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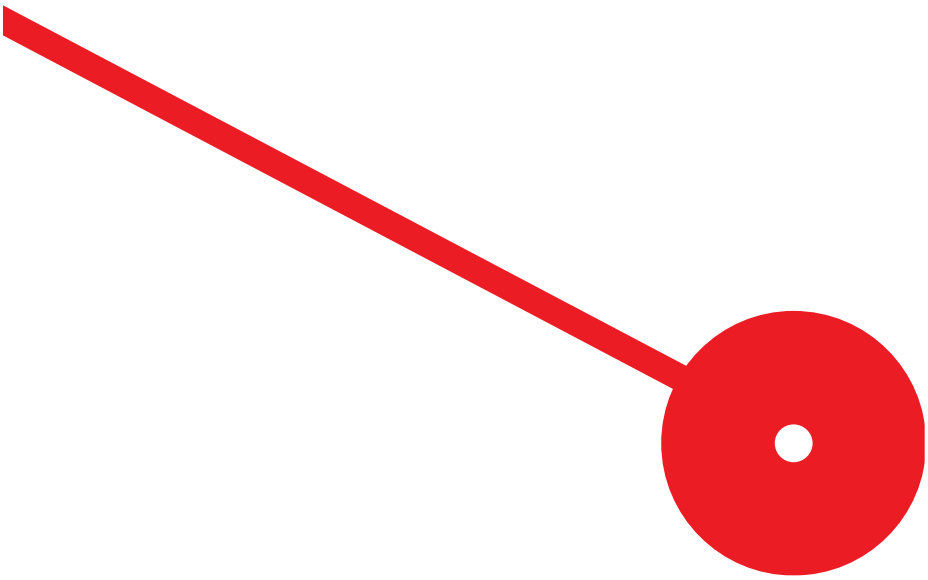
A Digital Transformation Model for Cooperatives of Services

Fábio André Pereira Couto

06/2023



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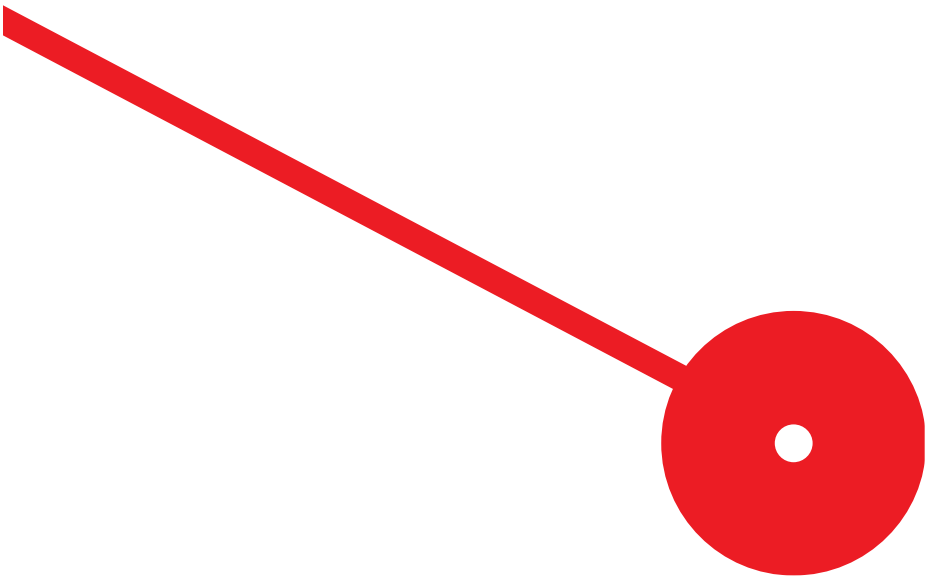
Dissertação de Mestrado apresentado ao Instituto Superior de Contabilidade e Administração do Porto para a obtenção do grau de Mestre em Negócio Eletrónico, sob orientação de Prof. Doutora Mariana Curado Malta e Prof. Doutora Ana Azevedo



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Resumo:

As Transformações Digitais são iniciativas que, com a pandemia da COVID-19, se tornaram ainda mais importantes para a competitividade das organizações. No entanto, estas iniciativas têm uma elevada taxa de insucesso, pois são processos complexos que exigem um planeamento e uma implementação cuidadosa e rigorosa.

O principal objectivo desta dissertação é adaptar um binómio DTM (Digital Transformation Model)-DMM (Digital Maturity Model) às características das cooperativas de serviços. Para este objetivo, realizamos revisões sistemáticas de literatura de modo a identificar os DTMs e DMMs existentes. Os modelos são analisados e comparados (7 DTM e 20 DMM), e os mais completos são seleccionados. Em seguida, propomos vários pares DTM-DMM de entre os modelos mais completos, com base em características como a dimensão e o sector das organizações. Tendo em conta as cooperativas de serviços e as suas especificidades, seleccionamos o par considerado mais adequado para servir de base ao trabalho de adaptação. Esta adaptação é efetuada através da consulta da literatura e de especialistas em cooperativas, de modo a abranger as idiossincrasias deste tipo de organizações.

Os resultados desta investigação têm implicações para a preparação e implementação de iniciativas de Transformação Digital no contexto das cooperativas de serviços. Os resultados apresentam duas ferramentas (DTM e DMM) adaptadas a este tipo de organização e que podem ser utilizadas numa abordagem combinada para o planeamento e a implementação de processos de TD rigorosos. Este têm o potencial de aumentar as taxas de sucesso da TD e, por conseguinte, melhorar a competitividade das cooperativas de serviços.

Palavras chave: Transição Digital, Maturidade Digital, Transformação Digital, Cooperativas de Serviços, Roadmap, Modelos

Abstract:

Digital Transformations are initiatives that, with the COVID-19 pandemic, became even more important for the competitiveness of organisations. However, these initiatives have a high failure rate, as they are complex processes that require careful and rigorous planning and implementation.

The main objective of this dissertation is to adapt a DTM-DMM binomial to the characteristics of the cooperatives of services. For this objective, we perform systematic literature reviews to identify existing DTMs and DMMs. The models are analysed and compared (7 DTM and 20 DMM), and the most complete ones are selected. Next, we propose several DTM-DMM pairs from among the most complete models, based on characteristics such as the size and sector of organisations. Taking into account the cooperatives of services and their specificities, we select the pair considered most suitable for the basis of model adaptation. This adaptation is made by consulting the literature and cooperative experts, so that it covers the idiosyncrasies of this type of organisation.

The results of this research have implications for the preparation and implementation of DT initiatives in the context of the cooperatives of services. The results present two tools (DTM and DMM) adapted to this type of organisation and that can be used in a combined approach for the planning and implementation of rigorous DT processes. This has the potential to increase DT success rates and therefore improve the competitiveness of the cooperatives of services.

Keywords: Digital Transformation, Digital Maturity, Digital Transition, Cooperatives of Services, Roadmap, Models

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List of Abbreviations

DT – Digital Transformation

DM – Digital Maturity

DTM – Digital Transformation Model

DMM – Digital Maturity Model

IOC – Investor-Owned Companies

SME – Small and Medium Enterprises

SWOT – Strengths, Weaknesses, Opportunities, Threats

KPI – Key Performance Indicators

ROI – Return On Investment

IT – Information Technology

PDCA – Plan, Do, Check, Act

CRM – Customer Relationship Management

ERP – Enterprise Resource Planner

CHAPTER I - INTRODUCTION

The single digital market (EU4Digital, 2023) has brought the mechanisms for exponential growth in digital-based activities. This framework has empowered digital-based activities and opened avenues for new businesses in the whole European Union. However, not all organisations are fully prepared for this possibility regarding human resources preparation and installed technological capacity. Given the importance of the digital-based economy, it is necessary to understand how organisations can envisage their transformation in terms of digital technologies - this is not an easy quest.

Digital Transformation (DT) is a change that supports the development and subsistence of organisations (Múnera et al., 2020) and consists of the reinvention or adaptation of business or value creation models using digital technologies. Digital technologies, in turn, make it possible to provide better customer experiences, improve internal operations and create radically different and innovative business models.

The recent pandemic has accelerated the necessity of DT, as the limitations placed on the free movement of the population have led to an increased technology dependency by organisations to face the challenges brought by COVID-19 (PDS, 2020).

Organisations consider digital channels a business opportunity; digital technologies improve productivity and enhance competitiveness. Investing in the DT of organisations is necessary to take advantage of all the potential new digital technologies provide. This DT does not exclusively encompass adopting new technologies but implies the implementation of new models of thinking, which emerge from the technological demands and the transformation of business models (Tovar & Cervantes, 2019).

Organisations sometimes fail to adopt coherent strategies, and comprehensive DT approaches, i.e., not focusing only on the technological aspects. According to Wade & Shan (2020), about 87.5% of organisations worldwide fail to adopt consistent strategies and comprehensive approaches to DT. Considering the complexity and importance of well-structured planning on the success rates of DT initiatives, the whole process must be carried out rigorously (Hess et al., 2016). DT efforts entail problems and difficulties, such as defining the correct approach or creating a DT vision aligned with organisations' objectives. According to Taylor (2022), 54% of organisations identified their lack of DT expertise as the main hurdle preventing them from progressing in their DT initiatives. Most SMEs find DT processes challenging due to resource limitations and a lack of guidance (Barann et al., 2019; Borštnar & Pucihar, 2021). These resource constraints are often related to a lack of skilled human

resources, which increases the likelihood of failure of such initiatives. Therefore, there is a need to create practical approaches focused on realistic and tangible objectives to minimise the high failure rate of DT initiatives (Wade & Shan, 2020). In addition, there is a need to simplify the complexity of DT projects and break them down into practical actions that facilitate understanding their various phases and concepts (Barann et al., 2019). When organisations successfully implement their DT, they find themselves in a new environment where conservative players cannot compete (Mamede et al., 2017).

Cooperatives are no exception to the changes brought about by technological advances and the increasingly competitive environment of the market economy. As organisations operating in the market economy, cooperatives must take advantage of digital technologies' benefits while remaining competitive (EURICSE & ICA, 2022). Consequently, they must also transform themselves digitally (Múnera et al., 2020). A successful DT is based on a strategy coherent with the organisation's objectives, adapted to the cooperative's specific needs and the sector's characteristics.

Cooperatives are distinct from non-cooperative firms. This is due to several defining characteristics of cooperatives, such as their adherence to the "user-owner" principle, their obligation to distribute accumulated equity to members, and the tax implications of profits distributed based on use (Iliopoulos, 2003). Cooperatives may also face restrictions to their growth and competitiveness due to limitations in acquiring sufficient risk capital for investments (Li et al., 2015). However, unlike investor-owned companies, the operational, financing, and investment decisions of cooperatives are not solely driven by the objective of profit maximisation.

Nevertheless, even though cooperative values differ from those of investor-owned companies, there is the same need to give its cooperators a unique combination of value and quality service by aligning their strategic DT objectives, automating processes, or preparing their human resources (Tovar & Cervantes, 2019).

Developments in digital technologies offer various possibilities for improvement to service cooperatives in fields such as member participation and organisational knowledge management. According to EURICSE & ICA (2022), service cooperatives can improve on daily management activities, online sales of their services, but also regarding member participation and communication with stakeholders.

New technologies enable advances in retrieving, processing and distributing organisational knowledge where and when needed. Additionally, digital technology innovations allow faster decision-making and help suppress problems related to members' geographical dispersion (Ciruela-Lorenzo et al., 2020). Considering the low engagement and participation rates in general assemblies (Meira, 2023), service cooperatives can benefit from implementing general assemblies using video conference systems. Furthermore, implementing a digital presence through a website provides more transparency, as, e.g. important documentation can easily be accessed on the cooperative's website. Digital channels such as social media create additional communication channels for the cooperators and the community. As a result, service cooperatives can become more decentralised and flat, that is, less hierarchical, gaining agility, responsiveness (Salla et al., 2013) and transparency while fostering participation and interaction with local communities (Meira, 2023). The collaborative or platform economy is a huge opportunity for service cooperatives as it allows for the creation and organisation of communities of interest empowered by smart technology (e.g., see Sarkar et al., 2023, on using algorithms to create virtual cooperatives).

It is, therefore, necessary to prepare DT strategies aligned with the objectives of the cooperative as a whole and aligned with the specific characteristics of these organisations – which are, as already said, different from the investor-owned companies. Furthermore, developing an appropriate DT plan may lead to competitive advantages that streamline, facilitate and expand the cooperatives' service offering, allowing a closer and more effective relationship in the cooperator-offering binomial (Tovar & Cervantes, 2019). However, it is crucial to balance virtual participation and in-person engagement, ensuring full participation of all members in the life of the cooperative (EURICSE & ICA, 2022).

Regarding the structure of this work, we start by introducing the topic of DT and how it affects cooperatives. Then, we explain the key concepts (DT, DTM, DM, DMM and Cooperatives of Services). After this, we explain the methodology adopted (systematic literature review and the adaptation of the models). The results are then presented and discussed (comparison of models, their nexus and the adaptations made). Lastly, we explain the conclusions, including limitations and future work.

1.1. Motivation

In view of the importance that DT has assumed in recent times, the creation of DTMs and DMMs specifically focused on service cooperatives is still not explored. Therefore, we

identify the need to develop a DTM-DMM pair suitable for the characteristics of service cooperatives, proposing a combined approach with both types of models.

The use of these tools has the potential to reduce the failure rate of DTs, as they guide the planning and implementation process of this type of initiative. Although the literature and consultants propose several DTMs and DMMs, we did not identify any that had been developed for service cooperatives.

Taking into account the limitations that (service) cooperatives face in terms of resources, the adoption of a combined DTM-DMM approach could be a useful solution to overcome or minimise the effects of these limitations.

1.2. Objectives and Expected Results

The main objective of this work is to adapt a DTM-DMM pair for service cooperatives.

The specific objectives of this work are: to identify the characteristics of service cooperatives; to analyse the state-of-the-art of DTMs and DMMs and to establish the nexus between both model types; to adapt a DTM-DMM pair to suit the needs and characteristics of service cooperatives.

The expected results include a final DTM and DMM that can be used by cooperatives of services. We select the most adequate ones from our systematic literature review, explain how they can be used together as complements and then proceed to adapt them. They should reflect the unique characteristics of this type of organisation and provide actionable measures and guidance for the planning of DT initiatives.

1.3. Research questions

Considering the importance and challenges that DT poses to cooperatives, it is essential to carefully plan DT processes in an attempt to improve success rates. Based on this premise, the main research question of this dissertation is:

- How can we prepare and implement robust DT plans as a way of increasing these initiative's success rates in the context of cooperatives of services?

Based on this question, three other research questions are formulated:

- Which are the most complete and robust DTMs and DMMs freely available?

- How can we adopt a combined approach to DT which includes both a DTM and a DMM?
- What are the necessary adaptations to make DTMs and DMMs encompass the characteristics of cooperatives of services?

In today's rapidly evolving digital landscape, organisations must adapt to the changes brought by technological advancements. The concept of DT has emerged to enable organisations to harness the potential of digital technologies and integrate them into their business strategies. DTM provide a structured approach for organisations to follow when undertaking a DT process. In parallel, DMM allows organisations to assess their current digital capabilities and identify areas for improvement.

2.1. Digital Transformation

Digital Transformation (DT) is a term whose exact definition varies depending on the authors. For some, DT is the reinvention of business and value creation models, using digital technologies that leverage the performance and reach of organizations, and end up improving customer experience, operations and business models (Fitzgerald et al., 2013; Kane et al., 2015; Westerman et al., 2011). For these authors, DT is a synonym of "Digitalization", but differs from "Digitization". In turn, Hess et al. (2016) share the same definition but add improvements to "product reinvention" and "organizational structure".

Other authors argue that DT is a more general term when compared to "Digitization" (conversion of analog information into digital, or process automation through technology) and "Digitalization" (implementation of a given technology in an organization, to digitally support certain processes) (Maltaverne, 2018). DT is, in this case, a process that affects organizations, and can be described as the creation of new ways of operating, leading to new sources of value.

Throughout this thesis, the definition of DT to be used it the one given by Westerman et al. (2011), Fitzgerald et al. (2013) and Kane et al. (2015).

However, DT can also have a more general definition, being characterized as dealing with the changes that digital technologies cause in human life (Kaplan, et al., 2010, as cited in Mäkinen, 2017). Another definition is that DT represents the ability of an organization to react and effectively use new technologies and procedures; this reaction and adoption of changes can lead to Digital Disruption (Herbert, 2017).

Digital Disruption is the change that occurs when new technologies and business models affect the value proposition of existing services and products (Wade et al., 2019). A lack of reaction to this Digital Disruption will lead to losses in revenue and profits (Bughin & Van Zeebroeck, 2017).

That being said, the natural evolution of DT will make it progress to Digital Disruption (Bradley et al., 2015), with the emergence of new business models feeding this disruptive

phenomena (authors here refer to “combinatorial disruption”, which they define as the decomposition of value sources into their digital constituent parts, being then recombined and leading to new disruptive business models), competitive change and other businesses’ transformation necessity (Bradley et al., 2015).

The primary force behind DT is the customer, as there is a generalized access to online information, as well as the existence of multiple channels (websites, apps and social networks), leading to an increase in expectations (Berman & Bell, 2011). There is a greater proliferation of information and greater ease and speed of access, making the customer more informed, and consequently, more demanding.

The fundamental question is no longer to give priority to DT initiatives, but how to adopt it and turn it into a competitive advantage while incorporating DT into business strategies (Hess et al., 2016).

Company managers have, in general, little clarity regarding the different options and elements to consider in a DT (Hess et al., 2016). This increases the risk of ignoring or forgetting important elements, which can eventually lead to unsuccessful initiatives: “[…] companies continue to struggle to establish concrete plans to implement digital transformation” (Ferreira, 2022). To help organizations, there are Digital Transformation Models available that can be used as guides (roadmaps that help define the “how?”), with due adaptation to each organization’s reality.

2.2. Digital Transformation Models

A well-structured DT strategy will help organisations by acting as a unifying and supportive concept in coordinating, defining priorities, and implementing the necessary initiatives for successful DT (Hess et al., 2016). In other words, a well-structured DT strategy will help to create a shared vision with clear and well-defined goals so that everyone knows which changes to be made, when and how to do those changes, and why they are essential. However, decision-makers still lack guidance when choosing the best path to initiate DT efforts (Kane et al., 2017). As a result, only a minority of organisations adopt a DT plan consistent with a well-articulated business strategy (Bughin & Van Zeebroeck, 2017).

DTM exist precisely to assist organisations in their DT journeys. They give guidance and act as roadmaps that help define the "how?" in DT, guiding the processes of developing a DT plan and consequent digital strategy. Roadmaps mean a clear and structured explanation of the processes needed to successfully plan DT initiatives, including techniques and methods

related to change management principles with deliverables and milestones. A DTM is important since SMEs lack DT expertise and know-how on how to conduct these complex changes, thus needing extensive guidance (Goerzig & Bauernhansl, 2018).

A DTM is a systematic and structured approach that provides guidelines, principles, and best practices for organisations to undertake a successful DT. These models typically include a set of stages, such as assessment, planning, implementation, and evaluation, which guide organisations through the process of DT. A DTM provides a holistic approach to DT and helps organisations define objectives, develop a roadmap, and monitor progress, ensuring the transformation is aligned with the organisation's goals and objectives. By providing a structured and standardised approach, DTM can help organisations optimise their DT efforts and improve their success chances.

2.3. Digital Maturity

DM is the result of progress in the development of a system: organizations (maturing systems), improve their capabilities over time towards a desired future state (Teichert, 2019). It is therefore possible to say that DM encompasses technological and management aspects, thus being holistic (Teichert, 2019) and not static, as the digital landscape is constantly changing, making it necessary to assess DM iteratively (Shahiduzzaman et al., 2017).

Constant changes in terms of digital landscape are caused by new technologies, creating opportunities for innovations capable of improving business models: "[…] digital maturity assessments are always made according to "moving targets" as (technological) possibilities evolve over time" (Chanias & Hess, 2016). This requires organizations to constantly update the technologies themselves, but also the best way(s) to take advantage of their potential. Responsiveness of organizations is fundamental: the ease of adaptation to changes in its sector in terms of technological advances, namely through frequent changes to their processes (Shahiduzzaman et al., 2017). These changes also affect DM levels, insofar as certain technologies or processes associated with a DM level can, at any time, become obsolete and be replaced by another more sophisticated technology or way of doing things.

Digitally mature organizations undergo an integration and gradual implementation of organizational and human processes, and other resources into digital processes (Aslanova & Kulichkina, 2020).

DM is at the base of DT: when organisations want to rank higher in the DM spectrum, they prepare a DT (Aslanova & Kulichkina, 2020). The objective of a DT initiative is to reach a higher DM level. The DM level, in turn, reflects the state in which an organisation is in terms of its DT (Chanias & Hess, 2016). The connection between DM and DT is depicted in Figure 1.

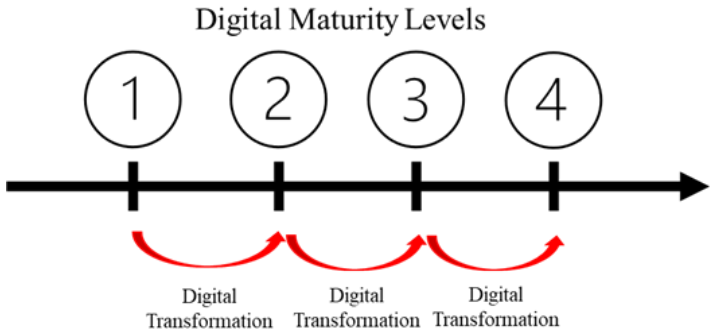

Figure 1 - Connection between DM and DT, according to Aslanova & Kulichkina (2020)

2.4. Digital Maturity Models

DMM are tools that assess the *status quo* of a given organisation in terms of its DT; that is to say, it helps define the "what?" in DT (Becker et al., 2009). These models offer predefined dimensions, which can be complemented by descriptions of what organisations need to achieve at each DM stage. Furthermore, some DMM can include evolutionary paths, i.e., show concrete measures to improve DM (Berghaus & Back, 2016). Finally, most DMM uses questionnaires with questions built with Likert-type scales for the different DM levels (Bertolini et al., 2019).

The DM level of an organisation provides a characterisation of its current performance regarding the use and integration of digital technologies. It is first necessary to know the current state of the DM of the organisation to increase the overall DM level. For that, we need to do an *as-is analysis* (Teichert, 2019) to identify the business areas needing improvement (Caralli et al., 2012; Cozmiuc & Pettinger, 2021). Resuming, it is first necessary to know in which DM stage the organisation is (Bumann & Peter, 2019) before identifying the goals of the DT process.

A DMM guides organisations on what to address and improve in their DT, influencing their DT strategies and plans. These models typically consist of stages or levels, each representing a level of DM ranging from basic to advanced. By assessing an organisation's DM,

a DMM helps identify strengths and weaknesses, prioritise digital initiatives, and guide the development of a roadmap for improving digital capabilities.

