Critical Elements in Digital Transformation Projects: Analysis of Companies in the Brazilian Sugar-Energy Sector

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Abstract

Digital Transformation (TD) plays a relevant role in the competitiveness of organizations, in particular, for companies in the Brazilian Sugar-Energy Sector, which historically live with the challenge of expanding the use of technology to implement their strategies. With this research, we sought to identify the critical elements for the success of initiatives that seek Digital Transformation (TD) in companies in the Brazilian Sugar-Energy Sector. The predominant methodological paradigm was the interpretivist one, with a qualitative study. Data were collected through a previously elaborated interview script. Based on the Grounded Theory method, the data collected in the interviews were analyzed for the coding of the collected data, using open, coaxial, focal, and theoretical codings. As a result, eight theoretical categories were obtained, among which the following stand out: i) Strategic Partnerships for Digital Transformation; ii) Cultural Issues for Digital Transformation; iii) Corporate and Technological Governance Relationship.

Keywords*: Digital Transformation; Sugar-energy sector; Strategic Partnerships.*

I. Introduction

The constant search for competitive advantages by organizations of various segments and sizes depends on how much they are able to innovate in products, processes, services, administration, marketing or in new business models. Companies are getting used to navigating the permanent uncertainty that causes changes to which organizations need to respond quickly. The pace of these changes appears to have reached unprecedented proportions, as data suggests that one-third of all publicly traded organizations will disappear in the next five years (Salles, 2018).

In the search for obtaining competitive advantage, what is observed – in practice – is the significant increase in the search for the so-called Digital Transformation (TD) using "digital technologies" both by organizations and by contemporary society. Its use became so frequent and expanded that it was characterized as a new process of change. Since the 2010s, TD has been frequently addressed in research in the academic field. In the marketing field, an expectation of substantial effects on competitiveness and on the way, organizations operate and make decisions has been generated.

Sandkuhl, Shilov and Smirnov (2019)claim that, in the scientific literature, there are different approaches to subdivide digitization and that, depending on the observer's point of view, it is possible to state that the academic production about digitalization is technology-oriented, aiming at socioeconomic change: (a) unleashed by digitalization, or (b) focused on specific industrial sectors.

For the necessary changes in technology and IT systems, different ways of executing these changes can be evaluated based on this TD ontology, which contain all the relevant information to identify which elements and concepts may be affected by changes in the scenario of any other element. In other words, it becomes possible to compare the "footprint" of change for different options (Sandkuhl, Shilov,& Smirnov, 2019).

Facing the challenge of digitalization, the Brazilian Sugar-Energy Sector stands out, which has undergone major technological developments in the last 30 years, especially regarding agricultural activity (Milanez, Souza & Mancuso, 2017). These advances were fostered by two development-inducing factors: (1) the expansion of Brazilian consumption of fuel alcohol and the increase in international demand for sugar, and

(2) the beginning of the full energy use of sugarcane as a renewable energy source. Despite all the advances, part of the sugar-energy plants face difficulties to align elements related to the paradigm shift with digital technologies.

Based on this problem, we proposed this question: **What are the critical elements for the success of initiatives that seek Digital Transformation in companies of the Brazilian Sugar-Energy Sector?** The general objective is to identify the critical elements for the success of initiatives that seek Digital Transformation in companies of the Brazilian Sugar-Energy Sector**.** The specific objectives are: 1) to evaluate the engagement of companies in the Brazilian Sugar-Energy Sector for TD; 2) identify what are the elements that make up the TD for the companies of the Brazilian Sugar-Energy Sector, and 3) analyze the identified elements that make up the TD for the companies of the Brazilian Sugar-Energy Sector.

The Brazilian Sugar-Energy Sector supports much of the country's fuel, sugar and electricity production. It has already become the largest producer of sugar and the second largest producer of ethanol in the world, according to the Bank of the Northeast (2019). In this area, companies in the sector will be able to understand, use and articulate more assertive strategies towards TD.

II. Theoretical Foundation

To Demo (2000), the best practice for research is to start with a solid theoretical foundation of explanatory character, indicating the procedures used for the elaboration of the theoretical foundation, define the key concepts and study in depth all the bibliography pertinent to the theme. In order to identify the state of the art about TD and OM, initially a research characterized as bibliometric was conducted.

a.   **Previous Bibliometric Study on Digital Transformation**

For the bibliometric study, the following bibliometric laws were used: (1) Bradford (1934); (2) law of Lotka (1926), and (3) law of Zipf (1932), as presented in the Figure1.

Figure 1: Combination of Bradford's law (1934), Lotka (1926) and Zipf (1932)
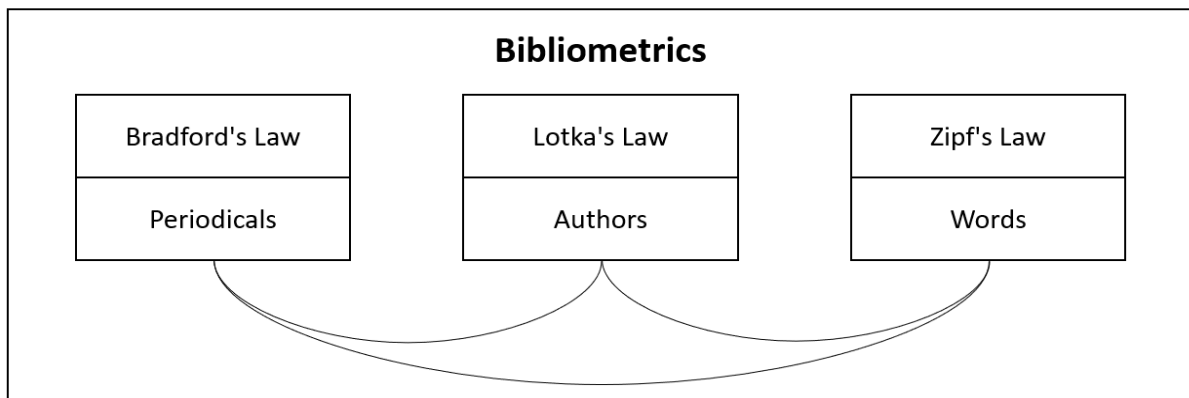
Source: Adapted from Bradford (1934), Lotka (1926) and Zipf (1932).

The law of Bradford (1934) seeks to estimate the degree of relevance of journals (*Magazines*) in a specific area of knowledge. The law of Lotka (1926) identifies the productivity of the authors, based on the premise that the publication numbers of the researchers present considerable variations. Finally, the law of Zipf (1932) refers to the frequency of occurrence of words found in a text to propose indexes. The bibliometric records were collected on the platform "Web of Science®" (WoS) that contains research in social sciences since the early twentieth century. The choice for this database was made, according to the range of journals that it contemplates, its completeness and richness of fields for collection and for being the oldest database for the most used and trusted bibliometric records in the world (Birkle*et al.*, 2020).

The collection of bibliometric records took place in October 2021, aiming to identify the volume, evolution, type, area, publications and journals in the bibliometric data. To achieve this: (1) samples of articles extracted from the Main Collection of the WoS platform (accessed by the CAPES Portal) were used, in a first stage, between the years 1950 and 2019 and (2) it was chosen, in a second stage, to compose a new base between the years 2009 and 2019.

