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# CORPORATE DIGITAL TRANSFORMATION: COMPANIES TOWARDS INDUSTRY 4.0

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## Abstract

**Purpose of the study:** To analyze the configuration of the status quo of digital transformation in a sample of organizations, through the model application proposed by Rogers (2017).
**Methodology:** It consisted of a quantum study in 2022 with 159 Brazilian companies, whose analysis was performed by modeling structural equations.
**Originality/Relevance:** Studies on the evolution of organizations in various contexts are of paramount importance for the establishment and implementation of actions, creating possibilities for continuous improvements in corporate environments. Thus, it is essential that analyzes on the boundaries of knowledge and executive realities in business scenarios are increasingly necessary for decision making in corporate daily life. Under this premise, and observing the phenomenon of digital transformation, this article developed,
**Main Results:** Significant adherence of the variables of the model was found to explain the digital transformation process experienced by the surveyed companies. Innovation and customer orientation activities were the most significant constructs of digital transformation, while the orientation for competition and data quality explained to a lesser extent, although the orientation for value creation was not statistically significant.
**Theoretical/Methodological Contributions:** The theme is emerging in the literature, and the vast majority of studies address it in the logic of reports and corporate courses. The resulting contributions of empirical research are still scarce. This work aims to offer a deeper and more timely speaker on this important theme.
**Social Contributions/Management Contributions:** It is intended to contribute with critical and dense content to organizational analysis and decision-making, especially those of the competitive environment.

**Keywords:** Digital transformation, Corporate governance, Business evolution, ESG.

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## TRANSFORMAÇÃO DIGITAL CORPORATIVA: A EMPRESA RUMO À INDÚSTRIA 4.0

**Resumo**

**Objetivo do estudo:** Analisar a configuração do status quo da transformação digital em uma amostra de organizações, mediante a aplicação modelo proposto por Rogers (2017).
**Metodologia:** Consistiu em um estudo quântico em 2022 com 159 empresas brasileiras, cuja análise foi realizada mediante a Modelagem de Equações Estruturais.
**Originalidade/Relevância do tema:** Estudos sobre a evolução das organizações em diversos contextos são de suma importância para o estabelecimento e implementação de ações, criando possibilidades de melhorias contínuas nos ambientes corporativos. Assim, é fundamental que análises sobre fronteiras do conhecimento e de realidades executivas nos cenários de negócios estejam cada vez mais necessárias às tomadas de decisões no cotidiano corporativo. Desenvolveu-se este artigo na premissa do fenômeno da transformação digital.
**Principais resultados:** Constatou-se aderência significativa das variáveis do modelo à explicação do processo de transformação digital vivenciado pelas empresas pesquisadas. As atividades de inovação e orientação para o cliente foram os construtos mais expressivos da transformação digital, enquanto a orientação para a concorrência e a qualidade dos dados explicaram em menor grau, embora a orientação para a criação de valor não tenha sido estatisticamente significativa.
**Contribuições teóricas/metodológicas:** O tema é emergente na literatura, e a maioria dos estudos o aborda na lógica de relatos e cursos corporativos. As contribuições resultantes de pesquisa empírica são ainda escassas. Este trabalho pretende oferecer uma anãlise mais profunda e oportuna sobre este importante tema.
**Contribuições sociais/Contribuições corporativas:** Pretende-se contribuir com conteúdo crítico e denso para as análises e tomadas de decisões organizacionais, especialmente aquelas do ambiente competitivo.

**Palavras-chave:** Transformação digital, Governança corporativa, Evolução dos negócios, ESG.

## TRANSFORMACIÓN DIGITAL CORPORATIVA: EMPRESAS RUMO À LA INDÚSTRIA 4.0

**Resumen**

**Objectivo:** Analizar la configuración del status quo de la transformación digital en una muestra de organizaciones, utilizando el modelo propuesto por Rogers (2017).
**Metodología:** Consistió en un estudio cuántico en 2022 con 159 empresas brasileñas, cuyo análisis se realizó utilizando Structural Equation Modeling.
**Originalidad/Relevancia del tema:** Los estudios sobre la evolución de las organizaciones son de gran importancia para el establecimiento e implementación de acciones corporativas. Así, es fundamental que los análisis en las fronteras del conocimiento y las realidades ejecutivas en los escenarios empresariales sean cada vez más necesarios para la toma de decisiones empresariales. Así se constuió esse arctículo, bajo el fenómeno de la transformación digital.
**Principales Resultados:** Hubo una adherencia significativa de las variables del modelo a la explicación de la transformación digital experimentado por las empresas investigadas. Las actividades de innovación y orientación al cliente fueron los constructos más expresivos de la transformación digital, mientras que la orientación a la competencia y la calidad de los datos explicaron en menor medida, aunque la orientación a la creación de valor no fue estadísticamente significativa.
**Contribuciones teóricas/metodológicas:** El tema está surgiendo en la literatura, y la mayoría de los estudios lo abordan como informes y cursos corporativos. Las contribuciones derivadas de la investigación empírica son aún escasas. Este trabajo pretende ofrecer un análisis más profundo y oportuno de este importante tema.
**Contribuciones sociales/contribuciones corporativas:** Se pretende contribuir con contenido crítico y denso para el análisis y la toma de decisiones organizacionales, especialmente en el entorno competitivo.

**Palabras clave:** Transformación digital, Gobiernancia corporativa, Evolución empresarial, ESG.

## 1 Introduction

The topic of digital insertion and digital transformation in companies has been rapidly explored in scientific research, articles, in theses and dissertations, as well as in technical and managerial reports. Contributions in this regard include Rogers (2016), Global Competitiveness Report (2018), Mikalef and Parmiggiani (2022) and the United Nations Environment Programme (2022). In this sense, in order to shorten the war by decoding German messages, a mathematical genius had the brilliant idea of using a machine to crack the codes of another war machine. Thus, Alan Turing gave birth to Cristopher, the first "computer" in history, responsible for breaking the codes of the Enigma coder used by Germany during World War II. Since then a lot has evolved, and with each step the computer science advances exponentially. From Turing thinking machines to microcomputers, ultrabooks and other electronic devices we currently have, impactful changes have been identified. In this context, it can be seen that systems and machines have evolved into the environment of the so-called Fourth Industrial Revolution, also known as Industry 4.0 (Schwab, 2018).

The gap between organizations and their processes, as well as their respective visibilities, has been reduced exponentially due to globalization. Small Brazilian entrepreneurs (Chiarini & Silva, 2016) already export their products in an international scenario, and in the last two decades, this volume has increased a lot, as well as the incentives for such. The effect of globalization, therefore, could only affect the computer industry (Pankowska, 2019), and thus affect the other sectors of the economy. With this smaller distance, new marketing and productive trends used in other nations enter the national territory. This factor culminates in a constant corporate evolution, whether due to the need to stay in business or opportunities to do so (Eller, Gielnik et al, 2020).

