Similarities and Differences between Digital Transformation Maturity Models

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Abstract: This article has the main purpose of structuring and analyzing the available literature in the field of research on Maturity Models of Digital Transformation, both in the academic literature and in the publications of Consulting companies and Market studies. The research method was content analysis and it was possible to find 11 categories in which comparative analyzes were performed between DTMM The result of the comparison and analysis of the models helps professionals from different areas of activity, specialists, and academics to understand the similarities and differences between the models, and to assess the organization's readiness and capacity to make significant changes, such as, strategy, business model, products and services, and technology.

1   Introduction

In an increasingly digital scenario, in society and business, it is essential to think and rethink the use of digital technology to solve traditional and everyday problems. In this way, the Information Technology area must be structured to understand, in detail, the company's value chain and, thus, to incorporate technological innovations, which

will serve as foundations for the creation of competitive advantage. Information-based strategies are used to facilitate process changes aimed at reducing costs, creating differentiation in the product or service, increasing customer loyalty, and leveraging new business models for revenue growth over time [1].

With technological evolution and the increase computing capacity, new disruptive technologies have gained more and more relevance. As an example, it can be mentioned the IoT, Internet of Things, that promises to connect not only people but also objects of different natures to the world network, such as household appliances, vehicles, industrial machinery, public lighting, among others.

These changes are some examples of how Digital Transformation technologies and innovation have the potential to cause intense changes in the economy and society, including changes in procedures in different areas. Digital Transformation impacts and modifies the paradigm of technology use, in culture, government, environment, politics, economy, labor market, entrepreneurship, education, medicine, arts, religion, science, global communication, international organizations [2].

Digital Transformation is a process that comprises several phases, leading the company to the ability to meet the demands of a digital world with excellence. This process, to be better understood, should be considered as a process of "maturity" [3].

There are many models developed to measure maturity, strategic alignment, continuous improvement, organization agility and flexibility, enterprise architecture and knowledge management, and business development. These models are prescriptive in nature and were designed to assess the competence, capacity, and performance level of a selected domain based on a more or less broad set of criteria, that is, to assess the maturity of processes in organizations.

There is an exponential increase in the number of models, but there are still many challenges, such as limited empirical studies on their validation and a limited extension of the actionable properties of these models in guiding their application.

Due to the high complexity of the Digital Transformation process, companies have significantly increased the number of initiatives to improve their competitiveness in the digital world. researchers and consulting companies have developed several Digital Transformation Maturity Models (DTMM), with the aim of help companies diagnose

their stage of maturity and guide the way they should move towards leveraging a higher level of digital maturity.

As the nomenclature DTMM – Digital Transformation Maturity Models is not unanimous among consulting companies, nor in academia, in this work, Maturity Models, related to industry 4.0 [4] are also considered as DTMMs. In the analysis of the DTMM current situation, Academics and of consulting companies identify three deficiencies: the first one is that the majority of DTMMs are not academic, therefore they lack methodological rigor. The second shortcoming is that most DTMMs have dimensions that have not been empirically tested, meaning problems of methodological rigor and relevance of dimensions. Finally, most DTMM define a process of linear evolution on the way to the maturity of Digital Transformation, criticized by the authors for disregarding the specific characteristics of the industry and the organization [4].

Many DTMMs were developed to assess the status of an organization's Digital Transformation, and most of them were developed by companies in the field of specialized market research, with many similarities and many differences between them. Additionally, the DTMMs mention that managers and academics lack information to help them choose the DTMM that presents the best diagnosis to identify the organization's level of maturity in the digital transformation process [3].

The main objective and contribution of this work is to Present a detailed and critical comparative analysis of Academic, Consulting Firms, and Market Research Firms DTMMs proposals in order to help entrepreneurs, managers, specialists, and academics understand the similarities and differences between DTMMs.

2   Literature review

In this section, the basic concepts of this article are presented. Initially, the framework regarding the relevance of digital transformation and the digital economy is presented. Next, the meaning of the Maturity Model, its origin, characteristics, and its applicability to different segments of the organization are exposed. Finally, the MMTDs

developed by academia, consulting firms, and companies specializing in market research are presented.