2.5. Cooperatives of Services

A Cooperative is an autonomous association, made up of people who unite voluntarily, seeking to achieve their common goal (economic, social and cultural), with all participants owning a percentage of the organization (the Cooperative), in a democratic management model (ICA, 2022).

This emphasis on cooperation between members is due to the focus of these types of organizations on people, with the aim of achieving a shared interest. Cooperatives seek to bring cooperative members together in a democratic and egalitarian way, which is why the "one member, one vote" rule applies, in which each member has the same voting rights, regardless of the capital each one has invested in the organization (ICA, 2022b).

As this is a type of business driven by values (not exclusively monetary), social justice and equality are always present in the search for an environment of mutual help, which results in the creation of a sustainable organization. Another important aspect is the possibility for each cooperator to be able to control and decide on their respective economic future, since a cooperative is not owned by any stakeholder, that is, the economic and social benefits arising from its activity are invested in the community; the profits are distributed by the members or else invested by the cooperative itself (ICA, 2022b).

Cooperatives are historically part of the Social Economy (Ordeñana et al., 2022), sharing the same values in terms of autonomy and freedom, democracy and focus on people. These have as their main characteristic the cooperation between members, that is, the cooperators (work, consume, sell and/or provide services in the cooperative). However, there is also the possibility of admitting investor members, who are part of a given cooperative only with share capital (Pinto, 2018).

The purpose of creating a cooperative is to meet the needs of its members, whether of an economic, social, or cultural nature, for example. Therefore, and contrary to commercial companies, the main objective is not to make profit, which makes it possible to say that a cooperative is not for profit (Pinto, 2018).

Service cooperatives, in this study, includes cooperatives whose goal is to provide a specialised service to its members (KCARD, 2020). Examples include healthcare, communication, transportation cooperatives, financial cooperatives or infrastructure services (electricity, water).

The goal of a cooperative of services, according to our consultation with a subject matter expert, is:

- to eliminate a middleman in the market, i.e., an employer;
- to get a more adequate compensation for the services provided;
- to provide a service at an approximated cost price, i.e., a non-speculative price;
- to provide a service in different conditions to those of an investor-owned company (IOC), due to its social and economic dimensions.

CHAPTER III – METHODOLOGY

3.1. Systematic Literature Review

This study started with a literature review to identify the research problem and define the objectives of the research. To achieve these objectives, we did a systematic literature review with a three-step approach (Webster & Watson, 2002): 1) a search for models in the main sources; 2) the selected models had their reference sections analysed for other potentially relevant models; 3) one last search for studies that cited the models selected in the previous steps.

We aimed to find corporate and academic models. To find the first type of model, we used *Google Search Engine* (https://www.google.com/), and for the latter, we used *Web of Science* (https://www.webofscience.com/wos/) and *Google Scholar* (https://scholar.google.com/).

Figure 2 presents a flowchart with the multiple steps of the methodology used in this study.

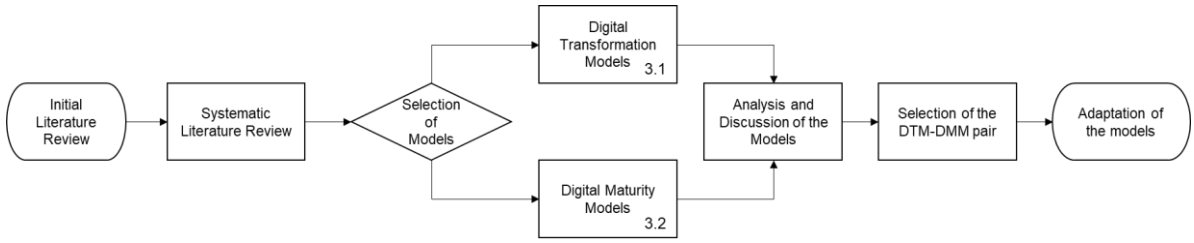

Figure 2 – The steps of the research process

The searches for the systematic literature review were conducted in May 2022. As a way of covering all the papers about DTM and DMM, it was decided to do the searches for both models with the same keywords. During the search process, we detected situations in which, despite an indication of a DTM proposal, the document ended up proposing a DMM instead. For example, IFRC (2021) names its document as "IFRC Digital Transformation Model", but that document proposes a DMM instead. DT-related language is not standardised; therefore, the same terms can lead to different results (Carrijo et al., 2021). We did not want to risk missing out on models, hence this decision.

The keywords used were: "Digital Transformation" AND "Digital Maturity"; "Digital Maturity Model"; "Digital Transformation Maturity"; "Digital Transformation Framework"; "Digital Transformation Model"; "Digital Maturity Framework"; "Digital Capability" AND "Framework"; "Digital Capability" AND "Model". These keywords were used on 1) *Google Search Engine* to collect corporate models and 2) *Web of Science* and *Google Scholar* for

academic models. We only selected documents and papers written in English and with free access.

After the searches, the documents and papers were analysed, and the models were selected and grouped based on their type (DTM or DMM). They were then filtered according to different criteria, depending on if they were DTM or DMM (see Appendix I, II, III and IV).

The models were subject to a comparative analysis, with different comparison parameters for each type of model (DTM or DMM). A more detailed description of this work is presented in the next sections.

3.1.1. Digital Transformation Models

This sub-section presents in detail the specific steps of the analysis of the literature collected regarding DTM (taken from articles and websites) and the framework for analysis of the DTM.

Concerning corporate DTM, the searches returned ten documents. We analysed them, studying the models. We kept the models with roadmaps and those that did not use paid proprietary tools to perform the defined tasks. As mentioned before, roadmaps were fundamental for guiding organisations' DT efforts. In contrast, models with paid proprietary tools limited our analysis as we could not access them fully. As a result, we ended up with two corporate DTMs.

Concerning academic DTM, the searches returned 93 papers. Again, we analysed the abstracts and rejected those unsuitable for the study, ending with 74 articles. By unsuitable, we mean papers that did not address DTM or whose primary focus was not DTM.

We ended with 14 DTM. But not all had complete papers. Those not complete were excluded, i.e., the papers that did not propose a new DTM or an adaptation of an existing DTM. Some papers, even though they were focused on the topic of DTM, do not propose new contributions, i.e., only analyse existing models or have different goals. Finally, the papers, including models that use paid tools to develop the activities or that did not propose a roadmap, were excluded, resulting in five academic DTMs being selected.

Figure 3 resumes the process just described.

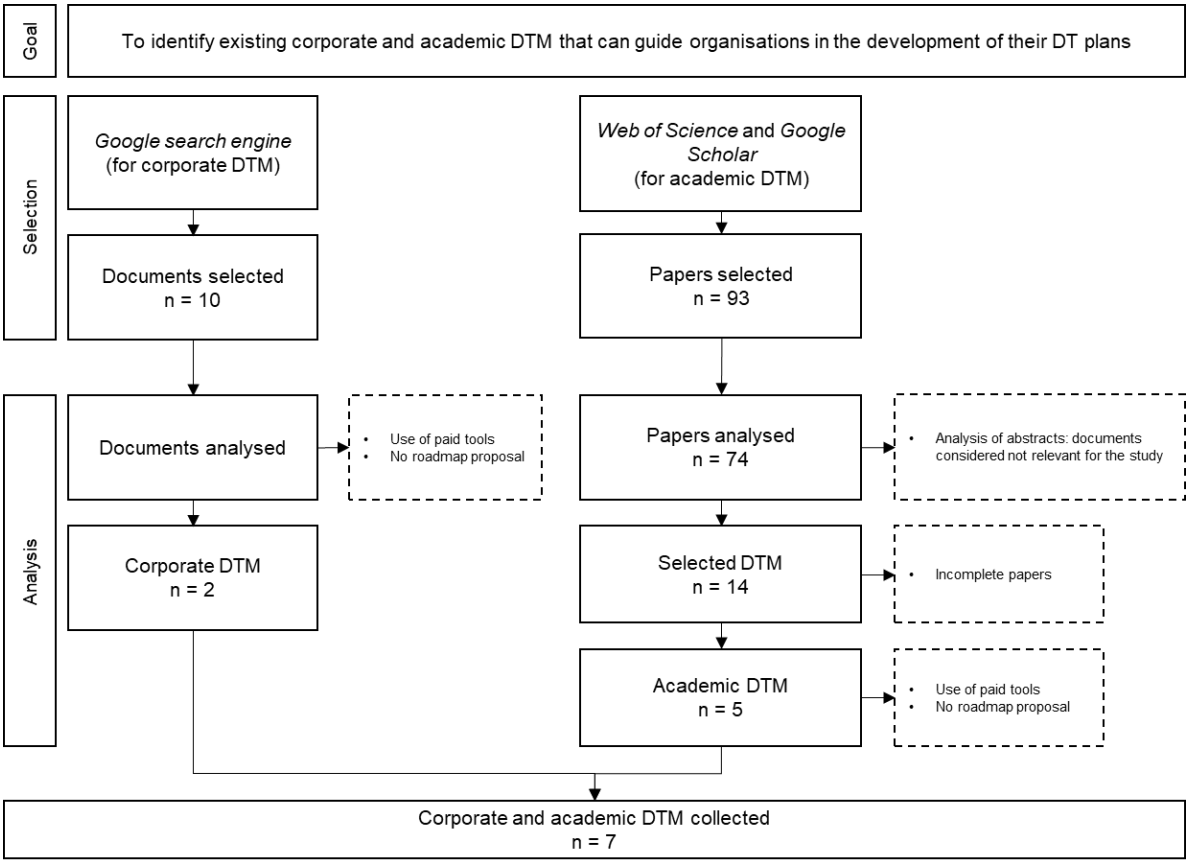

Figure 3 – Methodology used for DTM selection

3.1.2. Digital Maturity Models

This section presents in detail the specific steps of the analysis of the literature collected regarding DMM (taken from articles and websites) and the framework for analysis of the DMM.

Concerning corporate DMM, the searches returned 30 documents. We analysed them, studying the models. We kept the models that were not generic, i.e., focusing on specific characteristics such as industry or company size, ending up with seven corporate DMM. The option of excluding generic models relates to the idea that only specificity can help organisations measure and evaluate their DM, as generic models do not consider the particularities of each sector or the size of organisations (Chanias & Hess, 2016; Paasi, 2017; Remane et al., 2017; Valdez-de-Leon, 2016). These characteristics require DMM, whose objective is not to create a generic method of DM assessment (Paasi, 2017; Remane et al., 2017). Reaching the state-of-the-art in the context of a DT depends on the specific context of each activity sector (Chanias & Hess, 2016), and most DMM tend to be too generic and superficial in their approach (Valdez-de-Leon, 2016).

Concerning academic DMM, the searches returned 97 papers. We analysed the abstracts and rejected those not considered relevant for the study, ending with 74 papers. By not relevant, we mean papers that did not address DMM or whose primary focus was not DMM.

Next, 25 DMM were selected, excluding incomplete papers, i.e., the papers that did not contribute to the proposal of a new DMM or an adaptation of an existing DMM. Some papers, even though they were focused on the topic of DMM, do not propose new contributions, i.e., only analyse existing models or have different goals.

Finally, the papers including generic models, i.e., not having a specific focus on characteristics such as industry or company size, were excluded, resulting in 13 academic DMM selected.

Figure 4 resumes the process just described.

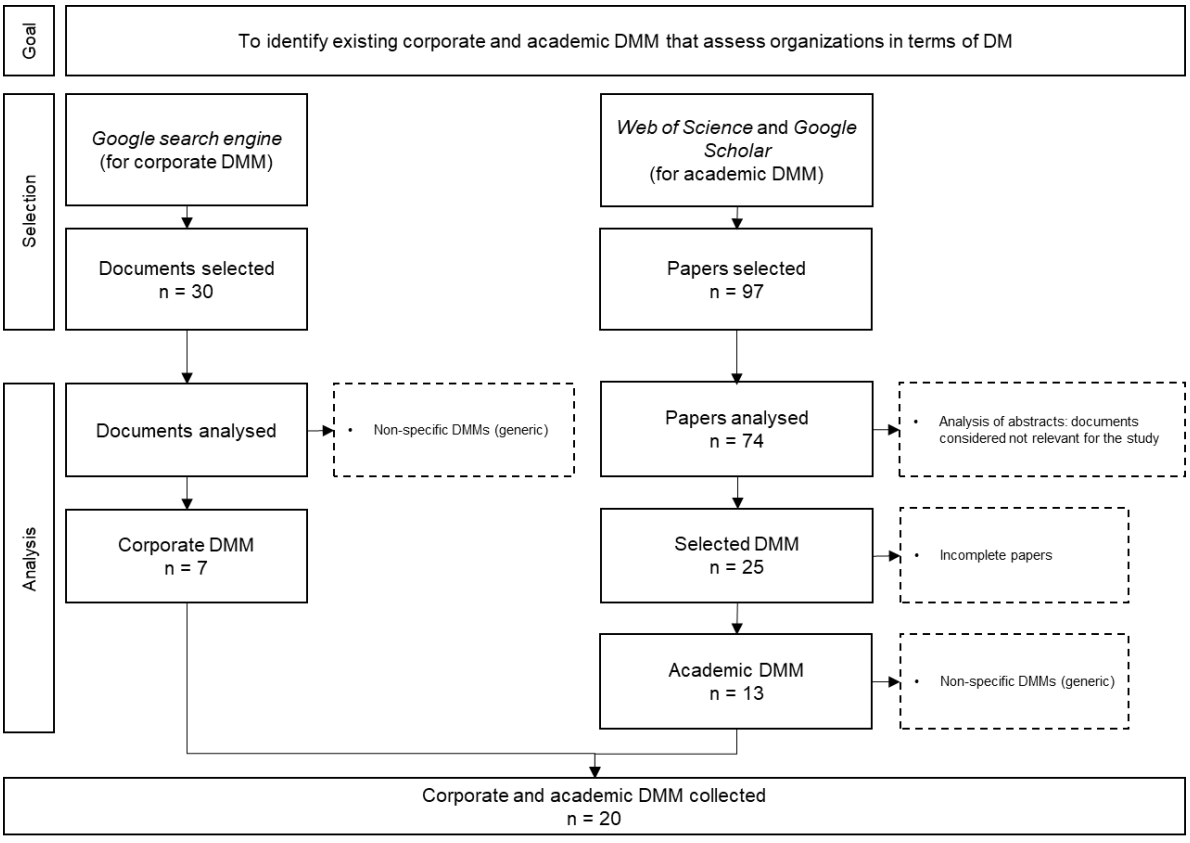

Figure 4 – Methodology used for DMM selection

3.2. Adaptation of the Models

Our main research objective is to adapt a DTM-DMM pair to suit the needs and characteristics of service cooperatives.

To achieve this objective, we first identify the characteristics of service cooperatives in contraposition with IOC. Since none of the models (DTMs and DMMs) we analysed was built with cooperatives in mind (they were built for IOCs), it was important to understand the differences between both types of organisation. To do this, we consulted an expert in cooperatives.

Based on the differences we identified in the previous step, we select the DTM-DMM pair considered most adequate as the basis for the adaptations, taking those characteristics into consideration. The pairs were chosen from the proposed DTM-DMM pairings when introducing the nexus between both types of models.

Then, we proceed with the adaptation of the DTM, and after this, we adapted the DMM. These adaptations were made based on the characteristics of service cooperatives and after consulting relevant literature. The literature allowed us to identify the main DM dimensions and specific components that should figure in the DMM.

3.2.1. Cooperatives *versus* Investor-owned Companies

Service cooperatives are different from IOC. To identify the main differences between cooperatives and IOC, we resorted to subject matter experts, i.e., experts in cooperatives. This interaction resulted in nine (9) main topics: goal; management; voting; participation; object; economic outcome; economic outcome distribution; transparency; education; training & information. The information in the paragraphs bellow was a result of our meeting (see Appendix V).

Starting with the goal, cooperatives are not built for profit generation, as happens with IOC. Cooperatives exist to meet the needs of its members, thus having a mutualistic goal. IOC, on the other hand, are created to generate profit to its shareholders as its ultimate goal.

The management also differs between both types of organisations. Cooperatives are self-managed, meaning they are managed and owned by its members, which manage, administer and supervise all its activities. IOC can be managed by someone who is not a shareholder, as there is a differentiation between property and management, e.g., they can be managed by an economist who is not a shareholder.

In terms of voting, cooperative's general assemblies are ruled by the one member one vote democratic principle, meaning every cooperator has the same influence no matter the amount of participation in the share capital. In IOC, shareholders' voting influence depends on

the participation in the share capital, i.e., the more share capital a shareholder owns, the more powerful its vote is, hence there are minority and majority shareholders.

The participation of members in cooperatives is considered instrumental, and every cooperator is obliged to participate in the cooperative's activities and governance. This means that a cooperative member can be elected to actively join the governance of the organisation. However, in IOC, no shareholder is obliged to actively join the company's bodies.

The object of a cooperative always includes an economic dimension (providing and selling a service at a fair price), and a social dimension (they must contribute to the sustainable development of the community). This social dimension is not found in IOC on a mandatory basis; its purpose is to develop a profit-generating activity and the adoption of social responsibility practices is voluntary.

In terms of economic outcome there are also differences. The economic results generated by the activity of cooperatives are called surplus, whereas the economic results generated by IOC are called profit.

The distribution of the economic outcomes also varies. In cooperatives, the members who work more, receive a higher percentage of surplus, meaning the distribution of economic outcomes is proportional to the participation in the cooperative's activities. In IOC, the distribution of profits between shareholders is made according to the participation in the share capital.

Regarding transparency, cooperatives are obliged to be transparent. Being these organisations democratically managed, transparency is a *sine qua non* clause; there is no democracy without transparency, and this applies both to internal (with members) and external (with the community) communication. In IOC, transparency is optional, as only companies listed on the stock exchange disclose their profits to the market, given that this may influence the value of their shares; companies not listed on the stock exchange do not have the obligation to disclose this type of information.

The cooperative principle of education, training and information is exclusive to cooperatives, being related to their social dimension. IOC are not obliged to have this social dimension, and therefore this topic is not applicable to them.

Despite the divergent values between cooperatives and IOC, both still require providing their members or customers with an exceptional combination of value and high-quality service.

To achieve this goal, cooperatives must align their strategic objectives for DT, automate processes, and prepare their human resources, just like any other company (Tovar & Cervantes, 2019).

Table 1 depicts the differences between these two types of organisations.

Table 1 - Differences between Cooperatives and Investor-Owned Companies

Topic	Cooperatives	Investor-owned Companies
Goal	Mutualistic	Profit
Management	Self-managed	Property ≠ Management
Voting	1 member = 1 vote	Dependant on shareholder participation
Participation	Mandatory participation in activities and governance	No shareholder is obliged to join the company's bodies
Object	Mandatory economic and social dimensions	Economic dimension for profit generation
Economic Outcome	Surplus	Profit
Economic Outcome Distribution	In proportion to the participation in activities	According to participation in the share capital
Transparency	Mandatory	Not mandatory
Education, Training & Information	Mandatory	Not Applicable

These differences demonstrate there needs to be an adaptation of the models, as they were built with IOC in mind and do not fully align with cooperative principles.

4.1. A Comparative Analysis of DTMs and DMMs

The systematic literature review resulted in eight (8) DTM and twenty (20) DMM. This section presents a comparative analysis of the DTMs and DMMs.

4.1.1. Definition Of The Parameters For The Framework Of DTM Analysis

We defined the parameters for the DTM comparative analysis based on the works of Kääriäinen et al. (2020) and Nwaiwu (2018), as they were the only peer-reviewed papers we found that included DTM comparisons.

Nwaiwu (2018) proposes a framework for comparing DTM to analyse their suitability and robustness in addressing DT. In this paper, the author evaluates their relevance and real-world applicability. The framework was created after an extensive review of DTM and based on insights from the author's reviews of these models. The framework uses the following parameters:

- Assess the current state of digitalisation - evaluate whether the model under analysis proposes an assessment of the current state of digitalisation in the organisations;
- What to transform - consists of three subgroups: the first analyses the total number of items that the DTM proposes to be changed based on the structure of the organisations. The second lists all these items. The third evaluates if these are explained in detail;
- How to transform - contains two subgroups: the first lists the actions to take, and the second an analysis of the actions to see if there is a description of those actions;
- Origin of the framework - determines whether the model under analysis comes from academic or corporate sources;
- Framework scientifically validated - analyses if the model was subject to rigorous scientific validation.

Kääriäinen et al. (2020) present a brief comparison of some DTM in their paper. The parameters used were based on a survey of relevant literature, which focused on published and peer-reviewed research papers. The comparison was made according to the following parameters:

- DTM phases – the authors identified how many phases the DTM had and also their names;

- DM assessment phase – analyses if the DTM has a phase dedicated to DM diagnosis (they call it the "Positioning Phase");
- Tools or Methods – a list of the tools or specific methods suggested by the DTM to be used during the different phases of the model;
- Validation – determines whether the DTM and its tools or methods were tested in SMEs and the number of organisations it was tested in.

Furthermore, the authors refer to the importance of depth and the consequent availability of additional information regarding the models, thus facilitating interpretation. This is based on SMEs not having, in most cases, experts with experience with all DT concepts.

Based on the works of Kääriäinen et al. (2020) and Nwaiwu (2018), we created our analysis framework. The following paragraphs present the parameters of the framework:

- Phases (ID1) - listing of all phases that the proposed roadmap includes (1.1); assess whether there is a detailed description of those listed phases, with explanations to justify their inclusion and why it is relevant to the activities, when and how to do it (1.2); analyse if there are any examples of real-life application of the model (1.3). This category helps to understand the structure of the model and the amount of expertise required (less information makes it harder to comprehend).
- DM Assessment (ID2) - refers to the existence of a construct or indication in the roadmap for the organisation's DM assessment. This parameter gives insight into the nexus between DTM and DMM.
- Tools (ID3) - assesses if the model gives any suggestion or indication about the most appropriate tools for each proposed phase and describes how to use them. This category helps to evaluate the models' robustness, making them more complete.
- Scientific Rigor (ID4) - analyses if the model complies with scientific rigour, i.e., if it presents reliable sources as the basis for its design or has been subject to peer review processes. The goal is to analyse how trustworthy the information given is.
- Origin (ID5) - identify the model's source. The source can be academic or corporate. This category helps to better understand where the contributions come from, being helpful to create a general overview of the different characteristics of academic and corporate DTM.
- Depth (ID6) - evaluate the depth of the DTM by analysing the additional information about the model. This point is vital since organisations may not have highly qualified employees with experience and know-how in all concepts addressed in the model

(Kääriäinen et al., 2020). The evaluation scale is a Likert-type (from 1 to 5), where 1 = no depth, 2 = minimum depth, 3 = some depth, 4 = high depth and 5 = very high depth. Table 2 below summarises the parameters used.