Given the constant evolution of organizations, the need to update several times in a short time and the increasingly competitive and demanding market, studies are needed in this area due to business consolidation. Most organizations seek to innovate to stand out in the market and bring exclusivity to customers (OECD, 2022). Within this context, it is therefore necessary to establish an overview of this innovation and digital transformation. To identify new possibilities for organizations that are innovating and rethinking their business, many business models have been created and tested by academics and executives. One of them, which aims to cover explanatory constructs of the orientation to digital transformation, is what was proposed by Rogers (2017), which presents five fundamental factors for digital transformation in

organizations. They are Customers, Competition, Data, Innovation and Value. Each of these has a glimpse of change into the digital age, which in its own context expresses a fragment of this transformation. The model considers the main characteristics of organizations and the constant need for change that they constantly demand.

Given the structuring and strategic conditions of organizations, associated with the architecture of the research model, the question that arises for this paper is: How do the impacting factors of digital business transformation in medium and large national organizations? According to this question, the general objective of this paper is to analyze the configuration of the state of digital transformation in organizations, according to the Rogers model (2017). The specific objectives were: 1) to identify the intensity of the contribution of the "customer" factor in the explanation of the model; 2) check the contribution level of the "competition" factor; 3) note the incidence of "informational data" for digital transformation; 4) characterize the importance of "innovation" for digital transformation; 5) point out the impact of the "customer value" factor on digital transformation; 6) identify the degree of correlation between model variables; and 6) to characterize the level of convergence of the model constructs in explaining the propensity for digital transformation.

This research aims to demonstrate the impacts and reflexes of digital evolutions within organizations. In view of this new scenario, it is of paramount and vital importance that ongoing studies be developed by management in the context of digital evolution and transformation (OECD, 2022). This theme, while new and emerging, is already rapidly spreading across diverse corporate contexts (Lucija, Vuk & Spremi, 2019). Studies of this nature are fundamental for the possibility of building and perpetuating knowledge through in-depth and structured research, with academic support and respective understanding of organizational processes. However, in a cohesive and modern way, this research is generally justifiable for organizations as well, since constantly reinventing itself is one of today's demands for market survival. Therefore, analyzing the main motivating and impacting factors of organizational changes, especially in the innovative and digital context, is one of the premises for 4.0 organizations, as pointed out by Kotler, Kartajaya & Setiawan (2017). When checking bases such as SciElo, Ebsco and Spell, under the references "digital transformation constructs", sixty published works were found, demonstrating the emergence of this theme in the literature.

## 2 Literature review and research model

From the perspective of contemporary organizations, a broadly competitive environment is obtained in many respects. According to the dense contribution of the literature, such as (Silva Júnior, Siluk et al, 2022), competitiveness comes with increased competition. Through a deeper look, despite an earlier theory, Porter (1979) describes in his acclaimed and criticized five-force model that other factors characterized as externalities contribute to the organization being able to compete in various markets. Thus, the themes of competition and competitiveness, due to their robust approaches, are permanently present in the literature, as well as in executive exercises in organizations.

As a contemporary determinant of competitiveness, digital transformation characterizes organizations towards the Fourth Industrial Revolution, or Industry 4.0, determining the dynamics of conduct in organizations, society and people (Ivaldi, Scaratti & Fregnan, 2021). Important contributions provided by Schwab (2017), for example, indicate that society flows together, since communication, technology, and globalization enable this heterogeneous and diverse growth, quickly and somewhat abruptly. Leverage in productive, educational, short-term and even entertainment processes demonstrates how people in this society behave and consume.

Digital transformation in companies and people's attitudes has great potential factors for this dynamism, affecting all sectors of organizational and human life (Schwab, 2017). In this sense, the Internet has reached almost all organizations and homes on the planet, being present in the daily lives of its users, characterizing the evolution of the phenomenon of digital transformation, as described in the literature (Lapatinas, 2019). Transforming from traditional to digital is possible as long as it does not treat people like machines and allows data to tell beyond what those involved are living and feeling (Ivaldi, Scaratti & Fregnan, 2021).

For this work, we chose to use as a reference an organizational assumptions model for the characterization of digital transformation orientation proposed by Rogers (2017), which consists of five main factors of analysis of digital transformation in companies. The adaptations consist in the formatting of the model aiming at the correlational and causal relationship studies intended in this study, as shown in figure 1.

Figure 1

*Synthetic Research Model Thus, the research hypotheses are established*

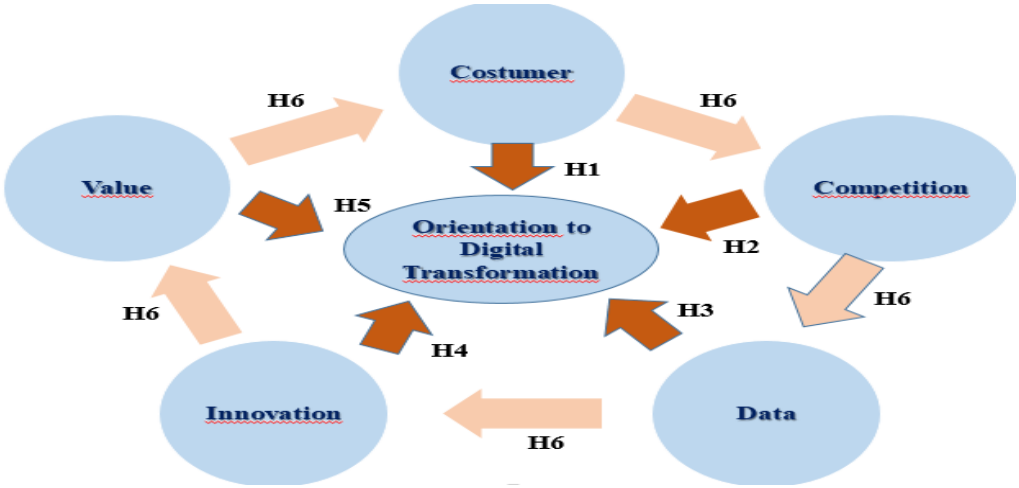



**Table 1**

*Model Hypotheses*

| | |
|---|---|
| H1 | Customer-driven actions positively determine the digital transformation orientation |
| H2 | Competitive actions positively determine the orientation to digital transformation |
| H3 | Data management positively determines the orientation to digital transformation |
| H4 | Innovation activities positively determine the orientation to digital transformation |
| H4 | Value-generating activities positively determine the orientation to digital transformation. |
| H6 | Model constructs are positively correlated |

**Source:** Survey data

In the model, the orientation to digital transformation is explained by the incidence and estimation of client constructs, competition, data structure, innovation and ability to create customer value.

