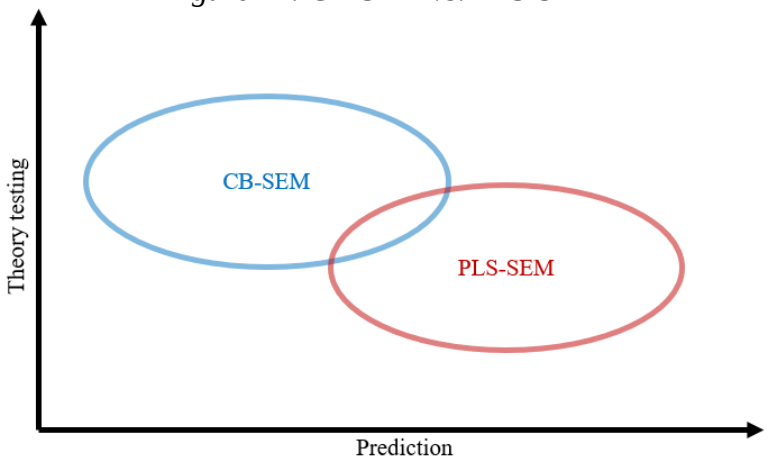
	PLS-SEM	**CB-SEM**
Objective	Prediction, exploration, theory extension	Theory testing and confirmation
Approach	Variance-based	Covariance-based
Measurement model	If formative constructs are part of the model	Formative measures can also be used but with limitations
Structural model	Complex (many constructs and many indicators)	Nonrecursive (includes reciprocal relationships or feedback loops)
Data characteristics	Sample size is relatively low	With large data sets, CB-SEM and PLS-SEM results are similar
Model evaluation	Need to use latent variable scores in subsequent analyses	Research requires a global goodness-of-fit criterion

Source: adapted from Hair, Ringle, & Sarstedt (2011); Urbach & Ahlemann (2010)

There are two SEM types: partial least squares SEM (PLS-SEM; also called PLS path modeling) and covariance-based SEM (CB-SEM), as shown in *Table 32*. Researchers mainly use CB-SEM to validate (or reject) theories (*Figure 71*). It determines if the proposed theoretical model can accurately estimate the covariance matrix for the sample data. On the other side, researchers mainly use PLS-SEM to develop theories in exploratory research.

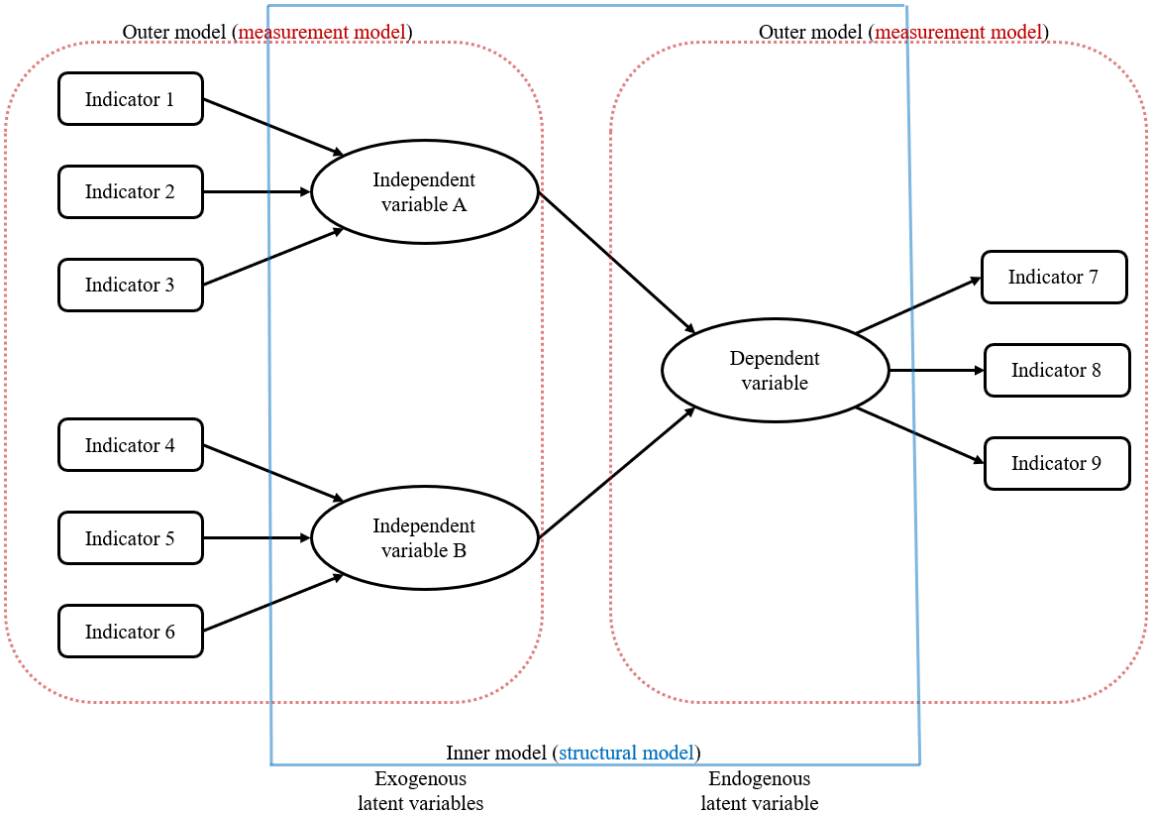
When examining the model, the focus is on explaining the variance in the dependent variables.

Figure 71: CB-SEM vs. PLS-SEM



Source: adapted from Henseler, Ringle, & Sinkovics (2009)

Figure 72: SEM inner and outer models



Source: adapted from Hair, Sarstedt, Hopkins, & Kuppelwieser (2014)

A PLS path model has two elements: structural model (inner model) and measurement models (outer model) (*Figure 72*) (Henseler, Hubona, & Ray, 2016). The inner one delineates the relationships (paths) between the independent and dependent latent variables, while the outer one delineates the relationships between the latent variables and their observed items (indicators). The independent variables are also called exogenous variables, and the

dependent variables are called endogenous variables. The exogenous variable has the path arrows pointing only outwards, as nothing leads to it. In contrast, the endogenous variable has at least one path pointing to it, representing the other variable's effects. In PLS-SEM path models, some variables may be affected by other variables and can also be the causes for other variables postulated later in the hypothesized causal sequence (Garson, 2016, p. 13). The measurement model (outer model) shows the relationships between the constructs and the indicator variables.

We tested our research model using the structural equation modeling – partial least squares (PLS-SEM). The software we used is SmartPLS version 3.3.2 for data analysis (Ringle, Wende, & Becker, 2015). We used PLS-SEM in this study for the following reasons. **First**, as we have IT governance as a formative construct, PLS-SEM will allow us to model constructs with formative indicators (Goo, Kishore, Rao, & Nam, 2009; Hair Jr, Hult, Ringle, & Sarstedt, 2016). **Second**, it is the preferred technique when the analysis is concerned with testing a theoretical framework from a prediction perspective, as applied to our study (Teo, Wei, & Benbasat, 2003; Garson, 2016, p. 8; Hair, Risher, Sarstedt, & Ringle, 2019, p. 5). **Third**, when analyzing path coefficients that are different from zero, the PLS technique would prevent restrictive distributional assumptions (Gefen & Straub, 2005). **Fourth**, researchers argue that PLS-SEM achieves better convergence behavior and high statistical power with a small sample size than covariance-based (CB-SEM) (Hair, Sarstedt, Hopkins, & Kuppelwieser, 2014; Wong, 2013). As we have a relatively small sample size, that seemed appropriate.

We conducted data analysis in our model by conducting a measurement model assessment (reflective and formative constructs) and a structural model assessment (Hair Jr, Hult, Ringle, & Sarstedt, 2016; Hair, Risher, Sarstedt, & Ringle, 2019). Some of our constructs are hierarchical models, e.g., IT governance (reflective-formative type) and IT capability (reflective-reflective type). These hierarchical models can have different relationships between the constructs (formative and reflective) (Becker, Klein, & Wetzels, 2012). We used the repeated indicators procedure to test them (Hair Jr, Hult, Ringle, & Sarstedt, 2016, p. 277). We assigned all indicators of the lower-order components to the higher-order construct. Then, we measured the higher-order construct (Ringle, Sarstedt, & Straub, 2012; Sarstedt, Hair Jr, Cheah, Becker, & Ringle, 2019; Hair Jr, Hult, Ringle, & Sarstedt, 2016).

6 RESULTS

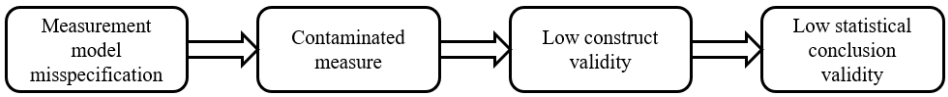
This chapter examines the results and the findings of the study. We explain the measurement models and their assessment. We emphasize specifying the measurement model accurately to avoid the risk of its misspecification. We indicate the significance of validity and reliability of our study.

Then, we outline the statistical analysis phases that we followed (*Figure 75*). It starts with the measurement model assessment and then the structural model assessment. The measurement model assessment has two parts: reflective followed by formative. Finally, after we proceed with the structural model assessment, we discuss our findings.

6.1 Measurement Model Assessment

Measuring constructs in information systems research is a daunting task. Different constructs can have a conceptual overlap when researchers use similar items to measure the constructs involved (Zmud, Sampson, Reardon, Lenz, & Byrd, 1994). Then, we have the problem of multi-dimensional constructs where identifying their dimensions can be a challenge. So, it is crucial to specify the measurement model accurately, as failing to do so would end up with measurement model misspecification (Jarvis, MacKenzie, & Podsakoff, 2003). That leads to a contaminated measure with a low construct validity and low statistical conclusion validity (*Figure 73*). That explains the steps we followed in using the selected scales in our study.

Figure 73: Measurement model misspecification



Source: adapted from Jarvis, MacKenzie, & Podsakoff (2003)

Testing will ensure that the scale measures the unobservable construct that we want to measure (i.e., the scale is "valid") and it measures the selected construct in a consistent and precise manner (i.e., the scale is "reliable"). We relied on reliability and validity for the evaluation procedure for the adequacy and accuracy of our measurement procedures.

Figure 74: Reliability vs. validity

Reliable but not valid | Valid but not reliable | Valid and reliable

Source: own work

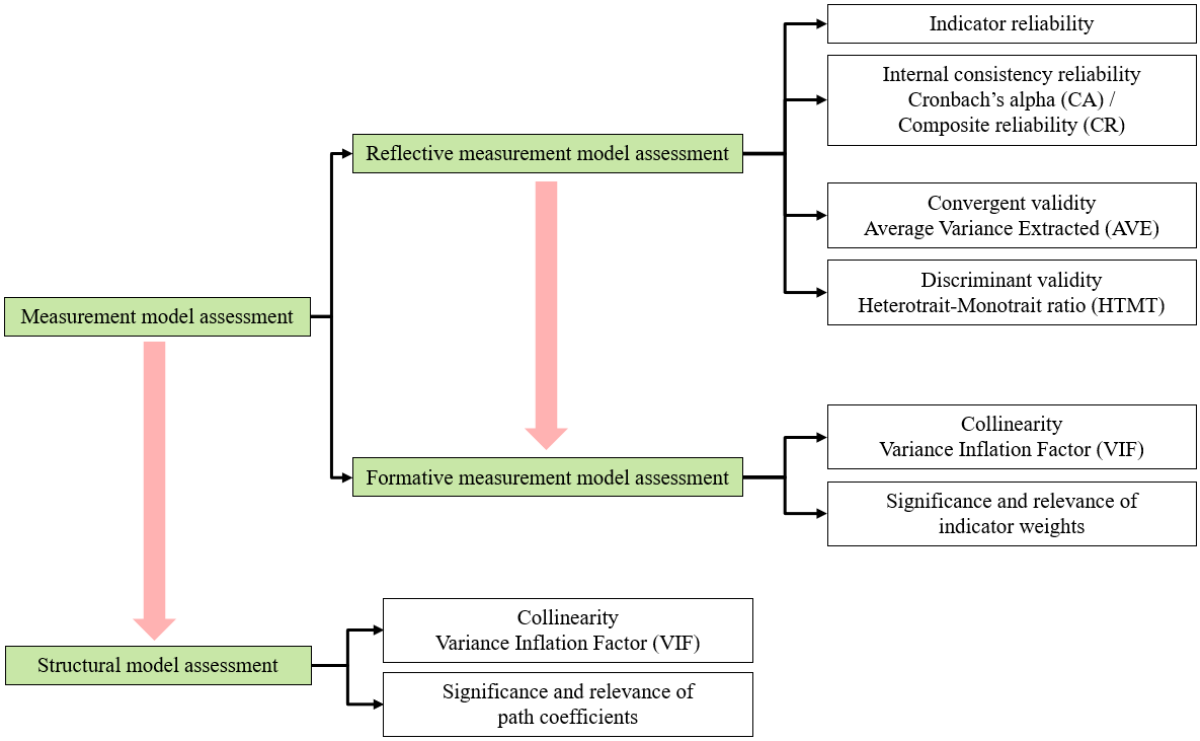
Reliability and validity are called the "psychometric properties" of measurement scales (*Figure 74*). Reliability indicates that the data collection techniques and the analytic procedures will produce consistent findings when repeated on different occasions or by other researchers (Saunders, Lewis, & Thornhill, 2012, p. 192). A measure can be reliable but not valid (*Figure 74*). That can happen if it measures a construct consistently, but it measures the

wrong construct. Furthermore, it can have validity but lacks reliability (*Figure 74*). That occurs if it measures the construct required but in a non-consistent manner. We needed both reliability and validity to ensure satisfactory measurement of the constructs. Below, we will discuss the reliability and validity testing for the constructs used in the study.

Statistical analysis steps

Some researchers use the goodness-of-fit (GoF) in preparation for statistical analysis. It examines how sample data fits a distribution from a population having a normal distribution. The GoF metric is not required when conducting PLS-SEM (Hair Jr, Howard, & Nitzl, 2020, p. 108; Hair Jr, Hult, Ringle, & Sarstedt, 2016, p. 202; Hair, Risher, Sarstedt, & Ringle, 2019, p. 7). However, it is applicable in a CB-SEM analysis.