To achieve the objectives initially proposed, the analysis of the data obtained was carried out in three consecutive stages: (1) descriptive analysis, in which a quantitative treatment of the selected articles was carried out, according to the filters used; (2) bibliometric analysis itself and; (3) bibliographic analysis in which for its

achievement, it was initially decided to delimit the period of publication and, subsequently, a time frame was defined, contemplating the interval of four years (2016-2019), finally the most cited articles published in the period were identified and analyzed.

b.   Digital Transformation

Digital Transformation (TD), in recent years, has been understood as an essential phenomenon to strategic research conducted by companies (Bharadwaj*et al.*, 2013; Hanelt*et al.,* 2015), as well as assists the professionals themselves (Fitzgerald*et al*., 2014). At the organizational level, it should be noted that, in the face of the highly dynamic market, companies must find ways from which they can innovate, according to the use of such technologies and, for this, the strategies must be understood as implications of TD (Hess, Benlian,& Mate; Wiesböck, 2016).

TD demands multiple changes in the organization, including its structure, processes (Carlo, Liitinen, & Boland Jr, 2012) and company culture (Karimi, & Walter, 2015). They are practices necessary for the generation of new paths and the creation of value. However, studies that focus more comprehensively, with emphasis on the implications, in their various levels of analysis, are still fundamental (Vial, 2019).

Through digital technologies, users become active participants, since there is constant dialogue between the organization and its stakeholders (Kane, 2017). The use of such technologies makes the company more competitive because customers no longer see themselves as captives of companies, which makes their transactions and their expectations regarding the services offered to them must meet their demands, which change every day (Lin & Lucas Jr; Shmueli, 2013; Sia, Soh, & Weill, 2016).

c.   A practical insight into digital transformation

Currently, TD facilitates the process of recombining existing products and services to be able to generate new ways in which services and products can be offered digitally (Yoo, Henfridsson, & Lyytinen, 2010). Thus, the barriers to entry were lowered (Woodard*et al.*, 2013). Digital platforms enable the redefinition of existing markets (Tiwana, Konsynski, & Bush, 2010).

The market potential of digital technologies is often much broader than the transformations that affect business processes, sales channels, or supply chains. In this sense, business models are constantly being reformulated, so what is widely used today may no longer be so in the near future (Downes, & Nunes, 2013). Managers in both countries expect that digital technologies added to IT strategies will increase their strategic contribution to the business world in the next decade (Hess*et al.*, 2016).

However, there is a wide range of recent examples of organizations that cannot keep up with the demands of digital transformations and that have not been able to adapt to the new digital reality (Hess*et al.*, 2016). An example is the bankruptcy of movie rental companies, which have not been able to survive in this new scenario. Among the causes for this problem, it was identified the difficulty in adapting to the digital transformations determined by the market. TD is constantly concerned with what the changes fostered by digital technologies can add to the business models of the most varied companies (Hess*et al.*, 2016).

d.   Elements of Digital Transformation

After the bibliometric study and literature review, it was identified the low amount of research that allows to operationalize this theme as a construct, aiming at its use in quantitative studies. Sandkuhl, Shilov and Smirnov (2019) proposed an instrument, seeking to aggregate, in the concept of TD, elements that facilitate analyses and inferences in comprehensive and complex aspects of TD.

This instrument is conceived as a representation, based on the ontology of multidimensional knowledge, being mister, still, to decide and plan stages of the Digital Transformation. For better understanding, here is a breakdown of each of the dimensions:

1. **Strategy:** A strategy seeks to create awareness of TD, thus expressing an accurate picture of the target. The objective of the strategy can be interpreted in different directions. For example, the goal may be to improve customer focus, greater efficiency, internal processes, or new business models.
2. **Leadership:** Managers must bring digitalization to the company and allow employees to participate. In this way, all corporate divisions must be involved in the implementation of the digital strategy.
3. **Products:** Communication with customers is essential. In addition, non-customer-oriented areas, such as IT, should seek dialogue with them. This point is important to gain an advantage over the competitors.
4. **People:** The tasks and templates required for the digital competencies of employees in all areas of the company must exist. Moreover, additional training opportunities should be provided.
5. **Culture:** It should always be considered, in a great process of change. Due to the fact that digitization does not occur only in individual departments, but across their borders, processes must be considered.

In this way, the organizational structure must be designed for digital processes, which can ensure transparency and dynamism. At the same time, communication, and cooperation within the company, but also with employees and external customers, should be promoted.

6. **Operations:** Other elements of the business need to be adapted, due to the new digital orientation. Digital communication in the company leads to more agility in the organization. External stakeholders can be better integrated by this type of communication (SANDKUHL; SHILOV; SMIRNOV, 2019).

7. **Governance:** TD activities must be visible and controllable to the company. Digital governance structures should assist in several tasks: (a) mobilizing resources; (b) acquiring digital skills, and (c) reducing redundancies in the system. Frameworks and guidelines are often used for this purpose. In addition, the digitization process must be evaluated, and that is why the digital strategy must be measurable by economic goals (Sandkuh, Shilov, &Smirnov, 2019).

8. **Technology:** an essential task linked to digitalization is the interaction between channels, in the field of the use of technology. Many customers use different communication channels. The service provider should have an overview of all transactions (e.g., purchases) and services for the customer.

In order to ensure the scope and capillarity of conceptualization, we drew up Table 1which contains a series of definitions found in the literature on Digital Transformation.

Table 1: Key Concepts of Digital Transformation

AUTHORS	CONCEPT
Bonnet and Nandan (2011)	Digital Transformation is the increasing adoption of digital tools and technologies by an organization to fundamentally alter its internal and external processes and functions.
Bharadwaj Sawy, Pavlou and Venkatraman (2013)	Digital Transformation does not imply gradual progressive changes at the individual, business, and social levels, but rather at radical changes at these levels due to digital technologies. These social, mobile, analytical and cloud technologies are recognized as those capable of generating business innovations that affect social and economic life.
Fitzgerald, Kruschwitz, Bonnet and Welch (2014)	Digital transformation is the use of new digital technologies (social media, mobile, analytics, or embedded devices) to enable major business improvements (such as enhancing the customer experience, streamlining operations, or creating business models).
Bradley, Loucks, Macaulay, Noronha and Wade (2015)	Digital business transformation is the organizational change, using digital technologies and business models to improve performance.
Hess, Benlian, Matt and Wiesbock (2016)	Digital Transformation occurs when leaders formulate comprehensive digital strategies with the clear goal of improving operational performance through technology. Organizations that prioritize a digital strategy for the business with a focus on opportunities to create and capture value need to look at four dimensions: Culture, People, Processes, and Technology.
Tolboom (2016)	Digital transformation can be understood as the process of change carried out from the use of social, mobile, analytical and cloud technologies.
Demirkan, Spohrer, and Welser (2016)	Digital Transformation is the deep and accelerated transformation of business models, activities, processes, and business competencies, to take full advantage of the changes and opportunities brought by digital technologies and their impact on the whole society in a strategic and prioritized way.
Schwertner (2017)	Digital Transformation is predominantly an approach to organizational change using technologies to replace a company's business model.
Dery, Sebastian and Van Der Meulen (2017)	Digital Transformation is a process that requires a change in the model used by organizations to guide their initiatives, as well as to plan future actions, focusing on longevity and innovation.
Eden, Jones, Casey and Draheim (2019)	Digital Transformation involves reviewing organizational processes, services, and products, noting the availability of digital technologies. This approach requires the preparation of the entire team to develop – through training – their ability to adapt and engage.
Solis, Li and Szymanski (2014)	Digital Transformation is the realignment or investment in new technologies, business models and processes to generate value for customers and employees and compete more effectively in an ever-changing digital economy.