Of these constructs, the customer is the core of the business in the digital age, presenting characteristics, values, expectations, emotions and cognitions, in their moments of convenience, requiring organizations to fully meet their demands. Because they are individuals, a number of external and internal factors change their profiles, influencing their perceptions about the world and things, about other people and organizations, about symbols and meanings, their sensory possibilities, their individual and social sensibilities, their desires and needs, and their hedonic and utilitarian conditions. Thus, the personality of the individual always influences the moment in which it reflects, plans and exercises to obtain a certain product (Lara, Novaes et al., 2022). Personality is characterized as the set of unique psychological characteristics that distinguish an individual or group (Goenka & Thomas, 2019). Usually it is described in traits such as self-

confidence, mastery, sociability, autonomy, endurance, adaptability and aggressiveness. The customer in the context of digital transformation is immediate, demanding, informed and contextualized to the most diverse forms of communication and self-centered in the market, through technological connectivity and experiences in multiple social networks. Thus, he empowers himself and exerts his power by influencing the evolutions in the digital transformation (Kraus, Jones, Kailer et al., (2021).

About the competition, the model highlights that it is one of the key factors in the business environment of the digital age, determining the organizational purposes and processes, or the pace and direction of business. Competitive factors and new business growth, being innovative, feed into corporate static and dynamics, shaping the corporate landscape in the Fourth Industrial Revolution. Literature has been lavish in providing all the nuances and possibilities of contemporary and future competition (Godwin, Chang & Cardinale, 2019).

New business models are platforms that are technologically sophisticated and thought-provoking and socially engaging, featuring marketplaces, new transaction and relationship systems, new multi-applicable hardware and software connectivity standards for organizations and people, new forms of intermediation and of disintermediation of business and relationships of all kinds in the economic, social and individual scenarios. Thus, Internet of Things - IoT, virtual reality, new computational technologies, blockchain, artificial intelligence, robotics, new materials, biotechnologies, neurotechnologies, augmented reality, new forms of energy, geoengineering, space technologies, among others, determine and will drive the competitiveness of the future (Schwab, 2018 and Dewanarayana & Wimalaratana, 2021).

The innovation factor constitutes an essential element in the creation of competitive capacity for organizations (Schumpeter, 1982). Innovation in products, processes, social actions and corporate competencies is what is expected of institutions that are - or expect - to undergo a digital transformation. Innovation stands out as a construct considered in the context of business cycles, people's quality of life, types of experiments for new product launches, and other models of new product creation. In the context of Digital Transformation in organizations, Rogers (2017) deepens the context for convergent and divergent experiments. Both have innovative contexts, however at different times. The first, convergent experiments, the author exemplifies with an attribute test or price test, in which the interviewer asks an exact question or a finite set of questions, the experimental project is formal (scientific), if it seeks an answer and needs from a representative sample of customers (test and control groups). The second, divergent example of putting a prototype in the hands of clients, translates into an informal

experimental project that presents an unknown set of questions, focuses on being able to answer or ask other questions and needs the right clients (who may not be average customers). Finally, in the context of Industry 4.0, all innovation modalities, including research formatting, will act as structuring elements (Schwab, 2018).

Academic and technical literature has been intensely addressing the importance of information, both for society and for organizations (Lafuente, Leiva, Moreno-Gómez & Szerb, 2019). Companies work with the capitation, maintenance and commercialization of registration data for various purposes. Databases are increasingly complex sources of information that organizations have to develop their products and plan services. The organization, the full use of organizational data, and the ability to convert it to information are the basis of the fourth element of the analytical model. It considers primary concepts such as data, storage, information conversion software and Big Data, and how institutions should make use of this valuable resource, especially in the digital environment. With all the information coming from registrations, we have the possibility to create a Data Warehouse, focused on the informational analysis of the markets (Laudon & Laudon, 2014). Data alone do not constitute information, and there comes the concept of Business Intelligence (BI), that is, the support that information provides for the decision making of business managers. The explanation of the Management Information System (GIS) concept requires consideration of the data, information and knowledge pillars that determine excellence in customer relationship management (CRM), competitiveness and orientation to digital transformation, in the context of the Fourth industrial Revolution.

The fifth prism of business digital transformation is the capacity that organizations have and plan for the effective creation of value for society, for other organizations and for people, as intended in the context of the Fourth Industrial Revolution, specifically Enterprise 4.0. (Schwab, 2018 and Reinartz, Wiegand & Imschloss, 2019).

The foundation of the value delivered to the customer requires the conception of the term, philosophy and meanings of multiple economic, social and individual values.

As the essence of business is the understanding, the creation, the communication and the attitude of providing value to the markets, the orientation to the digital transformation must be based on these purposes and processes at any moment in the evolution of the organizations.

## 3 Methodology and methodological procedures

This study is characterized as descriptive with primary data, since the main purpose is to demonstrate quantitatively how the orientation to digital transformation can be explained by the adopted model. A sample of 159 Brazilian companies, chosen by accessibility of the researchers, was studied through a survey, from December 2022 to February 2023. The objects of the study were companies of various sizes and sectors of the economy, predominantly those based in the metropolitan region of Belo Horizonte, capital of the state of Minas Gerais, Brazil.

A structured and undisguised questionnaire was applied, containing the model constructs, as well as their respective variables, designed to allow all possible and relevant contrasts to a descriptive and deterministic quantum study of the phenomenon of orientation to digital transformation. Responses consisted of respondents' five-point scale positions on terminology: “traditional company”, “traditional trend company”, “middle ground” “digital trend company” and “digital company” (from 1 to 5, in this sequence). The questionnaires were sent to the respondents through the Survey Monkey software and were later processed by the SPSS software.

The synthetic model of research on the causal relationship of companies' propensity to orient themselves to digital transformation can be literally described according to the equation:

$$Yc = \alpha + Competiton + Data/Information + Innovation + Value + € i \quad (1)$$

$\alpha$ = Constant; € i = Residual factor.

Thus, all the main data processing procedures recommended by the literature in quantitative research were performed, as well as considering all the meanings of the data obtained for a consistent analysis of the phenomenon.

