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Assessing the relevance of digital maturity axes in organizations: findings from a Delphi study

Avaliação da relevância dos eixos de maturidade digital nas organizações: resultados de um estudo Delphi

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Abstract

Purpose: This study examines the relevance of eight axes for evaluating the digital maturity of organizations, as perceived by a substantial and heterogeneous panel of participants that was engaged in a two-round Web-Delphi process.

Design/methodology/approach: The panel comprised individuals with varying degrees of knowledge, expertise, and practical experience in areas related to digital technology. Using the Welphi platform, each participant completed the following sentence for each of the eight axes: 'In terms of preparing for the digital age, achieving good performance on this axis is ...'. The choice between the following three levels of relevance was offered: critical, fundamental, and complementary.

Research, Practical & Social implications: It was found that participants who had engaged in digital transformation processes within their organizations were more likely to alter their opinions from the first to the second rounds. The analysis of the Delphi results indicated that, for the panel as a whole, the axes were perceived as having different levels of relevance, and that there were also differences in the perception of relevance between experts and non-experts with regard to each axis. It is thus recommended that future developments in enhanced digital maturity models should incorporate these findings and establish the axes' levels of relevance through collaborative processes.

Originality/value: Regarding the levels of relevance.

Keywords: Digital maturity, Digital transformation, Web-Delphi, Participatory approach.

Resumo

Objetivo: Este estudo examina a relevância de oito eixos para avaliar a maturidade digital das organizações, conforme percebida por um painel substancial e heterogêneo de participantes que participaram de um processo Web-Delphi em duas rodadas.

Metodologia/abordagem: O painel foi composto por indivíduos com diferentes níveis de conhecimento, experiência e vivência prática em áreas relacionadas à tecnologia digital. Utilizando a plataforma Web-Delphi, cada participante completou a seguinte frase para cada um dos oito eixos: "Em termos de preparação para a era digital, alcançar um bom desempenho neste eixo é...". Foi oferecida a escolha entre três níveis de relevância: crítico, fundamental e complementar.

Implicações práticas e sociais da pesquisa: Constatou-se que os participantes que haviam se envolvido em processos de transformação digital em suas organizações foram mais propensos a alterar suas opiniões da primeira para a segunda rodada. A análise dos resultados do método Delphi indicou que, para o painel como um todo, os eixos foram percebidos como tendo diferentes níveis de relevância, e que também houve diferenças na percepção de relevância entre especialistas e não especialistas em relação a cada eixo. Recomenda-se, portanto, que os desenvolvimentos futuros em modelos

aprimorados de maturidade digital incorporem essas descobertas e estabeleçam os níveis de relevância dos eixos por meio de processos colaborativos.
Originalidade/valor: Em relação aos níveis de relevância.
Palavras-chave: Maturidade digital, Transformação digital, Web-Delphi, Abordagem participativa.

Introduction

To remain competitive in the market, companies have to adapt their organisational models to meet challenges related to digital processes (Weritz et al., 2020). Improving digital competitiveness is a continuously challenging process, usually consisting of small steps (Kane et al., 2017). To support companies in establishing organisational digital maturity at an adequate level, several models have been developed, such as the McKinsey and MIT ones (Rossmann, 2019) (Teichert, 2019) (Ochoa, 2016). These are used to assess the status of organisations' digital transformation through different dimensions (axes), as well as their ability to continuously seek the best practices in the market (Remane et al., 2017).

Berghaus (2016) has emphasised the importance of involving all areas of the organisation in building dimensions for the digital transformation process. Nevertheless, despite the premise addressed by some authors, how to adapt maturity levels to the needs of organisations and each sector in the development of technological capabilities, with the participation of all those involved, has not so far been found in the literature. To achieve this goal, we share the view that a participatory methodology with a collective and integrated decision-making approach is recommended. This facilitates the capture of different perspectives of the relevant actors in the formalisation of an interdisciplinary and multidimensional model (Ochoa, 2016).

In fact, whenever there is a complex decision where the models are structured with the fundamental objective of measuring the status of the current situation of organisations, a methodology with the participation of everyone involved in the process is necessary (Ochoa, 2016). This increases the likelihood of establishing more relevant axes for the evaluation process (Salgado et al., 2020).

Given the above, there was an opportunity to explore a participatory approach for the assessment of the relevance, in the light of a variety of actors, of different axes that make up a digital maturity assessment process (Bana e Costa, 2019).

The axes analysed are the eight axes included in the CESAR Digital Transformation Index (ICTd) digital maturity assessment model: culture and people; consumers; competition; innovation; processes; business models; data and regulatory environments; and enabling technologies. ICTd is the index of digital transformation, launched

in 2019 by CESAR (the 'Centro de Estudos e Sistemas Avançados do Recife' (https://materiais.cesar.org.br/about-us), a Brazilian centre for innovation, with the objective of evaluating organisations, from various economic sectors, for the digital era, through an organisational diagnosis carried out through a questionnaire. As stated by CESAR (http://transformacao.cesar.org.br), the eight axes are relevant indicators that determine the digital maturity of an organisation in the construction of a new market survival value, and that transforms the organisation into a more competitive entity, through the digital integration of all its areas, with the main objective of a more viable communication throughout the entire process.

However, the ICTd implicitly takes the evaluation on all the eight axes as equally relevant to calculate an overall score to measure the level of digital maturity of an organisation, regardless of its sector of activity, which is in contradiction with some authors' recommendations, namely Marks & AL-Ali (2020) and Chanias & Hess (2016).

This article presents the results of a Delphi study that departed from the eight ICTd axes to address the following research question: To what extent do different types of actors involved in the digital transformation process perceive the hypothesis of equal relevance of all axes to be valid?

The rest of this article is organised as follows. Section 2 is devoted to digital maturity, and describes, after a short overview of the subject, different digital maturity models found in a literature review. Section 3 addresses the Delphi method used to capture participants' perceived relevance of the axes that compose the CESAR Index of Digital Transformation – ICTd. The results of the study are presented in Section 4 and discussed in Section 5. Section 6 concludes the article.