Source: Prepared by the authors based on the researched literature, 2023.

Based on the concepts cited in this section, it is considered that Digital Transformation is a new organizational paradigm that permeates the entire value chain of an organization, demanding a structured, broad, robust and effective digital strategy, enabling a new organizational model through the integration of new technologies that offer an unlimited set and opportunities for business.

III. Methodological Procedures

For designing this strategy, a set of procedures and techniques adapted from Charmaz (2006), Charmaz and Bryant (2019) and Corbin and Strauss (2015), with a qualitative research approach. The following procedures were adopted: Construction of the Initial Codes; Creation of Focal Codes and Formation of Theoretical Categories.

For Charmaz (2006) one *Grounded Theory* is a method of conducting qualitative research in the creation of conceptual schemes of theories through the construction of inductive analysis, from the data. For this reason, categories are directly "grounded" in the data. The method privileges analysis rather than description, new categories replacing preconceived ideas and existing theories, sequential data collection systematically focused on the place of large initial samples (Charmaz, 2006).

Three research strategies were adopted to conduct this study: (1) bibliographic research; (2) bibliometric research, and (3) *Grounded Theory*. The first two were used in the collection and exploration of secondary data and aimed: (a) to contextualize the research in the Sugar-Energy Sector; (b) enable the identification of phenomena that can be scientifically explained and that have not yet been contemplated in the research; (c) delimit the problem and the research question; (d) identify additional phenomena not observed during the bibliographic research; (e) identify the elements that contribute to the occurrence of such phenomena; (f) discuss how companies deal with such phenomena from the perspective of strategy concepts. In Figure 2, the research strategies previously described on which this study was based, are presented.

Figure 2: Research Strategy Template
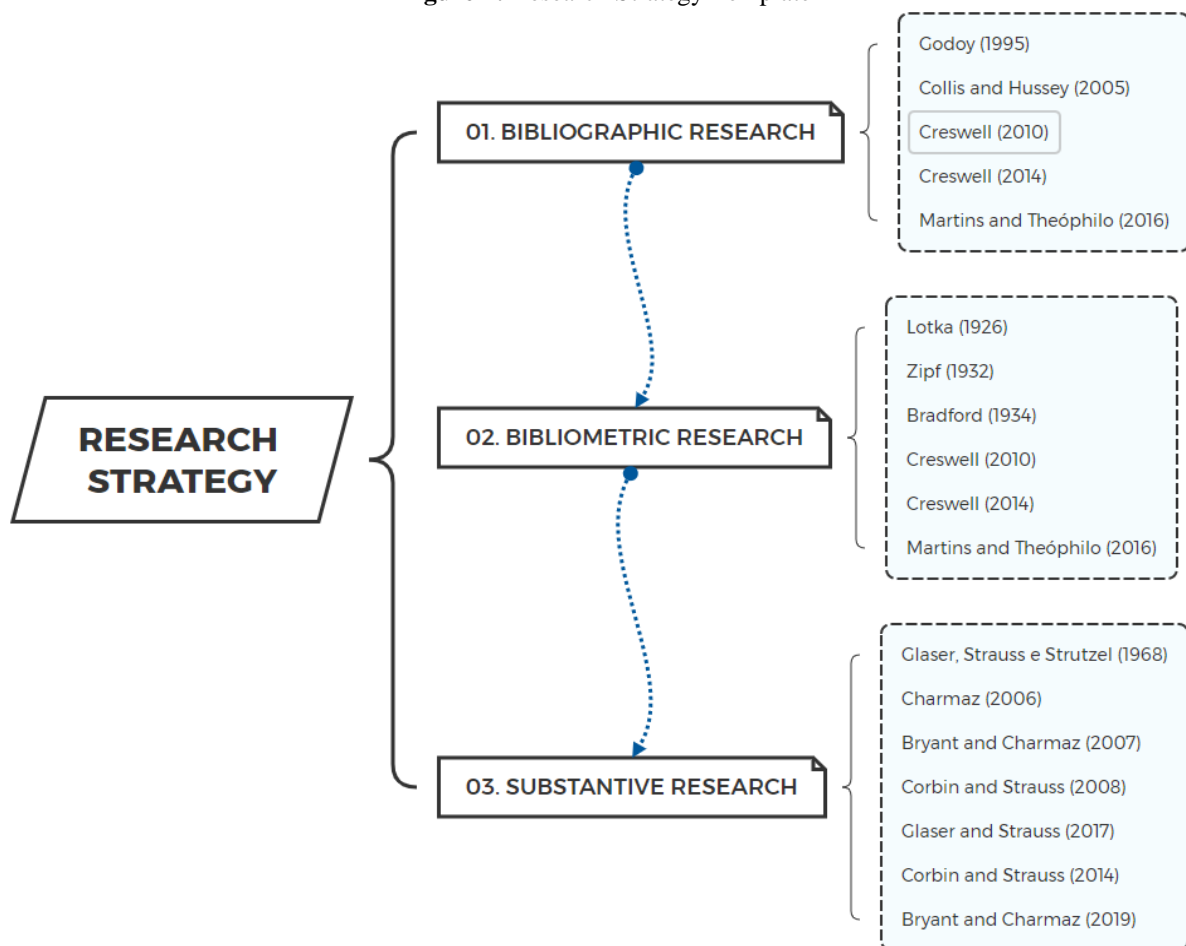
Source: Prepared by the authors based on the researched literature, 2023.

The following sections detail how each of the steps that make up the strategies of research was implemented. Based on the results obtained in the bibliometric study, as mentioned, it is understood that the most appropriate type of research is the *Grounded Theory* (in some of its stages), with this, it was sought to achieve the objectives presented in the introductory section of this research.

For Charmaz (2006), the methods constitute tools, which when combined with *perspicacity* and care in grounded theory, offer refined instruments to generate, extract and produce meaning from the data. In this way, grounded theory can bring flexible guidelines rather than rigid prescriptions to the study and thus let the imagination flow. According to the author, it is necessary to let the research question guide the methods to be chosen, being able to use combined or sequential approaches, which can lead the researcher to build new methods of data collection and to review the previous ones.

The qualitative research adopted in this study refers to the non-mathematical process of interpretation, elaborated with the objective of discovering concepts and relationships in the raw data and of organizing these concepts and relations in a theoretical explanatory scheme. The data should consist of interviews and observations, as well as documents, films or video recordings or census data (Corbin, & Strauss, 2008).

The type of research adopted in this project is exploratory and descriptive in nature. For Collis and Hussey (2005), research of a descriptive nature is research that describes the behavior of phenomena, used to identify and obtain information about the characteristics of a particular problem or issue. This type of research has been used to describe a social situation circumscribed in qualitative research, that is, the question of mechanisms and actors (the "how" and "what" of phenomena), through the precision of details to provide contextual information (Washers, & Kérisit, 2008).

Thus, the research is descriptive, as it seeks to describe the behavior of the phenomena, being used to identify and obtain information about the characteristics of a particular problem or issue, according to Collis and Hussey (2005). As these authors advise, the use of the type of research of an exploratory nature is justifiable when there is little or no previous study and it is possible to seek information about a problem or research question and aims to look for patterns, ideas or hypotheses (instead of testing hypotheses or confirming a hypothesis). The focus of this type of research, according to the authors, is to obtain *insights* and familiarity with the subject area for more rigorous investigation at a later stage.