Because it is a quantitative and deterministic research that used a questionnaire with structured and undisguised questions, according to the survey method, some situations may have constituted natural limitations of the research, such as: 1) the results are not representative of the population of companies that act in a process of orientation to the digital transformation, since the answers of the executives answering the questionnaires may present biases, due to the existence of differences of stage of the transformation process, as well as to the different perceptions about the intended answers; 2) the ability to provide answers required respondents to be trained and experienced in the concept of digital transformation; (3) There was a risk that the survey that was sent by email could be considered junk mail or spam.

## 4 Presentation and analysis of results

Data and analysis of this investigation are presented in the following units.

### *4.1 Descriptive Analysis*

Among respondents, most companies are headquartered in Betim (32.08%) and Belo Horizonte (25.79%). Most respondents (85.53%), are from the state of Minas Gerais. 25.79% of respondents said that the size of the company by annual revenue is microenterprise (less than or equal to R$ 2.4 million), while 6.29% said the size of the company is medium size (greater than R$16 million) and less than or equal to R$ 90 million). In table 1 it is possible to observe and identify the dispersion of the answers about the orientation to the digital transformation.

**Table 2**

*Descriptive statistics of dispersion of model variables*

| | Average | Standard Deviation | Coefficient of Variation |
|---|---|---|---|
| Change from “Customers as a Mass Market” to “Customers as a Dynamic Network”. | 3.14 | 1.425 | 45.41% |
| Change from “Communications is passed on to customers” to “Two-way flow communications”. | 3.41 | 1.379 | 40.45% |
| Change from “Company to key influencer" to "Customer is the key influencer." | 3.39 | 1.307 | 38.55% |
| Change from “Marketing change to induce shopping for marketing” to “Inspire buying, loyalty and brand advocacy”. | 3.45 | 1.301 | 37.68% |
| Change from “One-way value streams” to “Reciprocal value streams”. | 3.38 | 1.321 | 39.03% |
| Change from “Competition in delimited sectors” to “Competition in fluid sectors”. | 3.08 | 1.295 | 42.12% |
| Change from “Clear distinction between partners and rivals” to “Blurry distinctions between partners and rivals”. | 3.02 | 1.172 | 38.82% |
| Change from “Competition is zero sum game” to “Competitors cooperate in key areas”. | 3.08 | 1.273 | 41.30% |
| Change from “Key assets held in the company” to “Key assets are in external networks”. | 3.00 | 1.364 | 45.47% |
| Change from “Few dominant competitors by category” to “Winner takes everything due to network effects”. | 2.92 | 1.204 | 41.17% |
| Change from “Data is costly (expensive) to be generated in the enterprise” to “Data is continuously generated everywhere”. | 3.50 | 1.345 | 38.39% |
| Change from “The challenge of data is to store and manage it” to “The challenge of data is to convert it to valuable information”. | 3.71 | 1.244 | 33.54% |
| Change from “Data is managed across operational departments” to “The value of data is to connect it between departments”. | 3.62 | 1.277 | 35.31% |
| Change from “The company uses only structured data” to “Unstructured data is increasingly useful and valuable”. | 3.49 | 1.326 | 37.98% |
| Change from “Data are tools for managing processes” to “Data is intangible asset to create value”. | 3.57 | 1.300 | 36.38% |
| Change from “Decisions are made based on intuition” to “Decisions are made based on data”. | 3.48 | 1.377 | 39.60% |
| Change from Brainstorming is expensive, slow and difficult” to “Brainstorming is cheap, fast and easy”. | 3.23 | 1.365 | 42.22% |
| Change from “The focus is on the finished product” to “The focus is on products’ feasibility”. | 3.31 | 1.293 | 39.02% |
| Change from “Challenge in finding the right solution” to “The challenge is in solving the right problem”. | 3.40 | 1.341 | 39.42% |
| Change from “Failure is avoided at all costs” to “Failure is a source for learning”. | 3.21 | 1.387 | 43.26% |
| Change from “Industry defined value proposition” to “Customer defined value proposition”. | 3.29 | 1.361 | 41.38% |
| Change from “We executed our current value proposition” to “We discovered the next opportunity to create customer value”. | 3.34 | 1.422 | 42.59% |

**Source:** Survey data

We can observe, from a general perspective, that the coefficients of variation were high, demonstrating high dispersion, or high heterogeneity in the relationship between the standard deviations and the average ratings of respondents. The averages show, preliminarily, a general evaluation as “middle ground” to “digitally inclined company”, with values slightly above 3.

This indicates the incipience of the researched companies in the orientation towards digital transformation. Considering the business segments of the companies surveyed (industry, services, agribusiness, education and NGOs), studies that characterize these statistics in their respective segments are recommended.

The average frequency distributions of the constructs were: Digital Transformation for Customers (3.35); Digital Transformation for Competition (3.02); Digital Transformation for Data and Information Management (3.00); Digital Transformation for Innovations (3.32); and Digital Transformation for Customer Value Management (3.31).

### *4.2 Reliability Analysis*

Cronbach's alpha is a widely accepted criterion for estimating the reliability of a survey questionnaire. It measures the correlation between answers in a questionnaire by analyzing the answers given by the respondents, presenting an average correlation between the questions. The coefficient α is calculated from the variance of individual items and the variance of the sum of the items of each evaluator of all items of a questionnaire using the same measurement scale (Table 3). In this case, it demonstrated broad reliability. The Cronback's Alpha was 0,933.

**Table 3**

*Alfa de Cronbach*

| Cronbach's Alpha |
|---|
| 0.933 |

### *4.3 Factorial Analysis*

Exploratory factor analysis was performed for each of the constructs to verify how many factors were needed to explain each one of them and to know which variables were included. The results are in the tables 4, 5, 6, 7 and 8.

**Table 4**

*Factor Analysis Digital Transformation of Customers*

| Indicators | Factorial Load | Commonality |
|---|---|---|
| | Factor 1 | |
| Change from "Customers as a mass market" to "Customers as a dynamic network." | 0.780 | 0.609 |
| Changes from "Communications are transmitted to customers" to "Two-way flow communications." | 0.824 | 0.678 |
| Changes from "The company is the main influencer" to "The customer is the main influencer." | 0.854 | 0.729 |
| Changes from "Marketing to induce purchase to Marketing" to "Inspire purchase, loyalty and brand advocacy." | 0.751 | 0.563 |
| Changes from "One-way value flows" to "Reciprocal value flow." | 0.835 | 0.697 |
| **Explained Variance** | | 65.523 |
| **KMO** | | 0.816 |
| **Bartlett's test for Sphericity** | **$X^2$** | 388.538 |
| | **df** | 10 |
| | **Sig.** | 0.000 |

**Source:** Survey data

The Digital Transformation of Customers construct presented unidimensionality for the construct questions, which indicates that one factor, composed of the 5 construct questions, explains 65.52% of the data variability for this construct. Kaiser-Meyer-Olkin (KMO) sample adequacy measure: index used to assess the adequacy of factor analysis. High values (between 0.5 and 1.0) indicate that factor analysis is appropriate. Values below 0.5 indicate that factor analysis may be inadequate. As the measurement was 0.816, we could conclude that the analysis was appropriate. Bartlett's sphericity test is a statistic used to examine the hypothesis that variables are not correlated in the population. By analyzing the p-value (Sig = 0.000), as it was less than 0.05, it is concluded that the variables are correlated.