2.1 The Digital Transformation and the Digital Economy

Digital Transformation, which received an enormous contribution through the third industrial revolution, especially in terms of communications, the Internet, and ICT (Information and Communication Technologies), still presents some uncertainty in terms of its different phases, comprises two well-known concepts: transformation and digital [5]. By "transformation" it can be understood as a general process that starts from an initial situation and moves towards an altered situation, supposedly better. However, some authors recognize that the choice of the term "transformation" was not the best one, due to the fact that the alterations and transformations underlying the concept usually take place on a continuous basis, with no end in view. "Digital" suggests that many of the changes in society, business and industry will be driven by information technologies that allow real time data processing and intelligently derive information to provide stakeholders with enhanced knowledge about your processes and products [5].

The digital transition of the economy is transversal to all societies, irreversible, and is undergoing an accelerated implementation process, that is, it is global. Digitization is present in everyone's daily lives, technology evolves at a fast pace and the impact it has on the economy and on the real-life of society are significant.

The digital transformation of companies cannot be dissociated from investing in the training and empowerment of people with digital skills, in competitive infrastructure, in innovation and generation of a favorable ecosystem, or in the digitalization of public administration.

It is necessary to work on the strategy and positioning towards the Digital, in order to help prepare companies for the current technological disruptions and work with the public and private ecosystem to generate a favorable environment in the digital economy to take advantage of opportunities for modernization and competitiveness.

Digital transformation and the digital economies are a reality and a necessity for a large number of companies, and there is still a lot of work to do for companies to benefit from this process.

The digitization of companies is essential to ensure their competitiveness in a globalized economy based on information and knowledge.

As the Digital Transformation subject is a contemporary topic, many articles were identified and evaluated in the literature review, but only two articles carried out a systematic literature review on Digital Transformation:

• "The Shape of Digital Transformation: A Systematic Literature Review" [7].

• "Conceptualizing Digital Transformation in Business Organizations: A Systematic Review of Literature" [7].

A systematic review of the literature demonstrated the growth of publications on Digital Transformation in the last five years [6]. The articles identified an evolution of the concept of Digital Transformation, previously defined as the development, adoption, and use of digital technologies, also treated as technological innovation, to a broader concept of adoption of digital technologies, the transformation of processes and business model for that the company can compete effectively in a digital world" [8]. In this evolution, adopting digital technology is no longer the final objective of the transformation process, becoming just one of the factors necessary for the transformation of the business model, which will allow the company to survive in a more digital business environment.

The articles also found the evolution of the concept of Digital Transformation, of an implementation of digital technologies or development of digital capabilities, for business model or a remodeling of the existing business model, considering digital capabilities [9], [10].

2.2 Maturity Models (MM)

Conceptually, a maturity model can be defined as a conceptual structure, composed of parts and states that define the maturity or level of development of a particular study area of interest. Maturity models

help identify and describe the processes that an organization must work on and develop to achieve the desired future scenario. Maturity models reflect aspects of reality to classify capabilities of certain domains of interest that can be used for internal analysis, market analysis, competitor analysis, and comparisons with domain references (benchmark). These models generally include dimensions and levels [11].

The authors [12] carried out a bibliographic survey, demonstrating, firstly, the evolution of the concept of "Maturity", from 1993 to 2009, and found in their study that many authors, using the concepts of quality, continuous improvement and benchmarking, claim that the MM is an instrument used to assess qualitative and quantitative capabilities, through a series of sequential levels, which together form an anticipated or desired logical path from an initial state to a final state of maturity. In this way, the MM allows companies to compare their maturity levels with their competitors and with those that present the best market practices [13].

When consolidating the characteristics of several Maturity Models, [12] categorized the Maturity Models by a number of maturity levels (Level 1 - Initial; Level 2 - Managed; Level 3 - Defined; Level 4 - Quantitatively managed; Level 5 - In optimization); discrete or continuous nature; quantitative or qualitative results; if they present a vision of continuous improvement; by applicability; model dispersion level; ease of use; simplicity of interpretation and consistency in terms of continuity between versions of the model [14].

State that Maturity Models have five characteristics:

1. Object of evaluation: refers to the objects to be evaluated in terms of maturity, such as technology, systems, people, project management.

2. Dimensions: refers to the specific capability areas that describe different aspects of the maturity of the assessed object such as "digital impact" and "digital readiness". Dimensions must be exhaustive and straightforward.