The Data Collection Instruments were designed for semi-structured in-depth interviews, with previously elaborated interview scripts, and composed of previously established topics (Vergara, 2015). Initially, an interview script was elaborated and was adjusted after the pilot interview. For the elaboration of the interview script, a Mooring Matrix was used.

a.   Theoretical Sampling

In this study, it is understood as Theoretical Sampling, the process of collection, coding and analysis occurring simultaneously with the choice of the next question and place to be investigated in order to generate a Model capable of substantiating propositions, relating the elements of TD critical for companies in the Brazilian Sugar-Energy Sector.

The seven interviews were recorded and transcribed in full, and in a homogeneous way. The agendas with the interviewees took place between the period of January 2021 and February 2022, in person, or by online videoconference, in the cities of São Paulo (SP), Pradópolis (SP) and Ribeirão Preto (SP). The interviewed professionals have experience between 5 and 40 years in the Sugar-Energy Sector; some, with more than 40 years in the same company, with experience in IT and/or Business management, with activities of production and commercialization of ethanol, sugar, bioenergy and by-products from sugarcane at the strategic and tactical levels.

Following the procedures indicated by Charmaz (2006), Charmaz and Bryant (2007, 2019) in the Grounded Theory research strategy, with the definition of interviews at these two levels (strategic and tactical), it was possible to understand observed phenomena and, mainly, the consolidation of the understanding about certain diffuse aspects identified during the saturation stages. Thus, it was possible to collect data from professionals with different experiences, aiming to capture both the perspective of the executive of a company in the Sugar-Energy Sector and of the managers and coordinators who implement and manage businesses and/or technologies in the organizations to which they belong. Interviews were conducted with seven professionals to ensure confidentiality and privacy. The participants were named from "E1" to "E7", according to the order of the interviews conducted, as described in the Table 2.

Table 2: Profile of Interviewees

#ENT.	Level of Performance	First Formation	Last Training	Area of Acting	Time in the Organization	State
E1	Executive	Business Administration	MBAGare Business	Executive Management	6 years	São Paulo
E2	Executive	Agronomic Engineering	MBAGare Business	Executive Management	16 Years	São Paulo
E3	Executive	Agronomic Engineering	PhD in Soil Sciences	Executive Management	21 Years	São Paulo
E4	Tactical	Information Technology	Information Technology	Information Technology	39 Years	São Paulo
E5	Tactical	Agronomic Engineering	PhD in Soil Sciences	Production and Maintenance	14 Years	São Paulo
E6	Tactical	Systems Analysis	MBAGare Business	Information Technology	41 Years	São Paulo
E7	Tactical	Business Administration	MBAGare Business	Innovation and New Business	21 Years	São Paulo

Source: Research data, 2022.

According to Maykut and Morehouse (1994), a qualitative research sample should be constituted by participants who have excelled in their groups, in their activities and hold information considered in fact useful for the understanding of the researched problem. Groups need to have been formed naturally, such as a classroom, an organization, a department, or an organizational project team. Individuals should be designated according to their characteristics or attributes which, in this study, is characterized by their professional activities and the environment in which they are inserted (Creswell, 2010).

These aspects were targets of attention, with the objective of guaranteeing these premises, it was previously verified if the interviewees participate or participated in any initiative, program, project, area, or team formally dedicated to TD.

b.   Data Analysis Techniques

After the bibliographic and bibliometric research strategies, we chose to use the following steps from *Grounded Theory*. The objective of this research strategy is to explore the points of view and experiences of the agents who lead the motivating phenomena of the investigation. So the contents of Corbin and Strauss (2008, 2015), Charmaz and Bryant (2007, 2019), Charmaz (2006) were synthesized.

From this synthesis, it was proposed, then, to perform this research, using the procedures defined in six stages: (1) primary data collection; (2) open coding; (3) axial coding; (4) synthesis of the interviews; (5) selective coding; and (6) model generation. In Figure 3, the flow established for the accomplishment of the steps elaborated based on the *Grounded Theory* (Charmaz, 2006).

Figure 3: Stages of the Methodological Procedures
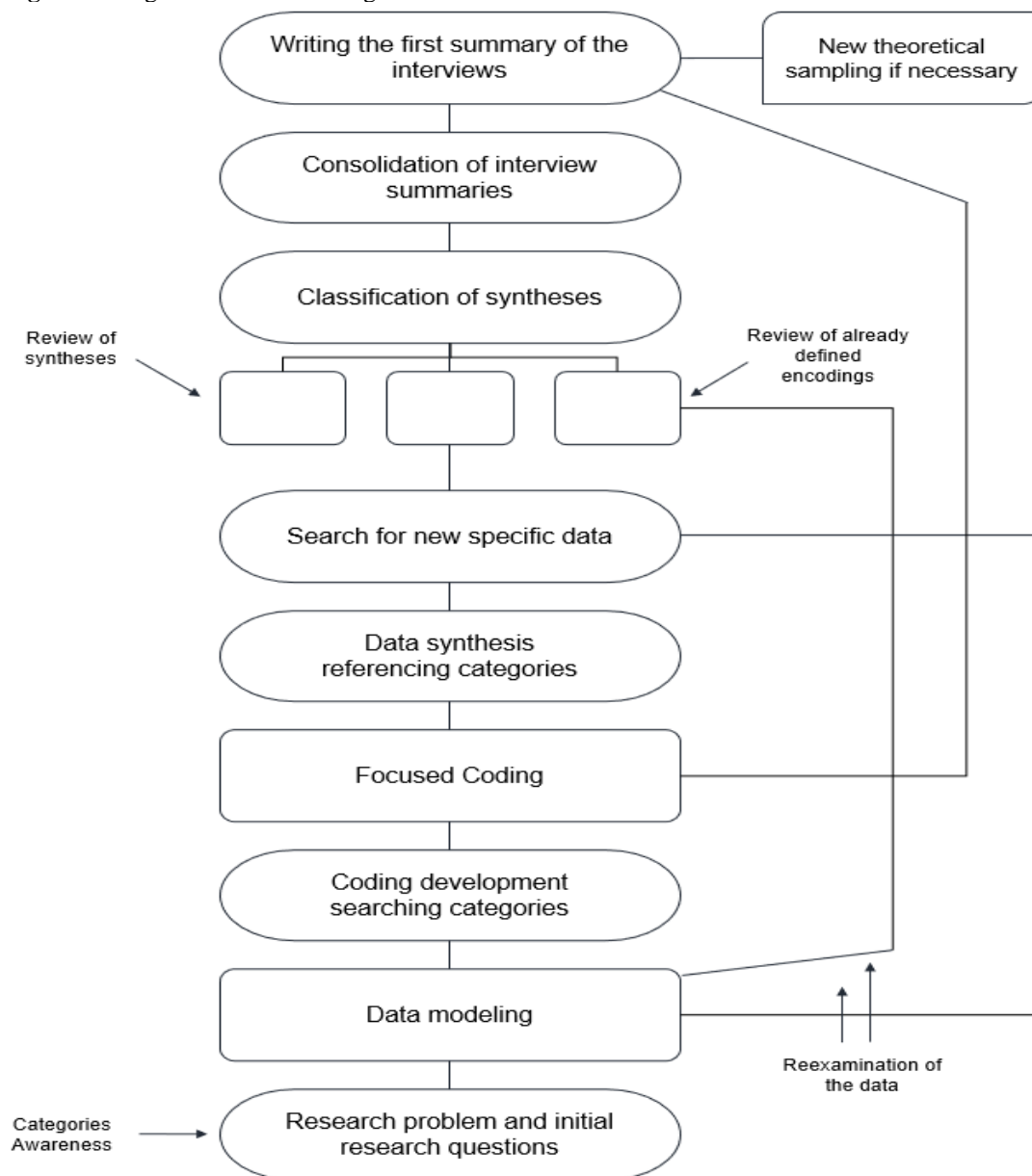
Source: Prepared on the basis of Charmaz (2006).