Literature Review

Digital maturity

Organisations have been facing new challenges in the process of integrating digital transformations (Jaico et al., 2019), changing operational models into digital models, optimising processes, and maximising value of goods and services (Rautenbach et al., 2019). From effective combinations of best practices and available resources, digital maturity models are increasingly applied with the aim of determining the behaviour manifested by organisations (Dutta et al., 2021), taking as a basis their skill levels with digital technology to draw the best performance from digital transformation (Ivančić et al., 2019). As organisations need to be flexible in order to become more competitive, Doneva et al. (2019) find digital maturity models should emerge at this time, to seek the best for each organisational reality, identifying desirable maturity levels, and helping to transform the strategic context of organisations.

Thus, digital transformation consists of adopting technologies to help organisations work in an integrated manner, providing faster responses, with greater flexibility through intelligent systematised processes (Gollhardt et al., 2020). Digital Maturity refers to the status of an organisation's digital transformation (Teichert, 2019) – the performance practices that led the organisation to build a more digital and competitive business, developing capabilities to respond to the environment in an appropriate way. For Doneva et al. (2019), the digital transformation adapted to the ability to integrate digital technologies of organisations in their business models, established the development of entrepreneurial and innovative organisations through changes in the organisational environment, in the transformation of structures, culture, and processes.

Digital maturity models

Teichert (2019) presents a study of 22 digital maturity models, 12 of them developed in academic institutions. The other ten, developed by industry-based consultant firms, are recognised as the most practiced models in the digital world. For Rossmann (2019), most of these models were driven by the PWC Industry 4.0 model, in anticipation of the development of more improved models; this justifies the fact that a greater number of models presented in the study highlight the assessment of manufacturing processes (Teichert, 2019, p. 1685). Each model proposes a set of different dimensions (varying from four to nine) for the evaluation process of digital maturity, with 'culture' taken as a more relevant role in the models developed by consultants than in those with origin in academia.

Most of the models, designated as non-prescriptive by Teichert (2019), have a digital maturity assessment protocol based on digital transformation, without dimensions contributing to reach a competitive digital maturity level. In addition, most of them do not present a preference model in relation to the established dimensions, that could allow for a collaborative and specific assessment for each organisation. For Morakanyane et al. (2017), organisations with the highest level of digital maturity have stood out in the market, with a competitive financial performance, by exceeding objectives in various dimensions: for this reason, digital transformation should have the creation of value for both the business and the customer as its main objective. However, for Ochoa (2016), in the various models that are imposed on the market, the understanding of 'how' to achieve this business value is not clear, as nothing else is available, apart from the chain of steps to progress to the maturity level.

As an evolutionary consequence, it is a fact that digital transformation has gained great emphasis in the business world in the sense of changes that must happen for the evolution of organisations in general. However, despite this importance, Teichert (2019) points

out that among the 22 models analysed, most provide incomplete results, and also do not make clear what they classify as 'the stages of digital maturity', considering only the importance of digital transformation in what is called 'domain manufacturing'. This author also stresses the importance of developing new models that can integrate other domains, in addition to manufacturing. Chanias and Hess (2016) complement this with the belief that, in the methodologies used in data processing, the procedures are difficult to understand, making it hard to communicate with the organisation's management and, consequently, to reproduce the results due to the lack of transparency.

Two digital maturity models that became references for the creation of new models were developed by McKinsey and MIT. They propose distinct evaluation measures. The McKinsey Digital Maturity Index is based on a model whose architecture emphasises the importance of digital transformation in each process (https//www.mckinsey.com), given the entire supply chain as being important for the transformation, with the integration of suppliers, passing throughout the internal process, up to the feedback from customers regarding the products and services offered (Ochoa, 2016).

The MIT model (Kane et al., (2017) arose from a study conducted by MIT in 400 organisations, in which they surveyed digital practices adopted, and how the adequacy of the actions was processed in the face of these new digital methodologies (Ochoa, 2016). Based on the survey feedback, the model was structured by combining two dimensions of great importance to define digital maturity: the digital intensity and the intensity of transformation management. For the MIT model, the informatisation of processes alone is not enough to maximise an organisation's value; it should also know how to use digital technology to add value, seeking to invest in new digital opportunities and develop a digital culture (Ochoa, 2016).

For Chanias and Hess (2016), despite the acceptance of the existing models in the process of transformation of digital technologies and capabilities, the standardisation of the assessment based one-dimensional indicators does not favour the achievement of the main objective, due to the fact that the whole process of digital maturity assessment is based on 'created recipes', without any flexibility to better adapt to the context of each organisation. The linearity of digital maturity models, emphasised by Remane et al. (2017), is considered a critical simplification that can lead to errors in the assessment process, requiring a more accurate analysis of digital maturity levels.

Remane et al. (2017) also state the need for a more complete digital maturity model that is able to define dimensions that would recognise the importance of digital transformation to meet the strategic needs of the organisation being evaluated. It is worthwhile emphasising that, as remarked upon by

Chanias and Hess (2016), in most models the dimensions refer to the strategic aspects of the organisation, focussing on the internal perspectives. This is in line with Ochoa (2016) in advocating the integration of all dimensions, such as people and cultures, management systems and, consequently, technology, in a long-term process for the implementation of capabilities, aiming at a progressive evolution.

Chanias and Hess (2016) also highlight the limitation of not considering performance indicators and market feedback in the digital maturity assessment process. In addition, most models do not indicate possible solutions to the identified restrictive gaps. This deficiency results from a superficial analysis carried out in both methods used by the models to obtain parameters for the assessment process, either qualitative or quantitative.

For Morakanyane et al. (2017), despite the existence of several models, there is still a difficulty in understanding the defined dimensions, due to the heterogeneity presented. Perhaps, this difficulty led to little understanding regarding the applicability in certain organisational sectors, as most of the models developed by both academics and consultants have an emphasis on production organisations. Moreover, these models only focus on the assessment of the level of digital maturity and not on a continuous assessment, which would offer a useful methodology for the development of processes with the aim of achieving a competitive level of digital maturity, in accordance with the objectives of the organisation.