3. Levels: refer to the maturity state of the evaluated object.

4. Maturity principles: refers to the type of continuous Model and Maturity, where the classification is measured by the average of individual levels of different dimensions, and to the type of "staged" Maturity Model, when all elements of the level must be carried out in order to move to the higher level.

5. Assessment: refers to the method used to assess maturity, which can be qualitative (interviews) or quantitative (questionnaires with Likert scales).

In general, the MMs are considered an excellent tool for evaluating business strategy, models, and processes. Its organization and systemic structure allows executives, specialists, and academics to evaluate different aspects of the organization, defining, by comparison with the best market practices, the strengths, the level of maturity in relation to benchmarking and competitors, enabling the elaboration of action guides to reach the highest levels of market maturity [12].

2.3 Digital Transformation Maturity Models (DTMM)

For many organizations, digital transformation is a strategic priority to renew their business and remain competitive. However, managers find it difficult to define and implement digital agendas because they are unsure about the process, topics, and configuration. In order to provide an overview of the most important topics to the management, a literature review identified eighteen validated digital maturity models and frameworks that describe various dimensions or fields of action to consider for a digital transformation strategy [15].

According to author [16], from VTT - Technical Research Center of Finland Ltd, the MMTD helps to understand and structure the concept of digitization. Furthermore, it provides an estimate of the organization's current capabilities and maturity and general directions towards the desired maturity level [16]. This process affects IT, strategy, business model, products and services, internal and external processes, organization, and culture of a company [16]. Several authors corroborate this definition [8] [4] [3] [17] [18] [19] [20] [21], [22].

While implementing a Digital Transformation strategy, managers need to understand the concept of Digital Transformation and indicate possible areas of action [17]. DTMM must consider the differences of industries and their stages of development, so that its diagnosis and the classification of the maturity level are related to the organization's reality [17]. Digital Transformation has different effects in different industries and those that are customer-oriented and B2C (Business-

to-consumer) are impacted by digitalization faster and much greater than those with B2B (business-to-business). DTMMs can be categorized as [23]:

a) descriptive - company's current maturity level and objective.

b) prescriptive - guidelines for the company to reach the desired level of maturity.

c) comparatives - comparison of the current level with the market benchmarking and the maturity levels of competitors.

The DTMM cannot be generic, as the model is intended to guide managers through the analysis of company and industry-specific dimensions and categories of digitization. In addition, it helps to define Digital Transformation guides, comparing benchmarking with other organizations and assessing DT level of maturity. Only specialization can make this process viable [16]. A descriptive-qualitative-comparative DTMM is, for the most part, composed of a database fed by a questionnaire in the format of a five-level "Likert" scale. Its dimensions and maturity levels are validated with specialists, executives, and managers [16]. In order to be able to offer a comparison of maturity levels with organizations of the same sectors, size and location, there must be a process of constant updating of the database, through a digital solution by internet and a final report with the diagnosis of the company's Digital Transformation [16]. When the model is owned by a Consulting Company or Market Research Company, road mapping, business modelling, training, benchmarking, process modelling and definition of digitization prerequisites for companies are offered, with the aim of help on the path of digitization [16].

In a quantitative-descriptive model, its categories, dimensions, and maturity levels are deliberated with the definition of categories, dimensions defined and validated by specialists, managers and academics, and their maturity levels, calculated by statistical methods [17] [24]. The DTMM research, covering the publication period from 2010 to 2019, which will be the subject of section III, resulted in 8 academic publications, and 10 from Consulting and Market Research companies.

3 Methodology

The methodology used for the selection, categorization, comparison, and analysis of DTMMs is the content analysis methodology. Content analysis is a set of communication analysis techniques [25]. It can be a research technique that, through an objective, systematic and quantitative description of the manifest content of the communications, aims at the interpretation of these same communications [26]. It encompasses initiatives to make explicit, systematize and express the content of messages, with the aim of making logical and justified deductions regarding the origin of messages [25].

It is configured as a set of communication analysis techniques that make use of systematic and objective procedures for describing the content of messages [25].

It consists of a few steps to carry out the content analysis, organized into three phases:

Phase 1 - Pre-analysis

It is considered the phase of organization of the material to be analyzed in which, based on the defined objectives, the documents are read and selected. Finally, the categories that will base the comparison of the DTMMs and the final interpretation are defined, according to the following five steps:

• Step 1.1 Floating reading

It refers to the survey and reading of articles referring to Digital Transformation, Maturity Model, and DTMM.