Table 2 - Framework of DTM analysis: the parameters

ID	Category Name	Author(s)	Description
1	Phases	Nwaiwu (2018); Kääriäinen et al. (2020)	1.1 – List of proposed phases; 1.2 – Detailed description of phases, which includes an explanation for having a given action and the reason why it is considered relevant (type of result: Boolean); 1.3 – Practical examples of application (type of result: Boolean).
2	DM Assessment	Nwaiwu (2018); Kääriäinen et al. (2020)	Analyse if the DTM includes a DM assessment phase (type of result: Boolean).
3	Tools	Kääriäinen et al. (2020)	Identify if there are suggestions of specific tools to be used (Business Model Canvas, SWOT analysis, KPI, etc.), as well as detailed instructions on how and when (in which phase) to use them (type of result: Boolean).
4	Scientific Rigour	Nwaiwu (2018)	Identify if the DTM was conceived according to scientific rigour (type of result: Boolean). For this, it will be necessary to present reliable sources that were the basis for the conception of the proposed model.
5	Origin	Nwaiwu (2018)	DTM origin: corporate or academic.
6	Depth	Kääriäinen et al. (2020)	Assessment of the depth of the DTM: the amount of additional information made available regarding the proposed model.

4.1.1.1. Presentation of the DTMs

The DTM selected are described regarding their phases and the main goals of each phase.

DTM ID-1 (Barann et al., 2019) is an academic model, it includes a reference to DM assessment and proposes five phases:

- Position Company – the AS-IS situation and the DM are analysed;
- Create Digitalisation Roadmap – generate ideas, evaluate them and develop a Digitalisation roadmap that orders and prioritises the DT goals;

- Create Supportive environment – create awareness, involve employees and generate a Digitalisation culture;
- Prepare Digitalisation Project – select the DT goal with the highest priority, identify opportunities with concrete action items, and build expertise with training efforts;
- Implement Solution – design, refine, realise and monitor the solutions.

DTM ID-2 (Gaffley & Pelser, 2021) is an academic model, it includes a reference to DM assessment and proposes seven phases:

- Evaluation – set the digital benchmark by identifying the digital gap;
- Variable Selection – select independent and dependent variables relevant to the digital strategy;
- Variable Impact and Urgency Analysis – prioritise, weight and rank the digital assets identified before;
- Prioritisation – list the prioritised digital assets using a digital planning map;
- Financial Plan - set a financial plan, develop and allocate detailed budgets for implementation;
- KPI and ROI – select cross-functional teams, assign responsibilities against KPI and ROI requirements;
- Execution and Review – execute, review, set timelines and update digital strategy every six to twelve weeks, incorporating it into the overall business strategy.

DTM ID-3 (Kääriäinen et al., 2020) is an academic model. It includes a reference to DM assessment and proposes four phases:

- Positioning – Digitalisation status of the organisation as a whole, including development ideas and digital vision(s);
- Current State Review – the digital vision(s) are examined in more detail, and conceptual solutions are developed;
- Roadmap – plan how to achieve the objectives and definition of metrics to evaluate success;
- Implementation – implementation of solutions and success evaluation.

DTM ID-4 (Lazaro-Aleman et al., 2020) is an academic model. It does not include a reference to DM assessment and proposes five phases:

- Risk Analysis – identify and analyse worker's needs, the company's current processes and risk assessment;

- BIM Initiation and Planning – develop a staff training plan, acquire a cloud platform and establish satisfaction, time, cost and quality indicators;
- BIM Stabilization – process follow-up and control, promote feedback practices and assess process performance;
- BIM Progression – standardise new digitalised processes, and establish continuous improvement practices;
- Benefits – more efficient document processing management, additional cost reductions and reprocesses.

DTM ID-5 (NG et al., 2018) is an academic model, it includes a reference to DM assessment and proposes five phases:

- Assessment of Current Business Model – identify current business strategies and activities;
- Design of Digital Business Model – design future digital business processes and requirements;
- Assessment of Current Digital Capabilities – assess current DM level;
- Identification of Future Digital Capabilities – identify the gap between the current DM level and future digital business processes and requirements;
- Development of Action Plan – develop an action plan, including a roadmap to implement the digital business model.

DTM ID-6 (Corver et al., n.d.) is a corporate model, it includes a reference to DM assessment and proposes six phases:

- Problem Framing – establish approach, state assumptions, develop a hypothesis, plan research;
- Insights – gather inputs from actors, existing data, competitors, adjacencies and market trends;
- Strategy Ideation and Development – sensemaking, value platform development, future mapping;
- Prioritisation & definition – prioritisation, roadmap development, defining future business model;
- Execution Planning – organisational realignment, funding model, change management, authority to proceed;
- Implementation – implement the plans and strategies established in the previous phases.

DTM ID-7 (Gartner, 2021) is a corporate model, it includes a reference to DM assessment and proposes five phases:

1. Ambition – the strategy is defined, and interest and excitement are generated;
2. Design – the options and ecosystem are assessed for plan development;
3. Deliver – minimum viable proofs of concept are executed and communicated;
4. Scale – the plan is commercialised and absorbed by the organisation;
5. Refine – assess, optimise and re-evaluate.

4.1.1.2. Comparative Analysis of the DTMs

Table 3 presents the comparative analysis of the DTMs according to the parameters defined in Table 2.

Table 3 - DTM comparative analysis

		Parameters							
ID	**Reference**	**(1.1)**	**(1.2)**	**(1.3)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
1	Barann et al. (2019)	Position Company; Create Digitalization Roadmap; Create Supportive Environment; Prepare Digitalization Project; Implement Solution	Y	N	Y	Y	Y	A	4
2	Gaffley & Pelser (2021)	Evaluation; Variable Selection; Variable Impact and Urgency Analysis; Prioritisation; Financial Plan; KPI and ROI; Execution and Review	N	N	Y	N	Y	A	2
3	Kääriäinen et al. (2020)	Positioning; Current State Review; Roadmap; Implementation	Y	Y	Y	Y	Y	A	5
4	Lazaro-Aleman et al. (2020)	Risk Analysis; BIM Initiation and Planning; BIM Stabilization; BIM Progression; Benefits	N	Y	N	Y	Y	A	2
5	NG et al. (2018)	Assessment of Current Business Model; Design of Digital Business Model; Assessment of Current Digital Capabilities; Identification of Future Digital Capabilities; Development of Action Plan	Y	N	Y	Y	Y	A	3
6	Corver et al. (n.d.)	Problem Framing; Insights; Strategy Ideation and Development; Prioritization & Definition; Execution Planning; Implementation	N	N	Y	Y	N	C	2
7	Gartner (2021)	Ambition; Design; Deliver; Scale; Refine	N	N	Y	Y	N	C	1

4.1.1.3. Discussion

There are five academic models (71%) and only two corporate models (29%). The cause for this value may be because corporate DTM often does not include roadmaps, or when they do, they include proprietary tools that are not free to access as they are part of the companies' consulting services.

Only one of the seven analysed DTMs (14%) does not include an evaluation of DM, and the proposed roadmaps have, for the most part, between four and five phases (the first phase, in half of the analysed models, involves assessing the DM of the organisation).

Regarding the information provided on these same phases, more than half of the DTMs (five out of seven - 71%) do not satisfactorily clarify the proposed actions to take, which might end up making it more challenging to understand fully.

As far as scientific rigour is concerned, it is possible to conclude that the corporate models analysed are both validated by use, being empirically validated by the companies based on their experiences.

DTM ID-1 is well described, with each phase and cycle well-detailed and well-structured. It focuses on organisations with fewer financial resources that would like to work with external support units.

DTM ID-2 has well-structured phases in its roadmap, but there is little information on each phase (dependent and independent variables, for example). In addition, the results obtained are not robust, so the authors themselves recognise the need to strengthen the study with complementary research.

DTM ID-3 focuses on SMEs and differentiates itself from the others by the free availability and easy access to all the tools mentioned by the authors. This abundance of information makes it possible to create a complete portfolio in terms of documentation of the TD planning process. The proposed phases are detailed and validated. There is also a considerable amount of information provided regarding the planning of interviews with stakeholders. Also meaningful is the existence of a website with additional information about the DTM and its tools.

DTM ID-4 is the only model which does not indicate a DM assessment in its roadmap. Given the importance of a maturity analysis (proven by the number of DTM that include a DM assessment), this was considered a less positive aspect. There is also a lack of detailed information on the proposed phases.

DTM ID-5 focuses on Industry 4.0. The model is well-structured, which facilitates understanding, but there could be more information about its phases. Some tools are suggested in specific phases, thus making the model more complete.

DTM ID-6 provides little information about each phase, with only short descriptions and occasional tool suggestions. This DTM suggested time frames for each phase, which is a detail that no other DTM had.

DTM ID-7 is the model with less information available. Each phase contains a small list of activities, but no further explanation exists.

DTM ID-1, ID-3, and ID-5 were considered the most complete. Taking into account everything discussed in the previous paragraphs, the DTM ID-1, DTM ID-3, and DTM ID-5 are the most comprehensive among all the models that we presented. They are, therefore, the ones used in the pairings presented in the section "Nexus between the DTMs and the DMMs".

4.1.2. Definition of the Parameters for the Framework of DMM Analysis

We defined the parameters for the DMM comparative analysis based on the works of Remane et al. (2017), Chanias & Hess (2016), Macruz et al. (2020), Carrijo et al. (2021), De Bruin et al. (2005), Paasi (2017) and Proença & Borbinha (2016), as they were considered references in terms of this type of model during our literature review of DMM.

The first parameter (ID#1 - DMM type) refers to the models' objective, which helps describe the DMM's goal. According to De Bruin et al. (2005), the models can be:

- Descriptive - description of the *status quo* of the organisation in terms of DM, without mentioning improvement options to move to higher levels of maturity;
- Prescriptive - proposal of options to improve in terms of DM, thus being potentially useful for the creation of roadmaps;
- Comparative - comparison of the DM assessment results with other organisations, in the same or sometimes in distinct industries.

The second parameter (ID#2 - Dimensions) aims to determine the number of analysis dimensions (and subdimensions) of the specific organisational areas, describing different maturity aspects of the evaluated organisations (Carrijo et al., 2021; Chanias & Hess, 2016; Macruz et al., 2020; Remane et al., 2017). It can give some insight into how embracing the DMM is.

The third parameter (ID#3 – DM levels) focuses on the number of proposed DM levels (Chanias & Hess, 2016; Remane et al., 2017). It can show how specific the final result is, as a model with two levels will not be as accurate as one with five.

The fourth parameter (ID#4 - Assessment Method) is the method used to assess DM. This category helps to understand if there might be a need for specialised external experts to either adapt or conduct interviews, for example. Furthermore, it can also help evaluate the adaptative potential to other industries, as more complex procedures might make it harder to adapt. The assessment method can be (Chanias & Hess, 2016):

- Quantitative - structured questionnaires (with Likert-type scales, for example), may vary in complexity, using combinations and mathematical-statistical procedures to calculate scores, for example.
- Qualitative - semi-structured interviews, with the assessment on an interpretive basis.

The fifth parameter (ID#5 – Results Presentation) concerns how the results are shown (Chanias & Hess, 2016). Here, depending on the type of audience (stakeholders), visual representations could be easier to understand, whereas in other cases, absolute numbers might be enough.

The sixth parameter (ID#6 - Origin) identifies the model's origin, which may come from academic or corporate sources (Carrijo et al., 2021; Proença & Borbinha, 2016). It helps identify where the contributions are coming from.

The seventh parameter (ID#7 - Data Collection Method) aims to specify the method used in the DMM to collect the necessary information for the DM assessment (Chanias & Hess, 2016). It could be done via online questionnaires (on a dedicated website), offline (Microsoft Excel or other software), or interviews. These aspects help when considering the adaptative potential of the models, as online questionnaires make it much more complex in terms of adaptation if need be.

The eighth parameter (ID#8 - Scientific Rigor) refers to whether reliable sources are used to conceive the model or if the paper was peer-reviewed, for example. It also analyses if the model was validated, either by use or by subject matter experts. This makes it possible to use the results of the application of the model in other scientific papers and to generalise the conclusions (Carrijo et al., 2021; Macruz et al., 2020; Remane et al., 2017).

The ninth parameter (ID#9 - Technology vs. Organisational Transformation) aims to identify the total dimensions focused on digital technologies and organisational transformation

(the change of the organisational paradigm). As the literature shows, there needs to be a balance between these two dimensions, which is why this category is relevant (Paasi, 2017).

The tenth parameter (ID#10 - Culture and Human Resources) determines if the DMM deals with organisational culture and human resources dimensions, as they are two fundamental aspects of successful DT (Paasi, 2017).

The last parameter (ID#11 - Business Model and Organisational Strategy) analyses if the DMM contemplates changes to the business model and organisational strategy, as it is considered an important aspect to bear into consideration whenever disruptive changes are equated (Carrijo et al., 2021; Macruz et al., 2020; Paasi, 2017).

The final list of parameters for the framework of DMM analysis is presented in Table 4.

Table 4 - Framework of DMM analysis: the parameters

ID#	Category Name	Author(s)	Description
1	DMM Type	De Bruin et al. (2005)	Identification of the DMM's goal: describe, prescribe, or compare.
2	Dimensions	Remane et al. (2017); Chanias & Hess (2016)	The total number of dimensions addressed. Includes subdimensions (if applicable)
3	DM Levels	Remane et al. (2017); Chanias & Hess (2016)	The total number of proposed DM levels.
4	Assessment Method	Chanias & Hess (2016)	Identification of the method used for DM assessment: qualitative or quantitative.
5	Results Presentation	Chanias & Hess (2016)	How the final DM results are presented after the assessment: numbers, tables, or graphs.
6	Origin	Proença & Borbinha (2016); Carrijo et al. (2021)	DMM origin (type of result: corporate or academic).
7	Data Collection Method	Chanias & Hess (2016)	The method adopted to collect the organisation's answers: online/offline questionnaires or interviews.
8	Scientific Rigour	Remane et al. (2017)	Identify if the DMM was conceived according to scientific rigour (type of result: Boolean). For this, it will be necessary to present reliable sources that were the basis for the conception of the proposed model, and validation.
9	Technology vs. Organisational Transformation	Paasi (2017)	Identify the total number of dimensions focused on digital technologies and the total number of

ID#	Category Name	Author(s)	Description
			dimensions focused on organisational transformation.
10	Culture and Human Resources	Paasi (2017)	Determine if the DMM deals with organisational culture and human resources dimensions.
11	Business Model and Organisational Strategy	Paasi (2017)	Analyse if the DMM proposes changes regarding business models and organisational strategy (type of result: Boolean).

4.1.2.1. Presentation of the DMMs

The DMMs selected are described regarding their main characteristics and goals in the following paragraphs.

DMM ID-1 (Blanchet et al., 2020) has a comparative goal focusing on Industry 4.0.

The seven evaluation dimensions proposed are: "Design & Innovation"; "Assets"; "Workforce"; "Planning"; "Supply Chain"; "Collaborative Platform"; "Foundation".

There are five DM levels: "Not Started," "Proofs of Concept," "Pilot," "Scale-up phase," and "Capability Fully Deployed."

The assessment is done quantitatively through an offline questionnaire with five possible answers (corresponding to each DM level) to each question. Results are compared to each industry's average and national averages.

DMM ID-2 (COTEC, 2020) has a prescriptive-comparative goal focusing on Industry 4.0.

Four evaluation dimensions are proposed, with subdimensions (see Table 5).

Table 5 – Dimension and subdimensions of DMM ID-2

Dimension	Subdimensions
Innovation and Change Management	• Vision and Objectives • Talent • Culture and Leadership • Innovation Ecosystem
Management of Intangible Assets	• Knowledge Management • Risk Management and Cyber Security • Technological Integration
Operations and Processes	• Horizontal and Vertical Integration in the Value Chain • Flexibility of Operations • Proactive Decision-Making

Dimension	Subdimensions
	• Financing
Customer Orientation	• New Products and Services • New Sources of Revenue • Client Knowledge • Channels and Connectivity • Client Experience

There are three DM levels based on points (see Table 6).

Table 6 - DM levels of DMM ID-2

Points	DM Level
0-600 points	Embryonic
601-700 points	Consolidated
701-1000 points	Mature

The assessment is done quantitatively through an online questionnaire on a dedicated platform. The results are shown in numerical scores with a radar chart that compares the results to the national average.

DMM ID-3 (GE Digital, n.d.) has a descriptive goal focusing on the context of process manufacturing organisations (food, pills, and drinks, among others).

Six evaluation dimensions are proposed: "Yield/Production Throughput; "Unplanned Downtime"; "Quality/Compliance"; "Traceability"; "Production Flexibility & Agility"; "Adoption of Continuous Improvement Principles".

There are six DM levels: "Automation & Controls"; "Plant/Site Execution"; "Enterprise Visibility"; "Advanced Analytics/Predictability"; "Prescription/Optimisation"; "Autonomous Adaptability".

The assessment is done quantitatively through an online questionnaire on a dedicated platform, with six possible answers to each question.

DMM ID-4 (IDC & Cisco, n.d.) has a descriptive goal focusing on small organisations.

Four evaluation dimensions are proposed: "Strategy and Organization"; "Processes and Regulatory Compliance"; "People and Skills," and "Technology."

There are four DM levels: "Digital Indifferent"; "Digital Observer"; "Digital Challenger"; "Digital Native".

The assessment is quantitative through an online questionnaire on a dedicated platform, with four possible answers (corresponding to each DM level) to each question.

DMM ID-5 (IFRC, 2020) has a descriptive goal focusing on humanitarian organisations.

It proposes three dimensions with subdimensions (see Table 7).

Table 7 - Dimensions and subdimensions of DMM ID-5

Dimension	Subdimensions
People	• Leadership and Culture • Human Resources and Data Literacy
Processes	• Engagement • Organisational Structure and Internal Collaboration • Partnerships and Service Delivery • PMEAL & Decision Making • Data Protection and Responsibility • Resource Mobilisation
Technology	• Data • Digital

There are five DM levels: "Basic"; "Structural Exploration"; "Professional Practices"; "Digital Expert"; "Future Proof".

The assessment is qualitative, through interviews that aim to understand where the organisation stands. The evaluator then determines the DM level based on the data collected.

DMM ID-6 (Ohio Manufacturing Extension Partnership, n.d.) has a comparative goal focusing on manufacturing organisations.

Eight evaluation dimensions are proposed: "Business"; "Production"; "Warehouses/Distribution Centers"; "Supply Chain"; "Logistics/Transportation"; "Customers"; "Support Functions"; "Smart Products".

There are six DM levels based on a scale of 0 to 5, and each maturity level has a set of characteristics suggested by the authors.

The assessment is quantitative through an online questionnaire on a dedicated platform, with six possible answers (corresponding to each DM level) to each question.

DMM ID-7 (Schuh et al., 2020) has a prescriptive goal focusing on the context of Industry 4.0.

Four evaluation dimensions are proposed: "Resources"; "Information Systems"; "Organisational Structure"; "Culture". These will be applied separately to each of the

organisation's functional areas: "Development", "Production", "Logistics", "Services" and "Marketing & Sales".

There are six DM levels: "Computerisation"; "Connectivity"; "Visibility"; "Transparency"; "Predictive Capability"; "Adaptability".

The assessment is quantitative, through an offline questionnaire, with six possible answers (corresponding to each DM level) to each question.

DMM ID-8 (Blatz & Dietel, 2018) has a descriptive goal focusing on SMEs.

Six evaluation dimensions are proposed: "Strategy and Leadership"; "Company Culture and Organization"; "IT Infrastructure"; "Data Maturity"; "Process and Operations," and "Product – Use phase."

There are three DM levels (see Table 8).

Table 8 - DM levels of DMM ID-8

Points	DM Level
> 0	1
> 2	2
> 3	3

The assessment is quantitative, through an offline questionnaire, with answers ranging from 0 (totally disagree) to 4 (totally agree). The result for each dimension will be the average from all the questions related to the dimension. The overall DM score depends on each dimension's relevance, predefined by the authors after an utility analysis.

DMM ID-9 (Borstnar & Pucihar, 2021) has a descriptive goal focusing on SMEs.

It proposes two evaluation dimensions, with subdimensions (see Table 9).

Table 9 - Dimensions and subdimensions of DMM ID-9

Dimension	Subdimensions
Organisational Capability	• Human Resources • Organisational Culture • Management
Digital Capability	• Use of Technology • Role of Informatics • Digital Business Model • Strategy

There are four DM levels: "Lagging Behind," "Initial," "Advanced," and "Digital Winner."

The assessment is quantitative, through an offline questionnaire using *DEXi* software. It has multiple-choice answers ranging from three to four points. The responses are analysed by using "if-then" formulas.

DMM ID-10 (Buntak et al., 2021) has a descriptive goal focusing on the supply chain of manufacturing organisations in an Industry 4.0 context.

Five evaluation dimensions are proposed: "Conduction of Digital Transformation"; "Communication in Organization and between Organisations with the Supply Chain"; "Creation of new business paradigms"; "Synergy in Organization and between Organisations within the Supply Chain"; "New Technologies used for Processes Optimization."

There are six DM levels based on a scale of 0 to 5, and each maturity level has a set of characteristics suggested by the authors.

No information is given regarding the assessment method.

DMM ID-11 (De Carolis et al., 2017) has a descriptive goal focusing on manufacturing organisations.

Four evaluation dimensions are proposed: "Process"; "Monitoring and Control"; "Technology"; "Organisation".

There are five DM levels: "Initial"; "Managed"; "Defined"; "Integrated and Interoperable"; "Digital-Oriented".

The assessment is quantitative, through an offline questionnaire, with five possible answers (corresponding to each DM level) to each question.

DMM ID-12 (Gollhardt et al., 2020) has a descriptive goal focusing on IT (information technologies) organisations.

Five evaluation dimensions are proposed: "Culture"; "Ecosystem"; "Operations"; "Governance"; "Strategy".

This DMM is in an exploratory phase, so it does not yet propose DM levels.

The assessment is done quantitatively, through an offline questionnaire, with the answers on a Likert-type scale.

DMM ID-13 (Ifenthaler & Egloffstein, 2019) has a descriptive goal focusing on educational organisations.

Six evaluation dimensions are proposed: "Equipment and Technology"; "Strategy and Leadership"; "Organisation"; "Employees"; "Culture"; "Digital Learning and teaching".

There are five DM levels (see Table 10).

Table 10 - DM levels of DMM ID-13

Points	DM Level
0-30 points	Minimalist
31-50 points	Conservative
51-70 points	Pragmatist
71-90 points	Advanced
91-100 points	Trailblazing

The assessment is done quantitatively, through an offline questionnaire, with multiple-choice answers. The final score is between 0-100 points.

DMM ID-14 (Marks et al., 2020) has a descriptive goal focusing on higher-education organisations.

Five evaluation dimensions are proposed: "DT Vision, Strategy, Leadership and Communication"; "DT Talent, Skills, and Knowledge"; "DT Processes, Controls, and Digital Technologies"; "DT Technology Infrastructure"; "Approach to Understand and Communicate with Customers."

There are four DM levels (see Table 11).