**Table 5**

*Factorial Analysis Digital Transformation of Competition*

| Indicators | Factorial Load | Commonality |
|---|---|---|
| | Factor 1 | |
| Change from "Competition in delimited sectors" to "Competition in fluid sectors." | 0.810 | 0.657 |
| Change from "Distinction between partners and rivals" to "Blurry distinctions between partners and rivals." | 0.703 | 0.494 |
| Change from "Competition is zero-sum game" to "Competitors cooperating in key areas." | 0.794 | 0.631 |
| Change from "Key assets held in the company" to "Key assets are in external networks." | 0.800 | 0.640 |
| Change from "Few dominant competitors by category" to "Winner takes it all due to network effects." | 0.734 | 0.539 |
| **Explained Variance** | | 59.211 |
| **KMO** | | 0.783 |
| **Bartlett's test for Sphericity** | **$X^2$** | 281.683 |
| | **df** | 10 |
| | **Sig.** | 0.000 |

**Source:** Survey data

The Digital Transformation Competition construct presented unidimensionality explaining 59.211% of the data variability. The Kaiser-Meyer-Olkin (KMO) test indicates that factor analysis is appropriate. Bartlett's sphericity test presented the p-value (Sig = 0.000), allowing to conclude that the variables are correlated.

**Table 6**

*Factorial Analysis of Digital Transformation for Data*

| Indicators | Factorial Load | Commonality |
|---|---|---|
| | Factor 1 | |
| Change from "Data is costly (expensive)" to "Generate in the enterprise so data is continuously generated everywhere. | 0.733 | 0.537 |
| Change from "The challenge of data is to store and manage it" to "The challenge of data is to convert it into valuable information." | 0.846 | 0.715 |
| Change from "Data is managed across operational departments" to "The value of data is to connect it between departments." | 0.848 | 0.718 |
| Change from "The company uses only structured data" to "Unstructured data is increasingly useful and valuable." | 0.850 | 0.723 |
| Change from "Data are tools for managing processes" to "Data is intangible asset to create value." | 0.852 | 0.727 |
| **Explained Variance** | | 68.406 |
| **KMO** | | 0,838 |
| **Bartlett's test for Sphericity** | **$X^2$** | 426.008 |
| | **df** | 10.000 |
| | **Sig.** | 0.000 |

**Source:** Survey data

The Digital Data Transformation construct presented unidimensionality for the questions indicating that a factor with five questions explains 68.406% of the data variability. The Kaiser-Meyer-Olkin (KMO) sample adequacy measure indicates that factor analysis is appropriate. Bartlett's sphericity test indicated the p-value (Sig = 0.000), making it possible to conclude that the variables are correlated

**Table 7**

*Factor Analysis Digital Transformation of Innovation*

| Indicators | Factorial Load | Commonality |
|---|---|---|
| | Factor 1 | |
| Change from "Decisions are made based on intuition" to "Decisions are made based on data." | 0.802 | 0.644 |
| Change from "Brainstorming is expensive, slow and difficult" to "Brainstorming is cheap, fast and easy." | 0.876 | 0.767 |
| Change from "The focus is on the finished product" to "The focus is on products' feasibility." | 0.710 | 0.504 |
| Change from "The challenge in finding the right solution" to "The challenge is in solving the right problem." | 0.857 | 0.734 |
| Change from "Failure is avoided at all costs" to "Failure is a source for learning." | 0.825 | 0.680 |
| **Explained Variance** | | 66.597 |
| **KMO** | | 0.866 |
| **Bartlett's test for Sphericity** | **X²** | 379.316 |
| | **df** | 10.000 |
| | **Sig.** | 0.000 |

**Source:** Survey data

Finally, the Digital Transformation of Value construct presented unidimensionality, explaining 88.942% of the data variability. The Kaiser-Meyer-Olkin measure demonstrates that factor analysis is appropriate. Bartlett's sphericity test presents the p-value (Sig = 0.000), indicating that the variables are correlated (Table 8).

**Table 8**

*Factorial Analysis Digital Value Transformation*

| Indicators | Factorial Load | Commonality |
|---|---|---|
| | Fator 1 | |
| Change from "Industry defined value proposition" to "Customer defined value proposition." | 0.937 | 0.878 |
| Change from "We executed our current value proposition" to "We discovered the next opportunity to create customer value." | 0.949 | 0.901 |
| **Explained Variance** | | 88.942 |
| **KMO** | | 0.500 |
| **Bartlett's test for Sphericity** | **X²** | 146.297 |
| | **df** | 1.000 |
| | **Sig.** | 0.000 |

**Source:** Survey data

*Correlations between Constructs, Mean Variance Extracted (AVE) and Square Root of AVEs*

AVE (Average Variance Extracted) is a value that is at least 0.5 (Hair et al., 2009). Analyzing the constructs, we see that the model has convergent validity. In addition to this validity, the discriminant validity is also verified for all constructs that form the tested model. To verify discriminant validity, it is necessary to compare the results of correlations of all constructs with the square root values of all AVEs. The results are presented in table 8, in which the diagonal matrix, represented by the bold values, contains the square root values of the construct AVEs and the other values of the correlation between the constructs, in which the relationships between the constructs that have valid discrimination.

**Table 9**

*Calculation of stroke and square root of AVEs*

| | AVE | Digital Transformation of Costumers | Digital Transformation of Competition | Digital Transformation of Data, Information | Digital Transformation of Innovation | Digital transformation of Value |
|---|---|---|---|---|---|---|
| Digital Transformation of Costumers | 0.655 | **0.809** | | | | |
| Digital transformation of Competition | 0.592 | 0.639 | **0.769** | | | |
| Digital transformation of Data /Information | 0.684 | 0.612 | 0.578 | **0.827** | | |
| Digital transformation of Innovation | 0.666 | 0.537 | 0.614 | 0.672 | **0.816** | |
| Digital transformation of Value | 0.889 | 0.649 | 0.59 | 0.581 | 0.687 | **0.943** |

**Source:** Survey data

Correlation is understood as a standardized measure existing between two variables, and indicates the degree of direction of this linear relationship between them. The correlation can be positive, which has a strong connection between two variables, or negative, which means a distance between these variables. In addition to positive or negative, the correlation between two variables can be linear, that is, when it is possible to fit a line between the observations. The proximity between the observations and the line determines the strength of the correlation,

or non-linear, that is, when it is not possible to adjust a line between the observations. The correlations between the model constructs, Pearson's correlations, are presented in table 8.