• Step 1.2 Formulation of objectives:

The objective defined for the content analysis of this work is to compare the selected DTMMs, identifying similarities and differences.

• Step 1.3 Choosing documents:

At this stage, the criteria for selecting the documents to be analyzed are defined.

• Step 1.4 Definition of categories for comparison and analysis:

In the last stage of phase 1, the categories to be used for comparison and analysis of the DTMMs are defined.

Phase 2 - Exploration of the material

At this stage, academic DTMMs, from Consulting Firms and from Market Research Firms are categorized and compared through the frequencies of each category.

• Step 2.1 Categorization

According to [26], categorization is the process by which raw data are systematically transformed and aggregated into units, which allow an accurate description of the relevant characteristics of the content.

• Step 2.2 Comparison of articles

To compare the DTMMs, quantitative analyzes will be used, through the frequency of the categories.

Phase 3 - Treatment of results, inference, and interpretation

The last phase consists of processing the results, inference, and interpretation. In this stage, the condensation and highlighting of information for analysis occurs, culminating in inferential interpretations, it is the moment of intuition, reflective and critical analysis (Bardin, 2016).

And for the selection of DTMMs, the following criteria and rules proposed by [26] were used:

• Exhaustiveness rule

The research field must be justified, in the case of Digital Transformation, Maturity Model, and DTMM and the database to be searched (Web of Science and Science Direct).

• Representativeness rule

The selected documents must be a representative part, in this case, of the Digital Transformation universe, Maturity Model and DTMM.

• Rule of Homogeneity

The documents selected must be homogeneous, that is, they must comply with precise selection criteria.

• Relevance rule:

The selected documents must be suitable, as a source of information, to support the concepts of the Digital Transformation and Maturity Model and for comparison with other DTMMs.

The selection of documents must meet the rules of exhaustiveness, representativeness, homogeneity, and relevance [25].

Of the total of 10 DTMMs from Consulting firms and from Market Research firms selected by the authors [4]. 6 DTMMs were discarded due to the lack of information necessary for their categorization and/or the impossibility of access. With the same criterion, the academic articles were selected, out of a total of 8 DTMM, 1 DTMM was discarded, according to Tables 1 and 2.

Table 1. Digital Transformation Maturity Models of Consulting Firms and Market Research Firms

DTMM	N.º	Name	Reference
Selected "Consulting Companies"	1	Deloitte	Achieving Digital Maturity - MIT Sloan Management Review and Deloitte University Press. (Kane et al., 2017)
	2	PWC	Digital Business: Towards a Value Centric Maturity Model. PwC Chair in Digital Economy at the Queensland University of Technology. Austrália. (Shahiduzzaman et al., 2017a, 2017b)
Selected "Market Research Companies"	3	Forrester	The Digital Maturity Model 4.0 Benchmarks: Digital Business Transformation Playbook, 2016 Forrester Research, Inc., 60 Acorn Park Drive, Cambridge, MA 02140 USA. (Gill & VanBoskirk, 2016)
	4	VTT	VTT Report "Towards a new era in manufacturing" Final report of VTT's For Industry spearhead programme. (Paasi, 2017)
Not Selected "Consulting Companies and Market Research Companies"	5	Acatech	Industrie 4.0 Maturity Index. Managing the Digital Transformation of Companies (Acatech STUDY), Munich: Herbert Utz Verlag. (Schuh et al., 2017)
	6	Accenture	Accenture. European Financial Services Digital Readiness Report. 2016. (Knickrehm et al., 2016)
	7	Arthur D Little	"Digital Transformation – How to Become Digital Leader" Arthur D. Little Digital Transformation Study. (Opitz et al., 2015)
	8	IBM	Digital transformation: opportunities to create new business models, Strategy & Leadership. (Berman & Bell, 2011)
	9	Microsoft	The Digital Transformation Report - Microsoft Company and Qvartz. Denmark. (Moller & Galskov, 2016)
	10	VDMA	Industrie 4.0 Readness - VDMA's IMPULS-Stiftung. Aachen. Cologne. (Lichtblau et al., 2015)