Table 11 - DM levels of DMM ID-14

Points	DM Level
0-24 points	Desire/Ambition
25-49 points	Planning and Designing
50-74 points	Delivering
75-100 points	Harvesting

The assessment is done quantitatively, through an offline questionnaire, with 100 points distributed by predefined processes. Each process will have a classification between 0 and 5 (predefined). The sum of all these individual scores will be the DM level.

DMM ID-15 (North et al., 2018) has a descriptive goal focusing on SMEs. It proposes sixteen evaluation dimensions, divided into four phases (see Table 12).

Table 12 - Phases and evaluation dimensions of DMM ID-15

Phase	Evaluation Dimension
Sensing Digitally Enabled Growth Potentials	• searching for digitally enabled growth opportunities • understanding and developing digital customer needs • sensing technology driven opportunities

Phase	Evaluation Dimension
	• use of external sources for digital innovation
Developing a Digitally Enabled Growth Strategy and Mindset	• digitally enabled growth strategy • digital leadership • digital mindset • empowered employees
Seizing Digitally Enabled Growth Potentials	• digitally enabled business models • digital market presence • digital customer experience • agile implementation/deployment of digitalisation initiatives
Managing Resources for Digital Transformation	• digital skills & learning • digital processes • digital technology & security • digital investments

There are six DM levels, based on a scale of 0 to 5, and each maturity level has a set of characteristics suggested by the authors.

The assessment is done quantitatively, through an offline questionnaire, with six possible answers (corresponding to each DM level) to each question.

DMM ID-16 (Pirola et al., 2019) has a descriptive goal focusing on Italian SMEs in an Industry 4.0 context.

Five evaluation dimensions are proposed: "Strategy"; "People"; "Processes"; "Technology Integration".

There are five DM levels (see Table 13).

Table 13 - DM levels of DMM ID-16

Points	DM Level
0-1,8 points	1
1,8-2,6 points	2
2,6-3,4 points	3
3,4-4,2 points	4
4,2-5 points	5

The assessment is done quantitatively, through an offline questionnaire, with a Likert-type scale. Each dimension will have its points predefined by the formula of Figure 5. *Qi* is the subset of questions referring to the dimension *i*, and b_j is calculated following way:

- $b_j = 0$ if the technology/feature *j* is deemed not applicable;

- $b_j = a_j$ (answers in a five-point Likert scale: $a_j \in \{1, \ldots, 5\}$) if the technology/feature is applicable, and the company is not planning to invest in it (or the investment already has been carried out and completed);
- $b_j = \min(a_j+1;5)$ if the technology/feature is applicable and the company is currently investing in it.

m_i is defined as shown in Figure 6.

$$S_i = \frac{\sum_{j \in Q_i} b_j}{m_i}$$

Figure 5 - Formula to calculate S*i*, an intermediate variable to calculate the DM level - DMM ID-16

$$m_i = \text{card}\left(\{j : j \in Q_i \wedge b_j > 0\}\right)$$

Figure 6 - Formula to calculate *mi*, *intermediate variable to calculate the DM level* - DMM ID-16

Finally, the DM score *I* is calculated using the formula of Figure 7.

$$I = \frac{\sum_{i=1}^{n} S_i}{n}$$

Figure 7 - Formula to calculate the DM level - DMM ID-16 ('n' is the total number of dimensions).

DMM ID-17 (Rauch et al., 2020) has a descriptive goal focusing on Industry 4.0 context amongst SMEs.

It proposes four evaluation dimensions with subdimensions (see Table 14).

Table 14 - Dimensions and subdimensions of DMM ID-17

Dimension	Subdimensions
Operations	• Agile Manufacturing Systems • Monitoring & Decision Systems • Big Data • Production Planning and Control
Organisation	• Business Model 4.0 • Innovation Strategy • Strategy 4.0 • Supply Chain Management 4.0
Socio-Culture	• Human Resources 4.0 • Work 4.0 • Culture 4.0 • Big Data
Technology	• Communication & Connectivity

Dimension	Subdimensions
	• Cyber Security • Deep Learning, Machine Learning, Artificial Intelligence • Identification and Tracking technology • Additive Manufacturing • Maintenance • Robotics & Automation • Product Design and Development • Standards 4.0 • Virtual Reality, Augmented Reality and Simulation

There are five DM levels, based on a scale of 1 to 5, and each maturity level has a set of characteristics suggested by the authors.

The assessment is qualitative, through interviews that aim to understand where the organisation stands and assess the DM level based on the data collected.

DMM ID-18 (Sándor & Gubán, 2021) has a descriptive goal focusing on SMEs.

It proposes two evaluation dimensions, with subdimensions (see Table 15).

Table 15 - Dimensions and subdimensions of DMM ID-18

Dimension	Subdimensions
IT	• Technical Solutions • Hardware • Software
Organisational	• Orgware • Online Presence • Peopleware

All items of each subdimension will have a relevance score, and the sum of all the items ticked by the organisation will be the final DM level. That sum will be a value between 0-1, and the closer to 1 the score is, the more mature the organisation is.

The assessment is quantitative, through an offline questionnaire, in which the organisation has to choose which items apply to its situation.

DMM ID-19 (Schumacher et al., 2016) has a descriptive goal focusing on Industry 4.0.

Nine evaluation dimensions are proposed: "Strategy"; "Leadership"; "Customers"; "Products"; "Operations"; "Culture" "People"; "Governance"; "Technology".

Based on a Likert-type scale, there are five DM levels, ranging from 1 – "Not implemented" to 5 – "Totally Implemented."

The assessment is quantitative, through an offline questionnaire, with five possible answers (corresponding to each DM level) to each question. Each question has a relevance score from one to five. The final DM score is calculated with a mathematical formula (see Figure 8).

$$M_D = \frac{\sum_{i=1}^{n} M_{DIi} * g_{DIi}}{\sum_{i=1}^{n} g_{DIi}}$$

M…Maturity
D…Dimension
I…Item
g…Weighting Factor
n…Number of Maturity Item

Figure 8 - Formula to calculate the DM level - DMM ID-19

DMM ID-20 (Valdez-de-Leon, 2016) has a descriptive goal focusing on telecommunication service providers.

Seven evaluation dimensions are proposed: "Strategy"; "Organisation"; "Customer"; "Technology"; "Operations"; "Ecosystem"; "Innovation".

There are six DM levels: "0 – Not Started"; "1 - Initiating"; "2 – Enabling"; "3 - Integrating"; "4 - Optimising"; "5 – Pioneering".

The assessment is quantitative, through an offline questionnaire. Each dimension has a DM score and a set of characteristics associated with each level. The organisation should choose the DM level that best represents its situation.

4.1.2.2. Comparative Analysis Of The DMMs

Table 16 presents the comparative analysis of the DMM according to the parameters defined in Table 4.

Table 16 - DMM Comparative Analysis

		Parameters										
ID	**Reference**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
1	Blanchet et al. (2020)	C	7	5	QT	Table	C	Offline Quest.	N	T:7	HR	N
2	COTEC (2020)	P/C	4 (16)	3 (0-1000 points)	QT	Numerical score; Radar chart	C	Online Quest.	N	T:2; OT:2	Cult & HR	Y
3	GE Digital (n.d.)	D	6	6	QT	Image	C	Online Quest.	N	T:6	-	N

		Parameters										
ID	**Reference**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
4	IDC & Cisco (n.d.)	D	4	4	QT	Numerical Score	C	Online Quest.	N	T:2; OT:2	HR	Y
5	IFRC (2020)	D	3 (10)	5	QL	Numerical score; Table	C	Interview	N	T:1; TO:2	Cult & HR	Y
6	Ohio Manufacturing Extension Partnership (n.d.)	C	8	6	QT	Numerical score; Comparative Charts	C	Online Quest.	N	T:7; OT:1	Cult	N
7	Schuh et al. (2020)	P	4	6	QT	Concentric Circles	C	Offline Quest.	Y	T:2; OT:2	Cult & HR	Y
8	Blatz & Dietel (2018)	D	6	3	QT	Numerical Score	A	Offline Quest.	Y	T:4; OT:2	Cult & HR	Y
9	Borstnar & Pucihar (2021)	D	2 (7)	4	QT	Radar Chart	A	Offline Quest.	Y	T:1; OT:1	Cult & HR	Y
10	Buntak et al. (2021)	D	5	6	-	-	A	-	N	T:3; OT:2	-	Y
11	De Carolis et al. (2017)	D	4	5	QT	Numerical Score	A	Offline Quest.	Y	T:3; OT:1	-	-
12	Gollhardt et al. (2020)	D	5	-	QT	-	A	Offline Quest.	Y	T:2; OT:3	Cult & HR	Y
13	Ifenthaler & Egloffstein (2019)	D	6	5	QT	Numerical Score	A	Offline Quest.	N	T:2; OT:4	Cult & HR	Y
14	Marks et al. (2020)	D	5	4	QT	Numerical Score	A	Offline Quest.	Y	T:3; OT:2	Cult & HR	Y
15	North et al. (2018)	D	16	6	QT	Numerical Score	A	Offline Quest.	N	T:10; OT:6	Cult & HR	Y
16	Pirola et al. (2019)	D	5	5	QT	Numerical Score	A	Offline Quest.	Y	T:3; OT:2	Cult & HR	Y
17	Rauch et al. (2020)	D	4 (22)	5	QL	Radar Chart	A	Interview	Y	T:3; OT: 1	Cult & HR	Y

		Parameters										
ID	**Reference**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
18	Sándor & Gubán (2021)	D	2 (6)	0-1 Points	QT	Numerical Score	A	Offline Quest.	N	T:1; OT:1	Cult & HR	Y
19	Schumacher et al. (2016)	D	9	5	QT	Numerical score; Radar Chart	A	Offline Quest.	Y	T:3; OT:6	Cult & HR	Y
20	Valdez-de-Leon (2016)	D	7	6	QT	Table	A	Offline Quest.	Y	T:4; OT:3	Cult & HR	Y

4.1.2.3. Discussion

More than half of the DMMS were developed in the academia (65%). In total, there are seven corporate models analysed (35%) versus thirteen academic DMM. A possible explanation is that consulting companies often have their DMM as part of their paid services and thus do not offer free access to them.

Only four of the twenty DMMs analysed do not have a descriptive goal (20%). Eighteen models (90%) have a quantitative approach, usually with Likert-type scales. Furthermore, only one of the corporate models (14%) meets the standards of scientific rigour, as there is not much information available regarding the sources and how the model was conceived; these models are usually based on companies' experiences as DT consultants.

The most common assessment method is through offline questionnaires. Online questionnaires are only used in corporate models. Interviews are only used in two DMMs.

Almost all the academic DMM propose changes to business models and organisational strategies (92%), whereas three out of seven corporate models (43%) do include any suggestion regarding business models and strategy in organisations.

Culture and Human Resources are also widely mentioned amongst DMMs, meaning there is growing awareness of the importance of skilled workforces and company values and behaviours towards new digital technologies.

Focusing on the specific context for which these models were conceived, half of them are related to manufacturing and Industry 4.0. However, there is still some diversity in the range of organisations covered, including SMEs, manufacturing, humanitarian, service providers, educational, and IT.

Regarding adaptability, models that use online questionnaires in a dedicated platform have a lower potential, as there is little information on how the DMM was built, and most of them are not open access.

Table 15 shows that thirteen DMM (65%) have incomplete information and a lack of scientific rigour (ID-1, ID-2, ID-3, ID-4, ID-5, ID-6, ID-10, ID-11, ID-12, ID-13, ID-14, ID-15 and ID-18), making them harder to fully understand, creating doubts regarding the validity of the results provided.

DT is about leveraging new digital technologies to support the transformation of businesses, which means there needs to be an equilibrium between the focus on technology and on transforming the organisations. Considering the necessary balance between digital technology and organisational transformation, many DMM fail to achieve this equilibrium. This situation happens when there is a significant difference (two dimensions or higher) between the dimensions focused on IT and on Organisational Transformation. The DMMs ID-8, ID-13, ID-15, ID-17, and ID-19 fail to achieve this.

DMM ID-16 is complete regarding the information provided and includes case studies with twenty SMEs. However, it also uses multiple complex mathematical-statistical computation procedures for calculating DM levels, making it harder to communicate to management and stakeholders, which ends up damaging its suitability (Chanias & Hess, 2016).

DMMs ID-7, ID-9, and ID-20 were considered the most complete and robust in our analysis. However, they also have their downsides.

DMM ID-7, even though it has a considerable amount of information available, does not propose a questionnaire to be used, meaning the questions need to be created depending on the specific organisational context.

DMM ID-9 requires specific software (*DEXi*). On the other hand, once the model is fully operational, it will provide instant results and has a built-in feature for automatically generating visualizations.

DMM ID-20 provides all the necessary information, including the DM level descriptions. Its primary disadvantage might be the information given regarding its dimensions, which could be more detailed.

Taking into account everything discussed in the previous paragraphs, the DMM ID-7, DMM ID-9, and DMM ID-20 are the most comprehensive among all the models that we presented. They are, therefore, the ones used in the pairings presented in the next section.

4.2. NEXUS BETWEEN DTM AND DMM

By "nexus", we refer to the relation between the two models (DTM and DMM) and how they can fit together. We explore how these two models are related and can be used together to achieve a common goal: a successful DT process in an organisation.

DT initiatives are complex processes that require extensive planning and coordination across an organisation. Therefore, a DTM is essential as it provides a structured approach to guide a DT process. This type of model typically includes a set of guiding principles, roadmaps for implementation, and a set of metrics to measure progress and success. Conversely, a DMM is a tool that assesses an organisation's digital capabilities and helps identify the business areas that need improvement. A DMM usually includes a set of critical capabilities required to move from one DM level to the next, along with an assessment tool to help organisations determine their current level of DM.

These two models are intrinsically linked. By using both on a DT process, organisations can engage in a more rigorous process since they can better understand their current DM level and know the steps needed to achieve their DT goals. A DMM provides a starting point for assessing an organisation's digital capabilities (AS-IS analysis) and defining DM objectives (TO-BE analysis). A DTM offers a structured approach to guide the DT process by helping to create a roadmap to achieve DM objectives.

A right-fit DTM-DMM framework provides a powerful toolset for organisations seeking to improve their chances of successful DT initiatives. When combined, it is possible to identify strengths and weaknesses regarding the DM process and develop a plan to achieve DT goals.

In the process of DT of an organisation, we need to identify the organisation's current state of DM (AS-IS analysis) and then the future state the organisation wants to achieve (TO-BE analysis) – a DMM is used for these analyses (AS-IS and TO-BE). The gap analysis between the current and future DM levels is done by analysing the information collected after the AS-IS and TO-BE assessments. It will then be possible to identify the goal and objectives of the DT process. When a DT process is over, the organisation reaches its defined DM level future state (so its DM level increases).

Figure 9 depicts where a DMM and a DTM are needed in the DT process of an organisation.

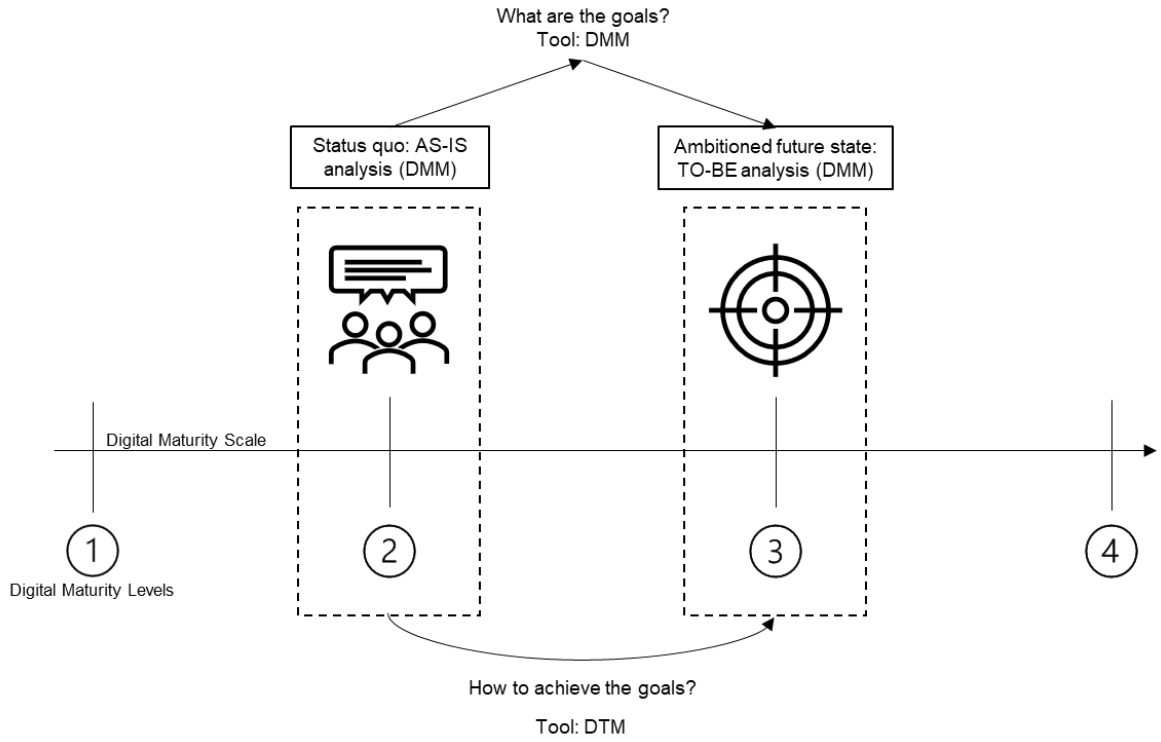

Figure 9 - DTM and DMM nexus

If the desired DM level is too high compared to the starting level, the process can go smoothly by doing various rounds – that is, after each round, the DM levels (AS-IS and TO-BE states) are re-assessed. Theoretically, a DT process can never end. The number of rounds depends on the level of DM organisations want to achieve and how carefully they want to move forward. A very high DM level cannot be achieved in only one process if the starting point is too low - it can disrupt organisations. Figure 10 presents an example of achieving this (with the combined approach between a DTM and a DMM), showing where the loop is introduced in the organisation's DT process.

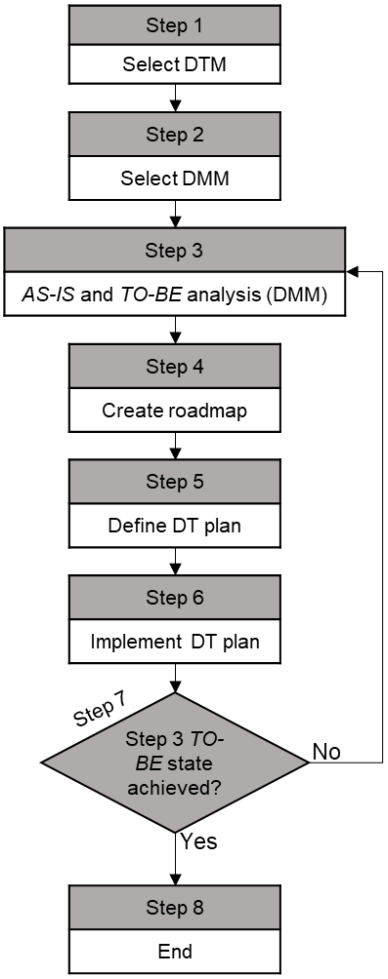

Figure 10 - Generic steps for a combined DTM-DMM approach

Steps three to eight can be repeated depending on the results of step seven. However, it does not mean there is one single correct way of approaching and preparing for DT initiatives; it is an example that aims to illustrate this study's proposed approach with a general lineament.

How can we create the perfect fit between a specific DTM and a DMM? Both models (DTM and DMM) must align with the organisation's characteristics: type of industry and size. Since there are models for different industries (e.g. manufacturing, service provider) and also for different company sizes (e.g. SME, micro-businesses, large companies), this fit has to take that into account.

4.2.1. Pairing DTM With A Specific DMM

Each of the three selected DTMs was analysed to find possibilities of matching with the three selected DMMs. The rationale for the matching was to understand which DTM would

work better in binomial relations with DMMs. To do that, we looked both at the context of application and company size.

Since one of the variables for the matching is the context of application, the results are divided into two main clusters, a DTM-DMM pairing focused on SMEs in the context of Industry 4.0 and DTM-DMM pairings focused on SMEs in the context of the non-manufacturing sector. We are targeting SMEs in both clusters, meaning the company size variable was also taken into account and we matched DTMs and DMMs that had that same focus.

4.2.1.1. DTM-DMM Pairing For SMEs - Industry 4.0

Among the three DTMs selected, DTM ID-5 is the only DTM available for pairing in this section since it is the only one that focuses on Industry 4.0.

Among the DMMs selected, DMM ID-7 is the only one focusing specifically on Industry 4.0.

Since DTM ID-5 does not provide much information regarding the development of the "Action Plan" (category ID-6), a prescriptive DMM (category ID#1) would be the best option for pairing in this scenario, as this type of DMM complements DTM ID-5 by providing information on achieving the DM goals (due to its prescriptive nature). That is to say, it provides helpful information on how to build a roadmap. Therefore, this pairing fills this DTM ID-5 regarding the "Action Plan".

As Chanias & Hess (2016), Paasi (2017), Remane et al. (2017), and Valdez-de-Leon (2016) said, DMMs must reflect industry-specific requirements. Therefore, this pair is the only option for manufacturing organisations wishing to develop Industry 4.0 capabilities.

DMM ID-7 should be used during DTM ID-5's phase:

- three (3) for the AS-IS analysis, thus assessing current digital capabilities.
- Four (4) to help identify future digital capabilities with a TO-BE analysis.

The information collected from phases three and four is then used to develop an action plan (phase five of DTM ID-5), as it establishes how the organisation is in the present and where it wants to be in the future. The implementation of the action plan leads to corporate development (identified as the goal of DMM ID-7).

Figure 11 presents a schema with the rationale for the pairing.