Finally, investing in the latest technology available, seeking to transform the organisation into a digital one, is little when compared to the need to develop, in parallel, the implementation of digital skills. In summary, a holistic model should be developed with dimensions that could enable the development and achievement of digital maturity in a progressive and continuous process, with a focus on a more flexible organisation and methodologies aimed at improving its products – and especially services (which have little representation in the models discussed). The importance of a transparent and replicable model is also highlighted, given the inevitability of continuous improvement of processes, as the models presented do not have the necessary information for organisations to reach their level of excellence in digital maturity.

CESAR index of digital transformation (ICTd)

Based on the two main reference models, the McKinsey and the MIT ones, and taking into account the importance of the evaluation process of an organisation's digital maturity as a competitive factor, CESAR centre for innovation created the ICTd with the objective of evaluating Brazilian organisations in relation to their digital strategies. Although CESAR clients are organisations from the most varied eco-

nomic sectors such as agribusiness, education, and government, most of CESAR's clients are manufacturing (industries). Nevertheless, the CESAR organisation also focusses on digital technology and software development. The process consists of evaluating organisations from the most varied sectors of the economy using eight perspectives considered by CESAR as relevant in digital transformation, in a qualitative and informative process in order to understand the organisational level of digital transformation.

The ICTd includes eight axes (described in Table 1) considered relevant for an organisation to reach its digital maturity: culture and people; consumers; competition; innovation; processes; business models; regulatory data and environments; and enabling technologies.

For each axis, a questionnaire should be filled in about the organisation's status according to several indicators, and at the end a report is sent to the organisation with considerations about its level of digital maturity on each axis and with an analytical score (the ICTd of the organisation) obtained by average sum, with equal weights assigned to all the eight axes. The discussion of the structure of this model is out of the score of this article.

Methodology

A Delphi process was conducted to analyse the relevance of each of the eight axes of the ICTd, as perceived by a large panel. The Delphi method is particularly useful to engage many participants and it is characterised by (see a discussion in (Landeta 2006)): i) iteration, with the existence of different rounds, where each participant has the opportunity to review their answers in light of the group's opinion; ii) controlled feedback, where group opinion feedback is provided after each round; iii) anonymity, and iv) statistical aggregation.

Hence, using the Delphi method enabled the creation of a participatory environment in line with what is being proposed in the literature. The Delphi process was divided into two stages (Figure 1). In the preparation stage, the problem was stated and the panel of participants was defined. In the second stage, the Delphi process was implemented using the Welphi web-based platform, see more details in (Vieira et al., 2020)). The process was designed to include two exploratory rounds, while keeping the process anonymous, along with the convergences and divergences between the individual judgements of the responders.

Stage 1: Delphi preparation

Problem Definition: Analysis of the relevance of each of the eight axes of the ICTd, in the eyes of different actors of the digital transformation process.

Delphi panel: Participants were selected from two different countries (Brazil and Portugal) following a 'snowball' sampling strategy (Taylor et al., 2015) to have a broader collection of

points of view and values, and to create a multidisciplinary group of respondents with a direct and/or indirect relationship with the topic addressed. The criteria used for selecting participants were the following demographic characteristics: the city in which they lived, their area of professional education and activity, in addition to the level of knowledge and involvement with the topic to be addressed in the research (digital transformation/digital maturity). These were intended to capture different levels of expertise of the participants, thus covering the most diverse areas of expertise in digital technology, in the search for the construction of a heterogeneous sample for the construction of knowledge.

According to their training and the activities carried out in their work, the participants were classified by their level of knowledge as Lay/Curious; Practical knowledge; Specialised knowledge; Highly specialised knowledge.

These categories were recorded in addition to reporting other important information to map their profile in a demographic survey.

It is important to highlight that there was an articulation so that most of the recruited participants were Brazilian because the CESAR organisation concentrates its activities in Brazil. However, as the process developed in the Portuguese language, this did not prevent the participation of respondents based in Portugal, thus allowing for a geographical diversification to support the analytical comparison in the results.

Process Design: The Delphi process was designed with two rounds. In the initial round, the Delphi questionnaire incorporated a demographic survey, together with a questionnaire aligned with the study's objective. The design of the questionnaire constituted the foundation of the study. The Welphi platform (see Figure 2) was used to present the participants with a list of the eight CESAR axes and to invite each of them to complete the following sentence for each axis: "In terms of preparation for the digital age, attaining a good performance on this axis is...´´. Each participant could select one of three levels of relevance: "critical", "fundamental", or "complementary" (or opt to not answer). A relevance scale is context-specific; for instance, a fourth level, "irrelevant," was included in a subsequent study on health (Freitas et al., 2023).

The definition of each of the three levels was originally proposed as follows in (Bana e Costa, 2019):

- Critical — without achieving a good level of performance on this axis, no organisation can attain a good level of preparation for the digital era;
- Fundamental — This axis should always be considered in evaluating the level of preparation of any organisation for the digital era;
- Complementary — although not fundamental, this axis can provide insights

for the evaluation of the level of preparation of an organisation for the digital era.

Digital Transformation Axes (ICTd)	Description
Culture and people	This is the perspective of the human being in relation to changes in the digital era, both in the role of the leader/author of transformations and in the role of instrument in the new configurations of societies and businesses, with a focus on innovative practices and transformative entrepreneurship within organisations.
Consumers	Digital Transformation is drastically changing organisations' relationship with their customers and consumers. Features that were previously unique to services consumed online are now demanded by consumers for all products and services in their daily lives. Everything needs to be available on demand, customisable, always connected, and able to be shared anywhere.
Competition	In the digital era, the boundaries of competition are no longer the same. Even the most diligent and prepared organisations can suffer from more agile, unexpected, and asymmetrical attacks of competitors.
Innovation	Innovation has other methods and processes. We left a world where organisations designed and launched their products on the market by themselves to a world of co-creation and continuous experimentation. The rule is to learn fast and innovate continuously.
Processes	This perspective brings an agile vision to the organisation's internal processes, making the user the main player. Digital allows processes to be rethought by becoming people oriented rather than task oriented. It seeks to understand how organisations are prone to use technology to rebuild old processes in order to optimise, automate and, above all, transform the organisation.
Business models	Asymmetric business models are the main disruptive agents for established businesses. Digital technologies that allow you to access new markets and find new ways to grow. Understanding and shaping new business models from the Digital Transformation journey is essential for the survival of organisations.
Regulatory data and environments	One of an organisation's most valuable assets is its data. Knowing how to use them is extremely relevant to the decision-making strategy of today's organisations. However, few know how to extract value from them and, at the same time, ensure intellectual rights in digital assets, privacy and consumer safety.
Technologies	To succeed in the Digital era, organisations need to go beyond knowing digital technologies (such as IoT, Big Data and Artificial Intelligence) to empower them, as these are great enablers and accelerators of transformation, and constitute the strength of competition.