Figure 75: Statistical analysis steps



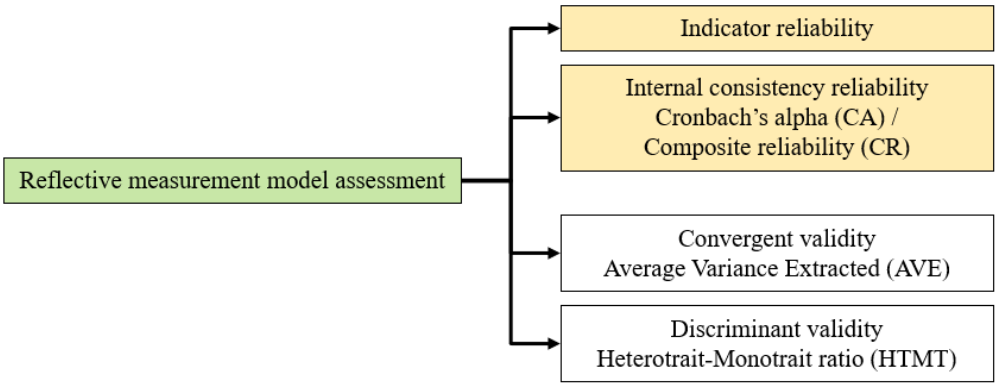
Source: own work

There are two phases to examine (*Figure 75*): the first is for the measurement model, and the second is for the structural model (Hair, Risher, Sarstedt, & Ringle, 2019; Sarstedt, Ringle, & Hair, 2021). As we have reflective and formative constructs in the measurement model, we needed to assess each one, starting with the reflective constructs. As the evaluation provided the support required for the measurement quality, we proceeded with the structural model assessment. In summary, phase one examines the measurement theory, while phase two addresses the structural one that investigates the relationships among the latent variables in the proposed hypotheses.

6.1.1 Reflective measurement model assessment

In the reflective measurement model assessment (*Figure 76*), the first step is to examine the indicator reliability by checking the indicator loadings.

Figure 76: Reflective measurement model assessment step 1



Source: own work

The recommended loadings should be ≥ 0.708 to indicate that the construct explains more than 50 percent of the indicator's variance (Hair Jr, Hult, Ringle, & Sarstedt, 2016, p. 137). That provides acceptable item reliability. The loadings for all reflective indicators in our study (*Table 47*) are above 0.708, indicating item reliability.

Table 33: Constructs reliability (CA and CR)

	Cronbach's Alpha (CA)	Composite Reliability (CR)
FP	0.938	0.955
IC	0.939	0.961
ITC	0.966	0.970
ITCB	0.951	0.965
ITCI	0.922	0.944
ITCP	0.959	0.970
ITGC	0.845	0.906
ITGD	0.846	0.908
ITGF	0.936	0.959
OA	0.915	0.935
OAM	0.904	0.940
OAO	0.825	0.895
MT	0.819	0.891
TT	0.828	0.892

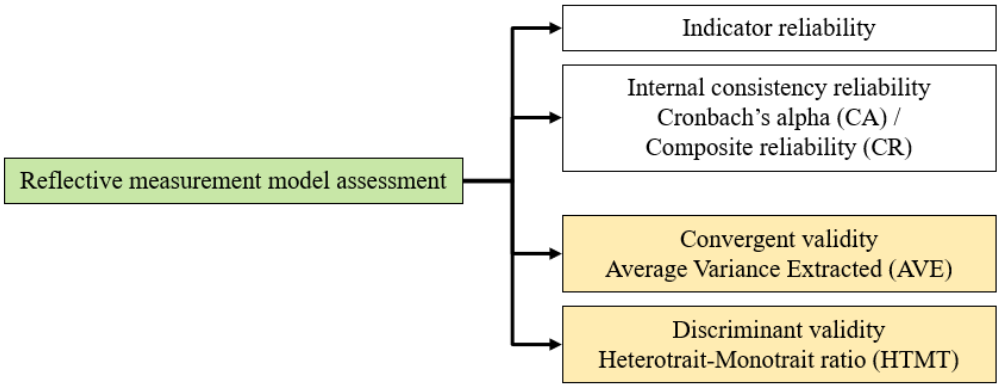
Source: own work

The traditional criterion for assessing internal consistency reliability is Cronbach's alpha (CA) or coefficient alpha. When used in multiple-question Likert scale surveys, for example, Cronbach's alpha will indicate how closely related a set of these items are as a group. A high alpha value assumes that the scores of all indicators with one construct have the same range and meaning. All construct measures in our study are above the 0.70 threshold (*Table 33*).

However, Cronbach's alpha assumes all indicators are equally reliable, and hence it tends to underestimate the internal consistency reliability of latent variables (LVs) in PLS-SEM.

Composite reliability (CR) is an alternative measure to Cronbach's alpha. It overcomes some of CA's deficiencies. It considers that the indicators have different loadings. Values of 0.70 – 0.90 are considered acceptable. All construct measures in our study are above the 0.70 threshold (*Table 33*). However, composite reliability tends to overestimate the internal consistency reliability, which results in higher reliability estimates. Hence, it is preferred to report both of them (Hair Jr, Hult, Ringle, & Sarstedt, 2016).

Figure 77: Reflective measurement model assessment step 2



Source: own work

When assessing PLS, researchers usually examine convergent and discriminant validity (*Figure 77*) for related constructs (Gefen & Straub, 2005). Measurement validity indicates the extent to which a measure adequately represents the construct that is supposed to measure.

Table 34: Constructs validity (AVE)

	Average Variance Extracted (AVE)
FP	0.843
IC	0.892
ITC	0.730
ITCB	0.872
ITCI	0.810
ITCP	0.891
ITGC	0.763
ITGD	0.768
ITGF	0.887
OA	0.706
OAM	0.839
OAO	0.741
MT	0.731
TT	0.735

Source: own work

Convergent validity indicates the degree of convergence of individual items on the construct they are supposed to measure. We used the average variance extracted (AVE) to evaluate the convergent validity of the reflective constructs. It should be 0.708 or higher (Hair Jr, Hult, Ringle, & Sarstedt, 2016, p. 137). All construct AVE measures in our study are above the 0.70 thresholds, which indicate convergent validity (*Table 34*).

Table 35: Heterotrait-Monotrait Ratio (HTMT)

	FP	IC	ITCB	ITCI	ITCP	ITGC	ITGD	ITGF	MT	OAM	OAO	TT
FP												
IC	0.581											
ITCB	0.524	0.791										
ITCI	0.538	0.757	0.830									
ITCP	0.561	0.843	0.866	0.765								
ITGC	0.409	0.756	0.718	0.610	0.655							
ITGD	0.310	0.593	0.560	0.546	0.439	0.809						
ITGF	0.391	0.654	0.623	0.571	0.582	0.760	0.819					
MT	0.324	0.423	0.326	0.470	0.382	0.276	0.357	0.373				
OAM	0.576	0.784	0.725	0.659	0.786	0.649	0.405	0.562	0.373			
OAO	0.546	0.853	0.771	0.600	0.785	0.663	0.471	0.572	0.231	0.906		
TT	0.433	0.553	0.442	0.551	0.538	0.346	0.355	0.434	0.740	0.435	0.402	

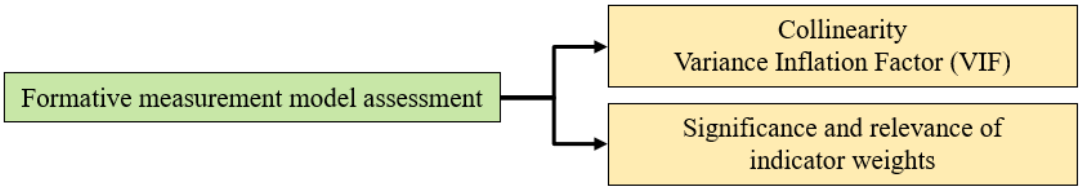
Source: own work

Discriminant validity refers to the degree measures do not discriminate from other constructs that they are not supposed to measure. Cross-loadings and Fornell-Larcker criterion provide evidence for the constructs' discriminant validity. However, neither of them allows for reliably detecting discriminant validity issues (Hair, Hollingsworth, Randolph, & Chong, 2017; Hair, Risher, Sarstedt, & Ringle, 2019). Instead, we used the Heterotrait-Monotrait ratio (HTMT) to examine the constructs' discriminant validity (Hair, Risher, Sarstedt, & Ringle, 2019). It was lower than the threshold of 0.9 (*Table 35*). Thus, the discriminant validity of the constructs is confirmed.

6.1.2 Formative measurement model assessment

The assessment of the formative measurement model requires examining the variance inflation factor (indicator collinearity) and indicator weights' statistical significance and relevance (*Figure 78*).

Figure 78: Formative measurement model assessment



Source: own work

Thus, because the formative construct of IT governance is a second-order construct (reflective-formative type), we assessed it for multicollinearity and statistical significance of the indicator weights (*Table 36*).

Table 36: Formative measurement model evaluation results

Formative construct (second-order construct)	Constructs (first-order reflective)	Weights	VIF
IT governance (ITG)	Decision-making structure (ITGD)	0.320***	2.150
	Formal process (ITGF)	0.426***	2.516
	Communication approach (ITGC)	0.371***	2.481

Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.10$

Source: own work

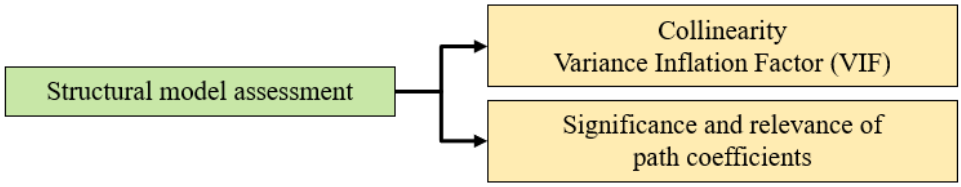
Researchers often use the variance inflation factor (VIF) to evaluate the collinearity of the formative indicators. VIF values ≥ 5 indicate critical collinearity issues. The optimum VIF value should be ≤ 3. *Table 36* shows that the VIF ranges from 2.15 (lowest value) to 2.51 (highest value). Our values are below the threshold of 3, indicating the absence of multicollinearity between variables (Hair, Risher, Sarstedt, & Ringle, 2019).

As PLS-SEM is a nonparametric method, we used bootstrapping to determine the statistical significance. In terms of significance and sign, the three are satisfactorily significant ($p < 0.01$) and with a positive sign (*Table 35*). Since the evaluation of the measurement model was considered satisfactory, we evaluated the structural model.

6.2 Structural Model Assessment

It was essential to have a satisfactory measurement model assessment before conducting a structural model assessment. Structural model assessment criteria include collinearity (VIF) and the coefficient of determination (R^2), as outlined in *Figure 79*.

Figure 79: Structural model assessment



Source: own work

In our model, we postulated that IT governance and the two capabilities (innovation capability and IT capability) act as resources that enable the organization's strategic pursuit of agility. We hypothesized that innovation capability and IT capability mediate the relationship between IT governance and organizational agility, and environmental turbulence moderates the governance-agility and capabilities-agility relationships. We also hypothesized that organizational agility positively influences firm performance.

The structural model in Figure 80 shows the variation and path coefficients. We performed bootstrapping with 5000 resamples to assess the significance levels of the hypothesized constructs (Hair Jr, Hult, Ringle, & Sarstedt, 2016, p. 170). As collinearity wasn't an issue, we proceeded to examine the R^2 value of the constructs. R^2 measures the model's explanatory power. R^2 ranges from 0 to 1, where higher values indicate higher explanatory power. In general, R^2 values of 0.75, 0.50, and 0.25 can refer to substantial, moderate, and weak explanatory power. The R^2 is a function of the number of predictor constructs. That means that the greater the number of predictor constructs, the higher the R^2. Hence, the interpretation of the R^2 should reflect the study's context. Our results show that R^2 values have substantial to moderate explanatory power (*Table 37*).

Table 37: R^2 values

IC	0.524
ITC	0.508
ITG	0.978
OA	0.656
FP	0.288

Source: own work

The outer loading of indicators measures indicator reliability, and loadings above 0.70, are considered acceptable item reliability (Hair, Risher, Sarstedt, & Ringle, 2019). In *Table 47*, all loadings are higher than 0.7, confirming indicator reliability. However, we dropped IC4, IC5, MT5, and TT4 due to a lack of indicator reliability.

The average variance extracted (AVE) measures the convergent validity for all items on each construct with a value of 0.50 or higher is considered acceptable. It indicates that the construct explains at least 50 percent of the variance of its items. As shown in *Table 38*, all the AVE values are higher than the acceptable threshold of 0.5, so convergent validity is confirmed (Hair, Risher, Sarstedt, & Ringle, 2019).

We modeled the formative IT governance construct as a second-order construct (reflective-formative type), so we assessed the measurement model for multicollinearity and weights' statistical significance for the indicators. We performed a multicollinearity evaluation using variance inflation factor (VIF), where values close to 3 and lower are considered acceptable. *Table 36* reveals that the VIF ranges from 2.15 (lowest) to 2.51 (highest). Our values are below the threshold of 3, indicating the absence of multicollinearity among the variables (Hair, Risher, Sarstedt, & Ringle, 2019). In terms of significance and sign, we found the three are satisfactory significant ($p < 0.01$) and with a positive sign. As the measurement model assessment was considered acceptable, we assessed the structural model.