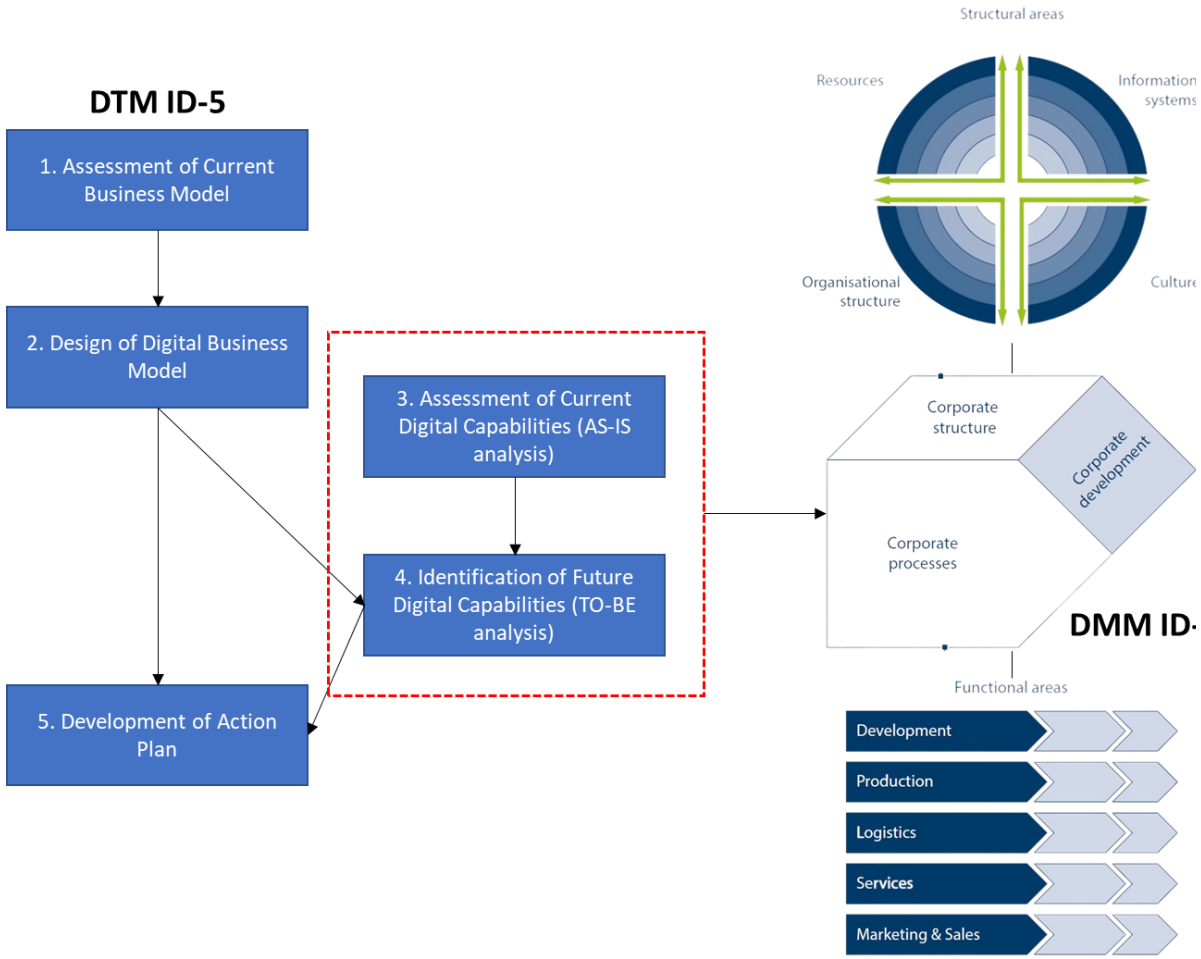

Figure 11 - DTM ID-5 paring: the use of DMM ID-7 with DTM ID-5. Adapted from NG et al. (2018) and Schuh et al. (2020)

4.2.1.2. DTM-DMM Pairings For SMEs - Non-Manufacturing

According to Taylor (2022), Barann et al. (2019), Borštnar & Pucihar (2021), Wade & Shan (2020) and Mamede et al. (2017), SMEs do not have human resources experts in DT, so it is important to provide information, suggest tools (category ID-3 e ID-6) and provide clear ways to communicate results (category ID#5), as they are helpful when communicating with stakeholders (Borštnar & Pucihar, 2021).

DTM ID-1 and DTM ID-3 were considered the most complete and robust DTM for SMEs outside Industry 4.0 contexts. These models provide information and guidance to develop DT roadmaps, thus prescribing best-practices for successful DT processes. They were also built with a focus on SMEs. Since these DTMs have a high depth and provide information on the development of the roadmap (category ID-3 and ID-6), DMMs with descriptive goals (category ID#1) were considered the most suitable pairings. A prescriptive DMM could

eventually overlap and then conflict with the instructions of the DTM, as there would be two models (the DTM and the DMM) prescribing potentially different orientations regarding the creation of the roadmaps. Considering this, these DMMs should have a descriptive goal (category ID#1) to be used during the positioning phase of the DTM (categories ID-1 and ID-2).

DMM ID-9 and DMM ID-20 were considered the most complete descriptive DMMs in our analysis, as we explained before:

- DMM ID-9 was built for SMEs using a method that is well accepted by users (Decision Expert method), according to the authors. Its architecture, i.e., being based on the *DEXi* software, has the advantage of automatically generating visualisations, as it is a built-in software feature (category ID#5). Furthermore, according to Borštnar & Pucihar (2021), the model also works with missing or unknown data, which is essential for SMEs. Therefore, one can say this model can be understood intuitively by SMEs. Furthermore, its descriptive nature (category ID#1) makes it a perfect pair with DTM ID-1 and ID-3.
- The design of DMM ID-20 makes it an easy-to-understand model with a distinctive focus on service providers. Each DM level includes a set of characteristics that businesses must demonstrate in each level. The results are shown in a table, making it visual and easier to communicate (category ID#5). Furthermore, its author considered complexity when building this model, thus making it as intuitive and adaptable as possible. These characteristics make it suitable for SMEs in the services sector. In addition, its descriptive goal (Category ID#1) makes it a valid option for pairing with DTM ID-1 and ID-3.

Now that we have identified the most suitable models, we demonstrate how these DMMs could be integrated with the DTMs, and in which phase(s) to use them.

Figure 12 presents the DTM-DMM pairings for DTM ID-1. During its first phase, "Position Company", the DMM is used to assess DM with an AS-IS and TO-BE analysis, influencing the creation of the digitalisation roadmap in phase number two. In this DTM, the first phase includes an indication to "Analyse Digital Maturity", hence our recommendation to use the DMM there. In phase two, "Create Digitalization Roadmap", one of the steps the authors mention is the generation of DT ideas, and here the results of the TO-BE analysis can help identify DT opportunities.

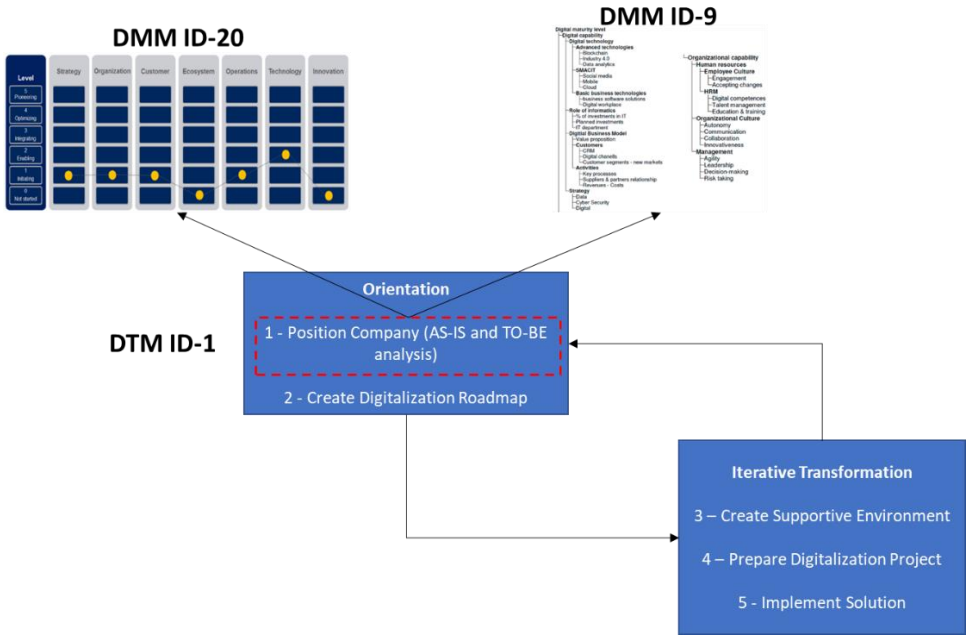

Figure 12 - DTM ID-1 pairings (adapted from Barann et al., 2019): the use of DMM ID-9 (Borstnar & Pucihar, 2021) and ID-20 (Valdez-de-Leon, 2016) in DTM ID-1

Figure 13 presents the DTM-DMM pairings for DTM ID-3. During the first phase of this DTM, "Positioning", a DMM helps perform the current state of DM and define the AS-IS situation. Then, to define the TO-BE state, i.e., the desired future state, a new assessment can be made with the help of a DMM. The results of this TO-BE analysis provide helpful information for the "Digital Visions", which can be defined as the goals of DT. These goals will influence the creation of the DT roadmap in phase three (Roadmap), as it will vary depending on what an organisation wants to achieve.

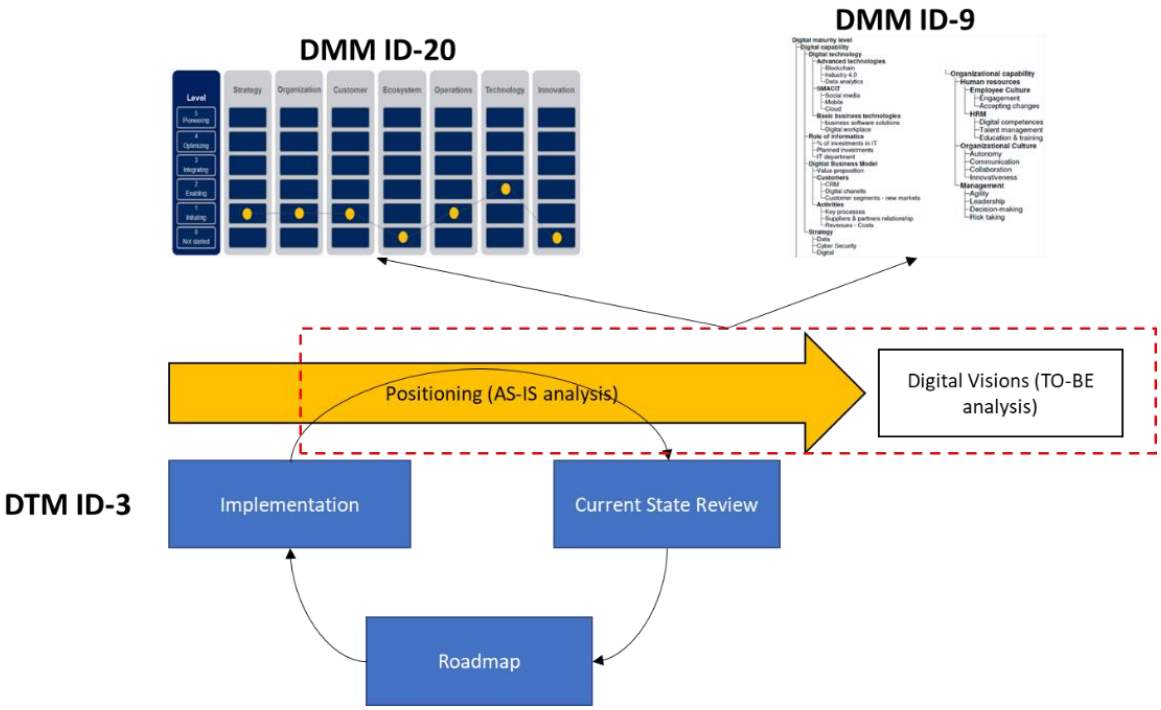

Figure 13 - DTM ID-3 pairings (adapted from Kääriäinen et al., 2020): the use of DMM ID-9 (Borstnar & Pucihar, 2021) and ID-20 (Valdez-de-Leon, 2016) with DTM ID-3

4.2.2. Selection of the DTM-DMM pair for adaptation to service cooperatives

Taking into consideration the DTM-DMM pairs identified before, DTM ID-3 was deemed the most appropriate for service cooperatives. Given the characteristics of service cooperatives, our choice was based on the following reasons:

i) Given our focus on service cooperatives, some DTM were deemed inadequate due to their focus on Industry 4.0. We are focusing on service cooperatives that do not have industrial factories nor assembly lines, which made us look for a DTM that did not focus exclusively on Industry 4.0;

ii) DTM ID-3 was validated within 19 organisations operating in multiple sectors, which is a proof of versatility. This versatile architecture can be confirmed by looking at the characteristics of the 19 organisations in which it was tested: solo entrepreneurs, micro companies and SMEs, ranging from IT to Real Estate, Manufacturers, Retail, Gyms, Restaurants, Electric Power Industries, or Photography Studios;

iii) There is a high amount of information and documentation available for this model, thus facilitating understanding and communication with stakeholders. It is very important to communicate complex processes such as DT in an accessible way. DTM ID-3 has different tools and templates built specifically for enabling better communication with stakeholders.

DTM ID-3 pairs with DMM ID-9 and DMM ID-20 (Figure 12). Given that we are focusing on service cooperatives, we identified DMM ID-20 as a suitable option. This DMM was built for service providers and its author confirms that "[…] the framework may be of interest to other industries, especially those in services" (Valdez-de-Leon, 2016). Furthermore, the selected DMM was built with adaptations in mind, which reflects on its architecture: Valdez-de-Leon (2016) suggests further developments of DMM ID-20 to adapt it to other industry-specific requirements. DMM ID-9 has a more general approach to DM, thus targeting SMEs but no industry in specific, and runs on software (*DEXi*), making adaptations more complex.

As we are focusing on service cooperatives that do not produce physical products, DMM ID-20 was the selected model: it focuses specifically on organisations within the services sector and has an adaptation-friendly architecture. For these reasons, we identified DMM ID-20 as the most appropriate baseline for our adaptation.

4.3. Adaptation of the Models to a Cooperative of Services

4.3.1. Adaptation of the DTM

After the selection process, it was time to adapt DTM ID-3. The first phase of this model, "Positioning", suggests using an online tool for positioning organisations in terms of digitalisation capabilities. However, this tool has two limitations for our case study: it does not accommodate the characteristics of cooperatives, such as the importance and relevance of its members (who also own a part of the cooperative); as an online tool, it cannot be adapted. To solve this, we opted to adapt DTM ID-3 and search for a Digital Maturity Model (DMM) that would suit the needs of service cooperatives both as a service provider and as a cooperative, thus substituting the original tool suggested.

DTM ID-3 is represented in Figure 14, which depicts the use of the online positioning tool suggested in its original version.

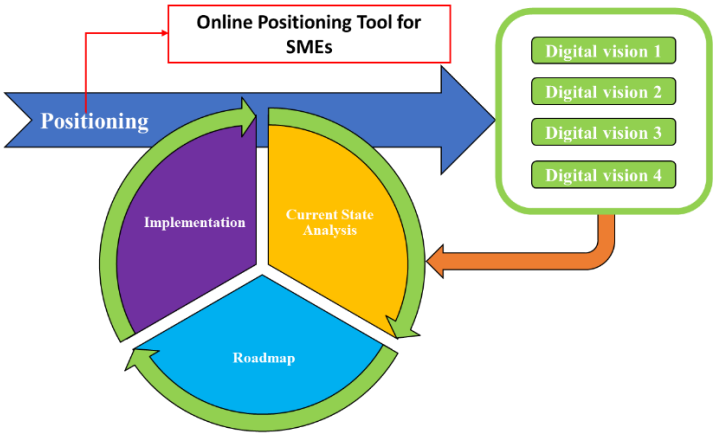

Figure 14 - DTM ID-3, adapted from Kääriäinen et al. (2020)

Phase number one (Positioning) includes the following activities (Figure 15): the online positioning tool, which we mentioned before; DigiSWOT, which is a SWOT analysis to DT; DigiTriangle, in which one analyses the ideas generated and organises them into three categories, namely "Internal Efficiency", "External Opportunities" or "Disruptive Change".

Figure 15 - Positioning phase of DTM ID-3

Phase number two (Current State Analysis) includes the following activities (Figure 16): analysis of the current state of the organisation, in which one analyses how the functions that will suffer changes work at the moment; a description of the business model; the identification and description of concept solutions; the planning of a new business model.

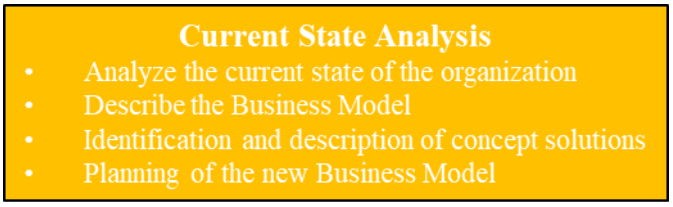

Figure 16 - Current State Analysis phase of DTM ID-3

Phase three (Roadmap) includes the following activities (Figure 17): a definition of concrete measures to reach the defined goals; the phasing of actions in terms of prioritisation; the assignment of responsibilities; the definition of metrics to evaluate the implementations.

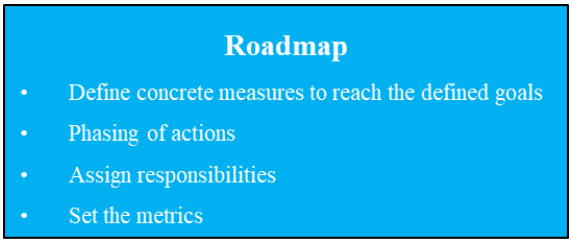

Figure 17 - Roadmap phase of DTM ID-3

Phase number four (Implementation) includes the following activities (Figure 18): the development of proofs-of-concept to validate solutions before full-scale implementations, the adoption of agile development methods, and the implementation of CEFO (Continuous Experimentation of Future Opportunities).

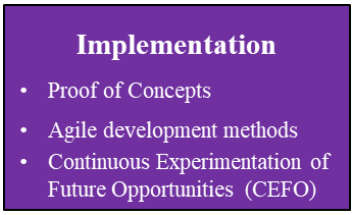

Figure 18 - Implementation phase of DTM ID-3

This DTM follows the plan-do-check-act (PDCA) principles, which are universally known for the continuous improvement of products, people and services (Moen & Norman, 2009). These principles of continuous improvement also apply to cooperatives (Santini et al., 2021) and therefore no further adaptations were made.

4.3.2. Adaptation of the DMM

For this adaptation, we used *Google Scholar* to identify papers that targeted the topic of DM in cooperatives. By using the keywords "Digital Maturity Cooperatives" and "Maturidade Digital Cooperativas", we identified the work of Prado (2019), which focuses on finding the most relevant DM dimensions for cooperatives. Furthermore, we used *Google Scholar* to search for adaptations of DMM ID-20 by other authors that could help us optimise the model. To do that, we searched for papers that cited Valdez-de-Leon (2016), and identified the work of Múnera et al. (2020), which adapts DMM ID-20 to credit unions.

The original version of DMM ID-20 is represented in Figure 19.

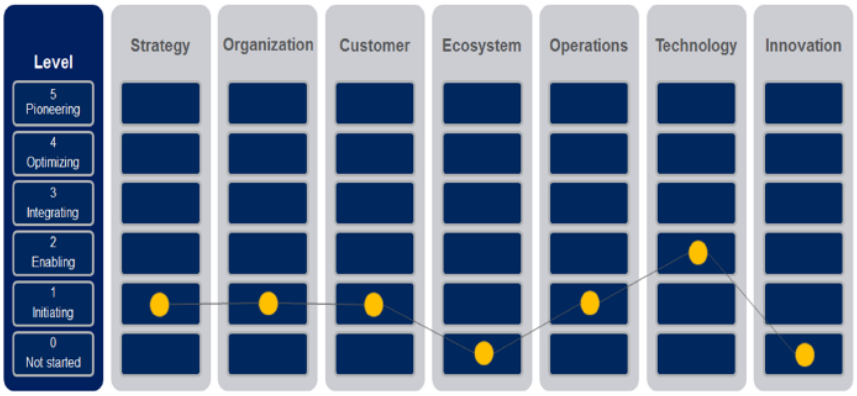

Figure 19 - Original version of DMM ID-20

Its original dimensions are represented in Figure 20.

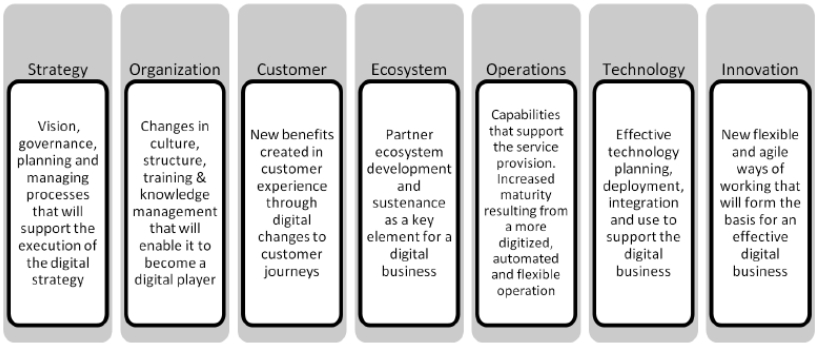

Figure 20 - Original dimensions of DMM ID-20

As mentioned before, a DMM needs maintenance: it matches against technology in constant change. As our understanding of DT changes, there is a need to further develop these models as well (Valdez-de-Leon, 2016). Furthermore, these models must reflect industry-specific requirements (Chanias & Hess, 2016; Paasi, 2017; Remane et al., 2017; Valdez-de-Leon, 2016).

Prado (2019) used the Delphi method, consulting with IT specialists that work with cooperatives, to identify the most important DM dimensions and components for cooperatives:

1. **Digital Vision and Strategy**: the generation of value for the cooperative members or digital customers, the commitment of top management to planning and alignment with digital, providing all the necessary resources for training and the prioritisation of digital products/services.
2. **Digital Culture**: includes expectations, experiences, philosophy, and values of an organisation, holding it together. It is expressed in its self-image, internal functioning, interactions with the external world and future expectations. This

is based on shared attitudes, beliefs, customs and written and unwritten rules developed over time. It is characterised by digital affinity, agility and error tolerance.

3. **Digitalisation – Processes and Technologies**: it evaluates the role of IT as a protagonist and supporter of DT processes, as it disseminates the latest technologies and drives the use of software to facilitate collaboration, communication and knowledge sharing in a structured way. The IT area suggests complete solutions to users and clients within acceptable physical and logical security parameters and privacy policies. This dimension comprises data-driven processes, digital supply chains, key performance indicators, and digital project and process management.
4. **Strategic Innovation**: it analyses the organisation's digital innovation process regarding its goods and services, whether the planning system impacts business models and whether cooperators are involved in the innovation process. Strategic innovation occurs through changes in the business model, technological innovation, testing, and learning experiments as a long-term investment.
5. **Digital Leadership**: strategically using a cooperative's digital assets to achieve business goals. It can be addressed at both organisational and individual levels and encompasses knowledge management, collaboration skills and talent management, thus creating space for DT.
6. **Digital Governance**: defined roles, responsibilities and decision-making in processes. DT follows a defined strategic plan. The structure that establishes responsibilities, roles, and authorities for decision-making about an organisation's digital presence. Digital policies guide instructions to manage risks and meet an organisation's interests.
7. **Customer & Cooperant Orientation**: availability of appropriate digital channels for communicating with customers and cooperators, thus promoting interaction. It can include CRM infrastructure with timely responses. The cooperative includes its customers and members in developing new product ideas and testing digital product improvements.

As our goal is to adapt DMM ID-20 to the specificities of service cooperatives, we integrated these dimensions into the original model, maintaining its structure. Some of the

dimensions mentioned by Prado (2019) were already represented in the original model, which means not all original dimensions were modified.