Table 1. Description of the eight digital transformation axes of the ICTd.
Font: Authors' translation of the descriptions in Portuguese available at https://transformacao.cesar.org.br

It is worth making a clear distinction between the concepts of critical and fundamental, noting that the former adds to the latter the assignment of a veto power to an axis. This means that when a respondent assigns a critical level to an axis, he or she understands not only that this axis is fundamental, but also that an organisation that fails to achieve a good level of preparation in this axis cannot be considered as well prepared to face the challenges of the digital era.

When desired, participants could input comments about their judgement. In the second round, each participant was presented with a statistics screen of the first round, for each axis, with the percentage of choices of each level of relevance by all the participants.

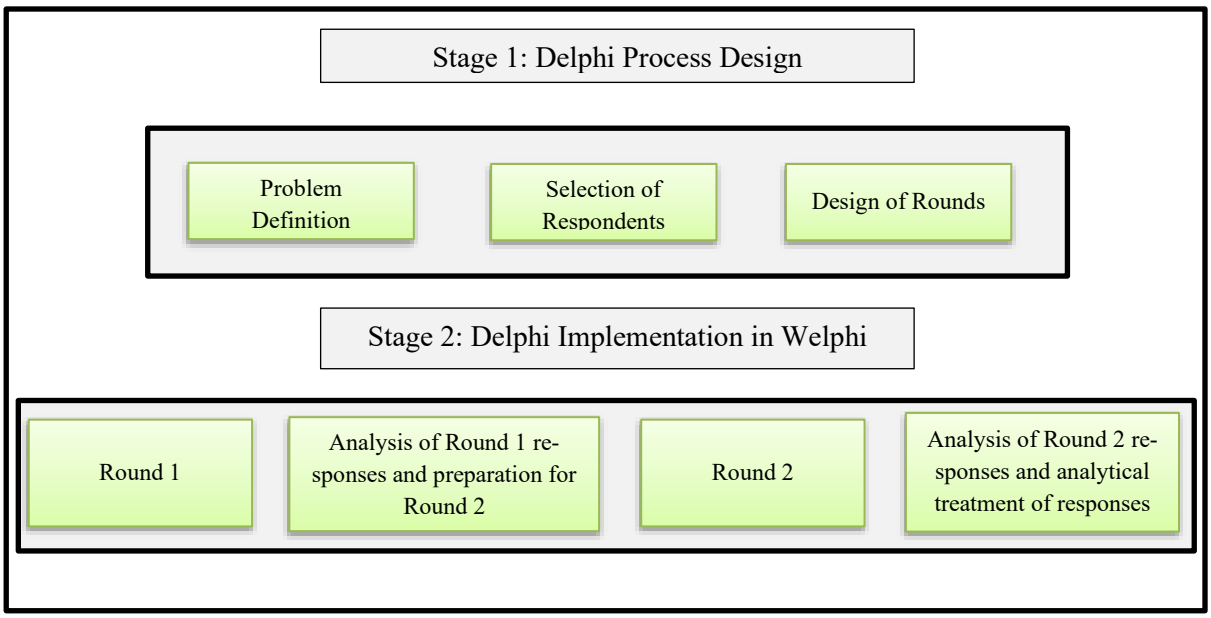

Figure 1. Description of the proposed Delphi process.

Given this group information each participant had the opportunity to review – or keep – the judgements made in the first round.

This design was intended to collect each participant's perception of the relevance of the axes in an integrated perspective, while preserving anonymity throughout the Delphi process.

Stage 2: Delphi Implementation

A significant number of persons were invited to participate in the web-Delphi process based on the selection criteria described above.

They initially received, via e-mail, an invitation letter with important information about the survey and the

methods, and instructions and explanations regarding the final use of the information collected. The response time set for the first round was one week.

To start Round 2, the 144 respondents to Round 1 received a second email with the appropriate instructions, with a deadline of another week, in which they could analyse their responses in the light of the results of the first round and confirm or revise each of them.

The participants who did not complete the first round were not invited for the second round and were excluded from the study. One hundred participants completed Round 2.