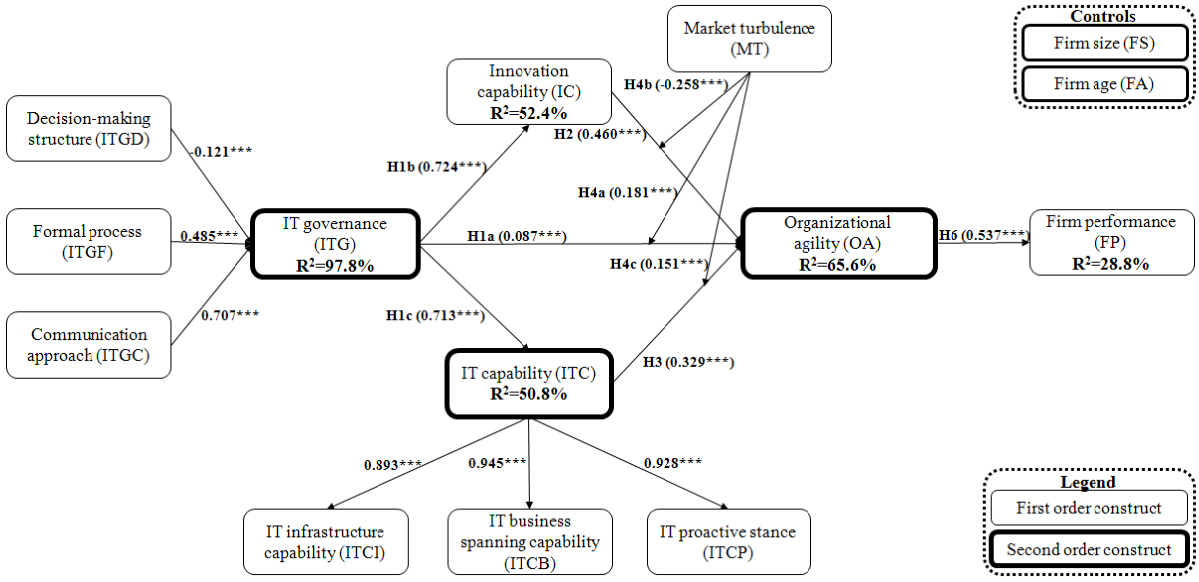
Table 38: Descriptive statistics, correlation, CR, and AVE

	Mean	SD	CR	ITGD	ITGF	ITGC	IC	ITCI	ITCB	ITCP	MT	TT	OAM	OAO	FP
ITGD	4.752	1.676	0.908	**0.768**											
ITGF	4.503	1.635	0.959	0.729	**0.887**										
ITGC	4.452	1.696	0.906	0.683	0.671	**0.763**									
IC	4.420	1.593	0.961	0.528	0.613	0.668	**0.892**								
ITCI	4.850	1.329	0.944	0.482	0.531	0.533	0.704	**0.810**							
ITCB	4.646	1.521	0.965	0.502	0.587	0.638	0.747	0.777	**0.872**						
ITCP	4.788	1.550	0.970	0.394	0.552	0.583	0.800	0.718	0.826	**0.891**					
MT	4.498	1.377	0.891	0.332	0.328	0.262	0.381	0.441	0.325	0.354	**0.731**				
TT	5.481	1.249	0.892	0.295	0.384	0.287	0.492	0.488	0.396	0.483	0.594	**0.735**			
OAM	4.098	1.571	0.940	0.353	0.517	0.562	0.723	0.602	0.672	0.731	0.313	0.387	**0.839**		
OAO	4.042	1.478	0.895	0.393	0.503	0.549	0.752	0.524	0.683	0.700	0.183	0.339	0.783	**0.741**	
FP	4.061	1.415	0.955	0.276	0.367	0.363	0.546	0.499	0.495	0.532	0.274	0.384	0.528	0.481	**0.843**

Notes: Values in diagonal (bold) are the AVE square root; Decision-making structure (ITGD); Formal process (ITGF); Communication approach (ITGC); Innovation capability (IC); IT infrastructure capability (ITCI); IT business spanning capability (ITCB); IT proactive stance (ITCP); Market turbulence (MT); Technological turbulence (TT); Market capitalizing agility (OAM); Operational adjustment agility (OAO); Firm performance (FP). Composite reliability (CR), average variance extracted (AVE)

Source: own work

Figure 80: Results of the research model



Notes: *** p < 0.01; ** p < 0.05; * p < 0.10

Source: own work

The structural model in *Figure 80* presents the variation and the path coefficients. We performed bootstrapping with 5000 resamples to assess the significance levels of the hypothesized constructs.

Table 39: Significance analysis of the direct and indirect effects

Effect of	Direct effect	Indirect effect	Interpretation
ITG → IC → OA	0.112	0.328***	Indirect-only (full mediation)
ITG → ITC → OA	0.112	0.177***	Indirect-only (full mediation)

Notes: *** p < 0.01; ** p < 0.05; * p < 0.10

Source: own work

First, our research model explains 52.4% of the variation in innovation capability (IC). IT governance (ITG) ($\hat{\beta}$ = 0.724; p < 0.01) has a significant and positive effect on innovation capability (IC). Thus, H1b is supported. Second, the model explains 50.8% of the variation in IT capability (ITC). ITG ($\hat{\beta}$ = 0.713; p < 0.01) has a significant and positive effect on ITC. Thus, H1c is supported. Third, our model explains 65.6% of the variation in organizational agility (OA). Innovation capability (IC) ($\hat{\beta}$ = 0.460; p < 0.01), IT capability (ITC), ($\hat{\beta}$ = 0.329; p < 0.01), have a significant and positive effect on organizational agility. Consequently, H2 and H3 are supported. Fourth, the moderation effect of market turbulence on IC ($\hat{\beta}$ = -0.258; p < 0.01), ITG ($\hat{\beta}$ = 0.181; p < 0.01), and ITC ($\hat{\beta}$ = 0.151; p < 0.01) have a significant and positive effect on organizational agility. Thus, H4a, H4b, and H4c are supported respectively. Finally, our research model explains 28.8% of the variation in firm performance (FP). Organizational agility (OA) ($\hat{\beta}$ = 0.537; p < 0.01) has a significant and positive effect on firm performance (FP). Thus, H6 is supported.

However, hypothesis H1a is not supported, which reveals that innovation capability and IT capability are full mediators between IT governance (ITG) and organizational agility (OA) (*Table 39*). Further, hypotheses H5a, 5b, and 5c are not supported, indicating that technological turbulence has a weak moderator effect on the relationship between IT governance, innovation capability, and IT capability on organizational agility. In summary, our model confirms five hypotheses out of six. None of the controls had a significant influence on any of the constructs.

7 DISCUSSION

We have three research questions that drove this study: (i) How does IT governance influence organizational agility and (ii) how does IT governance help develop the IT capability and innovation capability, and how do these capabilities contribute to organizational agility, and finally (iii) how does environmental turbulence affect IT governance, IT capability, and innovation capability on organizational agility?

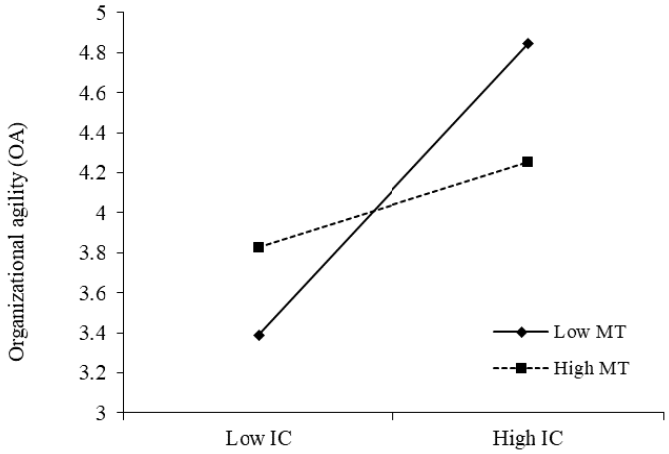
Our study addressed these questions by developing and empirically testing a theoretical model that places IT governance as the independent variable in the nomological network. We discuss the results of the data analysis below, and we outline the directions for future research in the following chapter.

The survey data collected from the 132 senior business managers support our research model and thereby validate our theoretical development for the study. The study has four significant findings. First, IT governance positively influences organizational agility mediated by innovation and IT capabilities. Our research offers insights into the mechanism through which IT governance can positively influence the status of organizational agility. The study

has a critical finding that IT governance positively impacts organizational agility indirectly. That answered our first research question regarding how IT governance influences organizational agility. Second, IT governance positively impacts innovation and IT capabilities. That finding suggests that IT governance is a significant antecedent to IT and innovation capabilities. That answers our second research question regarding the relationship between IT governance and IT and innovation capabilities and their impact on organizational agility. Third, market turbulence moderates the relationship between IT governance, IT and innovation capabilities, and organizational agility. That explained the answer to our third research question. Fourth, organizational agility positively impacts firms' performance.

Several researchers argue that the direct effect of mediation doesn't have to be significant when analyzing for mediation effect. They claim that while analyzing, researchers may not identify a note-worthy direct relationship because of the small sample size or absence of enough power to predict the effect. Therefore, the significance of the mediation analysis is the indirect effect (Ramayah, Cheah, Chuah, Ting, & Memon, 2018).

Figure 81: Market turbulence moderation on innovation capability

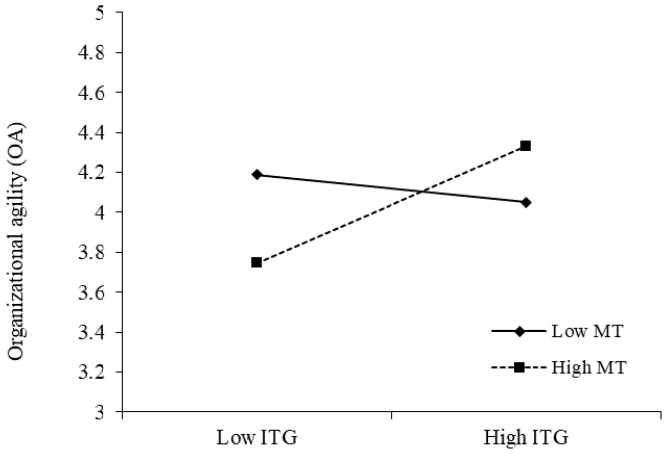


Source: own work

Regarding the moderating effects, we found that the impact of MT on the relationships between ITG, IC, ITC, and OA are mixed. In *Figure 81*, the effect of innovation capability on organizational agility is high when market turbulence is low.

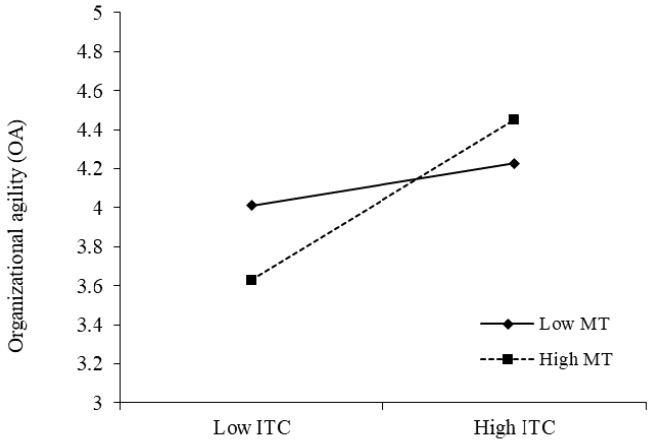
Conversely, IT governance exerts a strong influence on organizational agility when market turbulence is high, as shown in *Figure 82*. That is also true in the case of IT capability, as *Figure 83* shows that IT capability has a higher impact on organizational agility when market turbulence is high. Thus, when market turbulence increases, the importance of IT governance and IT capability increases, while that of innovation capability decreases.

Figure 82: Market turbulence moderation on IT governance



Source: own work

Figure 83: Market turbulence moderation on IT capability



Source: own work

It is worth noting that higher IT governance could lead to lower organizational agility. With low market turbulence, firms usually realize their business goals with the prevailing standards and the selected management controls. Imposing more IT governance management controls means potentially restricting the agility state. That is not the main concern for a company facing low market turbulence. Low market turbulence may not require higher organizational agility, especially since organizational agility comes with a high cost (Teece, Peteraf, & Leih, 2016). The deployed management controls of the IT governance mechanisms can support the current agility status. If IT governance enforces more management controls, organizational agility can suffer from the imposed restrictive state.

IT governance mechanisms provide the required assurance of a strategic alignment between IT objectives and business objectives. That strategic alignment would result in having the

necessary IT resources and capabilities that serve the business objectives. The dynamic development or acquisition of the needed IT capabilities associated with the required innovation will enable the firm to reach an agile state that can counteract changing environmental conditions. That will lead us to the research question. How can a firm's IT governance affect organizational agility under changing environmental conditions? That is the critical research question this study aims to examine theoretically and investigate empirically.

Firms with effective IT governance are prone to utilize their IT resources and capabilities better. The relationship between IT governance and IT is similar to corporate governance and business (Guldentops, et al., 2003). It provides a framework to assist the board and senior management in ensuring that IT capability supports business objectives with a higher IT investment return and better risk management (Wilkin & Chenhall, 2010; Ajamieh, Benitez, Braojos, & Gelhard, 2016). When a business enjoys such a higher capability, it will become more efficient, enhanced by the strong influence of innovation on resources (Huang, Wu, Lu, & Lin, 2016). IT governance requires validation of the IT business value that can act as an enabler for innovation. Thus, it is a balanced approach where stability is not regarded as a barrier but rather as an enabler for creativity.

8 IMPLICATIONS for RESEARCH and PRACTICE

This chapter reflects on two aspects: the theoretical contribution and the implications for managers. The main focus is on the role of IT governance in improving organizational agility under changing environmental conditions. In contrast to the literature that examines the determinants of IT governance success and its role in supporting organizational performance, this study develops a model that provides new insights into the stream of research examining the impact of IT governance on organizational agility under turbulent environmental conditions.

Specifically, we find that IT governance has no direct influence on organizational agility. However, we found that IT governance exerts its impact through IT capability and innovation capability. In addition, we found mixed effects of environmental turbulence on the relationships between IT capability, innovation capability, and organizational agility.

In the end, the chapter explains the limitations of our study and the future avenues for research.

8.1 Theoretical Contributions

This dissertation provides several contributions to the IS discipline. **First**, our research examines and demonstrates how the two theories, RBV and DCV combined, can explain the impact of IT governance on organizational agility under environmental turbulence. Both RBV and DCV are two views that allow us to understand how firms can achieve organizational agility using resources and capabilities. The RBV emphasizes that firms have valuable, rare, inimitable, and non-substitutable resources that allow them to maintain their agility state over a predictable and sustained period. Researchers used RBV in information systems research to explain how IT business value can provide a competitive advantage (Bharadwaj A. S., 2000). The RBV highlights how firm resources such as IT resources can be the main predictors of a firm's performance (Barney J., 1991). We used RBV theory to study the relationship between innovation capability, IT capability, IT governance, organizational agility, and firm performance. Looking through the RBV lens, the model explains how IT governance, innovation capability, and IT capabilities are potential sources for organizational agility.