The first dimension in the original model, "Strategy", encompasses vision, governance, planning and process management. It already mentions some of the dimensions identified by Prado (2019): Digital Vision and Strategy, Digital Governance.

The second dimension in the original model, "Organisation", encompasses culture, structure, training and knowledge management, meaning it already includes Digital Culture and Digital Leadership.

The third dimension in the original model, “Customer” does not encompass cooperators, which are fundamental and unique to cooperatives. This dimension is where most modifications were made, as we had to change the original dimension. The name was changed from “Customer” to “Customers & Cooperators”. The goal was to include cooperators as an essential part of DM and that had to be reflected in this dimension. To do so, we included cooperator’s participation in areas such as: the development of new ideas and initiatives; service improvements and better digital experiences; the importance of digital communication channels to facilitate interaction.

The original dimensions named “Ecosystem”, “Operations” and “Technology” encompass partner ecosystem development, IT capabilities, and technology planning, deployment, integration and use. Prado (2019) groups all these areas into Digitalization – Processes and Technologies. As a result, we decided not to change the original structure of DMM ID-20.

The seventh dimension in the original model, “Innovation”, encompasses new flexible and agile ways of working that foster digital innovation, investments in digital technology and data-driven innovation, which Prado (2019) mentioned in the Strategic Innovation dimension.

The next step was to make adjustments to the structuring of the subdimensions, i.e., deciding the most relevant dimension in which to group each one of the subdimensions identified. Our subdimensions resume the main topics within each dimension. Múnera et al. (2020) proposed a dimension and subdimension structure that we used as the basis to make these changes:

- The “Participation”, “Knowledge” and “Relationship” subdimensions were added to the “Customers & Cooperators” dimension;

- The “Processes” and “Digital Business Development” subdimensions were added to the “Ecosystem” dimension;
- The “Digitisation” subdimension was added to the “Operations” dimension;
- The “Infrastructure” and “Security” subdimensions were added to the “Technology” dimension.

By adding new dimensions and subdimensions, we had to define what each subdimension refers to. A further search was conducted to consider the less positive aspects of the original version of DMM ID-20, namely its lack of information on the dimensions and subdimensions. This was done to facilitate understanding for those needing to interpret our updated version of the model. To do it, multiple documents were consulted and are shown in Table 17.

Table 17 - Sources for subdimension definition

ID	Dimension	Subdimension Name	Sources
1	Strategy	Vision	Prado (2019)
2	Strategy	Governance	Prado (2019); (Nabben et al., 2021); (Ciruela-Lorenzo et al., 2020)
3	Strategy	Planning	Valdez-de-Leon (2016)
4	Organisation	Culture	Prado (2019)
5	Organisation	Structure	Prado (2019)
6	Organisation	Training & Talent Management	Pirola et al. (2019); Prado (2019)
7	Organisation	Knowledge Management	Prado (2019)
8	Customers & Cooperators	Participation	Prado (2019); (Nabben et al., 2021); EURICSE & ICA (2022)
9	Customers & Cooperators	Knowledge	Prado (2019)
10	Customers & Cooperators	Relationship	Prado (2019)
11	Ecosystem	Processes	Prado (2019)
12	Ecosystem	Digital Business Development	Prado (2019); (Nabben et al., 2021)
13	Operations	Digitization	Pirola et al. (2019)
14	Operations	Automations	Ciruela-Lorenzo et al. (2020); IBM (2022)
15	Technology	IT Planning	Prado (2019)
16	Technology	IT Infrastructure	Prado (2019)

ID	Dimension	Subdimension Name	Sources
17	Technology	Integrations	Pirola et al. (2019)
18	Technology	Security	Gartner (2022)
19	Innovation	Flexible and Agile ways of working	Prado (2019)

While most subdimensions were comprehensively described by Prado (2019), other definitions were taken from consulting companies and scientific papers.

Subdimension ID-1: DT is currently an integral part of a global vision in the business world. The generation of value defines the vision to the cooperators and customers, the commitment of senior management with planning and alignment for digital and providing the necessary resources for transformation.

Subdimension ID-2: Defined roles, responsibilities and decision-making in the processes. DT follows a defined strategic plan. Development of a structure that establishes responsibilities, roles and authorities for decision-making about an organisation's digital presence. There has been a greater demand for accountability in cooperatives, which can be addressed through technologies such as multi-signature wallets or smart contracts. Digital policies are guiding statements to manage risk and ensure that an organisation's best interests are served as it operates online. Digital standards determine who decides the nature of the digital portfolio, and they exist to ensure optimal digital quality and effectiveness. Compliance with practice requirements, legislation, regulations or terms of a contract. Definition of the cooperative's DT budget to guarantee the execution of planned innovation projects.

Subdimension ID-3 relates to the planning of the developed DT strategy, with roadmaps that map the different stages of implementation. This helps anticipating obstacles and possible difficulties, thus allowing the formulation of strategies to mitigate and control such risks.

Subdimension ID-4 includes an organisation's expectations, experiences, philosophy, and values that hold it together and are expressed in its self-image, inner workings, interactions with the outside world, and future expectations. They are based on shared attitudes, beliefs, and written and unwritten rules developed over time and considered valid.

Subdimension ID-5: the ability to change quickly or adapt in response to market changes. This helps a cooperative to successfully react to the emergence of new competitors, the development of new technologies that can change the industry, or to reach sudden changes in general market conditions. It also minimises the resistance to organisational change through the involvement of key stakeholders, usually organised in multidisciplinary groups participating in the design of strategies. Also includes the planning, control and monitoring of DT initiatives.

Subdimension ID-6: Staff training involves upskilling and reskilling actions to enable the potential exploitation of new technologies. Organisations lack knowledge, and lifelong learning and training need to be put in place as a way of improving in this area. These strategies also help retain talent. Talent Management gives business managers an especially important role in recruiting, developing and retaining committed, high-performing collaborators.

Subdimension ID-7: an effective method of transferring know-how between individuals, therefore, fundamental to creating and sustaining a competitive digital advantage. This approach promotes increased training, capacity building, job satisfaction and other measures, and improved hiring practices. In addition, external consultants can be involved to develop knowledge of digitalisation, and in-house experts on digital topics act as multipliers.

Subdimension ID-8: the management has the interests of all stakeholders (customers, cooperators, employees) as its highest priority. There are policies for including all audiences involved in elaborating digital strategies (online and offline). Stakeholders help in the development of new product ideas and in testing the improvement of digital services. Understanding the customer experience is integral to relationship management and learning so that the cooperative can offer products and services consistently across all digital channels. There is access to updated and trustworthy information by the members and public, to avoid gaps in transparency and information asymmetry, thus increasing members' and stakeholders' ability to oversee and control the cooperative.

Subdimension ID-9: insights derived from interactions, customer and cooperator data, and interaction experiences must be organised in the different channels. Customer and cooperator data are analysed and executed, ideally, in real-time through technologies such as data analytics.

Subdimension ID-10: personalised digital communication with customers and cooperators. The promotion of services is made through one or more forms of electronic media,

with promotions driven by the internet, social media, mobile phones and other digital channels. The availability of appropriate digital channels for communicating with customers and cooperators, integrated and with consistent content, to promote interactivity and responses to the organisation's digital flow. CRM (Customer Relationship Management) infrastructure with timely responses.

Subdimension ID-11: process management is an integral part of any modern operating system. To do it, the operating system must contain a data structure for each process that describes the state and resources used, allowing it to exercise control over each process.

Subdimension ID-12 evaluates the role of IT as a protagonist and supporter of the DT process, given that it disseminates the latest digital technologies and drives the use of software that facilitates collaboration, communication, knowledge sharing in a structured way and multiple applications in mobile technologies. Moreover, IT proposes complete solutions to users and customers within acceptable physical and logical security parameters and privacy policies. Digital tools for decentralised voting, treasury management solutions and automation of payments may improve the scalability of service cooperatives.

Subdimension ID-13: the level at which processes are digitised to transition from analogue practices (i.e., physically record data on paper sheets) to digital (i.e., no use of paper printed documents, and adoption of best practices such as digital signatures).

Subdimension ID-14: automation of routine processes, reducing human intervention. It streamlines and centralises routine tasks, increasing productivity and efficiency (e.g., automating payments and contracts using smart contracts).

Subdimension ID-15: process in which the organisation embarks on a journey with technology as a source of innovation and has been identified as a critical success factor to increase competitiveness by focusing on the technological aspects of a process or service. There is a systematic evaluation of digital technologies and innovations.

Subdimension ID-16: structured IT and up-to-date infrastructures ensure relevant digital technologies can be implemented. More and more industries are incorporating Automation, Cloud, Big Data, Analytics, Artificial Intelligence, and the Internet of Things to add connectivity, intelligence and autonomy to machines and software.

Subdimension ID-17: integration can be vertical and horizontal. Considering ERP as the company's core, it is assumed that vertical integration is achieved when all information

systems are integrated, meaning they exchange data in a bidirectional way. On the other hand, horizontal integration aims to improve efficiency through fluent information and finance flows among organisations. It is thus evaluated through communication and information sharing along the supply chain.

Subdimension ID-18: digital information and technology are now highly integrated into daily work, leading to increased cyber threats that have the potential to jeopardise organisations. IT security involves deploying people, policies, processes and technologies to protect organisations, their critical systems and sensitive information from these attacks.

Subdimension ID-19 analyses the organisation's digital innovation processes in its portfolio of services and measures whether there is a meaningful impact and whether stakeholders are involved in the innovation process. Strategic innovation occurs through technological innovation, testing proofs-of-concept, and as a long-term investment in the necessary resources.

The descriptions that complement the questionnaire were also adapted to reflect the changes and optimisations made to DMM ID-20, as it was not originally built for cooperatives. These modifications were made based on the characteristics of service cooperatives and other papers that contained relevant information to characterise each DM level within a given dimension and subdimension. These levels demonstrate the progression in DT efforts, with the DM level rising as the organisation implements changes and reaches its goals; each includes specific characteristics regarding implementations, investments, or established capabilities (Valdez-de-Leon, 2016).

In the "Strategy" dimension, the descriptions for each DM level were adapted to better reflect the characteristics of service cooperatives. These changes included removing descriptive items that focused primarily on revenue and profit, thus not being aligned with the characteristics of service cooperatives (ILO, 2016).

In the “Organization” dimension, the subdimensions “Talent Management” and “Training” were grouped together in the questionnaire descriptions, as they are closely related to each other. The original questionnaire of DMM ID-20 already referred both topics in “Training”: Talent Management was already included in the descriptions of "Training", but it was not explicit. This led to the decision to rename the original subdimension to better reflect its content. This subdimension is in accordance with the cooperative principle of training and education (Meira, 2020): a higher digital literacy of cooperators has the potential to turn IT

solutions such as digital general assemblies more efficient. This solution can increase member participation and diminish the limitations caused by cooperators' geographic dispersion.

The "Customers & Cooperators" dimension and respective subdimension descriptions adaptation included the cooperators as an essential part of the DM levels. The original model focused exclusively on customers and now also contemplates cooperator's participation. The involvement of cooperators must be done in a transparent way, namely through online repositories (like websites) in which important documentation is made available, as members have the right to information and active participation (Meira, 2020). Members bring new ideas and suggestions for service improvement, but this only works if good communication policies are in place. However, the community also has to be heard, as the cooperative value of active participation in local communities is also important (Meira, 2020).

Regarding the "Ecosystem" dimension, the subdimensions' descriptions in each DM level were modified, based on another DMM but maintained some original items.

Regarding "Processes", the update included the modification of the "Digital Business Development" descriptions based on North et al. (2018).

The "Operations" dimension had its descriptions for "Digitization" based on Pirola et al. (2019). The descriptions for the subdimension "Automations" were mostly maintained.

The "Technology" dimension had its descriptions adapted in terms of "Infrastructure", based on Múnera et al. (2020) and also in the "Security" subdimension, based on North et al. (2018). Description items related to automations were removed, as they are already included in the "Operations" dimension.

The "Innovation" dimension had its descriptions adapted, considering an approximation to the characteristics of service cooperatives. Item descriptions focusing primarily on revenue were removed as they do not align with cooperatives' philosophy. Cooperatives aim to maximize members' benefits, deriving from operations carried out within the cooperative, and not to make profit (Sarkar et al., 2023).

4.3.3. A DTM-DMM pairing for cooperatives of services

The final version of our proposed DTM adaptation is depicted in Figure 21. The "Positioning" phase now includes the usage of the DMM for service cooperatives in a combined approach of DTM-DMM.

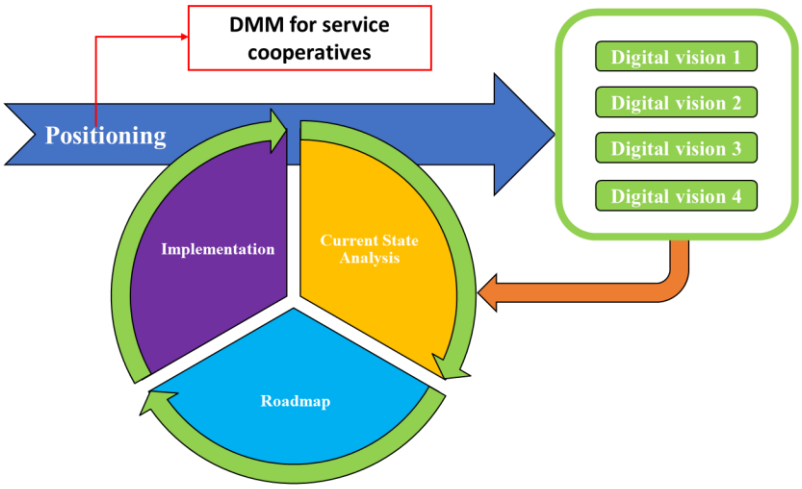

Figure 21 - Adapted version of DTM ID-3

After all the changes were made to the original DMM ID-20, based on Múnera et al. (2020) and Prado (2019), there were a total of seven dimensions and 19 subdimensions (Table 18):

Table 18 - DMM ID-20 dimensions and subdimensions after the adaptation process

Strategy	Organization	Customers & Cooperators	Ecosystem	Operations	Technology	Innovation
• Vision • Governance • Planning	• Culture • Structure • Training & Talent Management • Knowledge Management	• Participation • Knowledge • Relationship	• Processes • Digital Business Development	• Digitization • Automations	• IT Planning • Infrastructure • Integrations • Security	• Flexible and agile ways of working

The general description of each DM level is represented in Table 19. This model does not suggest that DM level five should be the goal of every organisation; its DM levels are intended to be a snapshot of the extent of implementation (Valdez-de-Leon, 2016).

Table 19 – DMM ID-20 final DM Levels

DM Levels					
0	1	2	3	4	5
Not started.	The organization has decided to move towards a digital business and is taking initial steps in that direction.	The organization is implementing initiatives within the dimension that will form the foundation of its digital business.	The organization's initiatives are being integrated across the organization to support end-to-end capabilities.	The organization's digital initiatives within the dimension are being fine-tuned and used to further increase overall performance.	The organization is digital oriented, based on a solid technology infrastructure. It is advancing the state of the practice and breaking new ground.

The final version of the DMM to be used is represented in Table 20 below. Organisations must define their ambitioned future state (TO-BE analysis), considering their

ambitions, context, resources and timeline (Valdez-de-Leon, 2016). The goal of this DMM is to help define the AS-IS and TO-BE states and offer relevant insights for the planning of DT initiatives.

Table 20 - Final version of the DMM

DM Level	Strategy	Organization	Customers & Cooperators	Ecosystem	Operations	Technology	Innovation
5							
4							
3							
2							
1							
0							

The description for each dimensions' DM level is not extensive, and its purpose it to provide a general and indicative overlook on some of the characteristics that represent each level. Starting with the Strategy dimension, the final result is shown in Table 21.

Table 21 - Strategy dimension

Strategy					
0	1	2	3	4	5
Not started.	The organization has defined an initial digital vision, albeit at this point it is mostly "siloed" and focused on incremental operational improvements. Some proof-of-concept projects have been authorized at a departmental level to experiment with digital tools (e.g., apps)	A digital strategy that incorporates most elements of this digital maturity model is signed off by *CxO* level. Formal investments aligned to the digital strategy have been approved. Digital leadership have been appointed to drive transformation. Budgets are incorporating digital targets.	A common digital strategy is shared across the whole organization at all levels. Investments have been authorized at *CxO* level for overall digital transformation. Digital initiatives are being implemented across the organization, including cross-departmental projects. Budgets, KPI and performance metrics across the organization include a digital element, including common (inter-departmental) targets. First set of digital initiatives are in the roadmap/delivered.	Digital strategy is well developed and drives the organization's direction and investments. Digital is a core competence in the organization. New business models are being implemented with pure digital elements. Digital strategy is being shared and reviewed with all stakeholders. Digital strategy is no longer owned by a dedicated team, but it is an inherent part of activities across the organization.	The digital strategy has for some time been driving management and investment decisions. The organization is now capitalizing on previous investments and transformation efforts.

Regarding the Organisation dimension, the results are demonstrated in Table 22.

Table 22 - Organization dimension

Organization					
0	1	2	3	4	5
Not started.	The organization has articulated the need for digital transformation. The need for digital competencies has been identified and a general development plan is being defined. Initial investments are being made to develop digital competencies, including training programmes. Recruitment of select "experts" to bring needed skills is ongoing, often in isolated teams.	The organization has a vision for digital transformation, which begins to drive change towards a digitally-savvy workforce. Digital units/teams are being created to explore digital opportunities. Training is being adapted to align with the digital strategy. Digital services are supported by a specific team.	Management is continuously communicating the digital strategy and advances in its implementation across the whole organization. Digital strategy is driving organizational change, including organizational structure and KPI. Digital initiatives incorporate people from several functions and departments, as well as external partners. Performance systems across the organization incorporate digital elements. Global processes are set to promote the transfer of global/central digital knowledge towards the organization.	Digital is fully embedded in the organizational culture. Digital capabilities are well developed, and partnerships are continuously formed to access new ones. A well-defined personnel development strategy is in place, including when to train, outsource, or acquire digital capabilities. KPIs are now mainly driven by digital services.	Collaboration with other ecosystem partners is well established, generating service innovation that is ahead of competition. The organization is flexible and easily adapts to changes in an agile way. The organization is focused on digital innovation.

In the Customers & Cooperators dimension, the final version is shown in Table 23.

Table 23 - Customers & Cooperators dimension

Customers & Cooperators					
0	1	2	3	4	5
Not started.	Basic self-help tools are available to customers and cooperators. Initial pilots of new digital tools such as self-service apps and social media support are being conducted. Initiatives and requirements to expand interaction beyond basic app-based self-support have been identified. Basic e-commerce capabilities are being implemented. There is a plan to collect ideas from customers/cooperators and other stakeholders.	An omni-channel vision has been fully articulated (although not necessarily completely executed). New digital engagement tools are being implemented. Customer and cooperator experience and usage data is actively collected and used to assist support and service improvements. The organization is starting to use external sources for digital innovation. New digital services are being made available to customers and cooperators.	An omni-channel vision is well under-way throughout customer/cooperator-facing operations (physical, online, mobile and call-center). Customers/cooperators can not only access support and information; service tools are also available across channels. Customer/cooperator experience and usage data is routinely collected across all channels and shared across organizational functions (marketing, support, network operations, etc.). External sources have contributed to identify innovation opportunities. It is possible to bundle new digital services with traditional services.	Customer/cooperator experience management has moved from reactive to proactive, including automated actions (e.g., next-best action, personalized promotions). Data analytics are being extensively used to improve value and development of new offerings, promotions and branding. Initial tests of data-driven dynamics is ongoing. Digital tools and systems are enabling full customization of services at the individual customer/cooperator level. Initial tests of data-driven dynamic are ongoing. There is regular collaboration with some external partners (customers/cooperators/stakeholders) to search for and develop digitally enabled growth opportunities.	Dynamic pricing is being used to maximize value through full personalization and flexibility. Machine learning and other advanced tools are being used to identify consumption trends and to develop new service and pricing strategies. New services are being developed based on deep knowledge (advanced analytics). Full integration of data across all touch points (e.g., one screen/app/bill for all services). There is a systematic and proactive open innovation approach: invite customers/cooperators/potential customers, to provide feedback and ideas via digital platforms.

The DM level descriptions for the Ecosystem dimension is represented in Table 24.

Table 24 - Ecosystem dimension

Ecosystem					
0	1	2	3	4	5
Not started.	The organization has developed a preliminary ecosystem strategy for digital services. Programs and key assets (e.g., people, technology platforms) have been identified and will form the basis for a digital ecosystem. Resources (e.g., people and funding) are being allocated to develop a digital ecosystem. Processes are poorly controlled or not controlled at all. The organization is reactive to the digital technology of competitors.	An ecosystem strategy, as part of a wider digital product strategy, has been signed-off by senior management. Process control is weak due to constraints in the organization and/or enabling technologies. There is an observation of new digital technologies/applications and their relevance for the organization.	The ecosystem strategy has been implemented gradually. Process control is limited by some constraints on the organizational responsibilities and/or on the enabling technologies. There is an adoption of some new digital technology.	The ecosystem strategy is almost fully implemented. Process control is possible in almost all the processes. There is an analysis on how some new technology driven opportunities can create value for specific customers/cooperants and are addressed properly.	The ecosystem strategy has been fully implemented. Process control has no limitations and works at industry best-practice standards. The organization takes a systematic and proactive approach to technology driven products/service innovation in the digital environment.

Regarding the Operations dimension, the final version is shown in Table 25.

Table 25 - Operations dimension

Operations					
0	1	2	3	4	5
Not started.	IT systems support only a few processes (processes are partially digitized or not digitized at all), and the current infrastructure does not allow process integration. Investments to automate key operations are being evaluated (e.g., billing). Improvements in visibility and automation are being evaluated. Initiatives to digitally update key business processes have been identified.	IT systems support routinary activities. Systems to support and automate digital services are being implemented. Advanced analytics are being deployed for service assurance improvements. Systems and processes to collect and analyze customer/cooperant usage data are being deployed. Processes and policies to better support digital services are being designed and implemented in some key areas of the organization.	IT systems support some additional processes. Automation of end-to-end processes is being implemented. Customer/Cooperant usage data is being collected and combined to provide visibility of end-to-end processes across the organization. Digital services are implemented and deployed jointly with traditional ones, and they share processes.	The organization is almost fully digitized. Automated processes are being optimized to improve efficiency and reduce costs. Real-time customer/cooperant usage data is being combined and analyzed to optimize service reliability as well as key processes (e.g., customer support). Some real-time, automated decision-making is being implemented in the service provision of digital services (e.g., in the event of service failure, send job order and customer-personalized message).	The organization is fully digitized, and it could easily be integrated with external partners (it is optimized). Full observability of service and usage data is now driving innovation within the organization, including dynamic offerings. Automated end-to-end processes ensure real-time data flows across functions for improved planning and decision-making. Real-time, automated decision making is fully implemented in the service provision of digital services.