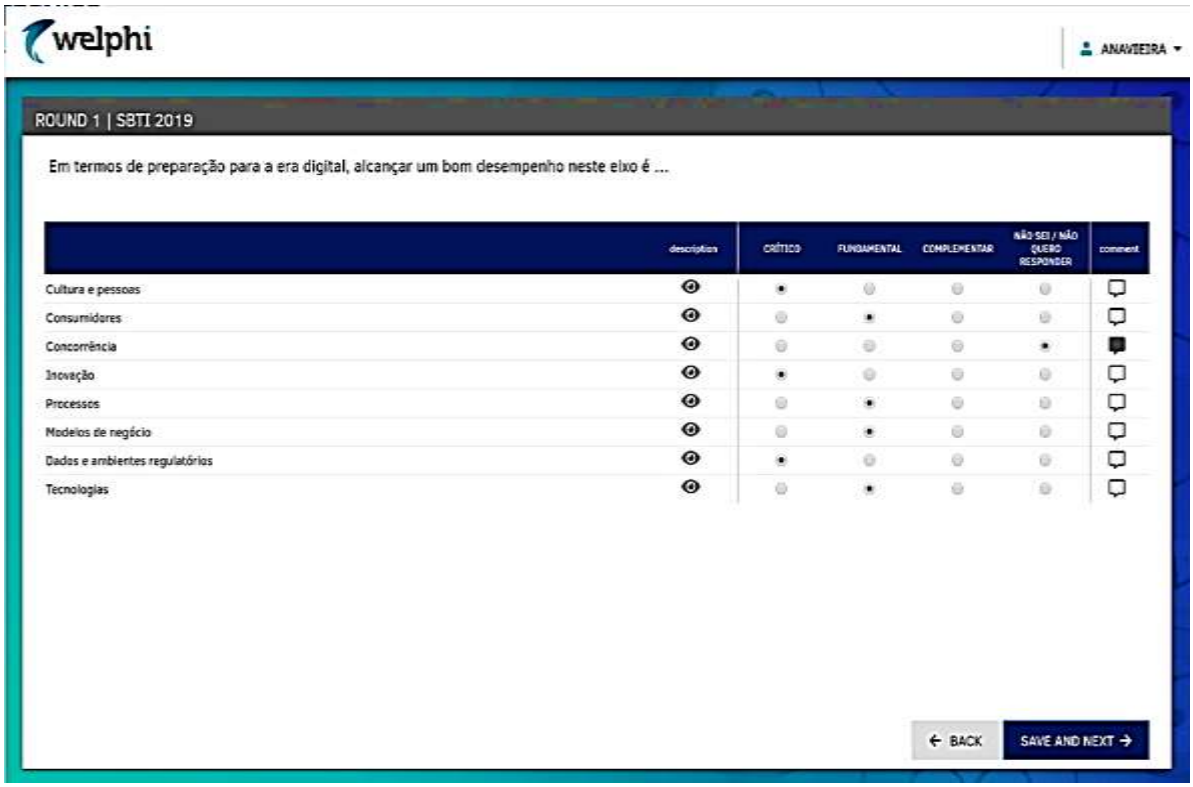

Figure 2. Description of the proposed Delphi process.

In terms of timing, the initial email with the invitation letter was sent on 14 October 2019, Round 1 ran until 21 October, the day Round 2 began, which concluded on 25 October; the Delphi process concluded with the sending of an email with a table of results on 30 October 2019.

Statistical Analysis

With the objective of obtaining alignment of answers by means of the participative approach of the Web-Delphi process (Vieira et al., 2020), the results about the relevance of each ICTd

axis were obtain by group-majority opinion of the participants.

Furthermore, these results were analysed in light of the involvement and level of experience of the responders in the topic addressed, to be able to investigate the level of agreement, exposing participants to the views of other participants, thus allowing interaction and reconsideration of their responses (Salgado et al., 2020).

Two additional analyses were conducted. The first one analysed the number of respondents who changed their opinion in relation to the answers given in Round 1. The aim of this analysis was to capture whether there was a learning process. The second one analysed qualitative feedback as an important critical factor in the relevance of each axis.

With the results obtained, it was permissible to characterise the sample according to the level of knowledge of the participants from different regions and their level of involvement in the process. The characterisation of the sample was defined according to the following classification regarding the level of knowledge: Lay/curious; Practical knowledge; Specialised knowledge; Highly specialised knowledge.

The results were classified by the distribution of answers through the feedback of the respondents, which were presented in categories and grouped in tables and graphs with the objective of making a comparative analysis of the similarities or discrepancies for each axis that occurred in the two rounds.

Results

The sample was randomly selected, both in relation to the level of involvement with the topic addressed, as well as with regard to the area of expertise, ensuring a diversification of professionals—with 37% of respondents with a degree in management, 34% in engineering, 9.8% in computing, 7.3% identified themselves to be in the humanities, and the others, who were less represented, had backgrounds in pharmacy, law, statistics, Economics, Accounting, and Health.

Respondent Classification

Although the second round had lower adherence (70%) compared to the first round, it is noticeable that the level of knowledge of responders in the round 2 remained as 'practical knowledge and specialised knowledge, maintaining a result that was equivalent to that of the first round, as shown in Table 2.

Regarding the level of involvement of participants in the technological change process, the result presented in round 2 showed that it was similar to the result presented in round 1 (Table 2), with a prominent percentage of participants in the technological change process 'in the organisation to which I belong'. This classification of respondents was based on self-reported information.

Table 3 shows the key results, allowing a comparison and better analysis in relation to some highlighted axis. As a related point, the results emphasise the comments made by the participants on the degree of relevance of some axes, especially the 'data and regulatory environments' axis with denser criticism directed at the relevance of this axis as fundamental for strategy and decision-making in organisations in order to add value to the business.

Level of Knowledge	Round 1	Round 2
Lay/Curious	22 (16%)	16 (16%)
Practical knowledge	61 (43%)	44 (44%)
Specialised knowledge	40 (28%)	29 (29%)
Highly specialised knowledge	13 (9%)	9 (9%)
Don't know/Don't want to answer	2 (2%)	2 (2%)
Did not inform	3 (2%)	0 (0%)
Level of Involvement in the process	**Round 1**	**Round 2**
In an organisation you do not belong to (e.g. customer)	25 (18%)	17 (17%)
In the organisation I belong to	76 (54%)	54 (54%)
Don't know/Don't want to answer	9 (6%)	6 (6%)
None	28 (20%)	21 (21%)
Did not inform	3 (2%)	2 (2%)

Table 2. Level of Knowledge vs. Level of Involvement of participants.

Axis	Assessment (%)			
	Critical	Fundamental	Complementary	Do not know / Do not want to answer
Culture and People	68	28	4	-
Consumers	29	62	8	1
Competition	19	54	24	3
Innovation	57	39	3	1
Processes	44	48	8	-
Business Models	27	58	14	1
Regulatory Data and Environments	22	68	10	-
Technologies	62	33	5	-

Table 3. Results (%) – Relevance of each axis.

Graphical representation of the reckoning by axis

To compare and identify similarities or differences in the evaluation of participants who considered themselves experts in relation to others in the research, the graphs below present the numbers of responses for each axis of the digital transformation process.

This option was made given the respondents who classified themselves as Specialists, as they have a direct interaction with the subject addressed through practical involvement within organisations and/or as consultants, taking into account their experience and qualification.

Based on the analysis of Table 3, and highlighted in the Figure 3 to 10, it is possible to observe greater emphasis on the four axes of Culture and People, Processes, Technologies, and Innovation. The three axes of Culture and People, Innovation, and Technology stand out as 'Critical' in preparing an organisation for the digital age, both for specialists and for most other respondents (others), emphasising the relevance of these axes in reaching digital maturity for an organisation.