However, RBV is confined to a static environment and does not explain the response to rapid and unpredictable environmental conditions (Eisenhardt & Martin, 2000). The dynamic capabilities balance that limitation by emphasizing how firms can use their internal resources and external capabilities to sustain their agility in a dynamically unpredictable environment. It extends the RBV by explaining how dynamic capabilities govern in a changing turbulent environment (Teece, Peteraf, & Leih, 2016). These capabilities have sensing, responding, and transforming resources that enable the firm to explore and exploit market opportunities and manage new unpredictable threats. Hence, extending the RBV with the DCV explains how IT governance can impact IT capability, innovation capability, and organizational agility. It can also explain how environmental turbulence can influence that impact. With environmental changes, the dynamic capabilities can enable firms to build and reconfigure their resource base, thus, helping them manage emerging opportunities or impending threats.

Second, our results showed that IT governance has a critical role in managing IT capabilities. IT governance provides the ability to choose among different options of IT resources and capabilities and hence, to have monitoring controls that allow a smooth transformation from one IT capability state to another. IT governance enables doing the right thing while doing things right. That is the expected behavior under normal conditions and more in a turbulent environment. That helped us to understand the paradox in this relationship. While IT capability needs flexibility and the ability to transform and respond quickly to market changes, IT governance demands standardization and stability.

Previous research on the impact of IT governance on IT capability is very scarce. There are limited studies that examine the moderating influence of environmental turbulence on such a relationship. Such an impact is critical with new and emerging technologies and the

innovative practice in implementing them. Market turbulence can be an organizational challenge, where different pressures can affect vital business processes. That will demand new or modified IT capabilities. Organizations often encounter the dilemma of balancing better operational efficiency against more IT investment (Philip, 2007). Organizations often face that balance, and they need to act under market pressure with early sensing and quick response. To have a transformation process, organizations need to align IT objectives with business objectives. IT governance plays a crucial role in managing this balance, especially when encountering a turbulent environment.

Firms that enjoy more effective IT governance are likely to have more effective and efficient IT capability. Effective management of IT capability can provide the firm with higher performance under different environmental conditions. That clarifies why IT governance is used by senior management and the board of directors to manage and control IT capabilities. It will enable them to realize the benefits critical to achieving the business objectives. Effective IT governance provides a framework for managing IT resources and capabilities. That ensures having the needed controls that allow monitoring and guided transformation from one IT capability state to another. Hence, IT governance provides effective management and utilization of IT resources and capabilities. Such effective management will enable the firm to sense and respond far better to changing market conditions with enhanced agility. IT governance serves as an antecedent to IT capability and provides a smooth transformation of IT-dependent business processes.

Third, in our study, we demonstrated that IT governance positively influences organizational agility mediated by the IT capability of the firm. IT governance can enhance organizational agility indirectly through mediation by IT capability. That is indeed a new relevant stream of research that influences organizational agility. IT governance mechanisms impose management control to align IT objectives with business objectives, and thus, they are essential for managing IT capability under unpredictable conditions encountered by the business. These mechanisms are crucial for achieving organizational agility mediated by IT capability.

Fourth, there is always a challenge to achieve strategic innovation without realizing the business value of IT in supporting or driving the innovation process (Peterson, 2004). The study provided evidence that IT governance is a critical antecedent for stability when innovative practice is needed. As mentioned earlier that the relationship between IT governance and innovation has powerful roots in how the board of directors or senior management manages the innovation process (Asensio-López, García, & Álvarez, 2019). Some senior managers prefer to take a proactive and exploring approach to stay ahead of the competition. However, other managers prefer risk-averse and take a reactive and exploiting approach to maintain their competitive status (Ashurst, Freer, Ekdahl, & Gibbons, 2012). However, in either case, it is challenging to achieve strategic innovation without the needed

service infrastructure and the realization of the business value of IT in supporting or driving the innovation process (Peterson, 2004).

In a dynamic environment, firms' ability to explore and exploit their critical resources would enhance their innovation process. Sensing market changes and responding with rapid innovations will enable the firm to minimize potential threats and capitalize on emerging opportunities. The ability of the firm to explore and exploit innovative technologies and practices varies. Firms respond by creating new products and services, changing core business processes, or changing the business model. The management control imposed through IT governance ensures that the modular IT infrastructure will support the desired innovative practice.

Fifth, effective IT governance also provides a reasonable assurance for maintaining business continuity and in-effect innovation continuity when threatened by environmental changes. Our study indicates that IT governance acts indirectly on organizational agility through the mediation of innovation capability. IT governance assures the strategic alignment of business and IT objectives. That enhances the innovation objectives of the firm, whether in its current practice or the upcoming plans. IT governance supports exploring and developing innovations (exploration) or exploiting the current system to increase organizational efficiency (exploitation) (Andersen, Svejvig, & Heeager, 2017). The findings of our study have shown that IT governance exerts its positive impact on organizational agility through mediation by the innovation capability of the firm.

Sixth, we developed and tested a nomological network linking IT governance, innovation capability, IT capability, organizational agility, and firm performance. Our study confirms previous findings on the role of organizational agility in improving the performance of firms (Chakravarty, Grewal, & Sambamurthy, 2013; Ravichandran, 2018; Sambamurthy, Bharadwaj, & Grover, 2003; Tallon & Pinsonneault, 2011). Agile organizations can detect and seize market opportunities quickly and effectively. Agility also enables firms to reconfigure their assets and become more capable of managing environmental turbulence leading to superior performance. Some showed that customer agility through aligning firms' customer sensing and responding capabilities is significantly related to firm performance (Roberts & Grover, 2012). Others found that organizational agility can improve a firm's performance through product and service innovation (Pavlou & El Sawy, 2010). Other research indicated that business process agility provides superior performance under environmental turbulence (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014).

8.2 Managerial Implications

From the professional aspect, managers may need to consider their appropriate IT governance mechanisms best suited for their practice to ensure alignment between IT and business

objectives, including the desired agility. That will enable both IT capability and innovation to contribute positively to business objectives in a turbulent environment. This study provides several practical insights to senior management, IT executives, and auditors.

First, IT governance provides a practical framework that enhances managing firms' IT resources and capabilities optimally. That has a significant impact on developing and acquiring new IT resources and capabilities. That is a critical step to achieving organizational agility. Our study emphasizes that firms need effective IT governance mechanisms to cover existing or emerging technologies that can disrupt the business environment by making current IT capabilities obsolete. IT governance mechanisms provide the ability to select among different options of IT resources and capabilities regarded as suitable for the current environment and in preparation for any unpredictable condition in the future. These mechanisms employ management controls that provide a smooth transformation from one IT capability state to another. Although IT capability requires flexibility and the ability to transform and respond quickly to market changes, IT governance provides much-needed standardization and stability.

Market turbulence can be an organizational challenge, where different pressures can affect vital business processes. That will demand new or modified IT capabilities. Organizations often encounter the dilemma of balancing better operational efficiency against more IT investment (Philip, 2007). Organizations acting under market pressure require early sensing and quick responding. However, a proper transformation process requires aligning IT objectives with business objectives. IT governance plays a crucial role in managing this balance.

Firms possessing more effective IT governance mechanisms are likely to have more effective and efficient IT capabilities. Effective management of IT capability can provide the firm with higher performance under different environmental conditions. Senior management and the board of directors use IT governance to manage and control IT capabilities enabling them to realize the desired benefits deemed critical to achieving the business objectives. Effective IT governance mechanisms provide a management framework for IT resources and capabilities. That provides the required assurance of implementing controls that allow monitoring and guided transformation from one IT capability state to another.

Second, in our study, we demonstrated that IT governance positively influences organizational agility mediated by the IT capability of the firm. IT governance can enhance organizational agility indirectly through mediation by IT capability. IT governance mechanisms impose management control to align IT objectives with business objectives, and thus, they are essential for managing IT capability under unpredictable conditions encountered by the business. Organizations should choose the most applicable IT governance mechanisms that allow them to sustain their businesses under normal conditions or to be able

to reconfigure them when facing turbulent conditions. These mechanisms are crucial for achieving organizational agility mediated by IT capability.

Third, there is always a challenge to achieve strategic innovation without realizing the business value of IT in supporting or driving the innovation process (Peterson, 2004). The study provided evidence that IT governance is a critical antecedent for stability when innovative practice is needed. As mentioned earlier that the relationship between IT governance and innovation has powerful roots in how the board of directors or senior management manages the innovation process (Asensio-López, García, & Álvarez, 2019). Some senior managers prefer to take a proactive and exploring approach to stay ahead of the competition. However, other managers prefer risk-averse and take a reactive and exploiting approach to maintain their competitive status (Ashurst, Freer, Ekdahl, & Gibbons, 2012). However, in either case, it is challenging to achieve strategic innovation without the needed service infrastructure and the realization of the business value of IT in supporting or driving the innovation process (Peterson, 2004).

IT governance provides a governed path for innovation capability to achieve the desired status of organizational agility. That will ensure having management controls when the firm changes from one state to another. That also provides the needed support to achieve the innovation objectives of the company, whether in current practice or upcoming plans. That means it will enable a governed, innovative manner to transform business activities successfully in a dynamic environment. Furthermore, in a dynamic environment, firms' ability to explore and exploit their critical resources would enhance their innovation process. Sensing market changes and responding with rapid innovations will enable the firm to minimize potential threats and capitalize on emerging opportunities. A firm's ability to explore and exploit innovative technologies and practices varies from creating new products and services, changing core business processes, or changing the business model. The management control imposed through IT governance ensures that the modular IT infrastructure will support the desired innovative practice.

Fourth, IT governance mandates the approval of senior business managers for the deployment of the assigned IT management controls. IT auditing is a critical management control practice exercised by the board and senior management over IT resources and capabilities. Hence, the audit committee and IT auditors need to consider the importance of IT governance mechanisms that oversee the preparation of IT capability required under turbulent conditions. IT auditors need to evaluate the specified management controls, including the sensing and responding ones. That will enable guarding against unpredictable environmental changes. They need to assess the selected management controls for IT governance in a dynamic environment, including the most critical, that is, the alignment of IT and business goals. They also need to identify the design factors suited for the specific context of the organization in such a dynamic environment (De Haes S. , Van Grembergen, Joshi, & Huygh, 2020).

Fifth, effective IT governance critically links with the business continuity program. It provides a reasonable assurance for maintaining the business continuity and in-effect IT and innovation continuity when threatened by environmental changes. Business continuity is a program that organizations have to implement to minimize the risks of unexpected turbulent conditions, especially those affecting the organization's primary services. It helps identify the time-critical business processes and the required recovery times to resume business-as-usual. Thus, the business continuity program establishes the capabilities that enable the organization to respond to unpredictable conditions that can threaten the organization. IT governance mechanisms provide the needed management controls for the business continuity of IT and innovation capabilities. Exploiting or exploring innovative practices requires imposing the management controls dynamically to render any digital transformation as safe and smooth as possible.

Sixth, our study shows that organizational agility positively influences firm performance. When encountering environmental turbulence, organizational agility enables the firm to sense and seize market opportunities better than its competitors. Further, it allows the firm to reconfigure its resources and quickly respond to unpredictable changes. Thus, it will enable the firm to sustain its competitive advantage. Studies showed many approaches that link organizational agility to better firm performance (Chakravarty, Grewal, & Sambamurthy, 2013; Chen, Wang, Nevo, Jin, Wang, & Chow, 2014; Pavlou & El Sawy, 2010; Ravichandran, 2018; Sambamurthy, Bharadwaj, & Grover, 2003; Tallon & Pinsonneault, 2011)

8.3 Limitations and Future Research

Our study has some limitations that can serve as avenues for future research. First, we used cross-sectional data to examine the impact of IT governance mechanisms on organizational agility. We also used it to evaluate innovation and IT capabilities as critical mediators. We cannot use cross-sectional studies to analyze behavior over time or establish long-term trends as they only represent a one-time measurement of the cause and effect. Longitudinal research can be helpful when conducted on related specific antecedents of effective IT governance and examining other relevant mediators. That can also provide more information on other key agility antecedents under environmental turbulence. In addition, a longitudinal study can also investigate the related consequences of effective IT governance and learn about the potential delayed effect of IT governance mechanisms over time.

Second, in the era of Industry 4.0 technologies, IT governance mechanisms may not cover some IT activities that interface with external IT resources and capabilities. In current practice, some activities dependent on the firm's IT capabilities exist outside the firm. That includes digital platforms, outsourcing, and open-sourcing (Aubert & Rivard, 2020). That

poses a need for IT governance mechanisms to extend their reach externally to the organization in an updated manner and offer the needed controls.

Third, we depended on a single respondent. That could imply that the results may have method bias. It is preferable to have more than one respondent for each company to enhance validity and reliability. In conducting field research, there is always difficulty obtaining responses to surveys, especially for topics such as IT governance. However, we tried to minimize such bias ex-ante and ex-post. On the ex-ante, we assured the respondents of both anonymity and confidentiality of their responses (Rogelberg & Stanton, 2007). We also designed the survey in a clear format avoiding ambiguous terms or complicated questions. We selected the measures of our study to be independent of each other and their expected outcomes. We also used the scale reordering procedure in the questionnaire (i.e., our dependent variables are after the independent variables). We conducted Harman's one-factor test ex-post to determine the bias extent of our results. The test suggests that method bias does not account for our study's results.

Fourth, we employed subjective measures of firm performance considered relative to their competitors. It is rare to find data used to assess performance relative to competitors. Instead, we used self-reported measures. That is an approach consistent with prior research investigating comparative performance measures (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014). However, future research could support our research by using objective measures of a firm's performance.

Fifth, as we conducted our study in Brazil, future research needs to examine the research model in other countries to generalize it across borders and explore whether our findings are valid in different countries.

Finally, as medium-to-large firms were the target of our study, there is a need to test if the proposed theory supports small firms.

CONCLUSION

This study focuses on the role of IT governance in improving organizational agility under turbulent environmental conditions. While the literature examines the determinants of IT governance success and its role in supporting organizational performance, this study develops a model that provides new insights into the stream of research examining the impact of IT governance on organizational agility under dynamic environmental conditions. While we showed that IT governance has no direct influence on organizational agility, the study demonstrated that IT governance exerts its impact through IT capability and innovation capability. In addition, we found mixed effects of environmental turbulence on the relationships between IT capability, innovation capability, and organizational agility. The

study also confirmed previous results that organizational agility positively influences firm performance.

Our research demonstrates how the two theories, RBV and DCV combined, can explain the impact of IT governance on organizational agility under environmental turbulence. They allowed us to understand how firms can achieve organizational agility using resources and capabilities. We used RBV theory to study the relationship between innovation capability, IT capability, IT governance, and organizational agility. The dynamic capabilities compensate for RBV's limitation by emphasizing how firms can use their internal resources and external capabilities to sustain agility in a dynamically unpredictable environment. Thus, extending the RBV with the DCV can explain how IT governance impacts IT capability, innovation capability, and organizational agility. It can also explain how environmental turbulence can influence that impact.