In the Technology dimension, the final version is shown in Table 26.

Table 26 - Technology dimension

Technology					
0	1	2	3	4	5
Not started.	A digital-specific, IT architecture is being developed. Efforts to define required transformation of IT architecture has been started. Some initial pilots are planned to test new digital tools and platforms. There is a regular backup of data, up-to-date antivirus software; further security solutions planned.	A digital-specific IT architecture has been defined and changes to organizations' IT are ongoing to align it to target architecture. Tactical IT investment plans are aligned to target architecture. Platforms are being deployed to support digital services (e.g., an IoT platform). Support systems are being implemented to support digital services (e.g., flexible billing). There is a process to evaluate IT investments based on their alignment to the digital strategy of the organization. Few cybersecurity measures are planned.	Digital enterprise IT architecture has been largely implemented, including consolidation of stove-pipe systems into platforms for support of omni-channel services. Processes across the organization (e.g., customer/cooperant support) are aligned to digital IT architecture. Analytics technologies are being implemented to facilitate data collection and sharing across functions. Some cybersecurity measures have been implemented.	End-to-end processes supporting digital services are being optimized by leveraging the IT architecture. Integration tools are deployed to reduce time and costs of integration. Digital IT architecture supports business agility through flexible tools and supporting processes. Analytics technologies are being used for optimization of services and processes. Cybersecurity is ensured for the most critical areas.	Technologies such as advanced analytics underpin innovation processes across the organization, from new service development through to service assurance to customer support. Tools using technology such as machine learning are implemented and used across the organization for predictive activities (e.g., service reliability, user consumption trends) that support digital business innovation. Comprehensive cybersecurity solutions have been implemented for all relevant areas; there is a cybersecurity plan in place.

Finally, the DM level descriptions for the Innovation dimension are represented in Table 27.

Table 27 - Innovation dimension

Innovation					
0	1	2	3	4	5
Not started.	A need to develop a more agile and innovative organization has been identified. The organization is developing a strategy for digital innovation across functions. Some initial changes are being made to the way digital services are developed with a focus hitherto on incremental improvements.	A digital innovation strategy has been developed with focus on agile development and open and data-driven innovation processes. Investments in digital technologies are aligned to innovation strategy and activities. New processes are being implemented to foster digital innovation. Investments in people development for digital innovation are underway.	Open innovation with external parties (partners, users, etc.) has been implemented to support digital innovation. Data (including service, customer/cooperant and usage) is shared across the organization to support innovation. Metrics and KPI specific to digital innovation are being implemented.	Innovation in new digital services is mature, with clearly defined targets, processes and KPI. Time to market new service propositions is being reduced through well-established innovation processes. Customer/cooperant co-creation of new services is used to advance innovation and reduce costs of development.	The organization is breaking new ground in the way it innovates. The organization is recognized in the industry as leader in digital innovation.

4.3.4. Discussion

Regarding the DTM, our adaptation modified the initial “Positioning” phase, by now including a DMM for service cooperatives. This follows our proposed DTM-DMM combined approach. The DTM will give guidance to service cooperatives and help them create roadmaps for DT processes.

Regarding the DMM, the main difference in this adaptation is the inclusion of cooperators, which are unique to a cooperative and thus play a central role in the DT of a service cooperative. A customer and cooperator centricity is essential to a cooperative, leading to a better customer and cooperator experience and good organisational performance. Cooperators relate to the cooperatives as owners but also as clients and thus demand benefits that go beyond financial profitability as a way of experiencing better services (Prado, 2019). DT initiatives should therefore place customers and cooperators at the heart of their strategies and work towards fulfilling their necessities and ambitions. The relationship between the different dimensions of this DMM is represented in Figure 22. We can see that all the dimensions must have a common goal: to better serve Customers & Cooperators, hence its central position.

Figure 22 - DMM dimension nexus

According to EURICSE & ICA (2022), the most important areas for cooperatives regarding the use of digital tools are:

- IT system security – represented in the Technology dimension of our DMM;
- Management software – represented in the Ecosystem and Technology dimensions of our DMM;

- E-Commerce – represented in the Technology dimension of our DMM;
- Cloud computing and remote management of services and infrastructure – represented in the Ecosystem and Technology dimensions of our DMM;
- Communication and creation of web and social media content - represented in the Customers & Cooperators dimension of our DMM;
- Digital participation of members – represented in the Customers & Cooperators dimension of our DMM;
- AI, Big Data processing and analysis – represented in the Technology dimension of our DMM;
- Automation – represented in the Operations dimension of our DMM.

Our adaptation of the DMM covers all of these areas identified by EURICSE & ICA (2022), meaning it addresses the most important tecnological aspects for service cooperatives regarding DT.

By using this DTM-DMM pair, service cooperatives can overcome resource constraints and develop structured DT plans. By developing a DT strategy aiming at specific and clear DM goals, these organisations can increase their chances of success, remaining competitive. We have developed an adaptation that provides useful information regarding its architecture, namely its dimensions and subdimensions, as the goal is to offer an easy-to-use and easy-to-understand set of tools.

Kääriäinen et al. (2020) developed a DTM that includes a DM tool for private companies. We made an alteration, so it would include a DMM specific to service cooperatives. (Valdez-de-Leon, 2016) contributed with a DMM for service providers, and we used it as the basis for building our DMM for service cooperatives. These contributions were essential to this study, being considered a good example of a robust and free-access DTM-DMM pair. However, they were not suited for service cooperatives, and we have managed to add an important contribute to help this type of organisation.

To optimize the benefits of DT in cooperatives, it is crucial to devise a DT strategy that is tailored to the cooperative's overall objectives and specific organisational characteristics, which differ from those of IOC. A well-crafted DT plan can give cooperatives a competitive edge by streamlining, enhancing, and expanding their service offerings, resulting in a closer and more productive relationship between cooperators and the cooperative.

We define the current state of the art of DTMs and DMMs, including models from academic and corporate sources. However, these models were built for IOCs and therefore place profit maximization at the centre. This shows that the models do not encompass the characteristics of cooperatives of services, namely the central role of cooperators instead of profit. For a combined approach, there needed to be an adaptation in the models.

The combined DTM-DMM approach provides structured guidance on the planning and implementation of DT processes. Transformative processes must be conducted with rigour, otherwise, they might fail. While a DTM provides a set of guiding principles and phases for implementing digital technologies and practices in organisations, a DMM is a tool that helps these organisations assess their current level of DM and identify areas that need improvement (AS-IS and TO-BE analysis).

We selected the most robust and complete models and proposed pairings according to companies' characteristics, such as size and industry. In the end, we suggest three pairings: One for SMEs in an Industry 4.0 context and two for SMEs not in the manufacturing industry.

Then, we select the most suitable DTM-DMM pairing and incorporate the characteristics of service cooperatives. The changes included the removal of profit-oriented objectives and the inclusion of cooperators as a central element of a DT. The cooperators were included in both the constructs and the DM level descriptions in the DMM.

The cooperatives of services now have a set of tools (DTM and DMM) that, when combined and used together can help creating structured DT plans and rigorous guidance regarding DT processes. With this, these organisations have the chance of potentially increasing the success rates of their DT efforts, overcoming eventual resource limitations.

This dissertation provides a new contribution for the study of the DT phenomenon in cooperatives of services.

5.1. Limitations of the work

Only the models (DTMs and DMMs) available in English were considered, which is one of the limitations of this study. In addition, the amount of DTMs and DMMs available for different types of organisation is still scarce, with most targeted at Industry 4.0 and SMEs. This scarcity makes the suggested binomial relations more limited in their scope. Furthermore, the model analysis was based on text interpretation by the author. Even though there was an attempt to be as unbiased as possible, different interpretations might be possible for others, as the results only reflect a possible point of view. Terms related to DT and DM are not standardised, meaning there are multiple ways to understand the text. Finally, this DTM-DMM adaptation still needs to be validated in practice. This can be done by applying the models in real-life scenarios, which could lead to refinements and further optimisations.

5.2. Future work

Future research recommendations include a broader analysis of DTM and DMM that have documentation in other languages, as well as the validation of this DTM-DMM pair in practice. These models can also be used for further adaptation to other types of cooperatives, as these organisations are underrepresented and must deal with DT complexity while most also deal with resource limitations.

Once this DTM-DMM pair is validated, it can be a useful starting point for service cooperatives and also the basis for further adaptations to other types of cooperative.

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Appendix I – Corporate DTMs screened in the systematic literature review

Table 28 – Corporate DTMs A1

Corporate DTMs – A1			
1	Achieving Digital Maturity	https://www2.deloitte.com/content/dam/Deloitte/za/Documents/technology/za_DUP_Achieving-digital-maturity.pdf	MIT Sloan Management Review & Deloitte, (2017)
2	Digital Transformation in the Saudi Levant Cluster	https://assets.kpmg/content/dam/kpmg/sa/pdf/2020/digital-transformation-playbook.pdf	KPMG, (2020)
3	DIGITAL TRANSFORMATION: A ROADMAP FOR BILLION-DOLLAR ORGANIZATIONS	https://www.capgemini.com/wp-content/uploads/2017/07/Digital_Transformation__A_Road-Map_for_Billion-Dollar_Organizations.pdf	Capgemini & MITSloan Management Review, (2011)
4	Digital transformation: Creating new business models where digital meets physical	https://s3-us-west-2.amazonaws.com/itworldcanada/archive/Themes/Hubs/Brainstorm/digital-transformation.pdf	IBM, (2011)
5	How to Win with Digital	https://www.cognizant.com/us/en/archives/whitepapers/documents/how-to-win-with-digital-codex4448.pdf	Cognizant, (n.d.)
6	Mulesoft Digital Transformation Blueprint	https://www.mulesoft.com/lp/whitepaper/api/digital-transformation-blueprint	Mulesoft, (n.d.)
7	Raising your Digital Quotient	http://www.eurasiancommission.org/ru/act/dmi/workgroup/materials/Pages/Mckinsey_Raising%20your%20Digital%20Quotient_2016.pdf	McKinsey & Company, (2015)
8	The Definitive Guide to DIGITAL TRANSFORMATION & THE DIGITAL MATURITY MATRIX	https://amplience.a.bigcontent.io/v1/static/DigitalTransformation-and-the-Digital-Maturity-Matrix-updated	Amplience, (n.d.)
9	The IT Roadmap for Digital Business Transformation	https://www.gartner.com/en/publications/the-it-roadmap-for-digital-business-transformation	Gartner, (2021)
10	Wipro's Digital Transformation Model	https://www.wipro.com/content/dam/nexus/en/industries/communication-service-providers/solutions/wipro-digital-transformation-model.pdf	Wipro, (2020)

Table 29 – Corporate DTMs A2

Corporate DTMs – A2			
1	How to Win with Digital	https://www.cognizant.com/us/en/archives/whitepapers/documents/how-to-win-with-digital-codex4448.pdf	Cognizant, (n.d.)
2	The IT Roadmap for Digital Business Transformation	https://www.gartner.com/en/publications/the-it-roadmap-for-digital-business-transformation	Gartner, (2021)

Appendix II – Academic papers screened in the DTM systematic literature review

Table 30 – Academic DTMs B1

Academic DTMs – B1		
1	A Big Data strategy to reinforce self-sustainability for pharmaceutical companies in the digital transformation era: A case study of Egyptian pharmaceutical companies	Hassanin & Hamada, (2022)
2	A Case Study Perspective to the Digital Transformation of a Hospital's Perioperative Process	Ryan, et al. (2019)
3	A Dynamic Capability Approach to Digital Transformation: a Focus on key Foundational Themes	Carcary, et al. (2016)
4	A Framework for BPM Software Selection in Relation to Digital Transformation Drivers	Brkic, et al. (2020)
5	A FRAMEWORK FOR DIGITAL TRANSFORMATION AND BUSINESS MODEL INNOVATION	Van Tonder, et al. (2020)
6	A Framework Integrating Internet of Things and Blockchain in Clinical Trials Reverse Supply Chain	Badulescu & Cheikhrouhou, (2021)
7	A Model for Librarians to Assess the Digital Capability of Research Teams	Wolski, et al. (2020)
8	AI led ethical digital transformation: framework, research and managerial implications	Saurabh, et al. (2021)
9	Applications of Blockchain Technology to Higher Education Arena: A Bibliometric Analysis	Reis-Marques, et al. (2021)
10	Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization	Kääriäinen, et al. (2020)
11	Artificial intelligence (AI) library services innovative conceptual framework for the digital transformation of university education	Okunlaya, et al. (2022)
12	Assessing Digital Transformation in Universities	Rodriguez-Abatia & Bribiesca-Correa, (2021)
13	Behavior-Based Network Management: A Unique Model-Based Approach to Implementing Cyber Superiority	Seng, (2016)
14	Big data and data analytics in auditing: in search of legitimacy	De Santis & D'Onza, (2021)
15	Building and Development of an Organizational Competence for Digital Transformation in SMEs	Gonzalez-Varona, et al. (2021)
16	Building Culinary Business Performance during the Covid-19 Pandemic: Transformational Leadership as a Trigger through Digital Capabilities	Permana, et al. (2022)
17	Challenges and Driving Forces for Industry 4.0 Implementation	Herceg, et al. (2020)
18	Conceptualizing and Testing a Social Cognitive Model of the Digital Divide	Wei, et al. (2011)
19	Constructing a Sustainable and Dynamic Promotion Model for Fresh Foods Based on a Digital Transformation Framework	Ou, et al. (2021)
20	Construction of a Digital Platform for Enterprise Financial Management Based on Visual Processing Technology	Deng, (2022)
21	Consultants' Tools to Manage Digital Transformation: The Case of PWC, Siemens, and Oracle	Cozmiuc & Pettinger, (2021)
22	CORPORATE SOCIAL AND DIGITAL RESPONSIBILITY	Orbik & Zozul'akova, (2019)
23	Cross-language Keyword Analysis of Digital Transformation for Business	Van Veldhoven, et al. (2020)
24	Current Trends in Air Services Distribution Channel Strategy: Evolution Through Digital Transformation	Poukali & Katsoni, (2020)
25	CUSTOMER EXPERIENCE AND ORGANIZATIONAL AGILITY DRIVEN BUSINESS MODEL INNOVATION TO SHAPE SUSTAINABLE DEVELOPMENT	Mihardjo, et al. (2019)
26	Delivering the digital region: leveraging digital connectivity to deliver regional digital growth	Knight, (2015)
27	Developing a digital transformation model to enhance the strategy development process for leadership in the South African manufacturing sector	Gaffley & Pelser, (2021)
28	Digital evolution and emerging revenue management practices: evidence from Aegean airlines distribution channels	Katsoni & Poulaki, (2021)
29	Digital innovation strategy: A framework for diagnosing	Nylen & Holmstrom, (2015)
30	Digital Privacy GDPR: A Proposed Digital Transformation Framework Completed Research	Russell, et al. (2018)

31	Digital transformation during a lockdown	Fletcher & Griffiths, (2020)
32	Digital Transformation Insights and Trends	Pihir, et al. (2018)
33	DIGITAL TRANSFORMATION MODEL FOR THE DEVELOPMENT OF TOURISM COMPANIES	Pumaleque, et al. (2021)
34	Digital Transformation Model for the Reduction of Time Taken for Document Management with a Technology Adoption Approach for Construction SMEs	Lazaro-Aleman, et al. (2020)
35	Digital Transformation Model: Analytic Approach on Participatory Governance & Community Engagement in India	Misra, et al. (2018)
36	Digital Transformation of Agencies for Students` Part Time Jobs in the Republic of Croatia	Visnjic & Vrcek, (2021)
37	Digital Transformation of Business: Approaches and Definitions	Zaychenko, et al. (2020)
38	DIGITAL TRANSFORMATION OF REQUIREMENTS IN THE INDUSTRY 4.0: CASE OF NAVAL PLATFORMS	Cerezo-Narvaez, et al. (2018)
39	Digital Transformation Strategies	Matt, et al. (2015)
40	Digital transformation: challenges faced by organizations and their potential solutions	Shahi & Sinha, (2021)
41	Digital Value Creation 22th February 2018	Seitz & Burosch, (2018)
42	Enterprise Digital Transformation in Ecuador: Strategic Options	Merchan & Paliz, (2020)
43	Environmental uncertainty, resource orchestration and digital transformation: A fuzzy-set QCA approach	Chen & Tian, (2022)
44	Framing the Digital Transformation of Educational Institutions	Furjan, et al. (2018)
45	Fraud Management Accounting and Organizational Value Creation: Evidence from Listed Firms in Thailand	Phornlaphatrachakorn, (2021)
46	Gearing up for successful digital transformation	Gurbaxani & Dunkle, (2019)
47	Grasp the Challenge of Digital Transition in SMEs-A Training Course Geared towards Decision-Makers	Azevedo & Almeida, (2021)
48	Health Professional Digital Capabilities Frameworks: A Scoping Review	Brice & Almond, (2020)
49	How will we Build Competences for Managing the Digital Transformation?	Wolff, et al. (2019)
50	Industrie 4.0 roadmap	Issa, et al. (2018)
51	Information Practices and Digital Perspectives of Municipal Waste Recovery Providers in Europe	Luic & Labura, (2021)
52	Information technology and marketing: an important partnership for decades	Graesch, et al. (2020)
53	IT Management and Governance Framework for Formulating a Digital Transformation Strategy	Korachi & Bounabat, (2022)
54	Key Drivers of Digital Transformation in Greek Businesses: Strategy vs. Technology	Karekla, et al. (2021)
55	Leadership matters in crisis-induced digital transformation: how to lead service employees effectively during the COVID-19 pandemic	Bartsch, et al. (2020)
56	Making the invisible visible	Singh, (2019)
57	Mastering the Digital Transformation Process: Business Practices and Lessons Learned	Ivancic, et al. (2019)
58	Methodology for Digitalization - A Conceptual Model	Ng, et al. (2018)
59	Mutual 'App'reciation: Co-production as a model for delivering digital capability within social work education	Turner, (2020)
60	Nexus of Digital Organizational Culture, Capabilities, Organizational Readiness, and Innovation: Investigation of SMEs Operating in the Digital Economy	Zhen, (2021)
61	Organizational competencies toward digital transformation at the events of disruptive changes: an operational process innovation perspective	Al-Edenat, (2021)
62	Quality of Digital Transformation Management on the Way of Formation of Innovative Economy of Russia	Veselovski, et al. (2019)
63	Role of Government to Enhance Digital Transformation in Small Service Business	Chen, et al. (2021)
64	Structural Requirements for Digital Transformation - Insights from German Enterprises	Murawski, et al. (2019)
65	Supporting Digital Transformation in Small and Medium-sized Enterprises	Barann, et al. (2019)

66	Survival in the digital age – A framework	Trenkle, (2019)
67	THE CONCEPT OF BUILDING A DIGITAL TRANSFORMATION MODEL FOR ENTERPRISES FROM THE SME SECTOR	Szopa & Cyplik, (2020)
68	The Digital Transformation Trajectory of Industrial Enterprises	Ismagilova, et al. (2019)
69	The Digitalization Transformation of Commercial Banks and Its Impact on Sustainable Efficiency Improvements through Investment in Science and Technology	Zuo, et al. (2021)
70	The effects of personality traits on digital transformation: Evidence from German tax consulting	Diller, et al. (2020)
71	The importance of Industry 4.0 and digital transformation for SMEs	Verhovnik & Duh (2021)
72	THE ROLE OF DISTINCTIVE ORGANISATIONAL CAPABILITY IN FORMULATING CO-CREATION STRATEGY AND BUSINESS MODEL INNOVATION	Mihardjo, et al. (2018)
73	The Shift towards Digital Literacy in Australian University Libraries: Developing a Digital Literacy Framework	Johnston, (2020)
74	Threats and Opportunities in Digital Transformation in SMEs from the Perspective of Sustainability: A Case Study in the Czech Republic	Simberova, et al. (2022)

Table 31 – Academic DTMs B2

Academic DTMs – B2		
1	A FRAMEWORK FOR DIGITAL TRANSFORMATION AND BUSINESS MODEL INNOVATION	Van Tonder, et al. (2020)
2	Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization	Kääriäinen, et al. (2020)
3	Assessing Digital Transformation in Universities	Rodriguez-Abatia & Bribiesca-Correa, (2021)
4	Developing a digital transformation model to enhance the strategy development process for leadership in the South African manufacturing sector	Gaffley & Pelser, (2021)
5	Digital innovation strategy: A framework for diagnosing	Nylen & Holmstrom, (2015)
6	DIGITAL TRANSFORMATION MODEL FOR THE DEVELOPMENT OF TOURISM COMPANIES	Pumaleque, et al. (2021)
7	Digital Transformation Model for the Reduction of Time Taken for Document Management with a Technology Adoption Approach for Construction SMEs	Lazaro-Aleman, et al. (2020)
8	Digital Transformation of Agencies for Students` Part Time Jobs in the Republic of Croatia	Visnjic & Vrcek, (2021)
9	Gearing up for successful digital transformation	Gurbaxani & Dunkle, (2019)
10	Industrie 4.0 roadmap	Issa, et al. (2018)
11	Methodology for Digitalization - A Conceptual Model	Ng, et al. (2018)
12	Supporting Digital Transformation in Small and Medium-sized Enterprises	Barann, et al. (2019)
13	Survival in the digital age – A framework	Trenkle, (2019)
14	Tackling the digitalization challenge: how to benefit from digitalization in practice	Parviainen, et al. (2017)

Table 32 – Academic DTMs B3

Academic DTMs – B3		
1	Applying the positioning phase of the digital transformation model in practice for SMEs: toward systematic development of digitalization	Kääriäinen, et al. (2020)
2	Developing a digital transformation model to enhance the strategy development process for leadership in the South African manufacturing sector	Gaffley & Pelser, (2021)
3	Digital Transformation Model for the Reduction of Time Taken for Document Management with a Technology Adoption Approach for Construction SMEs	Lazaro-Aleman, et al. (2020)

4	Methodology for Digitalization - A Conceptual Model	Ng, et al. (2018)
5	Supporting Digital Transformation in Small and Medium-sized Enterprises	Barann, et al. (2019)

Appendix III – Corporate DMMs screened in the systematic literature review

Table 33 – Corporate DMMs C1

Corporate DMMs – C1			
1	BOOST YOUR DIGITAL MATURITY	https://www.sofokus.com/wp-content/uploads/sofokus-boost-your-digital-maturity-guidebook.pdf	Sofokus, (2020)
2	Cisco Small Business Maturity Assessment	https://www.sb-maturityassessment.com/#	IDC & Cisco (n.d.)
3	Cotec - Digital maturity Self-assessment Theia	https://theia.cotec.pt/en	Cotec, (n.d.)
4	DigiMaturity tool	https://digimaturity.vtt.fi/	VTT, (n.d.)
5	DIGITAL BUSINESS: TOWARDS A VALUE-CENTRIC MATURITY MODEL	https://chairdigitaleconomy.com.au/wp-content/uploads/2018/04/Digital-Business-Part-A.pdf	QUT PwC Chair in Digital Economy, (2017)
6	Digital Manufacturing Execution Systems Maturity Quiz	https://www.ge.com/digital/sd/manufacturing-maturity-quiz/	GE Digital, (n.d.)
7	Digital maturity assessment BDC	https://www.bdc.ca/en/articles-tools/entrepreneur-toolkit/business-assessments/digital-maturity/digital-maturity-assessment	BDC, (n.d.)
8	Digital Maturity Assessment Gluu	https://gluu.biz/digital-maturity/digital-maturity-assessment/	Gluu, (n.d.)
9	Digital Maturity Framework	https://digitalmaturity.org/digital-maturity-framework/	Digital Leadership Ltd, (n.d.)
10	Digital Maturity Self-Assessment	https://actionpoint.ie/digital-maturity-assessment/	ActionPoint, (n.d.)
11	DIGITAL PERFORMANCE INDICATOR	https://www.bdodigital.com/calculators/digital-performance-indicator	BDO, (n.d.)
12	Digital Strategy Toolkit	https://www.dpc.sa.gov.au/__data/assets/pdf_file/0010/46567/Digital_Maturity_Assessment.pdf	Department of the Premier and Cabinet, (n.d.)
13	Digital Transformation for Manufacturers Assessment	https://research.mpi-group.com/jfe/form/SV_aYpkA5olEUatKJv	Ohio MEP, (n.d.)
14	Digital Transformation Maturity Assessment	https://tools.marketimpacttools.com/go/UST/digitalmaturity/	Forrester, (2021)
15	Digital Transformation Maturity Survey	https://dmmindex.emerson.com/	Emerson, (2020)
16	GB Tech Digital Maturity Model	https://www.gbtec.com/resources/digital-maturity-model-poster/	GB Tech, (n.d.)
17	Google Digital Maturity Benchmark	https://digitalmaturitybenchmark.withgoogle.com/en/advertisers/	Google & BCG, (2021)
18	How to increase solution efficiency through understanding your digital experience maturity	https://www.kentico.com/discover/resources/digital-experience-platform-as-a-modern-means-to-improve-business-performance	Kentico, (n.d.)
19	IDC Future Enterprise Maturity Assessment	https://future-enterprise.idcmaturityscape.com/#onepre	IDC, (n.d.)