Table 2. Academic Digital Transformation Maturity

DTMM	N.º	Name	Reference
Selected	1	(Berghaus et al., 2015)	Stages in Digital Business Transformation: Results of an Empirical Maturity Study. MCIS-Mediterranean Conference on Information Systems. Proceedings. 22. Suiça.
	2	(De Carolis et al., 2017)	A Maturity Model for Assessing the Digital Readiness of Manufacturing Companies. IFIP Advances in Information and Communication Technology. IFIP WG 5.7 International Conference, APMS.
	3	(Klötzer & Pflaum, 2017)	Toward the Development of a Maturity Model for Digitalization within the Manufacturing Industry's Supply Chain. Proceedings of the 50th Hawaii International Conference on System Sciences.
	4	(Remane et al., 2017)	Digital Maturity in Traditional Industries - An Exploratory Analysis. 25th European Conference on Information Systems. (In Proceedings).
	5	(Schumacher et al., 2016)	A maturity model for assessing Industry 4.0 readiness and maturity of manufacturing enterprises.
	6	(Tonelli et al., 2016)	A Novel Methodology for Manufacturing Firms Value Modeling and Mapping to Improve Operational Performance in the Industry 4.0 era. 49th CIRP Conference on Manufacturing Systems (CIRPCMS).
	7	(Valdez-de-Leon, 2016)	A Digital Maturity Model for Telecommunications Service Providers. Technology Innovation Management Review (Volume 6, Issue 8).
No Selected	8	(Lichtblau et al., 2015)	Industrie 4.0 Readiness. Impuls-Stiftung für den Maschinenbau, den Anlagenbau und die Informationstechnik, Online Publication.

In the systematic review of the literature, several studies were identified where it is possible to find a definition of the categories on which the comparative analyses between DTMM were performed [4] [3]. These authors proposed 17 categories for the comparative analysis between DTMM. These 17 categories were consolidated into 7 categories due to the similarity of content between them and added to 4 categories defined based on the main factors of implementation of the Digital Transformation process according to [16]. Totalling 11 categories presented in Table 3.

Table 3. DTMM Categories

	Categories	Content
1	Objective	Purpose of application of the DTMM.
2	Dimensions	Dimensions: refer to the specific capability areas that describe different aspects of the maturity of the assessed object, for example, "digital impact" and "digital readiness". Dimensions must be exhaustive and straightforward.
		Number and focus of dimensions: refer to the number of dimensions of analysis and the areas of focus capabilities of the analysis.
3	Maturity Levels	Clusters: refer to the maturity levels proposed by the DTMM.
		Digital maturity assessment refers to the maturity levels of the model.
		Evolution: refers to the process of linear or non-linear evolution between maturity levels.
		Axes of analysis or direction: refer to the number of alternatives or directions that the company has to go through the maturity levels, which can be unidirectional or with more directions.
		Determining the maturity level refers to the method for defining the maturity level, which can be qualitative (by interview), quantitative (questionnaire with a Likert scale, complex statistical techniques), or mixed.
4	Industry Type	Industry Type: refers to the type of industry in which the DTMM can be applied.
		Target Audience: Refers to the target audience that will gain value or benefits from your organization's maturity analysis.
5	Preparation and maintenance of the DTMM database	Result visualization: refers to the presentation models of dimensions and maturity levels, for example: graphs, tables, numerical scores, etc.
		Assessment and data collection: refer to the model for capturing data through self-assessment, the use of an online or printed questionnaire and indicators of best practices.
		Benchmarking and Gap Analysis: Refers to using industry-level benchmarks and presenting the difference analysis to the benchmark.
		Approach: refers to the method used to define maturity levels, which can be argumentative or empirical.
6	Descriptive, prescriptive, and comparative	Type of MM: refers to descriptive models, whose characteristic is to present only the organization's digital maturity level; also, the prescriptive models, which, in addition to presenting the level of maturity, offer a roadmap of actions to advance between the different levels of maturity, for each of the dimensions analyzed.
7	Methodological Rigor and Adaptive Potential	Methodological rigor: refers to the use of methodology to support the DTMM, allowing the use of its results for future research or generalizing its conclusions.
		Adaptive potential: refers to the ability of the DTMM to adapt to the characteristics of the company and industry, and to updates indicators with best practices.
8	Technology versus Organizational Transformation	Technology and Organizational Transformation refers to the comparison of the importance level of the model for actions focused on technology and/or for organizational transformation with the objective of DT process effectiveness.