In the evaluation of the Processes axis, there was a balance between experts and other respondents when they classified this axis between 'Fundamental' and 'Critical', consolidating the relevance of flexibility, agility and optimisation for the digital transformation, impacting the management of the entire supply chain.

Regarding the four axes of Competition, Business Models, Consumers, and Data and Regulatory Environment, they stood out as 'Fundamental' (Figure 7, 8, 9, and 10). Emphasis on the Data and Regulatory Environment axis demonstrated the importance of this axis in the implementation of digital technologies in process management.

The graphs indicate a conformity among experts and other respondents regarding the assessment of the relevance of each axis. This shows the important contribution not only from respondents with extensive expertise, but also from those with experience based on day-to-day practices. Even those who self-identified as "laymen/curious" and lacked practical experience in the area were able to provide valuable insights and pertinent commentary.

Participants who changed their opinion between Round 1 and 2

In comparison to the first round, the proportion of respondents in the second was around 70%, with a final result of the process that led to a reflection on the levels of relevance of some axes for strategy and decision-making in organisations, according to the ICTd.

From the results and comments obtained in the first round, the participants were able to assess their opinion, and changed their answer (or not) in light of the answers of all other respondents. The second round is of great significance in the survey as it seeks to improve the degree of convergence based on the responses and comments of the group.

Figure 11 informs the number of participants who changed their opinion for each axis evaluated between Round 1 and 2, after the interaction of the other participants' responses.

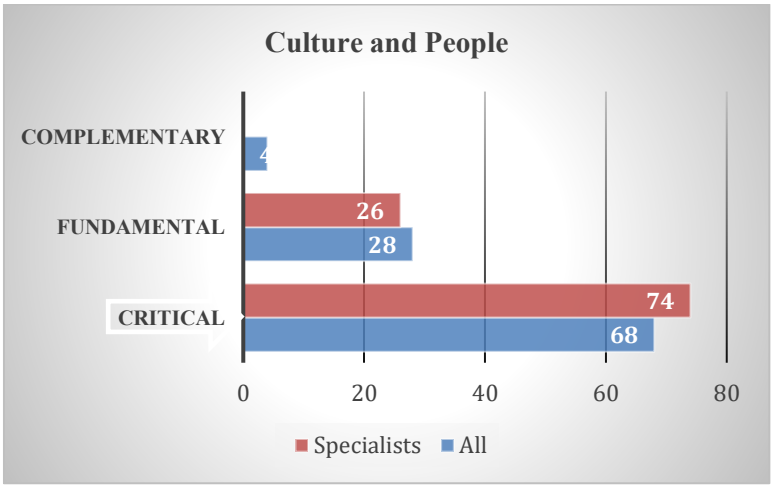

Figure 3. Evaluation (%) of the 'Culture and People' axis.

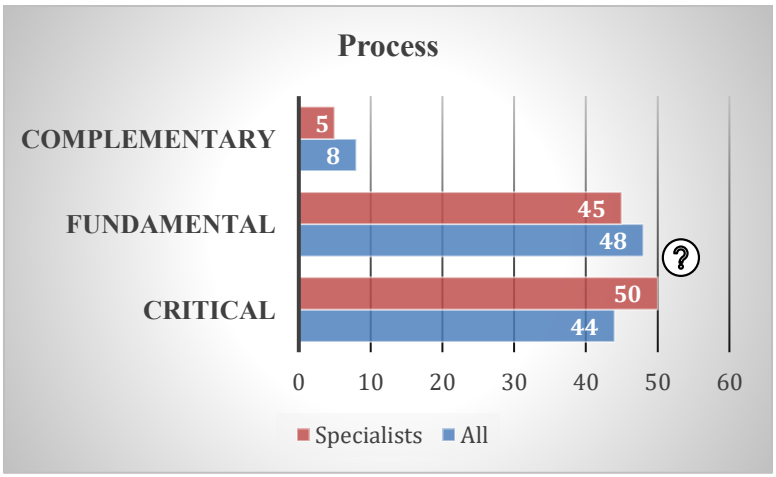

Figure 4. Evaluation (%) of the 'Processes' axis.

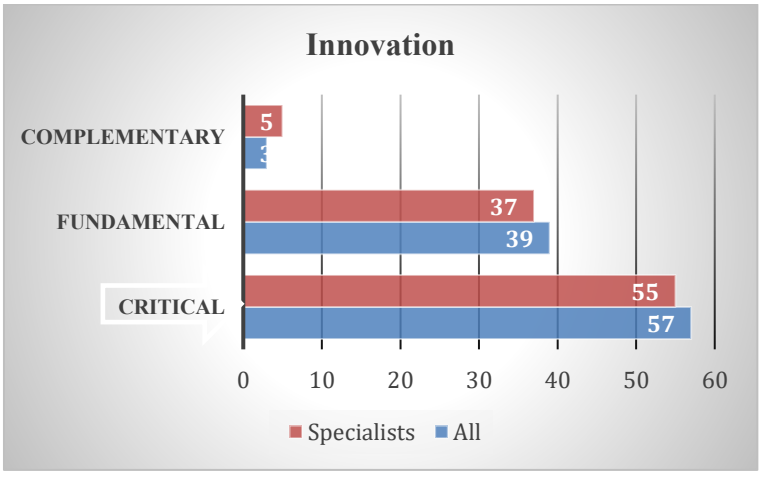

Figure 5. Evaluation (%) of the 'Innovation' axis.

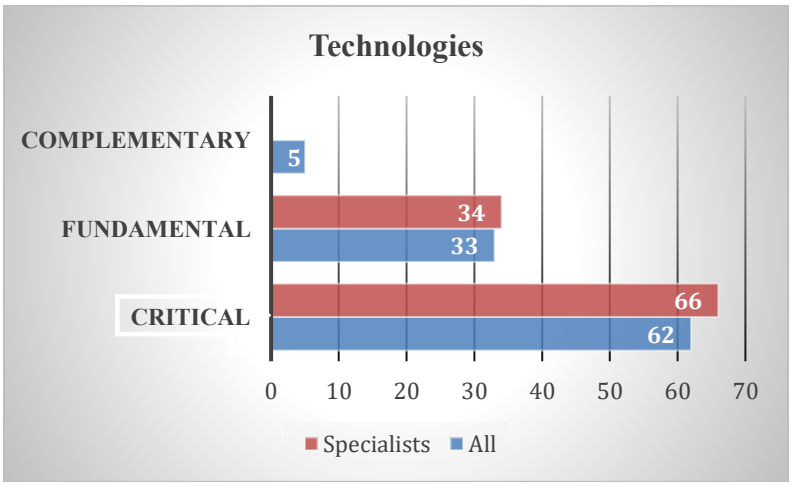

Figure 6. Evaluation (%) of the 'Technologies' axis.