The research strategy *Grounded Theory* provides for theorizing, based on conceptual saturation. This process is characterized by the reduction of the emergence of new open and axial codes as one progresses in conducting new interviews and subsequent transcriptions and analyses (Charmaz, &Bryant, 2007, 2019; Corbin, & Strauss, 2008, 2015; Glaser, & Strauss; Strutzel, 1968).

As the initial codes are defined, the researcher should direct the research seeking saturation through the comparison groups (Charmaz, 2006). Saturation is obtained from the cyclic process of primary data collection (step 1); open coding (step 2); axial coding (step 3); writing memoranda (step 4); selective coding (step 5) and field return for data confirmation (step 1) (Mendonca*et al.*, 2013).

The procedures of *Grounded Theory*, adopted in this work, were the result of the systematic process of data collection and coding in three levels (open, axial and selective). From the most relevant axial codes, the categories were identified systematizing the variabilities found in the data (Martins, 2008). To determine the relevance of the axial codes, the following sequence was adopted: (a) the amount of open-source components, and (b) the substantiality of the open-source components vis-à-vis the research question.

IV. Presentation And Analysis of Results

a.   Conceptual Saturation Cycles

The data collected in the interviews were debugged in open codes, axial codes and selective codes, based on the knowledge acquired in the first cycle of conceptual saturation and in the delimitation of the scope of the research, it was understood that it was not necessary to return to the field for a new round of interviews in order to confirm the understanding formed from the data obtained in the first cycle. For data collection, semi-structured scripts with questions were used to meet the concepts and relationships on which the consolidation of knowledge is sought.

b.   Step 1: Primary Data Collection

The stage of primary data collection was structured from the perceptions obtained in bibliographic and bibliometric research. Thus, it was considered essential that data collection should be performed with interviewed agents with executive and tactical profile, working in companies of the Sugar-Energy Sector that have projects and initiatives for TD, as presented in the subsection III.a.

The idea of understanding the reading of actors, in different positions on the same topics, is justified by the possibility of obtaining convergences on certain aspects. For Mendonça *et al.*, (2013), these convergences contribute to the robustness of the selective coding and theorizing processes proposed.

c.   Step 2: Synthesis of Interviews

Charmaz (2006)) defines memo as notes freely made by the researcher during the data analysis process. These notes come from reflections made by the researcher and aim to record insights that occur during the process of analysis of primary data. As mentioned earlier, a research strategy inspired by Grounded Theory was adopted. Therefore, for the open and axial coding processes, it was decided to use the syntheses of the interviews instead of the memoranda. With this, it was possible to identify the connections between the syntheses and the fragments of the texts for use in Open Coding.

d.   Step 3: Open Coding

Coding the data means decomposing, conceptualizing and reorganizing them, aiming at the realization of a deep process of interpretation. The coding process is understood as the assignment of concepts to groups of data that can become concepts or categories (Charmaz, & Bryant, 2019). Open coding is the process by which the first concepts emerge from data (VergARA, 2015) which, in the case of the research in question, are formed by the set of transcribed interviews. Thus, to identify the Initial Codes, a pre-analysis was performed, and then the transcribed files were uploaded to the NVivo®V12 software for further reading.

All the interviewees showed a lot of resourcefulness and mastery of their answers. Thus, there were cases in which the answers of the interviewees to the question asked, at a given moment, answered at least in part, the questions that were to come and, in other cases, in which those that had already been asked were complemented with answers to other questions. The NVivo®V12 software was used to support the elucidation of the content of the interviews. With it, we elaborated Figure 4, which presents a word cloud generated by consolidating the transcription of all interviews with only words cited at least seven times.

Figure 4: Word Cloud

Source: Survey Data (2022).

With the use of NVivo®V12 it was possible to perform several analyses on the collected data. One of these analyses is the word cloud that made it possible to identify themes that were saturated as "Strategy", "People" and "Technology" as indicated in the 4.

e.   Step 4: Axial Coding

For Corbin and Strauss (2015), axial coding can be understood as a process that consists of locating and connecting actions and interactions within a framework of "subconcepts". Still according to the authors, these subconcepts, perceived as the result of the open coding process, attribute meaning to the axial codes and enable them to explain what types of interactions are occurring.

For Charmaz and Bryant (2019), axial coding is translated into the enhancement and differentiation of open source. According to the authors, axial codes are composed of open sources that have common characteristics or connections to each other. It can be stated that axial coding is the process of identifying relationships between open sources (Charmaz, & Bryant, 2019; Vergara, 2015). After the stage of identification of the Initial Codes, it was possible to improve them for the formation of the Focal Codes, which are related and do not give rise to the Theoretical Categories.

f.   Step 5: Selective Codes and Theoretical Categorization

For Corbin and Strauss (2015), selective coding demands a high level of abstraction on the part of the researcher. While Corbin and Strauss (2015) refer to the product of this step as "Category", Mendonça*et al.*, (2013) call it "selective codes". To standardize the discourse, the term proposed by Corbin and Strauss (2015) is adopted here.

The selective coding process was used to identify intersections between axial codes. With this, it was possible to establish network maps, correlating two or more axial codes, aiming to identify open codes common to all. Checking the conceptual overlaps of the axial codes was essential to obtain selective codes that could bring together the meaning of the groups of axial codes and the formation of the categories, as reported in the Table 3. The nominations of the Theoretical Categories (TC01 – TC08) were based not only on the reports of the interviewees but also on the sensitizing concepts from the literature, which helped in the abstraction of the data and are listed in this section.

Table 3: Theoretical Categories Created

TC ID	THEORETICAL CATEGORY	FC	FOCAL CATEGORY
TC01	STRATEGIC PARTNERSHIPS FOR DT	FC01	ALIGNMENT ON DIGITAL TECHNOLOGIES WITH PARTNERS
		FC02	EXECUTIVE PENETRATION OF PARTNERS
		FC03	PARTNER EXPERIENCE WITH DT INITIATIVES
TC02	DIGITAL TECHNOLOGIES AND CAPTURING VALUE FOR BUSINESS	FC04	TECHNICAL ARCHITECTURE BETWEEN COMMON AND DIGITAL TECHNOLOGIES
		FC05	APPLICATION OF TECHNOLOGIES TO CAPTURE VALUE
		FC06	UNDERSTANDING OF THOSE INVOLVED ABOUT THE POSSIBILITIES OF USING DIGITAL TECHNOLOGIES
TC03	ALIGNMENT OF BUSINESS AND TECHNOLOGY STRATEGY	FC07	STRATEGIC PLANNING UNIFIED WITH TECHNOLOGICAL EVOLUTION PLANNING
		FC08	EXECUTIVES' UNDERSTANDING OF DT
TC04	TECHNOLOGICAL PARADIGM SHIFT	FC09	UNDERSTANDING TECHNOLOGY IS STOP BEING A MEANS TO BEING PART OF THE BUSINESS
TC05	INTERNAL TEAM DEDICATED FOR DT PROJECTS	FC10	PERCEPTION OF VALUE CAPTURE FOR THE NEW TECHNOLOGICAL SET
		FC11	INSECURITIES ABOUT KNOWLEDGE OF CHANGES GENERATED BY DT
		FC12	TEAM ENGAGEMENT ON THE CHANGES GENERATED BY DT
TC06	CULTURAL ISSUES FOR DT	FC13	LEADERSHIP LITTLE RISK TOLERANT
		FC14	MANAGEMENT LITTLE TOLERANT TO FAILURE
TC07	LEADERSHIP POSITIONING IN FRONT OF DT	FC15	LEADERS ENGAGEMENT FOR DT
		FC16	CLARITY ABOUT THE IMPORTANCE OF DT
		FC17	ARRANGEMENT FOR INVESTMENTS
TC08	RELATIONSHIP BETWEEN CORPORATE AND TECHNOLOGICAL GOVERNANCE	FC18	ALIGNMENT BETWEEN GOVERNANCE AND DT