Categories		Content
9	Organizational Areas and processes	Main organizational areas and processes refers to the comparison of the organizational areas and processes proposed by the authors to be addressed by the DTMM.
10	People Preparation	People preparation: refers to the comparison of the main human resources development factors proposed for the effectiveness of the DT process.
11	Business Model and Organizational Strategy	Business Model and Organizational Strategy refers to comparing the level of importance assigned to changing the organizational strategy and/or the business model.

4   Results and Discussion

The analysis of the results was obtained through the comparisons of Academic DTMMs, Consulting companies and Market Research companies based on the seven categories proposed by [3]. In addition, four more categories refer to the main critical factors for the implementation of the Digital Transformation process [16].

The analyzes were structured in order to compare the characteristics of the 11 selected DTMMs with 11 categories [27]. The use of 11 categories, in addition to meeting the categories of [3], aims to enable a comprehensive and detailed comparative analysis of DTMMs, from the perspective of the researcher, who wants to study and develop an DTMM, and from the perspective of the entrepreneur, who wants to use it as a tool to support him in defining a guide. and implement Digital Transformation.

The first category refers to the objectives of the DTMMs. When comparing the objectives of Academic DTMMs, Consulting companies and Market Research companies, it appears that three are common to all DTMMs, namely: 1. Identify the organization's level of digital maturity; 2. Compare your results with those presented by the researched market; 3. Present analysis and information that help the entrepreneur to define his Digital Transformation guide.

The second category refers to the dimensions of the DTMMs. Based on the comparison between Academic DTMMs, Consulting Firms and Market Research Companies, it can be verified that of the 8 DTMMs of greater complexity, 5 DTMMs use axis dimensions; that is, they consider that the dimensions referring to organizational management are impacted by Digital Transformation and should be

considered to assess the level of maturity in the DTMM. It is verified, when comparing the dimensions of DTMM of higher complexity with those of lower complexity, that the dimension "Organizational Strategy" is more referenced in models with higher complexity.

The third category involves maturity levels. It can be concluded that the organizational factors are preponderant, if compared to the technological ones, in the evaluation of the organizations' maturity levels. Furthermore, that all DTMM authors point out technology, management and human factors, business model and strategy as one of the five most relevant factors for the Digital Transformation process. The Academic DTMMs adopt the highest amounts of maturity levels, if compared with the DTMMs of Consulting companies and Market Research companies. Another point of analysis about DTMMs is about the type of evolution of maturity levels, which can be linear and one-dimensional, or non-linear and multidimensional.

In the fourth category, referring to the type of industry to be served by the DTMM, three different approaches are identified. In the first, the author specifies the type of industry to be served by the model, in the second, he develops a generic model to meet any type of organization, and finally, a generic model, to meet the objectives of Industry 4.0. The results demonstrate that two DTMMs are generic, nine are specialists and, of these nine DTMMs, eight are targeted at Industry 4.0. Of the two generic DTMMs, one is academic, and the other is from a consulting firm.

The fifth category refers to the formation and maintenance of the DTMM database. Regarding data entry, ten DTMMs use online questionnaires in a "Likert" scale format. When analyzing the update and maintenance of the model and the database, only five DTMMs update the database and review the dimensions and maturity levels. In the analysis of the formation of the database to define dimensions and maturity levels, it appears that all Academic DTMMs, from Consulting companies and Market Research companies, had their surveys, interviews and case studies carried out in European and U.S.

The sixth category refers to the classification of DTMMs into descriptive, prescriptive, and comparative. As for the descriptive models, only two descriptive DTMMs do not have a database that allows comparing the results with competitors and benchmarking. All other descriptive and comparative models have a historical database that allows you to compare the maturity level with benchmarking and

competitors presented online. It appears that only two DTMMs have their models defined as prescriptive and comparative by their authors. Despite being prescriptive, none of them presents a Digital Transformation guide as a result.