We also demonstrated that IT governance plays an important role when facing the moderating influence of environmental turbulence. That allowed us to understand the paradox in the relationships between the IT governance side and IT and innovation capabilities on the other side. While IT and innovation capabilities need flexibility and the ability to transform and respond quickly to environmental changes, IT governance demands standardization and stability. The significance of such an impact is critical with new and emerging technologies and the innovative practice in implementing them.

Our results emphasize that effective IT governance provides a management framework for IT resources and capabilities. That ensures having controls that allow monitoring and guided transformation from one IT capability state to another. Hence, IT governance provides better management and utilization of IT resources and capabilities. The study also demonstrates that the management control imposed through effective IT governance will support the desired innovative practice. Effective IT governance will also provide reasonable assurance for maintaining business continuity and in-effect innovation continuity when threatened by environmental changes. Furthermore, our study shows that IT governance acts indirectly on organizational agility through mediation by innovation capability. Finally, the study confirmed the direct impact of organizational agility on firm performance.

As a result of our study, managers need to assess and emphasize the appropriate IT governance mechanisms that are most suitable for their practice to ensure alignment between IT and business objectives, including the desired agility. That will enable IT and innovation capabilities to contribute to business objectives in a turbulent environment. The study highlights the need for effective IT governance to manage existing technologies or new and emerging ones in the new era of industry 4.0 that can disrupt the business environment and make current IT capability obsolete. The study also demonstrated that IT governance is a critical antecedent for stability when innovative practice is needed. IT governance acts as an enabler to creativity. Finally, the audit committee and IT auditors need to consider the

importance of IT governance mechanisms that oversee the preparation of IT capability required under turbulent conditions. IT auditors need to assess and provide a reasonable assurance of the designated management controls, including the sensing and responding ones. That will enable guarding against unpredictable environmental changes.

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APPENDICES

Appendix 1: Summary in Slovenian language / Daljši povzetek disertacije v slovenskem jeziku

1.1 Ozadje študije

IT se na splošno šteje za kritično podlago za organizacijski uspeh, ki vpliva na to, kako podjetja ustvarjajo in zajemajo vrednost ter prekašajo konkurente (Chen, Wang, Nevo, Jin, Wang in Chow, 2014; Grover, Chiang, Liang in Zhang, 2018; Hair Jr JF, Hult, Ringle in Sarstedt, 2016). Upravljanje IT je ključnega pomena pri maksimiranju poslovne vrednosti IT, saj vpliva na upravljanje virov in zmogljivosti IT ter nadalje zagotavlja stabilno in varno platformo za različne inovativne pristope. Posledično pomaga ohranjati konkurenčno prednost s spodbujanjem organizacijske agilnosti. Prejšnje študije o poslovni vrednosti IT so preučevale determinante uspeha upravljanja IT (Buchwald, Urbach in Ahlemann, 2014) in vlogo upravljanja IT pri podpori organizacijske uspešnosti (Chau, Ngai, Gerow in Thatcher, 2020; Harguem, 2021; Zhang, Zhao in Kumar, 2016), uspešnost projekta (Sirisomboonsuk, Gu, Cao, & Burns, 2018) in poslovno poročanje (Haouam, 2020). Kljub temu je vloga upravljanja IT v dinamičnem okolju in njegov vpliv na organizacijsko agilnost premalo raziskana in za raziskovanje te vloge je na voljo omejeno število raziskav.

V zgodnjih 2000-ih se je pojavilo veliko korporativnih škandalov, kot so Enron, Global Crossing in WorldCom, kar kaže, da je bil glavni vzrok pomanjkanje korporativnega upravljanja (Green, 2004). To je privedlo do izdaje zveznega zakona Združenih držav, imenovanega Sarbanes-Oxleyjev zakon (SOX) za upravljanje podjetij in oddelka SOX 404 za notranje kontrole. SOX 404 je vplival na okvir upravljanja IT in je močno vplival na izvajanje kontrol upravljanja v organizacijski praksi (Karanja & Zaveri, 2014). Raziskave na področju upravljanja IT so se skozi leta razvijale na različne poti, kar je bilo zaradi sprememb v pristopu upravljanja ter dinamičnih zahtev in pričakovanj trga zelo pričakovano. Poleg tega so razvoj in inovacije informacijske tehnologije, postopen ali moteč, izrazito prispevali k novim zahtevam trga in nenehno spreminjajočim se željam strank. Žal se akademske raziskave na področju upravljanja IT niso toliko povečale, kljub pomembnemu vplivu na akademske kroge in poklicno prakso (Liang, Chiu, Wu in Straub, 2011). Upravljanje IT nadzira načrtovanje, razvoj, uvajanje in vzdrževanje zmogljivosti IT, ki avtomatizirajo in olajšajo poslovne postopke, vključno z zunanjim izvajanjem (Kim, Lee, Koo in Nam, 2013). Upravljanje IT podpira tudi raziskovanje in razvoj inovacij ali izkoriščanje sedanjega sistema za povečanje organizacijske učinkovitosti v spreminjajočih se okoljskih razmerah (Andersen, Svejvig in Heeager, 2017).

Razvoj organizacijske agilnosti s pomočjo IT in inovacij je dolgoročen proces in težka naloga za vsako organizacijo (Lowry & Wilson, Ustvarjanje agilnih organizacij s pomočjo IT: Vpliv percepcije internih informacijskih storitev na kakovost IT storitev in agilnost IT., 2016; Teece , Peteraf in Leih, 2016). Okvir upravljanja IT zagotavlja strateško usklajenost ciljev IT s poslovnimi cilji organizacije (Gregory, Kaganer, Henfridsson in Ruch, 2018). To bi podprlo

in izboljšalo organizacijsko agilnost (Gregory, Kaganer, Henfridsson in Ruch, 2018; Wu, Straub in Liang, 2015) in uspešnost podjetja (Chau, Ngai, Gerow in Thatcher, 2020). Učinkovito upravljanje IT zagotavlja okvir, ki organizacijam omogoča, da izkoristijo svoje vire in zmogljivosti IT ter upravljajo svoje inovativne prakse. Zmogljivost IT lahko pripravi podjetje na okoljske turbulence, kar je odvisno predvsem od procesa odločanja o IT (Benitez-Amado & Walczuch, 2012; Mithas, Ramasubbu in Sambamurthy, 2011). Zmogljivost IT potrebuje občasno ali celo stalno ocenjevanje, da se preveri, ali je primerna za priložnosti in grožnje, s katerimi se podjetje srečuje ali pričakuje. To lahko povzroči nadgradnjo in ponovno konfiguracijo IT virov in zmogljivosti, ki podjetjem omogočajo preživetje v zelo konkurenčnem okolju s številnimi spreminjajočimi se okoljskimi pogoji. Ko se soočamo s takšnimi negotovostmi, dinamične zmogljivosti zagotavljajo potrebne sposobnosti za ohranjanje konkurenčne prednosti (Teece D. J., 2007).

V literaturi o informacijskih sistemih (IS) se IT kompetenca in inovativna sposobnost običajno štejeta za kritične sposobnosti za razvoj organizacijske agilnosti (Chakravarty, Grewal in Sambamurthy, 2013; Ravichandran, 2018; Tallon, Queiroz, Coltman in Sharma, 2019). Organizacije kažejo heterogenost v svojih virih IT, kot so IT infrastruktura, človeške IT veščine in zmožnost uporabe IT za nematerialne koristi (Bharadwaj A. S., 2000; Ray, Muhanna in Barney, 2005). Te organizacije, ki dosegajo konkurenčno prednost z IT, so prepoznale potrebo po učinkoviti združitvi svojih IT virov, da bi ustvarile celotno zmogljivost IT. Zmogljivost IT se je izkazala za zelo uporabno v različnih vidikih organizacijske prakse. Raziskovalci so ugotovili, da zmogljivost IT omogoča inovacije izdelkov (Chen, Wang, Nevo, Benitez-Amado in Kou, 2015) in inovacije storitev (Chen & Tsou, 2012) z izboljšano učinkovitostjo podjetja. Zmogljivost IT omogoča tudi digitalno preobrazbo podjetij (Nwankpa & Roumani, 2016) in vpliva na razvoj digitalnih platform skozi čas (Tan, Pan, Lu in Huang, 2015). Dejansko lahko zagotovijo večjo angažiranost za stranke družbenih medijev in e-trgovine (Braojos, Benitez in Llorens, 2019). Zmogljivost IT lahko izboljša uspešnost podjetja neposredno ali posredno prek posrednikov, kot je organizacijska agilnost (Felipe, Leidner, Roldán in Leal-Rodríguez, 2020; Sambamurthy, Bharadwaj in Grover, 2003; Lu in Ramamurthy., 2011). Poleg tega omogoča poslovni razvoj in inovacije ter zagotavlja potrebno prožnost za olajšanje raziskovanja in izkoriščanja različnih tržnih priložnosti. To pa vodi do boljšega odziva podjetja in sposobnosti, da ohrani svojo konkurenčno prednost v turbulentnih okoljskih razmerah (Benitez, Llorens in Braojos, 2018).

Medtem ko zmožnost IT ponuja organizacijam priložnosti, da so agilne, je lahko obseg zajemanja teh priložnosti med drugimi dejavniki odvisen od sposobnosti organizacije za inovacije (Ravichandran, 2018). Raziskave že dolgo menijo, da je inovacijska sposobnost ključna sposobnost, ki poganja organizacijske spremembe (Linder, Jarvenpaa in Davenport, 2003). Inovativne organizacije, kot so Amazon, Google in Facebook, nenehno eksperimentirajo z mnogimi vidiki svojega poslovnega modela in procesov, da bi bile agilne (Rindova & Kotha, 2001). Takšno neprekinjeno preoblikovanje je značilno za agilna podjetja

(Rindova & Kotha, 2001). Zato je bolj verjetno, da bodo inovativne organizacije naredile takšne prilagoditve, zato je inovativna sposobnost kritična komplementarna sposobnost, ki bi lahko pojasnila odstopanje v organizacijski agilnosti (Ravichandran, 2018). Inovacijska sposobnost podjetja pomeni sposobnost podjetja, da ustvari in sprejme nove ideje, ki se odmikajo od starih delovnih praks. To kaže na sposobnost spreminjanja starih načinov poslovanja in preizkušanja nepreizkušenih idej, kot so nove prakse upravljanja, novi marketinški koncepti in nove korporativne strategije (Camisón & Villar-López, 2014; Menguc & Auh, 2006). Podjetja z inovativno sposobnostjo so lahko reaktivna ali proaktivna, odvisno od okoljske turbulence, na katero se srečujejo. Isto podjetje se lahko odzove različno glede na svoje IT zmogljivosti v tistem trenutku. Izberejo lahko tudi radikalno inovativen pristop ali raje postopoma, odvisno od narave zahtevanih sprememb izdelka ali storitve.

Raziskovalci vidijo organizacijsko agilnost kot manifestacijo organizacijskih zmožnosti višjega reda, kar podjetju omogoča učinkovito in učinkovito upravljanje svojih virov za ustvarjanje vrednosti kot odziv na različne notranje in zunanje pogoje (Teece, Peteraf in Leih, 2016; Overby, Bharadwaj, & Sambamurthy, 2006). Dinamične zmogljivosti organizacije določajo, kako integrira, gradi in rekonfigurira notranje in zunanje kompetence za obravnavo spreminjajočih se poslovnih okolij (Teece D., 2018). Tako RBV kot DCV sta dva pogleda, ki nam omogočata, da razumemo, kako lahko podjetja dosežejo organizacijsko agilnost z uporabo virov in zmogljivosti. Vendar RBV ne pojasnjuje odziva na tržne turbulence (Eisenhardt & Martin, 2000). Turbulenca na trgu lahko povzroči hitre in nepredvidljive spremembe v potrebah in preferencah strank (Jaworski & Kohli, 1993). Te spremembe so lahko nenehno dinamične in predstavljajo zahtevno grožnjo za konkurenčno stanje organizacije. Z nepredvidljivimi okoljskimi spremembami lahko dinamične zmogljivosti podjetjem omogočijo, da zgradijo in ponovno konfigurirajo svojo bazo virov; tako jim pomaga obvladovati nastajajoče priložnosti ali grozeče grožnje. Dinamične zmogljivosti poudarjajo, kako lahko podjetja uporabijo svoje notranje vire in zunanje zmožnosti za vzdrževanje svoje agilnosti v dinamično nepredvidljivem okolju. DCV razširja RBV z razlago, kako lahko dinamične zmogljivosti vladajo, ko se soočajo z nemirnimi okoljskimi razmerami (Teece, Peteraf in Leih, 2016).

Okoljske turbulence ustvarjajo nepredvidljivo stanje, ki je nenehno dinamično in lahko predstavlja kritično grožnjo za konkurenčno stanje podjetja. Tržna in tehnološka turbulenca sta dva vidika okoljske turbulence, ki predstavljata tveganje za nepričakovane spremembe, kar vključuje tako priložnosti kot grožnje (Jaworski & Kohli, 1993). Hitrost in nepredvidljivost, povezana s spremembo tehnologije, zahtevata inovativno raziskovanje ali izkoriščanje na podlagi priložnosti in groženj, s katerimi se srečujemo. Poleg tega stopnja sprememb v preferencah strank in njihovih novih zahtevah zahtevajo nenehna prizadevanja podjetja za inovacije v svojih linijah izdelkov in storitev, ki jim omogoča hiter in učinkovit odziv z zmožnostjo IT. Upravljanje IT zagotavlja okvir nadzora upravljanja, ki zagotavlja razumno zagotovilo za uspešno preoblikovanje podjetja iz enega stanja v drugo. Podjetja z uveljavljenimi dinamičnimi zmogljivostmi imajo boljšo učinkovitost kot njihovi konkurenti,

kar se kaže v povečanju tržnega deleža, višji rasti prodaje in splošni dobičkonosnosti (Chen, Wang, Nevo, Jin, Wang in Chow, 2014).