Source: Research Data (2022).

g.   Step 6: Discussion of Theoretical Categories

The Categories and Propositions were the result of the systematic process of data collection and coding in three levels (open, axial and selective). From the most relevant axial codes, it was intended to identify the categories and then systematize the variabilities that can be found in the data (Martins, 2008). To determine the relevance of the axial codes, the following sequence was adopted: (a) the amount of open-source components, and (b) the substantiality of the open-source components vis-à-vis the research question.

In a first analysis of the interviews conducted in this study, it was possible to identify the original codes, created to bring the researcher closer to the data. According to Belgrave and Seide (2019), the initial coding allows to identify which information is most important for the development of the research.

The interviews were conducted in organizations in the interior of São Paulo that have a program and portfolio of specific projects for TD, and are executing the projects of this portfolio, which allowed understanding of the main characteristics and concerns in projects of this nature. Next, the eight Theoretical Categories (TC01 – TC08) are presented and discussed.

h.   TC01 - Strategic Partnerships for Digital Transformation

The category TC01 - Strategic Partnerships for Digital Transformation was formed through the Focal Categories indicated in Table 4 and seeks to evaluate the relevance of strategic partnerships that seek TD in companies in the Brazilian Sugar-Energy Sector.

Table 4: TC01 - Strategic Partnerships for Digital Transformation

TC ID	THEORETICAL CATEGORY	FC	FOCAL CATEGORY
TC01	STRATEGIC PARTNERSHIPS FOR DT	FC01	ALIGNMENT ON DIGITAL TECHNOLOGIES WITH PARTNERS
		FC02	EXECUTIVE PENETRATION OF PARTNERS
		FC03	PARTNER EXPERIENCE WITH DT INITIATIVES

Source: Research Data, obtained with NVivo®V12 (2022).

It was evident that, in all interviews, the respondents present a clear understanding of TD and its elements. Thus, they were able to elucidate, with examples, the current stage of their companies and their understanding of how the elements of TD can affect the performance of their organizations, as in the following excerpt of speech.

> **E6**: "[...] We have many initiatives that have been generated by our transformation program, there are literally dozens and dozens of technology projects and projects of other topics such as change management, culture and process management."

Research investigating TD's contribution to the Information Technology (IT) sector identifies that technology is only one part of a complex puzzle, which must be solved for organizations to remain competitive in an intrinsically digital world (Bharadwaj*et al.*, 2013; Mate, Hess, & Benlian, 2015). Following the same understanding, the interviewees indicated that TD has several aspects and elements that need to be considered for the success of their projects.

Respondents also converged on the lack of expertise of their team to promote comprehensive changes in multiple areas simultaneously, indicating that the best solution was to identify partner entities that are experts in the topics that involve the elements of TD.

> **E1**: "[...] the company already has its DNA, as I said earlier. Naturally with the growth that the company has been having in recent decades, it has also been advising itself very well, with consultancies and specialist companies. KPMG is an example, which has been working with us for a long time and knows well how things are going here, this has helped the company to make the strategies really happen."

From the description of the interviewees regarding their projects in execution, as well as their elements, challenges and performance of the partner companies, it is concluded that the data collected confirm the existence of the element "Strategic Partnerships for Digital Transformation" as indicated Table 4.

i.   TC02 - Digital Technologies and Business Value Capture

The category TC02 - Digital Technologies and Business Value Capture was formed through the Focal Categories indicated in the Table 5 and seeks to evaluate the relevance of digital technologies and the capture of value for the business in companies of the Brazilian Sugar-Energy Sector.

Table 5: TC02 - Digital Technologies and Business Value Capture

TC ID	THEORETICAL CATEGORY	FC	FOCAL CATEGORY
TC02	DIGITAL TECHNOLOGIES AND CAPTURING VALUE FOR BUSINESS	FC04	TECHNICAL ARCHITECTURE BETWEEN COMMON AND DIGITAL TECHNOLOGIES
		FC05	APPLICATION OF TECHNOLOGIES TO CAPTURE VALUE
		FC06	UNDERSTANDING OF THOSE INVOLVED ABOUT THE POSSIBILITIES OF USING DIGITAL TECHNOLOGIES

Source: Research Data, obtained with NVivo®V12 (2022).

As mentioned, in all interviews, respondents presented a clear understanding of TD and its elements and elucidated, with examples, the current stage of their companies and their understanding of how the elements of TD can affect the performance of their organizations. Considering that the increasing dynamics and versatility of the market generate a continuous pressure for new advances in IT, the competitive environment has modernized and become increasingly digital (Bharadwaj*et al.*, 2013; Loader, & Heppelmann, 2015; Rigby, Sutherland, & Takeuchi, 2016), as indicated in the following excerpt.

> **E2**: "[...] For our company it is very clear all the engagement and perception of executives as to the need for this transformation. This is based, mainly, on the need to keep the company updated technically, technologically, with these new digital technologies, such as Big Data, IoT with the harvester sensors that I mentioned and consequently be there at a sufficient and necessary level to compete with the other companies that are also working on this idea of digital transformation."

For the interviewees, when they describe their projects in execution, as well as their elements, challenges and performance of the partner companies, it is concluded with the analysis of the data collected the existence of the element "Digital Technologies and the Capture of Value for the Business", as indicated in the Table 5.

j.   TC03 - Alignment of Business and Technology Strategy

The category TC03 - Alignment of Business and Technology Strategy was formed through the Focal

Categories indicated in the Table 6 and seeks to evaluate the relevance between the alignment of the business strategy with the technological strategy in companies of the Brazilian Sugar-Energy Sector.

Table 6: TC03 - Alignment of Business and Technology Strategy

TC ID	THEORETICAL CATEGORY	FC	FOCAL CATEGORY
TC03	ALIGNMENT OF BUSINESS AND TECHNOLOGY STRATEGY	FC07	STRATEGIC PLANNING UNIFIED WITH TECHNOLOGICAL EVOLUTION PLANNING
		FC08	EXECUTIVES' UNDERSTANDING OF DT

Source: Research Data, obtained with NVivo®V12 (2022).

The creation of digital strategies has particularities that can foster significant changes in the performance of activities. Although it is a widely accepted perspective, the formulation of digital strategies is still linked to some challenges. Researchers investigating the theme should emphasize the informal aspects when studying the creation of digital strategies so that it is possible to understand the dynamics established in organizations regarding the use of digital mechanisms (Chanias, Myers, & Hess, 2019).

> **E2**: "[...] with each executed project of our transformation portfolio our executive body becomes more and more engaged, before there was an initiative only from the IT area for transformation, today digital transformation permeates all company planning, seeking this alignment between all business strategies along with our technological planning has been challenging and increasingly necessary".