The constructs that showed the strongest correlation were VALUE Digital Transformation and INNOVATION Digital Transformation with a correlation of 0.687. The constructs that presented the lowest correlation were INNOVATION Digital Transformation and CUSTOMERS Digital Transformation with 0.537. All correlations marked by (**) were significant considering an alpha of 5%, i.e., the correlations between the variables are nonzero.

### *4.5 Regression Analysis*

To test the significance of the adjusted model, the test statistic was used through the estimation method known as the ordinary least squares method.

Like this,

- H0: The model is not statistically significant.
- H1: The model is statistically significant.

**Table 10**

*Regression Analysis: Model Fit Information*

| Model | Sum of Squares | D.F. | Medium Square | F | P-value |
|---|---|---|---|---|---|
| Regression | 127.626 | 4 | 31.907 | 5509.700 | 0,000 |
| Residual | 0.892 | 154 | 0.006 | | |
| Total | 128.518 | 158 | | | |

**Source:** Survey data

Thus, it was verified if any of the averages of the constructs influence the response variable (Orientation for Digital Transformation). Since the p-value is less than 0.001, it can be concluded at a 5% significance level that some of the constructs influence the response variable.

The Multiple Determination Coefficient ($R^2$) represents the proportion of the Y variability explained by the regressive variables. Thus, the closer $R^2$ is to 1, the greater the explanation of the response variable by the fitted model. Whereas Adjusted Determination Coefficient ($R^2$ adj) may be lower when another variable X enters the model, because the decrease in the sum of squares of errors can be offset by the loss of 1 degree of freedom in the denominator (n-p). Thus, the table below shows the coefficients for the adjusted model.

**Table 11**

*Regression Analysis: Determination Coefficients*

| R | $R^2$ | $R^2$ Adjusted | Residual Standard Deviation |
|---|---|---|---|
| 0.997 | 0.993 | 0.993 | 0.076 |

**Source:** Survey data

$R^2$ indicates that the explanation of the response variable by the adjusted model is high. The hypotheses for testing the significance of any regression coefficient individually are given by,

- H0: $\beta j = 0$; for any $j = 1, ..., n$
- H1: $\beta j \neq 0$; for any $j = 1, ..., n$

**Table 12**

*Regression Analysis: Parameter Estimation*

| Model | Coefficients | Standard Deviation | T | P-value |
|---|---|---|---|---|
| Constante | 3.320 | 0.006 | 550.059 | 0.000 |
| Digital Transformation of COSTUMERS | 0.284 | 0.009 | 33.196 | 0.000 |
| Digital Transformation of COMPETITION | 0.238 | 0.009 | 27.288 | 0.000 |
| Digital Transformation of DATA | 0.245 | 0.009 | 27.239 | 0.000 |
| Digital Transformation of INNOVATION | 0.303 | 0.009 | 34.543 | 0.000 |

**Source:** Survey data

Since the Value construct was not significant in the regression, the model is defined as:

Digital Transformation Orientation = 0.284 * CUSTOMERS Digital Transformation + 0.238 * COMPETITION Digital Transformation + 0.245 * DATA Digital Transformation + 0.303 * INNOVATION Digital Transformation + ∉i

In Multiple Regression the assumptions of the fitted model need to be validated for the results to be reliable. Residual analysis is a set of techniques used to investigate the suitability of a Residual -based regression model.

- H0: Residues are normal.
- H1: Residues are not normal.

**Table 13**

*Regression Analysis: Normality Test*

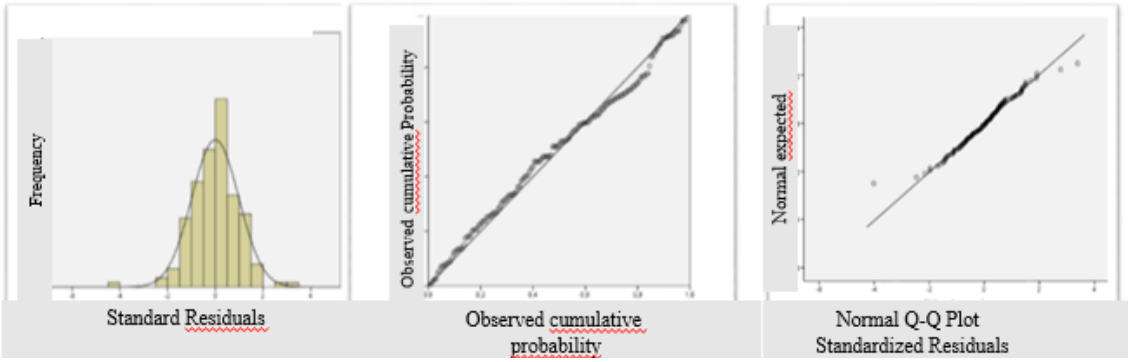
| | Kolmogorov-Smirnov | | |
|---|---|---|---|
| | **Statistic** | **.F.** | **P-value.** |
| **Resíduos Padronizados** | 0,063 | 59 | 0,200 |

**Source:** Survey data

The Kolmogorov-Smirnov normality test indicates that the residues are normal, since the hypothesis of normality of residues at a significance level of 5% is not rejected.

**Figure 2**

*Residuals Distribution*




**Source:** Survey data

The histogram shows that the standardized residues are close to a normal distribution, giving further validity to the above tests which indicated that the residues are normal. The Normal P-P Plot represents the cumulative probability that would be expected if the distribution were normal, as a function of the cumulative observed probability of errors. The points on the graph tend to be concentrated around the slope line 1 that passes at the origin, which gives evidence that the distribution of errors is normal. The quantile-quantile plot graphic (Q–Q plot) is used to determine if two data sets belong to the same probability distribution. In such graphs the points are formed by the sample quantiles, and if in the result the points align on a slope line 1, the distributions of the two samples can be considered the same. What we can conclude from the graph is that the data approximates the normal distribution, supporting the test that indicated that the data is normal.

Structural Equation Modeling allows configuration of survey data in multivariate analyzes, including regressions, factor analyzes, correlations, and variance analyzes. Thus, it

was possible to estimate and present the Rogers model applied in this research through a diagram to show the hypothetical relationships between constructs and between variables, as shown in Figure 3.