Anketirali smo višje menedžerje iz različnih panog v 132 podjetjih, da bi preučili vpliv mehanizmov upravljanja IT na organizacijsko agilnost in raziskali posredniško vlogo zmogljivosti IT in zmogljivosti za inovacije v tem odnosu. Preučili smo tudi zmerno vlogo okoljske turbulence, ko je organizacijska agilnost zelo potrebna. Raziskali smo tudi vpliv organizacijske agilnosti na uspešnost podjetja. Predlagani konceptualni model smo preizkusili z vzorcem višjih menedžerjev v srednjih do velikih podjetjih, empirična analiza pa potrjuje našo teorijo. Naša študija kaže, da zmožnost IT in zmožnost inovacij v celoti posredujeta učinek upravljanja IT na organizacijsko agilnost. Naši rezultati kažejo tudi močan vpliv upravljanja IT in zmogljivosti IT na organizacijsko agilnost, kadar je povezan z visoko tržno turbulenco. Vendar pa je učinek inovacijske zmogljivosti na organizacijsko agilnost velik, ko je tržna turbulenca majhna. Če pogledamo skozi objektiv RBV, naš model pojasnjuje, kako so upravljanje IT, zmogljivosti za inovacije in zmogljivosti IT potencialni viri organizacijske agilnosti. RBV smo razširili z DCV, da bi pojasnili, kako lahko upravljanje IT vpliva na zmogljivost IT, inovativne zmogljivosti in organizacijsko agilnost. Prav tako kaže, kako lahko spreminjajoče okoljske razmere vplivajo na ta vpliv.

1.2 Namen raziskave

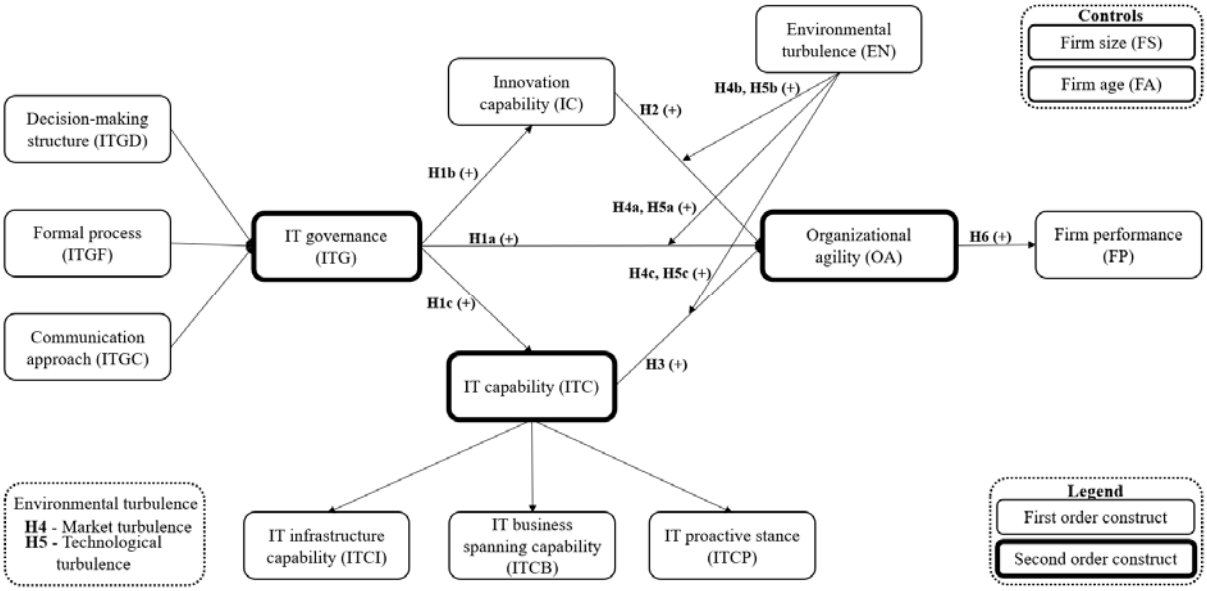
Poslovna vrednost informacijske tehnologije (IT) še vedno predstavlja pomemben teoretični in praktični izziv, zlasti s pojavom novih tehnologij, novih trgov in groženj (Bharadwaj AS, 2000; Bhatt & Grover, 2005; Chen, Wang, Nevo , Jin, Wang in Chow, 2014; Melville, Kraemer in Gurbaxani, 2004; Shea, Dow, Chong in Ngai, 2019). V današnjem nestanovitnem in hitro razvijajočem se konkurenčnem okolju IT splošno velja za kritičen temelj za uspeh organizacije, ki vpliva na to, kako ustvarjajo in zajemajo vrednost ter prekašajo konkurente (Chen, Wang, Nevo, Jin, Wang, & Chow, 2014; Grover , Chiang, Liang in Zhang, 2018; Lu in Ramamurthy., 2011). Prejšnje raziskave na tem področju so odkrile vlogo številnih virov, kot so posebne vrste IT (Aral & Weill, 2007), organizacijske zmogljivosti (Sambamurthy, Bharadwaj in Grover, 2003), komplementarnost virov (Nevo & Wade, 2010), in interno prileganje (Sharma, Yetton in Zmud, 2008) pri ustvarjanju poslovne vrednosti iz IT. Upravljanje IT je ključnega pomena pri maksimiranju poslovne vrednosti IT, saj vpliva na upravljanje virov in zmogljivosti IT ter nadalje zagotavlja stabilno in varno platformo za različne inovativne pristope. Prejšnje študije o poslovni vrednosti IT so preučevale determinante uspeha upravljanja IT (Buchwald, Urbach in Ahlemann, 2014) in vlogo upravljanja IT pri podpiranju organizacijske uspešnosti (Chau, Ngai, Gerow in Thatcher, 2020; Zhang, Zhao in Kumar, 2016).

Kljub temu je vloga upravljanja IT v dinamičnem okolju in njegov vpliv na organizacijsko agilnost premalo raziskana in za raziskovanje te vloge je na voljo omejeno število raziskav. Poleg tega obstajajo omejene študije, ki preučujejo zmerni vpliv okoljske turbulence na tak

odnos. Pomen takšnega vpliva se zdi bistven in kritičen pri novih in nastajajočih tehnologijah ter inovativni praksi pri njihovem izvajanju. Učinkovito upravljanje IT in inovacijskih zmogljivosti lahko podjetju zagotovi potrebno agilnost in večjo učinkovitost v različnih okoljskih pogojih.

Razvoj organizacijske agilnosti s pomočjo IT in inovacij je dolgoročen proces in težka naloga za vsako organizacijo (Lowry & Wilson, Ustvarjanje agilnih organizacij s pomočjo IT: Vpliv percepcije internih informacijskih storitev na kakovost IT storitev in agilnost IT., 2016; Teece , Peteraf in Leih, 2016). Učinkovito upravljanje IT zagotavlja okvir, ki organizacijam omogoča, da izkoristijo svoje vire in zmogljivosti IT ter upravljajo svoje inovativne prakse. Okvir upravljanja IT zagotavlja strateško usklajenost ciljev IT s poslovnimi cilji organizacije (Gregory, Kaganer, Henfridsson in Ruch, 2018). To bi podprlo in izboljšalo organizacijsko agilnost (Gregory, Kaganer, Henfridsson in Ruch, 2018; Wu, Straub in Liang, 2015) in uspešnost podjetja (Chau, Ngai, Gerow in Thatcher, 2020).

Slika 1: Raziskovalni model in hipoteze



Vir: lastno delo

V naši študiji predlagamo, da lahko upravljanje IT neposredno ali posredno vpliva na organizacijsko agilnost. Lahko močno vpliva na zmogljivosti IT in težko si je predstavljati, kako lahko IT-zmogljivost deluje brez takega upoštevanja. Upravljanje IT kot predhodnik lahko pojasni dinamični vpliv zmogljivosti IT na organizacijsko agilnost. Poleg tega je upravljanje IT bolj vezano na stabilnost in standarde, medtem ko je inovacijska zmogljivost bolj povezana s prilagodljivostjo in izključenimi rešitvami. Izziv je doseči strateško inovacijo, ne da bi se zavedali poslovne vrednosti IT pri podpori ali spodbujanju inovacijskega procesa (Peterson, 2004). Nadzor upravljanja, ki ga uvede upravljanje IT,

zagotavlja, da bo modularna IT infrastruktura podpirala želeno inovativno prakso. Obstaja paradoks v razmerju med upravljanjem IT in zmožnostjo inovacij. Zato moramo razumeti ključno vlogo upravljanja IT pri organizacijski agilnosti in če ima IT in inovacijske zmogljivosti kot posrednike za tak učinek. Zato postavljamo naslednja raziskovalna vprašanja:

(i) Kako lahko upravljanje IT vpliva na organizacijsko agilnost?
(ii) Kako upravljanje IT pomaga pri razvoju zmogljivosti IT in inovacijskih zmogljivosti in kako te zmogljivosti prispevajo k organizacijski agilnosti?
(iii) Kako okoljske turbulence vplivajo na upravljanje IT, zmogljivosti IT in inovacijske zmogljivosti na organizacijsko agilnost?

1.3 Konceptualni okvir

Tako pogled na podjetje na podlagi virov (RBV) kot pogled na dinamične zmogljivosti (DCV) sta dva pogleda, ki nam omogočata razumeti, kako lahko podjetja dosežejo organizacijsko agilnost z uporabo virov in zmogljivosti. RBV poudarja, da imajo podjetja dragocene, redke, neponovljive in nenadomestljive (VRIN) vire, ki jim omogočajo, da ohranijo svoje stanje agilnosti v predvidljivem in trajnem obdobju (Barney J., 1991). Vendar pa dinamične sposobnosti poudarjajo, kako lahko podjetja uporabijo svoje notranje vire in zunanje zmožnosti za vzdrževanje svoje agilnosti v dinamično nepredvidljivem okolju (Teece, Pisano in Shuen, 1997). Nobelov nagrajenec za ekonomske znanosti Oliver E. Williamson je trdil, da je najboljši učinkovit pristop k poslovni strategiji zmožnosti, ki temeljijo na virih, ali dinamične zmožnosti, ko se ukvarjajo s ključnimi poslovnimi vprašanji. Nakazoval je celo možnost njihove kombinacije (Williamson, 1991, str. 76).

Pogled dinamičnih zmogljivosti (DCV) razširja pogled na vire (RBV) podjetja z razlago, kako dinamične zmogljivosti vladajo v tako spreminjajočem se turbulentnem okolju (Teece, Peteraf in Leih, 2016). Te zmogljivosti vključujejo zaznavanje, odzivanje in preoblikovanje virov, ki podjetju omogočajo raziskovanje in izkoriščanje tržnih priložnosti ter obvladovanje novih nepredvidljivih groženj. Razširitev RBV z DCV pojasnjuje, kako lahko upravljanje IT vpliva na zmogljivost IT, inovacijske zmogljivosti in organizacijsko agilnost ter kako lahko okoljske turbulence vplivajo na ta vpliv. Z okoljskimi spremembami lahko dinamične zmogljivosti podjetjem omogočijo izgradnjo in rekonfiguracijo svoje baze virov; tako jim pomaga obvladovati nastajajoče priložnosti ali grozeče grožnje. Čeprav običajne zmogljivosti omogočajo nove procesne inovacije, so dinamične zmogljivosti tiste, ki pomagajo prepoznati nove izdelke in storitve (Helfat & Raubitschek, 2018). Poleg tega lahko podpirajo podjetje pri spremljanju okoljskih sprememb in ocenjevanju izvedljivosti trenutnega poslovnega modela z možnostjo ustvarjanja novih poslovnih modelov.

Če pogledamo skozi objektiv RBV, naš model pojasnjuje, kako so upravljanje IT, zmogljivosti za inovacije in zmogljivosti IT potencialni viri organizacijske agilnosti. Med

različnimi viri podjetja imajo IT viri in zmogljivosti najpomembnejšo vlogo, zlasti pri nastajajočih tehnologijah industrije 4.0. V takem konkurenčnem okolju je pogled na podjetje, ki temelji na virih (RBV), teorija, ki lahko pojasni in napove poslovno vrednost IT in kako lahko IT viri kot del virov podjetja podjetju zagotovijo konkurenčno prednost (Cao, Duan in Cadden, 2019). RBV smo razširili z DCV, da bi pojasnili, kako lahko upravljanje IT vpliva na zmogljivost IT, inovativne zmogljivosti in organizacijsko agilnost. Prav tako kaže, kako lahko spreminjajoče okoljske razmere vplivajo na ta vpliv.

1.4 Zasnova raziskav

Naša raziskava se je začela z našo predstavo, da je upravljanje IT ključnega pomena za razvoj organizacijske agilnosti. Predlagamo, da lahko upravljanje IT močno vpliva na IT in inovacijske zmogljivosti ter tako lahko vpliva na organizacijsko agilnost. Če lahko rezultati naše empirične študije dokažejo naše domneve, bo študija močno vplivala tako na akademske raziskave kot na vodenje. Naša raziskovalna pot je potekala skozi tri korake.

Najprej smo preučili literaturo in potrdili vrzel, ki smo jo ugotovili. Identificirali smo svoja raziskovalna vprašanja in postavili teorije, ki lahko pojasnijo odgovore nanje. Drugič, načrtovali smo našo raziskovalno zasnovo tako, da smo opredelili naše instrumente raziskovanja in strategijo vzorčenja. V skladu s tem smo pripravili našo spletno anketo. Tretjič, zbrali smo podatke in jih analizirali. Nato smo predstavili naše ugotovitve in razpravljali o tem, kako rezultati prispevajo k akademskemu raziskovanju in praksi upravljanja.

Raziskovanje

Nismo se mogli odločiti za temo in raziskovalna vprašanja, razen če smo izvedli raziskovalno iskanje, da bi ugotovili in potrdili raziskovalno vrzel, ki bi morda potrebovala nadaljnjo preiskavo. Pregled literature je torej pomagal prepoznati in potrditi vrzel. Prav tako je pomagalo izboljšati in potrditi raziskovalna vprašanja ter jih povezati s teorijo. Naša raziskovalna vprašanja zagotavljajo vpogled v to, kaj bo študija raziskala, in poudarjajo obseg z opredelitvijo, na kaj bo študija odgovorila. Predpostavili smo, da bosta RBV in DCV pojasnila odgovore na naša raziskovalna vprašanja in sta bila z njimi povezana čim prej.

Oblikovanje

Načrtovanje zasnove raziskave vključuje uporabo raziskovalnega instrumenta, opredelitev narave študije, oris naše strategije vzorčenja in opredelitev naše raziskovalne metode. Narava študije se nanaša na to, ali gre za prečni ali vzdolžni prerez. Za testiranje raziskovalnega modela smo uporabili presečno anketo, kot enoto analize pa smo uporabili podjetje. Naša raziskovalna metoda je kvantitativni pristop. Kvantitativne raziskave so pogosto povezane z

anketnimi raziskovalnimi strategijami prek vprašalnikov. Raziskavo smo izvedli, da bi pojasnili in vzpostavili vzročno zvezo med našimi predlaganimi spremenljivkami.