For the interviewees, when they describe their projects in execution, as well as their elements, challenges and performance of the partner companies, it is concluded, with the analysis of the collected data, the existence of the element "Alignment of the Business and Technological Strategy", as indicated in the Table 6.

k.   TC04 - Technological Paradigm Shift

The category TC04 - Technological Paradigm Change was formed through the Focal Categories indicated in the Table 7 and seeks to evaluate the Technological Paradigm Change in companies of the Brazilian Sugar-Energy Sector.

Table 7: TC04 - Technological Paradigm Shift

TC ID	THEORETICAL CATEGORY	FC	FOCAL CATEGORY
TC04	TECHNOLOGICAL PARADIGM SHIFT	FC09	UNDERSTANDING TECHNOLOGY IS STOP BEING A MEANS TO BEING PART OF THE BUSINESS

Source: Research Data, obtained with NVivo®V12 (2022).

New markets and competitors are constantly emerging. Organizations must change and adapt to ensure their survival and growth. This demand arises as the economic, social, political and especially technological environment is transformed, generating various organizational movements (Al-Haddad, & Kotnour, 2015).
It should be noted that there is a growing change in the demands for products and services in the general market. In this way, companies are under pressure to adapt their business models to capture new demands. In this sense, business models are constantly being reformulated, with Digital Transformation as the protagonist (Chanias, Myers, & Hess, 2019; Downes, & Nunes, 2013; Hansen, & Sia, 2015; Lee *et al.*, 2015). Following the understanding indicated in the following excerpt of speech.

> **E4**: "[...] This industry has a reputation for being conservative, so our competitors often wait to see what we're doing here before they take a chance as well, for us this is a great opportunity to evaluate more properly before others how these new technologies can improve our business model."

According to the interviewees, when they describe their projects in execution, as well as their elements, challenges and performance of the partner companies, it is concluded that the data collected confirm the existence of the element "Technological Paradigm Shift", as indicated in Table 7.

l.   TC05 - Internal Team Dedicated to Digital Transformation Projects

The category TC05 - Internal Team Dedicated to Digital Transformation Projects was formed by the Focal Categories indicated in Table 8, which seeks to evaluate the relevance of strategic partnerships that seek TD in companies of the Brazilian Sugar-Energy Sector.

Table 8: TC05 - Internal Team Dedicated to Digital Transformation Projects

TC ID	THEORETICAL CATEGORY	FC	FOCAL CATEGORY
TC05	INTERNAL TEAM DEDICATED FOR DT PROJECTS	FC10	PERCEPTION OF VALUE CAPTURE FOR THE NEW TECHNOLOGICAL SET
		FC11	INSECURITIES ABOUT KNOWLEDGE OF CHANGES GENERATED BY DT
		FC12	TEAM ENGAGEMENT ON THE CHANGES GENERATED BY DT

Source: Research Data, obtained with NVivo®V12 (2022).

Digital transformation is linked to the creation of market offers, processes and business models that make the continuous use of technology so that the organization becomes more competitive, implying a change in the posture of employees throughout the company. A strategy that has increasingly caught the attention of organizations and enables TD is the implementation of dedicated units for digital transformations. (Nambisan*et al.*, 2017). Similar strategies were identified in this research as indicated:

> **E1**: "[...] after defining the strategy for the next five years, we have created three dedicated cells for our digital transformation, one within IT, another in the back-office team and one in the agribusiness team, they are responsible for the projects that make our digital transformation".

There are multiple challenges arising from the incorporation of technology in organizations; however, the possibilities are diverse. Thus, companies that wish to master digital technologies need to develop dedicated digital capabilities (Chan, & Ahuja, 2015). The digital capabilities developed should foster the superior performance of digital innovations (Carlo, Liitinen, & Boland Jr, 2012; Yoo, Henfridsson, & Lyytinen, 2010). In the following excerpt, another similar strategy is highlighted.

> **E2**: "[...] we create a team within the agribusiness team, their main function is to identify, map and generate a score for new startups that create technology for our sector, the best scored startups enter a list of organizations that we initially want to buy to aggregate the technology they are creating for our business, eventually those that we cannot buy we signed partnership agreements or exclusivity in technology, This has created an extraordinary result."
>
> **E6**: "[...] To talk about this I will take the example of agricultural automation, which is the latest and the most indicative of this, the largest of this, this project has triggered several others, some are companies that we buy along with the technology and others are even services of partners, such as *Data Lake*, for example, Big *Data*, to bring autonomy in the field with regard to the data network, another was a private 4G network that we developed as well. So, it's all part of that context."

For the interviewees, when they describe their projects in execution, as well as their elements, challenges and performance of the partner companies, it is deduced that the data collected confirm the existence of the element "Internal Team Dedicated to Digital Transformation Projects", as indicated in the Table 8.

m.   TC06 - Cultural Issues for Digital Transformation
The category TC06 - Cultural Issues for Digital Transformation was formed with the Focal Categories indicated in Table 9. It seeks to evaluate the relevance of strategic partnerships that seek TD in companies of the Brazilian Sugar-Energy Sector.

Table 9: TC06 - Cultural Issues for Digital Transformation

TC ID	THEORETICAL CATEGORY	FC	FOCAL CATEGORY
TC06	CULTURAL ISSUES FOR DT	FC13	LEADERSHIP LITTLE RISK TOLERANT
		FC14	MANAGEMENT LITTLE TOLERANT TO FAILURE

Source: Research Data, obtained with NVivo®V12 (2022).

Digital Transformation generates implications related to work procedures, organizational structures and organizational cultures (Zheng, Venters, & Cornford, 2011). Therefore, a large-scale transformation is necessary, this being part of the TD (Paasivaara*et al.*, 2018). It was identified, in this research, indications of scenarios in which new functionalities built from digital and with potential for value generation are not explored by elements not evident still require action, as evidenced in the following fragment.

> **E5**: "[...] For a very simple reason there is still no action on things that would make a big difference in the field, such as the data flow from the harvester sensors that is still unidirectional, only for data storage and then analysis. It is possible to act, just as we do today, but with the current sensors, through

the operation center we could open a valve, turn an engine on or off, anyway."

For the interviewees, when they describe their projects in execution, as well as their elements, challenges and performance of the partner companies, it is concluded that the data collected confirm the existence of the element "TC06 - Cultural Issues for Digital Transformation", as indicated in Table 9.

n.   TC07 - Leadership Positioning in the Face of Digital Transformation
The category TC07 - Positioning of Leadership in the Face of Digital Transformation was formed through the Focal Categories, indicated in Table 10, which seeks to assess relevance of strategic partnerships that seek TD in companies of the Brazilian Sugar-Energy Sector.

Table 10: TC07 - Leadership Positioning in the Face of Digital Transformation

TC ID	THEORETICAL CATEGORY	FC	FOCAL CATEGORY
TC07	LEADERSHIP POSITIONING IN FRONT OF DT	FC15	LEADERS ENGAGEMENT FOR DT
		FC16	CLARITY ABOUT THE IMPORTANCE OF DT
		FC17	ARRANGEMENT FOR INVESTMENTS

Source: Research Data, obtained with NVivo®V12 (2022).