**Figure 3**

*Relationships between variables and constructs of the Digital Transformation model*

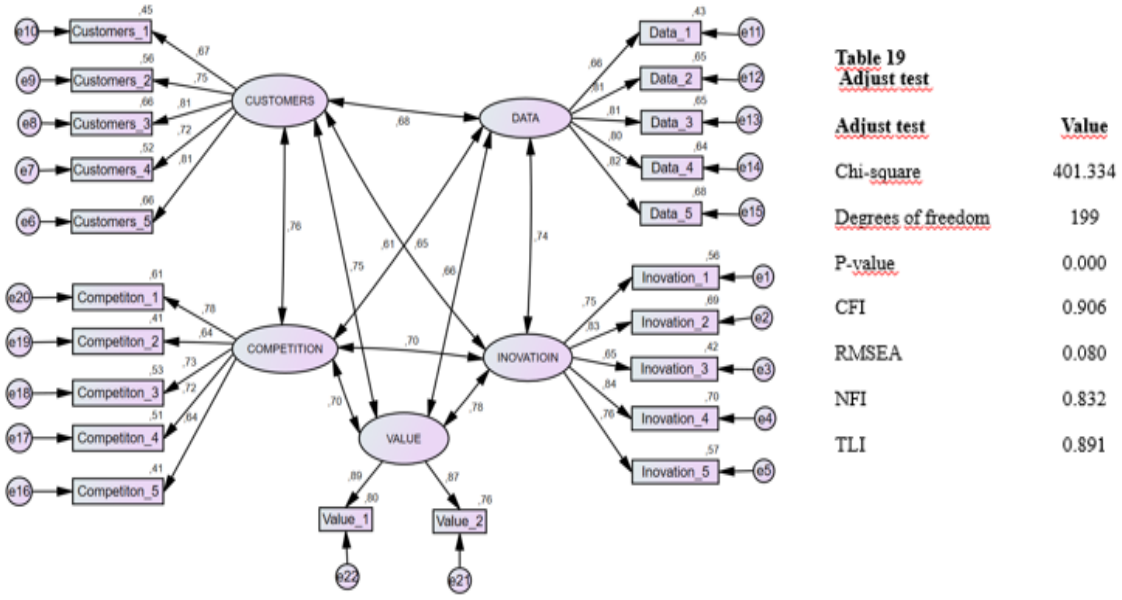



**Table 19**
**Adjust test**

| Adjust test | Value |
|---|---|
| Chi-square | 401.334 |
| Degrees of freedom | 199 |
| P-value | 0.000 |
| CFI | 0.906 |
| RMSEA | 0.080 |
| NFI | 0.832 |
| TLI | 0.891 |

**Source:** Survey data

In this context, the hypothesis tests indicated:

**Table 14**

*Conclusions on the hypotheses*

| | | |
|---|---|---|
| **H1** | Customer-driven actions positively determine the orientation to digital transformation | Not Rejected |
| **H2** | The competitive actions positively determine the orientation to digital transformation | Not Rejected |
| **H3** | Data management positively determine the orientation to digital transformation | Not Rejected |
| **H4** | Innovation activities positively determine the orientation to digital transformation | Not Rejected |
| **H4** | Value-generating activities positively determine the orientation to digital transformation | Rejected |
| **H6** | Model constructs positively correlate | Not Rejected |

**Source:** Survey data

## 5 Discussion of results

In frequency distributions, the executives interviewed showed a tendency to consider that companies have predominantly been moving in the direction of digital transformation. Apart from an expected and enthusiastic perspective from executives, organizations for various reasons, from the internal and operational context to the external environment, have been forced to undertake modernization, seeking efficiency and competitiveness (Ismail, Khater & Zaki, 2017 & Shehadeh, Almohtaseb, Aldehayyat & Abu-AlSondos, 2023). The internal context determines the implementation of strategies and structures that allow the creation of new procedures or the updating of software formats aimed at improving efficiency parameters or metrics, providing greater precision in production and service operations (Turgel, Pobedin & Panzabekova, 2022 & Vejseli, Proba, Rossmann & Jung, 2018). All too often, softwares from consulting firms, startups, and corporations themselves are emerging to drive corporate efficiency in almost every organizational function.

At the same time, the technological environment-oriented culture is gradually formed by the daily exercise of digitization-oriented activities (Schwab, 2018). Certainly, increased technological competence enables organizations to better integrate into increasingly competitive, comprehensive, sophisticated, and intelligent business chains (Leachman & Scheibenreif, 2023 and Malchyk, Popko et al., 2022).

As expected, the tests did not confirm the assumption of data normality. The averages were very volatile and the deviations presented significant discrepancy between them, generating high coefficients of variation. In investigations based on perceptual evaluations, the literature recognizes this nature of scientific production, assuming reasonable coefficients for the adopted metrics - Cronback Alpha, $R^2$ and more usual ones (Malhotra, 2011). The validations of the model proved to be consistent and robust.

The factor analysis of the variables that test the congruence of the model constructs is consistent with the purpose of the study. The adequacy (KMO), sphericity (Bartlett), and reliability (Cronbach's alpha) tests were consistent in justifying the quantitative methodology. This configuration demonstrates that, in addition to the relevance of the constructs and variables, other elements such as sample size met the construct and variable validation requirements. The composite reliability and the mean variation extracted demonstrated the convergent validity in the model, as well as the discriminant validation, by the correlation matrix between the constructs, even if averagely positive, attesting the consistency of the tests. Organizations, notably those that operate competitively in the Industry 4.0 environment, are

increasingly demanding of metrics that define their operations. These that were used here, although classic, have a significant explanatory power of organizational phenomena, in the measurement stage.

The essential objective of a deterministic work is to verify the nomological validity of a model and, in this case, the Digital Transformation Model. Thus, combining tests already exposed in this work, we present the structural equation modeling (SEM), to verify if the relations established as references in theory are reached by mean empirical data, calculated from the generalized least squares estimation method (GLS), considering that the sample has no normal distribution. It was possible to conclude that the model to explain the orientation for digital transformation in the researched organizations has nomological validity (Figure 2). All relationships between the constructs described in the theory presented statistical significance. In addition, all fit tests confirmed consistency, except for the value provided to customers, possibly by autocorrelation between constructs.

Although discriminant and convergent validations occur, this type of occurrence is possible in social research, when the number of variables participating in the constructs is sufficiently different. Because no studies that tested the Digital Transformation model using these same metrics were found, comparability with other contributions from the literature is considered impossible.

## 6 Final considerations

The study and application of the original Digital Transformation Model made it possible to configure a systemic view of this important phenomenon that currently occurs in the context of organizations, evolving from a traditional company to an effectively digital company. It is in this scenario that it intends to contribute as a breakthrough in the knowledge of contemporary organizations and a new field of descriptive and deterministic studies, as intended in this study.