The seventh category refers to the methodological rigor and adaptive potential of DTMMs. As a result of the methodological rigor analysis, all qualitative DTMMs lack information on the criteria for defining organizational dimensions and maturity levels. As for the adaptability of the DTMMs regarding the database and new versions, three DTMMs do not present information that indicates the process of updating the data in the database and the model itself. Regarding the adaptability of DTMMs for applications in other industries, it is verified that all models categorized as generic by their authors meet this requirement.

The eighth category refers to the comparison of technological and organizational factors. It appears that 100% of the authors report the greater relevance of organizational factors compared to technological factors in the process of Digital Transformation. In the comparative analysis of Academic DTMMs, Consulting companies and Market Study companies, regarding dimensions, not only the presence of organizational factors is observed, but also the greater weight attributed to these factors in the composition of DTMMs regarding technology. And it turns out that all DTMMs have several dimensions with organizational factors much larger than the technological ones.

As for the ninth category, organizational areas are one of the factors for comparing the DTMMs that allow us to understand the authors' view regarding the extent of the impact of Digital Transformation within the organization. It appears that all authors refer to organizational areas as a basic factor for calculating and evaluating the level of digital maturity of the organization involved in a process of Digital Transformation. Five DTMMs define that all areas must be analyzed generically, without their digital maturity levels being calculated individually. Two academic DTMMs define that all organizational areas must be analyzed individually, and their digital maturity levels calculated. Due to the different languages and criteria used by the authors of the DTMMs, they can treat organizational areas as processes.

As for the tenth category, to analyze the preparation of human resources for the Digital Transformation process, the dimensions

"Digital Talent", "Leadership" and "Culture" should be considered. It appears that the DTMMs of Consulting companies and Market Research companies point out the factors "Digital Talent", "Leadership", "Culture" with less frequency in organizational dimensions and maturity levels than Academic DTMMs.

The last category refers to the comparison of DTMMs by the factors "Business model" and "Organizational strategy". Based on the data presented, it can be inferred that the authors of the Academic DTMMs, from Consulting companies and Market Research companies studied, consider the two dimensions, "Business Model" and "Organizational Strategy", as the relevant factors for assess and calculate the level of digital maturity of an organization. In addition, planning and adapting these factors to the reality of the digital world will help entrepreneurs, managers, and experts to define a more effective Digital Transformation guide, which can help the company to leverage higher levels of digital maturity. Still, taking advantage of the benefits of a more digital world to achieve your goals.

5   Conclusion

The present study had as its starting objective "To present a detailed and critical comparative analysis of Academic DTMMs, Consulting companies and Market Research companies to help entrepreneurs, managers, specialists and academics understand the similarities and differences between them".

This objective was fully achieved with the presentation of the comparative and critical analysis of the DTMMs, as the results of the analysis should help entrepreneurs, Digital Transformation specialists, and academics to:

> ➢ Understand and structure the concept of digitization.

> ➢ Understand the impact and assess the organization's readiness and ability to change strategy, business model, technology, products and services, internal and external processes, organizational structure, and company culture.

> ➢ Guide managers in the analysis of dimensions and categories of digitization specific to the company and industry to which it belongs.

▷ Provide general instructions with a guide to Digital Transformation towards the desired maturity level.

▷ Analyze the similarities and differences of the Digital Transformation Maturity Models studied and presented in this work, help companies from different sectors to identify at what level of digital maturity the business is, and will help in the evaluation of the technologies used, to observe the organizational culture, thinking about the market vision and being attentive to the customer experience.

The great value of models based on levels or stages of maturity lies in their ability to provide organizations with guidelines to consistently develop their processes, which implies that these will be documented, measured, controlled, and continually improved over the course of time. time.

The results presented must be analyzed with restrictions, recognizing their limitations. The first involves the reduced amount of information from DTMMs from Consulting Firms and Market Research Firms. As scientific rigor is not required for these documents, much information is not presented, which limits the analysis of comparison categories. The main impact of the lack of this information is at the level of comparative analysis of the business models and the proposed digital strategies. Another limitation refers to the categorization of the DTMMs: categorizations and consolidations were made in the axis-dimensions, organizational dimensions and in the factors of maturity levels. The analyzed texts are written in English, originating in different countries, types of industry and market. Categorizations were made by interpreting the text of the DTMMs, by the author of this work. As the language of Digital Transformation and the DTMM is not standardized, different interpretations can be given to the analyzed texts, which can imply interpretation bias.