Organizations that adopt strategies for Digital Transformation need Leadership to promote and coordinate the alignment of the entire company so that Digital Transformation is a constant in the company. This element is able to indicate the most viable way for technologies to be incorporated in a more advantageous and competitive way (Bharadwaj *et al.*, 2013). This understanding was also identified in the data collected as in the following excerpt of speech.
> **E6**: "[...] As a critical factor, that we can ponder for the success that we are managing to have today, mainly is this vision of the executives of the areas. It stands to reason that technically a lot is still happening, a lot is still disconnected and for that our transformation program is in place."
> The Digital Transformation impacts the entire daily life of the company, especially the way, from which the subjects involved interact, being a process beyond the borders with customers, they are comprehensive that involve the entire functioning of an organization (Bharadwaj *et al.*, 2013), as indicated in the following speech fragment.
> **E5**: "[...] Our executive body having the vision that needs to have a transformation program and that this program permeates all the initiatives of the company, this is fundamental. When we talk about digital transformation, we are talking about uniting everything and it would be impossible to gather all the necessary resources for a real transformation if this does not come from the top down, I mean, from each area director making team time, people and passing on their focus on the theme to motivate these teams as well."

According to the interviewees, when they describe their projects in execution, as well as their elements, challenges and performance of the partner companies, it is possible to infer that the data collected confirm the existence of the element "TC07 - Positioning of Leadership in the Face of Digital Transformation", as indicated in Table 10.

o.   TC08 - Corporate and Technological Governance Relationship
The category TC08 - Corporate and Technological Governance Relationship was formed through the Focal Categories, indicated in the Table 11, seeks to evaluate the relevance of strategic partnerships that seek TD in companies of the Brazilian Sugar-Energy Sector.

Table 11: TC08 - Corporate and Technological Governance Relationship

TC ID	THEORETICAL CATEGORY	FC	FOCAL CATEGORY
TC08	RELATIONSHIP BETWEEN CORPORATE AND TECHNOLOGICAL GOVERNANCE	FC18	ALIGNMENT BETWEEN GOVERNANCE AND DT

Source: Research Data, obtained with NVivo®V12 (2022).

TD requires changes in the organization, including structure and elements related to the organizational culture. Reproducing new controls are fundamental so that current processes and systems, concomitantly with

modern technologies, can be managed and controlled. Therefore, comprehensive changes and aggregations in organizational governance are necessary (Carlo, Liitinen, & Boland Jr, 2012; Karimi, & Walter, 2015; Vial, 2019), as indicated in the following excerpt.

      E3: "[...] One concern of ours that has started to gain focus is how to keep all of this in control not only during, but after the projects slow down, it's a lot to organize and control, so we're starting a new comprehensive project focused on governance that started just as a master plan, now not only the processes, but policies, regulations and even new positions are being created to be able to control everything."

For the interviewees, when they describe their projects in execution, as well as their elements, challenges and performance of the partner companies, it is concluded that the data collected confirm the existence of the element "Digital Technologies and the Capture of Value for the Business", as indicated in Table 11.

V. Final Considerations

With this research, we sought to answer the following question: What are critical elements for the success of initiatives that seek TD in companies of the Brazilian Sugar-Energy Sector? Based on a constructivist perspective, this study used a qualitative approach to achieve the objectives. In particular, the methodological procedures were based on *Grounded Theory* as an investigation strategy.

As for the first specific objective proposed, related to the engagement of companies in the Brazilian Sugar-Energy Sector for TD, it was verified that the changes and adaptations generated during TD, enables an unlimited set and opportunities for value creation in business. It stands out as a critical factor for the success of the transformation the engagement and leading role of the business areas of the organization to develop, execute and incorporate digital strategies in their routines.

It should be noted that, considering the cultural characteristics of the Sugarcane Sector, the engagement demanded for the advancement of Digital Transformation programs is rarely spontaneous and needs to be driven by executive leaders who include in their routines activities to strengthen the organization's transformation agenda, highlighting the importance of transformation for the specific themes of their teams.

In addition, as a critical element for the success of initiatives that seek TD, we highlight actions that seek the engagement and leading role of business areas to develop, execute and incorporate digital strategies into their routines; such actions rely on the creation and capture of value for the organization.

In this discussion about the relationship between the engagement and leadership of the business areas and the creation and capture of value, it should be considered about the scope of the actions that seek to enable the TD, for example, the lack of specialization in particular themes for TD of the teams evidenced in TC01 (Strategic Partnerships for Digital Transformation), should be considered previously since the annual budget planning, making it easier to make up for the deficiency.

Regarding the second specific objective proposed – to identify what are the elements that make up the TD for companies in the Brazilian Sugar-Energy Sector – eight critical elements for TD were identified, according to the relationship proposed in Table 3. Regarding the third specific objective proposed, the analyses of the eight elements identified in companies of the Brazilian Sugar-Energy Sector were detailed and theoretically supported with the concepts presented in the sections 4.7 through 4.15.

Thus, it is concluded that TD occurs through the execution of multidisciplinary projects that transcend themes such as Technology and Strategy. Organizations that seek TD tend to succeed when they plan a long-term journey with a portfolio of projects that, in addition to technological issues, considers social and cultural particularities generating changes in paradigms already consolidated in organizations.

The theoretical relevance of the present work lies in the theoretical advance about TD and the critical elements for the success of initiatives and projects in companies of the Brazilian Sugar-Energy Sector, considering the gap identified in the bibliometric study (previously carried out) when uniting complex themes, of great importance, but insufficiently addressed together until then.

Thus, given that management research is challenged to develop knowledge from the perspective of science while contributing to the development of management practices, it is understood that, in companies in the Sugar-Energy Sector, change usually occurs with a focus on the organizational level, requiring academic research applied in real organizations, with the participation of agents at different levels (executive, tactical and operational) and in order to contribute with practical solutions, from the theoretical foundation of Digital Transformation and its elements (Pettigrew; Woodman; Cameron, 2001).

The Brazilian Sugar-Energy Sector supports much of the country's fuel, sugar and electricity production. It has already become the largest producer of sugar and the second largest producer of ethanol in the world, according to the Bank of the Northeast (2019). Doing that companies in the sector will be able to understand, use and articulate more assertive strategies in the sense of TD.

Given the findings described during the research, it is considered that this can bring relevant theoretical contributions to the advancement of digitalization also in other Brazilian industrial sectors. The other point is the complexity of TD, which implies understanding and changing central pillars of the competitiveness of organizations.

Of course, the research has some limitations: the results described here are typical of the companies studied and cannot be generalized or extended to other institutions, however, they can be useful for managers of organizations that intend to understand real characteristics and examples, according to what was described by the interviewees. The research took place during a delicate time for society, as the most intense part of the work occurred during the pandemic, caused by COVID-19, both in the organizations that were part of the research, and with the researchers, who had to adapt to the new reality.

At the end of this study, it is recommended that further research be carried out, aiming to increase the sample of interviewees, develop research in other regions of the country, apply other qualitative techniques (focus groups, Delphi), or quantitative techniques, which can test models and hypotheses elaborated based on the categories indicated in Table 3.

Quantitative studies may be able to evaluate and improve the conceptual model proposed in this research and thus measure the elements of TD. In addition, it is relevant to direct the studies to other sectors of economic activity, in order to verify whether the findings of this research can be applicable to other contexts.

It is recommended, for future studies, the validation and improvement of the Relationship Model between the Categories and their Elements, considering its use in quantitative studies. It is also understood that a primary study would be the adequacy of this model to a perspective of relationship between the element Partnerships with the grouping composed of Strategy, Leadership and Governance, and later with the grouping composed of Culture, People and Technology.

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