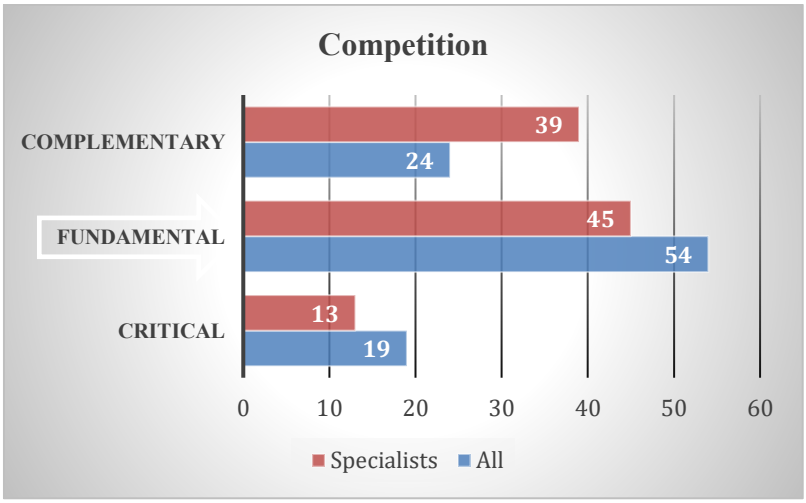

Figure 7. Evaluation (%) of the 'Competition' axis.

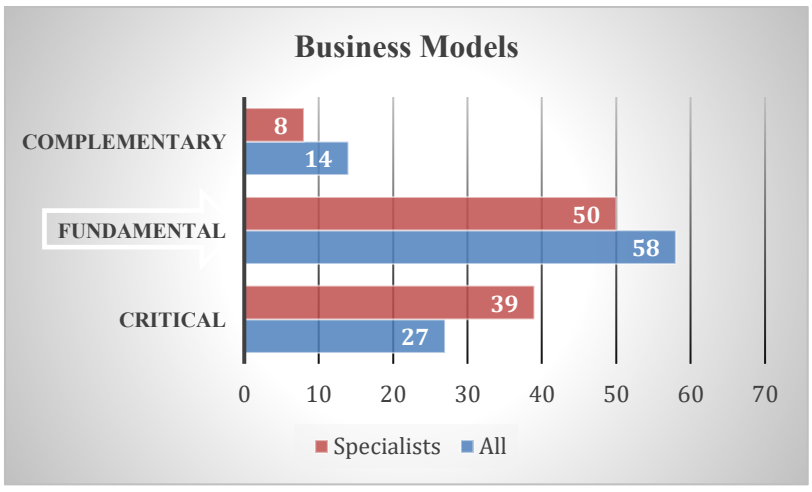

Figure 8. Evaluation (%) of the 'Business Models' axis.

Figure 9. Evaluation (%) of the 'Data' axis.

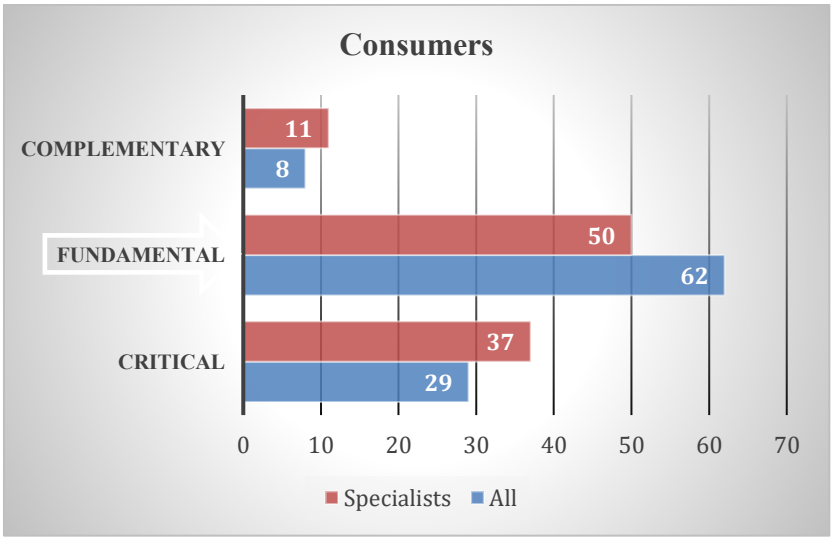

Figure 10. Evaluation (%) of the 'Consumers' axis.

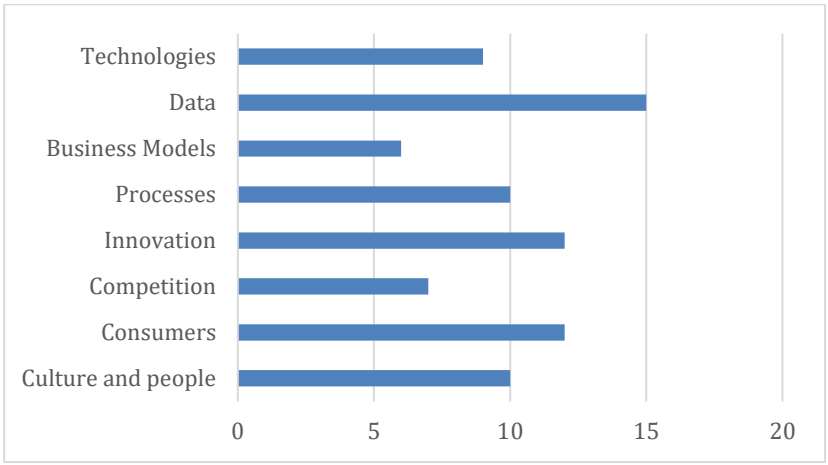

Figure 11. Number of participants who changed their minds between Round 1 and 2.