It is believed that this work has great potential for several future works, as it deals precisely with a relevant and extremely current theme. Thus, one possibility and suggestion for further research is to carry out surveys and studies of other dimensions for a more consistent Digital Transformation, such as: i) Digital Technologies and Processes; ii) Analytical and Predictive Capacity (Predictive Analytics); iii) Relationship with Customers; iv) Network Relationship (Suppliers, Startups, Governments, Universities, Investment Funds, among others); v) Risks and Investments.

The massification of Internet access and the use of smartphones has been causing one of the biggest and fastest transformations in human history. Never has human society undergone so many transformations in such a short space of time, as in the period since the turn of the millennium. The way people work, communicate, inform, and entertain has changed radically in recent years, largely due to the entry of digital into the various components of our lives. And not to mention the countless changes, possibilities and impacts resulting from the Covid-19.

In this context, Digital Transformation is one of the main topics on the agenda of companies, in the most diverse sectors and geographies. In the relationship with consumers, companies are using digital technology to get to know their customers better and, thus, provide products and services that are more personalized and customized to the needs and preferences of each one. Digital is also being used to expand the channels available to consumers, such as e-commerce (Electronic Commerce) and e-care (automated health care) solutions, which allow customers to purchase products and services, as well as manage their relationship with companies, anytime and from anywhere.

Digital technology is currently also the main driver of innovation and transformation of the way companies operate. The digitization and automation of processes guarantee strong gains in efficiency, allowing employees to dedicate themselves to functions with greater added value. The dematerialization of documents is an example of how digital allows cost reduction with strong environmental benefits. Additionally, the emergence of digital tools allows for greater agility in the way people work. In many companies, there are no more fixed jobs, with employees having the freedom to sit next to colleagues with whom they are collaborating on a given project, and there are more and more mobility solutions where work from home is allowed for several days. per week.

Companies also play a key role in ensuring that the benefits of digital technology reach the greatest number of people and have a positive impact across society.

Another conclusion of this article, after the research and studies carried out, is the need for companies to create a culture for Digital Transformation. Considering the suggested conceptual model, there is an urgent need to better understand that a digital culture is a

consequence of a new organizational structure, facing risks, invest-
ments, and new digital business models.

In this sense, the search for Digital Transformation has been an
alternative to overcome the lack of understanding on the subject and
the future risks for the business. Therefore, it is essential to have a
renewed business agenda with a broader perspective, which combines
new processes, management, effective technological conditions, and
decision levels committed to the new business environment.

The success of digital transformations depends on several varia-
bles, the speed of Digital Transformation can vary depending on the
company and according to how close a sector is to its inflection point.
The need to invest in resources to capture value from existing business
models, or to develop new ones, increases with the transformation of
the sector.

It is worth mentioning that companies that want to be successful in
their Digital Transformation and want to reach higher levels of digital
maturity in the global context need to be attentive to specific actions
that are directly related to the dimensions investigated in this work,
and to the dimensions suggested in the item "Proposal for future
work" of this work.

Strategy: Important and essential to execute digital initiatives in-
side or outside the company: deciding where to execute the initiatives
according to the strategy, leveraging existing strengths in units within
the company (e.g., channels and customer base) or launching initia-
tives "from the zero", which have fewer synergies, separately.

Skills: It is recommended to develop new skills in the company:
choose a digitalization model that allows digital skills to mature, es-
tablish policies, tools, and new ways of working with the goal of
achieving an organization in which digital and the rest of the business
are indistinguishable.

Organization: In organizations, ensuring accountability for the
transformation: defining the structure and governance to follow up on
the transformation (e.g., a centralized "transformation office", gov-
ernance forums), minimizing management fragmentation and aiming
for greater accountability on the part of the organization's top man-
agement. Search, hire and have digitally savvy leaders in the organi-
zation directly involved in the transformation supporting the mindset
of challenging the status quo and driving change. Broadly, build dig-
ital competencies in the organization, preparing the employees of the

future, in addition to digitizing tools and work processes of daily use and expanding decision-making based on data and analytics.

Culture: Work and promote new ways of working that foster greater autonomy, continuous learning, and open work environments. Often communicate the purpose of the transformation, using both digital and traditional means.

In short, the success of a company's Digital Transformation will be decisive for its permanence in the current and future market.

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