Izvedba

Ciljne organizacije v tej študiji so bila podjetja v Braziliji. Podatke smo zbrali s spletno anketo med vodilnimi v srednjih in velikih podjetjih (zasebnih in javnih), ki niso specifična za panogo, torej mešana panoga. Enota analize je podjetje. Izvedli smo pilotno testiranje z uporabo vzorca, ki je majhna podskupina ciljne populacije. Lahko odkrije morebitne težave pri načrtovanju raziskav ali uporabljenih instrumentih. Ker nekatera vprašanja morda niso primerna za ciljni vzorec, je bilo ključnega pomena zagotoviti, da so uporabljeni merilni instrumenti zanesljivi in veljavni ter merijo konstrukte študije. Prejeli smo 132 odgovorov, ki so presegli priporočene zahteve.

Empirični okvir, uporabljen za testiranje raziskovalnega modela, je modeliranje strukturnih enačb – delni najmanjši kvadrati (PLS-SEM) z uporabo SmartPLS različice 3.3.2 za analizo podatkov (Ringle, Wende, & Becker, SmartPLS 3., 2015). V tej študiji smo uporabili PLS-SEM iz različnih razlogov. Prvič, ker je upravljanje IT formativni konstrukt, PLS-SEM omogoča modeliranje latentnih konstruktov s formativnimi kazalniki (Goo, Kishore, Rao, & Nam, 2009; Hair Jr, Hult in Sarstedt, Primer za modeliranje strukturnih enačb z delnimi najmanjšimi kvadrati (PLS-SEM)., 2016). Drugič, to je prednostna tehnika, ko je na voljo malo teorije in je potrebna napovedna natančnost, kar velja za našo študijo (Teo, Wei in Benbasat, 2003; Garson, 2016, str. 8).

Podatke v našem modelu smo analizirali tako, da smo izvedli oceno merilnega modela (odsevni in formativni konstrukti) in oceno strukturnega modela (Hair Jr J. F., Hult, Ringle in Sarstedt, 2016; Hair, Risher, Sarstedt in Ringle, 2019). Na koncu smo predstavili naše ugotovitve in razpravljali o tem, kako rezultati prispevajo k akademskemu raziskovanju in praksi upravljanja (naslednji razdelek).

1.5 Glavna področja prispevkov

Čeprav obstaja redka literatura, ki obravnava razmerja med upravljanjem IT ter zmožnostjo IT in zmožnostjo inovacij, je področje raziskav med organizacijsko agilnostjo in upravljanjem IT še manjše. Da bi odpravili to vrzel, smo raziskali učinke upravljanja IT na organizacijsko agilnost, neposredno ali posredno. Postavili smo tri raziskovalna vprašanja, ki so vodila to študijo: (i) kako upravljanje IT vpliva na organizacijsko agilnost, (ii) kakšne so vloge IT in inovacijskih zmogljivosti pri posredovanju takšnega vpliva in (ii) kako okoljske turbulence ublažijo ta vpliv? Naša študija je ta vprašanja obravnavala tako, da je razvila teoretični model in ga empirično preizkusila. Raziskovalni model ima upravljanje IT kot predhodnik organizacijske agilnosti. Ugotovili smo tudi, da to razmerje posredujeta zmožnost IT in zmožnost inovacij. Podatki iz ankete, zbrani od 132 višjih menedžerjev, podpirajo predlagani raziskovalni model in tako potrjujejo naš teoretični razvoj raziskave.

Z akademskega vidika

Naša raziskava ponuja več prispevkov k disciplini IS. Najprej preuči in pokaže, kako lahko obe teoriji RBV in DCV skupaj pojasnita vpliv upravljanja IT na organizacijsko agilnost v spreminjajočih se okoljskih razmerah. Drugič, pokazali smo, da ima upravljanje IT pomembno vlogo pri soočanju z zmernim vplivom okoljskih turbulenc. Medtem ko zmogljivost IT zahteva fleksibilnost in sposobnost preoblikovanja in hitrega odzivanja na okoljske spremembe, upravljanje IT zahteva standardizacijo in stabilnost. Tako nam je model omogočil razumevanje paradoksa v tem odnosu. Predhodne raziskave o preučevanju vpliva upravljanja IT na zmogljivosti IT so zelo redke. Pomen takšnega vpliva se zdi bistven in kritičen pri novih in nastajajočih tehnologijah ter inovativni praksi pri njihovem izvajanju. Učinkovito upravljanje IT zagotavlja okvir upravljanja za vire in zmogljivosti IT. To zagotavlja nadzor, ki omogoča spremljanje in vodeno preoblikovanje iz enega stanja zmogljivosti IT v drugo. Tretjič, težko je doseči strateško inovacijo, ne da bi se zavedali poslovne vrednosti IT pri podpori ali spodbujanju inovacijskega procesa (Peterson, 2004). Nadzor upravljanja, ki ga uvedejo mehanizmi upravljanja IT, bo zagotovil, da bo informacijska tehnologija omogočila želeno inovativno prakso. To pomeni, da bo izboljšalo raziskovanje in razvoj inovacij ali izkoriščanje sedanjega sistema za povečanje organizacijske učinkovitosti (Andersen, Svejvig in Heeager, 2017). Četrtič, naša študija kaže, da upravljanje IT deluje posredno na organizacijsko agilnost, ki jo posredujejo IT in inovacijske zmogljivosti. To je pomemben korak k boljšemu razumevanju predhodnikov agilnosti podjetja in predstavlja odstopanje od trenutnega toka raziskav. Nazadnje smo potrdili prejšnje rezultate, da organizacijska agilnost pozitivno vpliva na uspešnost podjetja.

Z vodstvenega vidika

Vodje bodo morda morali razmisliti o svojih ustreznih mehanizmih upravljanja IT, ki so najbolj primerni za njihovo prakso, da bi zagotovili usklajenost med IT in poslovnimi cilji, vključno z želeno agilnostjo. To bo omogočilo, da tako zmogljivosti IT kot inovacije pozitivno prispevajo k poslovnim ciljem v turbulentnem okolju. Ta študija ponuja več praktičnih vpogledov višjemu vodstvu, vodstvenim delavcem IT in revizorjem IT. Prvič, mehanizmi upravljanja IT izboljšajo upravljanje IT virov in zmogljivosti podjetja na najboljši optimalen način. Naša študija kaže, da ima učinkovito upravljanje IT pomemben vpliv na razvoj in pridobivanje novih IT virov in zmogljivosti, kar je korak za doseganje organizacijske agilnosti. Drugič, študija je zagotovila dokaze, da je upravljanje IT kritičen predhodnik stabilnosti v inovativni praksi. To pomeni, da deluje bolj kot spodbuda kot ovira za ustvarjalnost. Mehanizmi upravljanja IT zagotavljajo urejeno pot za inovacijske zmogljivosti za doseganje želene organizacijske agilnosti. Tretjič, upravljanje IT zahteva odobritev višjih poslovnih menedžerjev za uvedbo dodeljenih kontrol upravljanja IT. Revizija IT je ena od teh praks nadzora upravljanja, ki jih izvaja uprava in višje vodstvo nad viri in zmogljivostmi IT. Revizorji IT morajo upoštevati pomen mehanizmov upravljanja IT, ki nadzorujejo pripravo IT in inovacijskih zmogljivosti za turbulentne okoljske razmere, ter

potrebo po okrepljenem nadzoru upravljanja, da bi se zaščitili pred temi nepredvidljivimi spremembami. Četrtič, učinkovito upravljanje IT zagotavlja razumno zagotovilo za ohranjanje neprekinjenega poslovanja in neprekinjenega delovanja inovacij, kadar ga ogrožajo tržne spremembe.

Zaključek

Ta študija se osredotoča na vlogo upravljanja IT pri izboljšanju organizacijske agilnosti v turbulentnih okoljskih razmerah. Medtem ko literatura, ki preučuje determinante uspeha upravljanja IT in njegovo vlogo pri podpiranju organizacijske uspešnosti, ta študija razvija model, ki ponuja nov vpogled v tok raziskav, ki preučujejo vpliv upravljanja IT na organizacijsko agilnost v dinamičnih okoljskih razmerah. Medtem ko smo pokazali, da upravljanje IT nima neposrednega vpliva na organizacijsko agilnost, je študija pokazala, da upravljanje IT učinkuje prek zmogljivosti IT in inovacijskih zmogljivosti. Poleg tega smo odkrili mešane učinke okoljske turbulence na razmerja med zmogljivostjo IT, inovativnostjo in organizacijsko agilnostjo. Študija je potrdila tudi prejšnje rezultate, da organizacijska agilnost pozitivno vpliva na uspešnost podjetja.

Naše raziskave kažejo, kako lahko obe teoriji RBV in DCV skupaj pojasnita vpliv upravljanja IT na organizacijsko agilnost v okoljskih turbulencah. Omogočili so nam razumeti, kako lahko podjetja dosežejo organizacijsko agilnost z uporabo virov in zmogljivosti. Teorijo RBV smo uporabili za preučevanje razmerja med inovativnostjo, zmožnostjo IT, upravljanjem IT in organizacijsko agilnostjo. Dinamične zmogljivosti kompenzirajo omejitve RBV s poudarjanjem, kako lahko podjetja uporabijo svoje notranje vire in zunanje zmogljivosti za ohranjanje agilnosti v dinamično nepredvidljivem okolju. Tako lahko razširitev RBV z DCV pojasni, kako lahko upravljanje IT vpliva na zmogljivost IT, inovacijske zmogljivosti in organizacijsko agilnost. Lahko tudi pojasni, kako lahko okoljske turbulence vplivajo na ta vpliv.

Pokazali smo tudi, da ima upravljanje IT pomembno vlogo pri soočanju z zmernim vplivom okoljskih turbulenc. To nam je omogočilo razumeti paradoks v odnosih med stranjo upravljanja IT ter zmožnostjo IT in inovativnostjo na drugi strani. Medtem ko zmogljivost IT in zmogljivost inovacij zahtevata fleksibilnost ter sposobnost preoblikovanja in hitrega odzivanja na okoljske spremembe, upravljanje IT zahteva standardizacijo in stabilnost. Pomen takšnega vpliva se zdi bistven in kritičen pri novih in nastajajočih tehnologijah ter inovativni praksi pri njihovem izvajanju.

Naša študija kaže in poudarja, da učinkovito upravljanje IT zagotavlja okvir za upravljanje virov in zmogljivosti IT. To zagotavlja nadzor, ki omogoča spremljanje in vodeno preoblikovanje iz enega stanja zmogljivosti IT v drugo. Zato upravljanje IT zagotavlja boljše upravljanje in uporabo virov in zmogljivosti IT. Študija tudi dokazuje, da bo nadzor upravljanja, uveden z učinkovitim upravljanjem IT, podprl želeno inovativno prakso.

Učinkovito upravljanje IT bo zagotovilo tudi razumno zagotovilo za ohranjanje neprekinjenega poslovanja in neprekinjenega delovanja inovacij, kadar ga ogrožajo okoljske spremembe. Poleg tega naša študija kaže, da upravljanje IT posredno deluje na organizacijsko agilnost s posredovanjem inovacijskih zmogljivosti. Končno je študija potrdila neposreden vpliv organizacijske agilnosti na uspešnost podjetja.

Kot rezultat naše študije bodo morda morali menedžerji razmisliti o svojih ustreznih mehanizmih upravljanja IT, ki so najbolj primerni za njihovo prakso, da bi zagotovili usklajenost med IT in poslovnimi cilji, vključno z želeno agilnostjo. To bo omogočilo, da tako zmogljivosti IT kot inovacije pozitivno prispevajo k poslovnim ciljem v turbulentnem okolju. Študija poudarja potrebo po učinkovitem upravljanju IT za pokrivanje obstoječih tehnologij ali novih in nastajajočih tehnologij v novem obdobju industrije 4.0, ki lahko poruši poslovno okolje in naredi sedanje IT zmogljivosti zastarele. Študija je zagotovila tudi dokaze, da je upravljanje IT kritičen predhodnik stabilnosti, ko je potrebna inovativna praksa. To pomeni, da deluje bolj kot spodbuda kot ovira za ustvarjalnost. Nazadnje, revizijska komisija in IT revizorji morajo upoštevati pomen mehanizmov upravljanja IT, ki nadzorujejo pripravo zmogljivosti IT, ki je potrebna v turbulentnih razmerah. Revizorji IT morajo oceniti določene kontrole upravljanja, vključno s tistimi, ki zaznavajo in se odzivajo. To bo omogočilo zaščito pred nepredvidljivimi okoljskimi spremembami.

Appendix 2: Constructs definitions

Table 40: Constructs‘ definitions

Construct	Dimensions	Definition
IT governance mechanisms		IT governance is the ability of senior management to control the formulation and implementation of the IT strategy through organizational structures and processes. That will produce desirable behaviors and ensure that IT initiatives sustain and extend the business strategy and objectives. Three main IT governance mechanisms contribute to effective IT governance and are considered unique to the organizations.
	Decision-making structure	The first mechanism is the decision-making structure, which refers to the degree to which the organization has established organizational units and roles responsible for making IT decisions, e.g., committees.
	Formal process	The second mechanism is the formal process, which refers to how much the organization has developed a standard approach to monitor and ensure that IT policies are consistent with business needs.
	The communication approach	The third mechanism is the communication approach which refers to how much the organization has created channels that ensure appropriate communication and thus, disseminate IT governance principles.
Organizational agility		Organizational agility is the firm-wide capability to deal with changes that often arise unexpectedly in business environments via rapid and innovative responses that exploit changes as opportunities to grow and prosper.
	Market capitalizing agility	Market capitalizing agility is the firm’s ability to quickly respond to and capitalize on changes through continuously monitoring and quickly improving products/services to address customers’ needs.
	Operational adjustment agility	Operational adjustment agility is the firm’s ability in its internal business processes to physically and rapidly cope with market or demand changes.
IT capability		IT capability is a firm’s ability to implement and reconfigure IT resources to enable and enhance business strategies and work processes.
	IT infrastructure capability	IT infrastructure capability refers to the ability to implement shareable platforms. That indicates its proficiency in managing different activities and services, e.g., data services and architectures, network services, and application services.
	IT business spanning capability	IT business spanning capability is the management ability of the firm to exploit IT resources to enable and enhance business objectives. It reflects the extent of having a clear IT strategic vision, the integration of business and IT strategic planning, and the management’s ability to understand the value of IT investments.
	IT proactive stance	IT proactive stance refers to the firm’s ability to proactively search for ways to explore IT innovations or exploit existing IT resources to create business opportunities. It reflects the intent to be current with IT innovations, to constantly seek new approaches to enhance effective use of IT, and to have the culture of adopting new ways of using IT.
Innovation capability		Innovation capability is the ability of the firm to introduce new products, services, processes, and systems through the continuous transformation of its knowledge and idea.
Market turbulence		Market turbulence refers to the degree of change in customers’ preferences and their changing new demands.
Technological turbulence		Technological turbulence refers to the rate and unpredictability associated with technology change which requires innovative exploration or exploitation or both based on the analysis of the opportunities and threats encountered.
Firm performance		Firm performance is the degree to which a firm has superior performance relative to its competition.