Discussion

The results obtained evidenced the relevance of each axis in the process of assessing the digital maturity of an organisation. This contributes to new studies of indicators that integrate other digital maturity assessment models, in anticipation of the development of a model that meets the needs of organisations, as highlighted by Chanias and Hess (2016). This emphasises the importance of making the model more flexible according to the reality of each organisation, thereby providing easy understanding of data interpretation, and facilitating the analysis of results for decision-making that can help organisations in the technological changes of its processes.

Regarding the Methodology

The proposed methodology was innovative, as no similar methodology applied to the assessment of axes that are part of a digital maturity assessment model has been found in the literature, as pointed out by Remane et al., (2017), thus highlighting the importance of building a participatory methodology with a collective approach.

The survey, conducted via the Web-Delphi platform, placed particular emphasis on the multidisciplinary and diverse range of practices of the respondents in activities related to the Technological Transformation/Digital Maturity topic. This reinforced the conviction in the agreement presented by the results, through the process of interaction on the Welphi platform. It encouraged learning among participants in light of the responses of others, providing more consistent results through comparison judgments, and avoiding simplifications that could lead to errors in the assessment process, as highlighted by Remane et al. (2017).

The results obtained validate the importance of the methodology in achieving the objective of the work, as well as highlighting the interaction of respondents in the participatory process of evaluating the degree of relevance of the axes that make up the ICTd.

Regarding Crucial Aspects

The ICTd model under study assesses the level of digital maturity of an organisation, and offers a set of actions that can help organisations reach different levels of digital maturity, but it assumes equal weights through an eight-axes evaluation. The results of the Delphi process clearly recommend assigning different levels of relevance to the axes. This recommendation could be drawn in general terms without considering any specific sector of activity.

The relevance of each axis was highlighted in both in the results presented in the graphs and the comments made by respondents. The Culture and People axis deserved particular attention from respondents due to the accelerated pace of technological transformation - where it is necessary to build a culture of digital technology in the search for efficiency and effectiveness in the process, thus having greater commitment on the part of employees in the implementation of new technological management systems.

The two axes of Technologies and Innovation are emphasised, as important in the integration with all other dimensions, aiming at a progressive evolution in the digital transformation process, and in accordance with all respondents, as highlighted in the comments below:

> *'Living on the margins of technological progress is something that is not accepted in the contemporary world, which is integrated, systemic and globalised. The role of technology in this context is unquestionable and determinant for the success of any undertaking.'*
>
> *'… Technology and Innovation are not the ultimate goal of TD, but they are important to enable the achievement of the goals.'*

Regarding the Processes axis, the levels of assessment presented in this axis (Fundamental and Critical) are justified by the fact that it depends on the other axes highlighted in the preparation of the digital maturity process, as remarked by some respondents in their comments.

Although all the axes have their relevance for the development of quality strategies in reaching digital maturity, it is considered that an organisation's digital maturity goes far beyond just the development of technological tools, but rather the ability to adapt needs of organisations, developing management models that meet these needs more effectively, integrating reality.

Regarding the Exploratory Nature of the Study

We would like to point out that the study was exploratory in nature, essentially to analyse whether the fact that ICTd gives equal weight to the eight axes corresponds to the perception of a significant number of actors in the field of digital transformation. This objective was achieved. However, the formulation of definitive conclusions and recommendations with a broader

scope seems to us to merit further study.

This is why we intend to propose a new Delphi process with a new design that incorporates the lessons learnt. In addition, we intend to involve the actors that will participate in the new study also in another Delphi process focused on the barriers they feel may arise in implementing potential actions outlined to improve the performance of each organisation in the various axes.

This approach will allow us to carry out a "desirability-doability" (2xD) analysis, as described in Bana e Costa et al (2023) – therefore complementing the performance model by identifying the doability of the potential actions in face of the identified barriers.

Conclusion

The relevance of the axes that integrate the ICTd was investigated through the application of a methodology that enabled the involvement of stakeholders in the evaluation process and the operationalisation of a model capable of meeting the peculiarities of each organisation. With the results obtained, it was possible to understand the challenges of the sensitivity analysis of each significant axis to integrate the dimensions in the development of digital capabilities in organisations, so that they could progress through levels of maturity.

It is worth highlighting the contribution of the work both to the literature and to organisations, as well as the relevance of each axis that integrates the digital maturity assessment process, through the qualitative judgements of stakeholders, leading to a more accurate analysis of the digital maturity level and actions that can help in the improvement process, working in combination with the evaluation process with the transparent analysis of important determinants in the organisation's preparation for the digital process.

We suggest that, in a first phase of intervention, priority should be given to the development and implementation of actions that will enable the organisation to improve its maturity to a satisfactory level in the critical axes where it may have been identified as not performing well enough to meet the challenges of the digital era in those axes. To this end, it is essential that the assessment model clearly describes what is meant by a 'good' level in each axis. In a second phase, once the organisation has achieved good levels in all the critical axes - as a result of implementing the priority actions - it will then be possible to calculate a value for the ICTd as a whole, once the vetoes have been removed, and to carry out a more comprehensive diagnosis to design an action plan covering all the axes.

In light of the pivotal role of a participatory procedure in determining the relevance of each axis that constitutes an organisation's digital maturity

assessment model, it is proposed that future research adopt an approach integrating the Web-Delphi with a multicriteria decision support method.

This would assist in corroborating the work developed in Delphi through the construction of a multi-criteria model based on the Collaborative Value Modelling (Vieira et al., 2020) and the 2xD frameworks, derived from the collective perspective of a group of experts, with the objective of providing the organisation under evaluation with a more comprehensive understanding of the mechanisms required to attain the most competitive level of digital maturity, thereby facilitating a more effective adaptation.

From a technical perspective, future research should examine the theoretical and substantive significance of the compensatory aggregation model employed in the ICTd to assign overall scores.

This paper did not have as an approach the definition of a specific domain for the analysis of the relevance of the axes under study; thus, in view of this perspective, it also suggests, for future investigation, the application of the methodology to specific sectors and the comparison of the different results obtained.

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