It was identified that many organizations must be willing to generate or acquire new technologies, leading actions in this transition process. For many of them it is the possible alternative in the purpose of the status quo of competitiveness. It is in this sense that it was possible to identify traces of a beginning of corporate evolution in the digitalization environment, even in very conservative companies.

Regarding public administration, although the data have not been disaggregated from the others, it is observed that, increasingly, it has been computerizing government procedures

and softwares, notably those that improve the management of management processes. Use of information requires significant security, as well as robust and powerful quantitative processing, as for the private sector. Thus, it is necessary to constantly process data and information, increasingly requiring sophisticated and intelligent methods. According to the research data, in a public health service organization, there are digital government tools as well as programs for the promotion and generation of data such as e-SUS, SINVAM, SIM, among others, especially in the issues that investigate the descriptors "value" and "customer".

The survey also identified companies that are in an accelerated process of expanding the database. In this situation, a lot of information comes from computerization in operational processes, allowing the optimization of planning and analysis actions. Thus, they place themselves on the trajectory of transformation into a digitization-oriented organization. This scenario requires companies to be increasingly agile, flexible, coherent and consistent to implement transformation with customer participation, or co-creation of value with customers.

Many companies have begun digital transformation without full knowledge of the basic concepts and implementation processes. In these cases, there is a tendency for costs to be high and learning curves to be long. Many organizations are making significant investments in implementing the digital transformation culture. Therefore, the answers to this survey were provided based on this time of change and not necessarily on the current product / service model. It is observed that public / private partnerships, an increasingly contemporary and convenient development model, are being created to serve the market in the best possible way in this new era, focused on the customer and their needs. In this case, digital transformation spreads across all business chains, as a strategy and structure necessary for managing increasingly complex systems.

Currently, information does not circulate in the same way as it is collected. Its intelligent and strategic use requires increasingly complex processing, assuming a new reality called Big Data. This phenomenon implies that information and fragmented data are multiprocessor, providing specific use for each context of need. Even in a very traditional organization, where its top leaders do not invest reasonably in innovation, they tend to be more complacent in obtaining information, often outsourced, allowing them to operate in profit-related sectors.

In this research, it was possible to identify, specifically, that in a federal public higher education institution, the digital and technological evolution required the renewal of the employees profiles and a large investment in technologies and equipment. Still, it has significantly promoted the provision of courses in the Humanities area, in contrast to clear demands for courses in science and technology. In other companies, it could be identified that

digital transformation is one of the pillars of medium-term strategic planning, despite the recognition that the route is intense and long, and that it will require capital, human and capital purposes, strategies and structures commitment to organizational sustainability due to intense competition.

In another particularity, in a private organization that uses public financial resources, the activities are different from a conventional market organization. It is in the midst of changing organizational culture and digital transformation is one of the main focuses in planning strategy. Leaders realized that the key change and digital transformation must occur in the minds and culture of collaborators and employees, resulting in a successful context for all stakeholders. This requires a conscious, consistent and continuous attitude of strategic management of stakeholders. They consider that digital transformation is a path without return, that is, either the company follows and effects the digital transformation or is excluded from the market.

In the educational environment, the research showed evolutions for the registration of students' activities and the migration to distance learning. Digital trends involving the availability of content at any time of the day and the virtualization of various processes corroborates the distance learning environment increasingly resembles that of face-to-face.

In the health environment, several systems and tools for digitizing operations were identified, such as the RES (electronic patient health record), applied to both public and supplementary health organizations, enabling the achievement of immeasurable gains to the health system in Brazil.

The research also reinforced the trend of digital transformation in the service environment, as well as in production companies, with initiatives to reinvent itself and not lose market, as well as to monitor and better serve their customers. It is observed that, due to internal decisions or to the need to integrate into business chains, organizations every day tend to become, or became, more digital. It was also observed that in industries there are still several obstacles to be overcome. They are constantly improving their actions in the face of this process, but not at a pace compatible with competition or market developments, requiring more direct contacts and clear communication with all sectors to bring about effective and efficient change.

Some organizations represented by respondents prioritized this process of evolution and developed a new digital programming company within its own framework. One of the solutions presented was to intensively train collaborators and employees to make them understand the usefulness of computer data, as there is still some resistance to record them correctly.

All of these factors therefore respond to the research problem initially presented, i.e., what the impacting factors of digital business transformation in medium and large national organizations are.

Consequently, the general objective that guided this research, to analyze the state of digital transformation in organizations according to Rogers model, was achieved, since the strategies and technologies of quantitative analysis presented in a systemic and topical way, elements that characterize the phenomenon of orientation to digital transformation in organizations. Each of the specific objectives was treated in a deterministic logic, seeking the validations of the constructs "customer", "competition", "informational data", "innovation" and "customer value" as proposed in the original model. The validations were consistent. The variables, or indicators, generated from the constructs were equally analyzed and contrasted, allowing the clarification of specific parameters that are intended for validations in other contexts, as well as analyzes with managerial objectives in organizations. The level of discrimination, convergence and nomological properties of the model constructs, in explaining the propensity for digital transformation, were of great value as drivers for the central objective of the work.

As recommendations for future studies, this research, through its theoretical and methodological contributions, allows us to indicate that new applications are made in companies separated by segment (health, commerce, hospitality, industry and services, for example), or by economic axes (Services, Agriculture, Industry and Commerce, for example). In this way, it will be possible to identify and analyze the degrees of orientation to digital transformation in these axes separately, identifying and testing new constructs and explanatory variables of the phenomenon, as presented in the context of the New Industrial Organization, or Industry 4.0. It is also recommended to apply the research in qualitative mode, using in-depth interviews, focus groups and immersion through ethnography, allowing to obtain robust and dense contents in the investigation of this important theme.

## Author's contributions

| Contribution | Lara, J. E. | Batista, A. S | Ribeiro, R. M. | Tissot-Lara, T. A |
|---|---|---|---|---|
| Contextualization | X | X | X | X |
| Methodology | X | X | ------- | ------- |
| Software | X | X | ------- | X |
| Validation | X | X | ------- | ------- |
| Formal analysis | X | X | X | ------- |
| Investigation | X | X | ------- | ------- |
| Resources | ------- | X | ------- | ------- |
| Data curation | X | X | ------- | X |
| Original | X | X | ------- | ------- |
| Revision and editing | X | ------- | X | ------- |
| Viewing | X | X | X | ------- |
| Supervision | X | ------- | ------- | ------- |
| Project management | X | ------- | ------- | ------- |
| Obtaining funding | ------- | X | ------- | ------- |

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