Source: own work

Appendix 3: Constructs and items

Table 41: Measurement items

Construct	Items	Authors
IT governance mechanisms		
Decision-making structure	ITGD1: Our company has a Steering Committee at Executive or senior management level responsible for determining IT development prioritization. ITGD2: Our company has a Steering Committee composed of business and IT people focusing on prioritizing and managing IT projects. ITGD3: CIO has a direct reporting line to the CEO and/or COO.	(Wu, Straub, & Liang, 2015) (De Haes & Van Grembergen, 2009) (Weill & Ross, 2004)
Formal process	ITGF1: Our company has established a formal prioritization process for IT investments and projects in which business and IT is involved. ITGF2: Our company has established formal processes to define and update IT strategies. ITGF3: Our company has established formal processes to govern and manage IT projects.	
Communication approach	ITGC1: CIO is a full member of the executive committee. ITGC2: Our company has a committee at level of broad of directors to ensure IT is regular agenda item and reporting issue for the board of directors. ITGC3: The CIO or similar role in our company is able to clearly articulate a vision for IT's role in the company.	
IT capability		
IT infrastructure capability	ITCI1: Data management services & architectures (e.g., databases, data warehousing, data availability, storage, accessibility, sharing etc.) ITCI2: Network communication services (e.g., connectivity, reliability, availability, LAN, WAN, etc.) ITCI3: Application portfolio & services (e.g., ERP, ASP, reusable software modules/components, emerging technologies, etc.) ITCI4: IT facilities' operations/services (e.g., servers, large-scale processors, performance monitors, etc.)	(Lu & Ramamurthy, 2011) (Bharadwaj, Sambamurthy, & Zmud, 1999) (Fichman, 2004) (Mata, Fuerst, & Barney, 1995) (Ross, Beath, & Goodhue, 1996) (Weill, Subramani, & Broadbent, 2002)
IT business spanning capability	ITCB1: Developing a clear vision regarding how IT contributes to business value ITCB2: Integrating business strategic planning and IT planning ITCB3: Enabling functional area and general management's ability to understand value of IT investments ITCB4: Establishing an effective and flexible IT planning process and developing a robust IT plan	
IT proactive stance	ITCP1: We constantly keep current with new information technology innovations ITCP2: We are capable of and continue to experiment with new IT as necessary ITCP3: We have a climate that is supportive of trying out new ways of using IT ITCP4: We constantly seek new ways to enhance the effectiveness of IT use	
Innovation capability		
	IC1: Technical innovation, based on research results, is readily accepted. IC2: We actively seek innovative ideas. IC3: Innovation is readily accepted in program/project management. *IC4: Employees are penalized for new ideas that do not work. *IC5: Innovation in our company is perceived too risky and is resisted.	(Menguc & Auh, 2006) (Hurley & Hult, 1998)
Organizational agility		
Market capitalizing agility	OAM1: We are quick to make and implement appropriate decisions in the face of market/customer-changes. OAM2: We constantly look for ways to reinvent/reengineer our organization to better serve our market place. OAM3: We treat market-related changes and apparent chaos as opportunities to capitalize quickly.	(Lu & Ramamurthy, 2011) (Tsourveloudis, Valavanis, Gracanin, & Matijasevic, 1999)
Operational adjustment agility	OAO1: We fulfill demands for rapid-response, special requests of our customers whenever such demands arise; our customers have confidence in our ability. OAO2: We can quickly scale up or scale down our production/service levels to support fluctuations in demand from the market. OAO3: Whenever there is a disruption in supply from our suppliers we can quickly make necessary alternative arrangements and internal adjustments.	
Environmental turbulence		
Market turbulence	MT1: In our kind of business, customers' product preferences change quite a bit over time. MT2: Our customers tend to look for new product all the time. MT3: We are witnessing demand for our products and services from customers who never bought them before. MT4: New customers tend to have product-related needs that are different from those of our existing customers. *MT5: We cater to many of the same customers that we used to in the past.	(Jaworski & Kohli, 1993)
Thechnological turbulence	TT1: The technology in our industry is changing rapidly. TT2: Technological changes provide big opportunities in our industry. TT3: A large number of new product ideas have been made possible through technological breakthroughs in our industry. *TT4: Technological developments in our industry are rather minor.	
Firm performance		
Firm performance	The extent to which your firm's performance during the last 2 or 3 years, relative to all other competitors FM1: Our profitability has been substantially better. FM2: Our return on investment has been substantially better. FM3: Our growth in market share has been substantially better. FM4: Our sales growth has been substantially better.	(Chen, Wang, Nevo, Jin, Wang, & Chow, 2014)

* Indicators were dropped due to low indicator reliability.

Source: own work

Appendix 4: Constructs abbreviation

Table 42: Short names for the constructs

Short name	Second-order construct	First-order construct
OA	Organizational agility	
OAM		Market capitalizing agility
OAO		Operational adjustment agility
ITG	IT governance mechanisms	
ITGD		Decision-making structure
ITGF		Formal process
ITGC		Communication approach
ITC	IT capability	
ITCI		IT infrastructure capability
ITCB		IT business spanning capability
ITCP		IT proactive stance
IC	Innovation capability	
EN	Environmental turbulence	
MT	Market turbulence	
TT	Technological turbulence	
FP	Firm performance	

Source: own work

Appendix 5: Control variables

Table 43: Firm size

Firm size (number of employees)	N = 132	%
> 499	79	59.8
100-499	18	13.6
50-99	9	6.8
20-49	7	5.3
10-19	3	2.3
0-9	16	12.1

Source: own work

Table 44: Firm age

Firm age (number in years)	N = 132	%
>25	85	64.4
21-25	11	8.3
11-20	18	13.6
6-10	12	9.1
1-5	6	4.5

Source: own work

Table 45: Industry sectors

Industry sector	N = 132	%
Manufacturing	7	5%
Insurance	1	1%
Banks	2	2%
Financial Services	6	5%
Retail	6	5%
Transportation	3	2%
Public service utilities	100	76%
Others	7	5%
	132	100%

Source: own work

Appendix 6: Sample journal scoring

Table 46: Sample journal scoring (ABS and VHB)

Journal Title	[5]AJG Score	[6]VHB Score
Academy of Management Journal	**4**	**A+**
Academy of Management Perspectives	**3**	**B**
Academy of Management Review	**4**	**A+**
Administrative Science Quarterly	**4**	**A+**
British Journal of Management	**4**	**B**
Business & Information Systems Engineering	**2**	**B**
Business Horizons	**2**	**C**
California Management Review	**3**	**B**
Communications of the ACM	**2**	**B**
Communications of the Association for Information Systems	**2**	**C**
Decision Sciences	**3**	**B**
Decision Support Systems	**3**	**B**
European Journal of Information Systems	**3**	**A**
European Journal of Operational Research	**4**	**A**
European Management Journal	**2**	**B**
Harvard Business Review	**3**	**C**
Information and Management	**3**	**B**
Information and Organization	**3**	**B**
Information Systems and e-business Management	**2**	**C**
Information Systems Frontiers	**3**	**B**
Information Systems Journal	**3**	**A**
Information Systems Management	**2**	**C**
Information Systems Research	**4**	**A+**
Information Technology and Management	**1**	**C**
International Journal of Accounting Information Systems	**2**	**C**
International Journal of Information Management	**2**	**C**
Journal of Business Research	**3**	**B**
Journal of Enterprise Information Management	**2**	**C**
Journal of Information Systems	**1**	**C**
Journal of Information Technology	**3**	**A**

Source: own work

[5] AJG: Academic Journal Guide published by the Association of Business Schools
[6] VHB: The German Academic Association of Business Research (Verband der Hochschullehrer für Betriebswirtschaft)

Appendix 7: Indicators loading and cross-loading

Table 47: Loading and cross-loading

	FP	IC	ITCB	ITCI	ITCP	ITGC	ITGD	ITGF	OAM	OAO	MT	TT
FM1	**0.921**	0.567	0.494	0.492	0.534	0.390	0.281	0.336	0.525	0.455	0.279	0.363
FM2	**0.914**	0.521	0.473	0.439	0.497	0.376	0.319	0.363	0.485	0.460	0.265	0.357
FM3	**0.918**	0.478	0.437	0.484	0.469	0.264	0.215	0.329	0.473	0.441	0.276	0.349
FM4	**0.918**	0.439	0.412	0.424	0.454	0.307	0.229	0.320	0.465	0.402	0.186	0.352
IC1	0.550	**0.947**	0.697	0.674	0.766	0.664	0.504	0.617	0.704	0.711	0.383	0.485
IC2	0.528	**0.940**	0.732	0.675	0.745	0.635	0.512	0.584	0.652	0.698	0.296	0.488
IC3	0.475	**0.945**	0.689	0.648	0.753	0.629	0.492	0.537	0.694	0.732	0.367	0.449
ITCB1	0.449	0.696	**0.921**	0.772	0.785	0.605	0.422	0.498	0.616	0.614	0.257	0.395
ITCB2	0.466	0.710	**0.952**	0.742	0.773	0.622	0.501	0.549	0.654	0.640	0.319	0.387
ITCB3	0.454	0.714	**0.928**	0.706	0.771	0.591	0.450	0.545	0.620	0.660	0.255	0.394
ITCB4	0.486	0.671	**0.934**	0.682	0.762	0.612	0.524	0.603	0.621	0.648	0.235	0.348
ITCI1	0.424	0.657	0.744	**0.907**	0.659	0.515	0.467	0.495	0.519	0.486	0.336	0.465
ITCI2	0.407	0.597	0.678	**0.887**	0.578	0.527	0.511	0.475	0.449	0.421	0.333	0.401
ITCI3	0.509	0.629	0.689	**0.892**	0.664	0.449	0.380	0.475	0.605	0.515	0.373	0.467
ITCI4	0.464	0.652	0.687	**0.913**	0.693	0.470	0.420	0.466	0.592	0.481	0.383	0.493
ITCP1	0.488	0.733	0.801	0.749	**0.949**	0.567	0.359	0.497	0.697	0.690	0.278	0.444
ITCP2	0.496	0.746	0.793	0.704	**0.955**	0.550	0.395	0.490	0.671	0.655	0.296	0.440
ITCP3	0.493	0.755	0.720	0.603	**0.918**	0.533	0.370	0.522	0.660	0.632	0.364	0.488
ITCP4	0.538	0.787	0.807	0.662	**0.953**	0.608	0.398	0.574	0.737	0.678	0.347	0.484
ITGC1	0.304	0.522	0.502	0.395	0.432	**0.867**	0.523	0.535	0.459	0.442	0.221	0.202
ITGC2	0.338	0.567	0.528	0.459	0.490	**0.899**	0.686	0.567	0.480	0.464	0.232	0.243
ITGC3	0.317	0.678	0.659	0.557	0.626	**0.855**	0.573	0.673	0.551	0.557	0.152	0.321
ITGD1	0.260	0.505	0.454	0.503	0.390	0.594	**0.932**	0.705	0.343	0.353	0.277	0.294
ITGD2	0.332	0.506	0.527	0.506	0.424	0.628	**0.930**	0.697	0.360	0.345	0.282	0.297
ITGD3	0.134	0.377	0.336	0.254	0.222	0.574	**0.756**	0.511	0.228	0.339	0.228	0.185
ITGF1	0.371	0.588	0.558	0.509	0.527	0.667	0.684	**0.926**	0.528	0.536	0.275	0.341
ITGF2	0.338	0.581	0.555	0.511	0.517	0.656	0.729	**0.948**	0.479	0.448	0.382	0.404
ITGF3	0.327	0.565	0.546	0.479	0.513	0.604	0.661	**0.952**	0.456	0.441	0.286	0.356
OAM1	0.440	0.593	0.586	0.537	0.606	0.448	0.269	0.413	**0.893**	0.676	0.246	0.304
OAM2	0.442	0.736	0.658	0.617	0.732	0.539	0.341	0.498	**0.938**	0.755	0.314	0.441
OAM3	0.577	0.656	0.602	0.501	0.671	0.583	0.375	0.513	**0.915**	0.739	0.347	0.392
OAO1	0.428	0.747	0.665	0.582	0.696	0.538	0.360	0.459	0.802	**0.872**	0.282	0.411
OAO2	0.370	0.598	0.544	0.358	0.557	0.500	0.355	0.458	0.651	**0.886**	0.113	0.241
OAO3	0.444	0.594	0.553	0.412	0.551	0.405	0.292	0.384	0.567	**0.823**	0.115	0.260
MT1	0.131	0.247	0.286	0.341	0.244	0.229	0.281	0.190	0.163	0.087	**0.592**	0.285
MT2	0.284	0.312	0.251	0.377	0.259	0.191	0.282	0.318	0.273	0.135	**0.837**	0.532
MT3	0.263	0.326	0.249	0.392	0.293	0.187	0.213	0.201	0.221	0.144	**0.827**	0.541
MT4	0.187	0.318	0.241	0.280	0.315	0.206	0.270	0.321	0.335	0.225	**0.900**	0.539
TT1	0.347	0.440	0.339	0.460	0.435	0.285	0.212	0.309	0.405	0.317	0.631	**0.878**
TT2	0.291	0.345	0.260	0.289	0.340	0.229	0.255	0.289	0.161	0.189	0.416	**0.776**
TT3	0.352	0.478	0.416	0.498	0.463	0.249	0.312	0.392	0.414	0.364	0.523	**0.912**

Source: own work