20	IFRC Digital Transformation Model	https://www.510.global/wp-content/uploads/2020/09/IFRC-Digital-Transformation-Model-V1.pdf	IFRC, (2021)
21	Industrie 4.0 Maturity Index	https://en.acatech.de/publication/industrie-4-0-maturity-index-update-2020/	Acatech, (2020)
22	Measuring Industry Digitization: Leaders and Laggards in the Digital Economy	https://www.strategyand.pwc.com/gx/en/insights/2002-2013/measuring-industry-digitization/strategyand-measuring-industry-digitization-leaders-laggards-digital-economy.pdf	Booz & Company, (2011)
23	Overview of the Digital Maturity Index (DMI)	https://orgcmf.com/en-gb/pages/digital/dmioverview/	ODTI, (n.d.)
24	Plotting your Path to Personalization with the Digital Experience Maturity Model	https://www.martechcube.com/resources/sitecore/plotting_your_path_to_personalization/2019-DXMM-WP.pdf	Sitecore, (2019)
25	The 4 stages of digital maturity	https://www.danaconnect.com/the-4-stages-of-digital-maturity-what-is-digital-maturity-and-strategies-to-achieve-digital-maturity/	Dana Connect, (n.d.)
26	The Fast Track to Digital Marketing Maturity	https://www.thinkwithgoogle.com/_qs/documents/11989/BCG-The-Fast-Track-to-Digital-Marketing-Maturity-Aug-2021.pdf	BCG, (2021)
27	THE RACE FOR DIGITAL OPERATIONS TRANSFORMATION	https://www.accenture.com/_acnmedia/PDF-139/Accenture-The-Race-for-Digital-Operations-Transformation.pdf	Accenture, (2020)
28	The Researcher's Blueprint for Achieving Digital Maturity	https://www.similarweb.com/corp/reports/digital-maturity-guide/	SimilarWeb, (2021)
29	What's your Digital Maturity Level?	https://infocert.digital/digital-maturity-model/	InfoCert, (n.d.)
30	What's your digital maturity?	https://www.axway.com/en/maturity-assessment	Axway, (n.d.)

Table 34 – Corporate DMMs C2

Corporate DMMs – C2			
1	Cisco Small Business Maturity Assessment	https://www.sb-maturityassessment.com/#	IDC & Cisco (n.d.)
2	Cotec - Digital maturity Self-assessment Theia	https://theia.cotec.pt/en	Cotec, (n.d.)
3	Digital Manufacturing Execution Systems Maturity Quiz	https://www.ge.com/digital/sd/manufacturing-maturity-quiz/	GE Digital, (n.d.)
4	Digital Transformation for Manufacturers Assessment	https://research.mpi-group.com/jfe/form/SV_aYpkA5olEUatKJv	Ohio MEP, (n.d.)
5	IFRC Digital Transformation Model	https://www.510.global/wp-content/uploads/2020/09/IFRC-Digital-Transformation-Model-V1.pdf	IFRC, (2021)
6	Industrie 4.0 Maturity Index	https://en.acatech.de/publication/industrie-4-0-maturity-index-update-2020/	Acatech, (2020)
7	THE RACE FOR DIGITAL OPERATIONS TRANSFORMATION	https://www.accenture.com/_acnmedia/PDF-139/Accenture-The-Race-for-Digital-Operations-Transformation.pdf	Accenture, (2020)

Appendix IV – Academic papers screened in the DMM systematic literature review

Table 35 – Academic DMMs D1

Academic DMMs – D1		
1	A Comparison of the Digital Divide Across Three Countries with Different Development Indices	Chang, et al. (2015)
2	A critical review of digital capability frameworks: a consumer perspective	Malchenko, et al. (2020)
3	A Digital Maturity Model for digital banking revolution for Iranian banks	Goumeh & Barforoush (2021)
4	A Digital Maturity Model for Telecommunications Service Providers	Valdez-De-Leon (2016)
5	A Maturity Level-Based Assessment Tool to Enhance	Rauch, et al. (2020)
6	A maturity model for assessing Industry 4.0 readiness	Schumacher, et al. (2016)
7	A Maturity Model for Assessing the Digital Readiness of Manufacturing Companies	De Carolis, et al. (2017)
8	A Measuring Tool for the Digital Maturity of Small and Medium-Sized Enterprises	Sandor & Guban, (2021)
9	A study of knowledge management systems processes and technology in open and distance education institutions in higher education	Altinay, et al. (2019)
10	An Innovative Digital Maturity Assessment Model for Smart Cities	Topuz, et al. (2022)
11	Analysis of companies' digital maturity by hesitant fuzzy linguistic MCDM methods	Buyukozkan & Guler, (2020)
12	Analysis of the adoption of emergent technologies for risk management in the era of digital manufacturing	Rodriguez-Espindola, et al. (2022)
13	APPROACH FOR THE SYSTEMATIC TRANSITION OF THE COMPANY INTO INDUSTRY 4.0	Gajsek (2019)
14	Assessing digital maturity of schools: framework and instrument	Redjep, et al. (2021)
15	Assessing the Digital Maturity Level of Higher Education Institutions	Durek, et al. (2018)
16	Assessing the digital maturity of micro and small enterprises: a focus on an emerging market	Da Costa, et al. (2022)
17	Assessing the level of digital maturity of enterprises in the Central and Eastern European countries using the MCDM and Shannon's entropy methods	Brodny & Tutak, (2021)
18	Beyond description: in search of disciplinary digital capabilities through signature pedagogies	Vargas-Atkins, (2020)
19	Building Holistic Social Media Strategy Refering to Social Intelligence and Digital Maturity	Boufim & Barka (2015)
20	Building organizational resilience with digital transformation	He, et al. (2022)
21	Building skills in the context of digital transformation: How industry digital maturity drives proactive skill development	Ostmeier & Strobel, (2022)
22	Company readiness for digital transformations: problems and diagnosis	Dolganova & Deeva (2019)
23	Comprehensive Review of Digital Maturity Model and Proposal for A Continuous Digital Transformation Process with Digital Maturity Model Integration	Minh & Thanh, (2022)
24	Conditioning Factors of Digitally-Enabled Growth Strategy in SMEs	Aramburu, et al. (2020)
25	Contextualizing the outcome of a maturity assessment for Industry 4.0	Colli, et al. (2018)
26	Development and Implementation of a Maturity Model of Digital Transformation	Ifenthaler & Egloffstein, (2020)
27	Development of a Digital Transformation Maturity Model for IT Companies	Gollhardt, et al. (2020)
28	Digital Maturity Framework for Higher Education Institutions	Durek, et al. (2017)
29	DIGITAL MATURITY MODEL FOR BULGARIAN HIGHER EDUCATION INSTITUTIONS	Doneva, et al. (2019)

30	Digital Maturity: Definition and Model	Aslanova & Kulichkina, (2020)
31	Digital readiness assessment of Italian SMEs	Pirola, et al. (2020)
32	Digital Readiness Frameworks Current State of the Art and Research Opportunities	Voss & Pawlowski, (2019)
33	Digital technology adoption in a bank Treasury and performing a Digital Maturity Assessment	Von Solms & Langerman, (2022)
34	Digital technology, digital capability and organizational performance: A mediating role of digital innovation	Khin & Ho, (2019)
35	Digital transformation capability maturity model enabling the assessment of industrial manufacturers	Gokalp & Martinez, (2021)
36	Digital Transformation Capability Maturity Model Framework	Aguiar, et al. (2019)
37	Digital Transformation in Higher Education: A Framework for Maturity Assessment	Marks, et al. (2020)
38	Digital transformation maturity assessment: development of the digital transformation capability maturity model	Gokalp & Martinez, (2021)
39	Digital Transformation Projects Maturity and Managerial Competences: A Model and Its Preliminary Assessment	Ravarini, et al. (2020)
40	Dominant platform capability, symbiotic strategy and the construction of Internet plus WEEE collection business ecosystem : A comparative study of two typical cases in China	Sun, et al. (2020)
41	Essence of digital transformation-Manifestations at large financial institutions from North America	Pramanik, et al. (2019)
42	Evaluating Digital Maturity and Patient Acceptability of Real-Time Patient Experience Feedback Systems: Systematic Review	Khanbhai, et al. (2019)
43	Exploring Ambivalence in Technological Embeddedness: The Role of Technological Competence and Dependence in the Information Gap	Park, et al. (2019)
44	Exploring the Antecedents of Digital Transformation: Dynamic Capabilities and Digital Culture Aspects to Achieve Digital Maturity	Weritz, et al. (2020)
45	Exploring the impact of port-centric information integration on port performance: the case of Qingdao Port	Jiang, et al. (2021)
46	Extended Maturity Model for Digital Transformation	Soares, et al. (2021)
47	Fostering digital transformation of SMEs: a four levels approach	Garzoni, et al. (2020)
48	How to increase the digitalization of company management	Maslennikov, et al. (2019)
49	Identifying Critical Capabilities for Improving the Maturity Level of Digital Services Creation Process	Devi, et al. (2022)
50	Implementing a dynamic FMECA in the digital transformation era	Colli, et al. (2019)
51	Industry 4.0: A Proposal of Paradigm Organization Schemes from a Systematic Literature Review	Rocha-Jacome, et al. (2022)
52	Introduction of a digital maturity assessment framework for construction site operations	Wernicke, et al. (2021)
53	Key Barriers of Digital Transformation of the High-Technology Manufacturing: An Evaluation Method	Borovkov, et al. (2021)
54	Maturity model of digitization for SMEs	Blatz, et al. (2018)
55	Measuring Digital Capability Maturity: Case of Small-Medium Kampong-Digital Companies in Bandung	Ramantoko, et al. (2018)
56	Measuring Digital Transformation Maturity of Supply Chain	Buntak, et al. (2021)
57	Methodology for Assessing Industrial Ecosystem Maturity in the Framework of Digital Technology Implementation	Babkin, et al. (2021)
58	Multi-Attribute Assessment of Digital Maturity of SMEs	Borstnar & Pucihar, (2021)
59	Pathways to Developing Digital Capabilities within Entrepreneurial Initiatives in Pre-Digital Organizations A Single Case Study	Keller, et al. (2022)

60	Performance management of SMEs: a systematic literature review for antecedents and moderators	Kafetzopoulos (2022)
61	Problems of an Innovation Project Management for a Formation of Digital Engineer	Brusakova (2018)
62	Promoting digitally enabled growth in SMEs	North, et al. (2020)
63	Recognizing events 4.0: the digital maturity of events	Ryan, et al. (2020)
64	Smart production: features of assessing the level of personnel digital readiness	Mitrofanova, et al. (2021)
65	Smart, Digitally Enhanced Learning Ecosystems: Bottlenecks to Sustainability in Georgia	Jeladze & Pata, (2018)
66	Smart-Specialization of The Agro-Industrial Complex in The Context of Digital Transformation of Regional Economic Systems	Kulik, et al. (2021)
67	Synthesizing Dimensions of Digital Maturity in Hospitals: Systematic Review	Duncan, et al. (2022)
68	Technological Capabilities to Assess Digital Excellence in Hospitals in High Performing Health Care Systems: International eDelphi Exercise	Krasuka, et al. (2020)
69	THE PANDEMIC OF COVID-19 AND THE LEVEL OF DIGITAL MATURITY OF MICRO AND SMALL BUSINESSES, A GLOBAL CONCERN	De Barros, et al. (2021)
70	The Patterns of School Improvement in Digitally Innovative Schools	Pata, et al. (2022)
71	The Role of Digital Maturity Assessment in Technology Interventions with Industrial Internet Playground	Aagaard, et al. (2021)
72	Toward cooperative competitiveness for community development in Economic Society 5.0	Wahyuningtyas. et al. (2022)
73	Using Blueprints to promote interorganizational knowledge transfer in digital health initiatives-a qualitative exploration of a national change program in English hospitals	Williams, et al. (2021)
74	Where Enterprise Architecture Development Fails A multiple case study of governmental organizations	Banaeianjahromi (2018)

Table 36 – Academic DMMs D2

Academic DMMs – D2		
1	A Digital Maturity Model for Telecommunications Service Providers	Valdez-De-Leon (2016)
2	A maturity assessment approach for conceiving	Colli, et al. (2019)
3	A Maturity Level-Based Assessment Tool to Enhance	Rauch, et al. (2020)
4	A maturity model for assessing Industry 4.0 readiness	Schumacher, et al. (2016)
5	A Maturity Model for Assessing the Digital Readiness of Manufacturing Companies	De Carolis, et al. (2017)
6	A Measuring Tool for the Digital Maturity of Small and Medium-Sized Enterprises	Sandor & Guban, (2021)
7	Analysis of companies' digital maturity by hesitant fuzzy linguistic MCDM methods	Buyukozkan & Guler, (2020)
8	Assessing the level of digital maturity of enterprises in the Central and Eastern European countries using the MCDM and Shannon's entropy methods	Brodny & Tutak, (2021)
9	Company readiness for digital transformations: problems and diagnosis	Dolganova & Deeva (2019)
10	Comprehensive Review of Digital Maturity Model and Proposal for A Continuous Digital Transformation Process with Digital Maturity Model Integration	Minh & Thanh, (2022)
11	Development and Implementation of a Maturity Model of Digital Transformation	Ifenthaler & Egloffstein, (2020)
12	Development of a Digital Transformation Maturity Model for IT Companies	Gollhardt, et al. (2020)
13	Digital Maturity: Definition and Model	Aslanova & Kulichkina, (2020)
14	Digital readiness assessment of Italian SMEs	Pirola, et al. (2020)

15	Digital Transformation Capability Maturity Model Framework	Aguiar, et al. (2019)
16	Digital Transformation in Higher Education: A Framework for Maturity Assessment	Marks, et al. (2020)
17	Digital transformation maturity assessment: development of the digital transformation capability maturity model	Gokalp & Martinez, (2021)
18	Maturity model of digitization for SMEs	Blatz, et al. (2018)
19	Measuring Digital Transformation Maturity of Supply Chain	Buntak, et al. (2021)
20	Multi-Attribute Assessment of Digital Maturity of SMEs	Borstnar & Pucihar, (2021)
21	Promoting digitally enabled growth in SMEs	North, et al. (2020)
22	Stages in digital business transformation	Berghaus & Back, (2016)
23	Strategy for Digital Organization: Testing a Measurement Tool	Kontic & Vidicki, (2018)
24	The Digital Maturity Model 4.0	Gill & VanBoskirk, (2016)
25	Towards a Micro-enterprise–focused Digital Maturity Framework	Kuusisto, et al. (2021)

Table 37 – Academic DMMs D3

Academic DMMs – D3		
1	A Digital Maturity Model for Telecommunications Service Providers	Valdez-De-Leon (2016)
2	A Maturity Level-Based Assessment Tool to Enhance	Rauch, et al. (2020)
3	A maturity model for assessing Industry 4.0 readiness	Schumacher, et al. (2016)
4	A Maturity Model for Assessing the Digital Readiness of Manufacturing Companies	De Carolis, et al. (2017)
5	A Measuring Tool for the Digital Maturity of Small and Medium-Sized Enterprises	Sandor & Guban, (2021)
6	Development and Implementation of a Maturity Model of Digital Transformation	Ifenthaler & Egloffstein, (2020)
7	Development of a Digital Transformation Maturity Model for IT Companies	Gollhardt, et al. (2020)
8	Digital readiness assessment of Italian SMEs	Pirola, et al. (2020)
9	Digital Transformation in Higher Education: A Framework for Maturity Assessment	Marks, et al. (2020)
10	Maturity model of digitization for SMEs	Blatz, et al. (2018)
11	Measuring Digital Transformation Maturity of Supply Chain	Buntak, et al. (2021)
12	Multi-Attribute Assessment of Digital Maturity of SMEs	Borstnar & Pucihar, (2021)
13	Promoting digitally enabled growth in SMEs	North, et al. (2020)

Appendix V – Transcript of the meeting with a specialist in cooperatives

09/03/2023 21:02h-21:56h via Zoom meeting

Fábio Couto: Boa noite, professora. Desde já muito obrigado por aceitar o meu convite e estar disponível para dar o seu contributo.

Deolinda Meira, PhD: Boa noite, Fábio. Foi com muito gosto que aceitei o seu convite e congratulo-o por estar a desenvolver uma tese inovadora. O Fábio pretende saber mais sobre

as diferenças entre as sociedades comerciais e as cooperativas, mais especificamente as cooperativas de serviços, correto?

Fábio Couto: Sim, correto. O meu objetivo é perceber se há diferenças entre estes dois tipos de entidade. Havendo diferenças, pretendo saber quais são essas diferenças de modo a adaptar com sucesso um modelo de maturidade digital que reflita as idiossincrasias das cooperativas de serviços. Os modelos que analisei foram criados para sociedades comerciais, e por isso a oposição entre empresas e cooperativas: ajudar-me-á a perceber quais as adaptações a ser feitas.

Deolinda Meira, PhD: Ok, então eu preparei uma pequena apresentação para que lhe possa explicar quais são essas mesmas diferenças. Posso começar?

Fábio Couto: Da minha parte, pode começar.

Deolinda Meira, PhD: Então já posso explicar de uma forma simples o que distingue uma cooperativa de uma sociedade comercial e aqui, com foco nas cooperativas de serviços. Portanto, eu vou de forma muito sucinta dizer-lhe o que as distingue.

Primeiro: o que são cooperativas de serviços? No direito português e no Direito em geral, no direito cooperativo internacional, quando nós falamos de cooperativas de serviços, estamos a falar de dois tipos de dimensões nas cooperativas serviços: nalgumas delas só encontra uma, noutras encontra as duas.

Nós temos as cooperativas de produtores de serviços e as cooperativas de utentes de serviços. Por exemplo, a Mútua dos Pescadores em Portugal é simultaneamente uma cooperativa de produtores de serviço ou de prestadores de serviços, e de utentes de serviços.

O que são cooperativas de produtores de serviços? As cooperativas de produtores de serviços correspondem ao ramo cooperativo, em que três ou mais pessoas (porque o número mínimo de cooperadores de uma cooperativa é de três), se juntam para, em conjunto, cooperando, prestar um serviço no mercado. Pode essa cooperativa ser simultaneamente uma cooperativa de utentes de serviço, ou seja, tem dois tipos de cooperadores: os que prestam serviços e os que usufruem desse serviço (e que também são cooperadores).

A Mútua dos Pescadores presta serviços na área dos seguros, mais especificamente dos seguros de pesca, e tem um conjunto de cooperadores que são aqueles que realizam atividade na cooperativa, que tratam da atribuição do seguro, que desenvolvem toda a atividade

relacionada com a concessão do seguro e tem pescadores que são também cooperadores na qualidade de utentes do serviço. Portanto, são estas as duas dimensões que pode encontrar numa cooperativa de serviços.

Vamos pensar numa cooperativa só de produtores de serviços. Vamos imaginar que três enfermeiros e três psicólogos se juntam para prestar a sua atividade profissional no âmbito da saúde mental e, em vez de trabalharem para uma sociedade comercial com a qual celebrariam um contrato de trabalho subordinado, decidem fazê-lo em conjunto, sendo trabalhadores que exercem a sua atividade em cooperação. Eles trabalham na cooperativa, não trabalham para a cooperativa, são como que empresários de si mesmos.

O que é que eles pretendem? Pretendem eliminar aqui um intermediário no mercado, que é o patrão, o empregador e, sendo empresários de si mesmos, conseguirem uma mais adequada remuneração do seu trabalho e ainda, prestar o trabalho em condições diferenciadas daquelas que acontecem no contexto de uma sociedade comercial, como veremos já de seguida.

O objetivo de se constituir uma cooperativa, seja uma cooperativa de prestadores de serviços, seja uma cooperativa de habitação, seja uma cooperativa de consumo, é exatamente a de eliminar um intermediário no mercado. No caso específico das cooperativas de produtores de serviços, conseguir, desta forma, uma mais justa retribuição do seu trabalho. Se a cooperativa for também de utentes de serviços, conseguirem um determinado serviço, a um preço aproximado ao preço de custo, portanto um preço não especulativo. Portanto, é isto que a cooperativa de serviços visa.

As cooperativas distinguem-se claramente das sociedades comerciais porque elas não nascem com o propósito de gerar um lucro. Uma sociedade comercial, aquilo a que vulgarmente chamam empresas, têm um propósito, que é gerar um lucro. Eu e o Fábio constituímos uma sociedade por cotas: eu entro com mil euros e o Fábio entra com mil e quinhentos euros. O que é que nós pretendemos? Nós pretendemos que daqui a um ano os meus mil euros e os seus mil e quinhentos euros valham dez mil euros e quinze mil euros. Portanto, nós queremos rentabilizar o capital com que entramos para a sociedade.

Numa cooperativa, o propósito é o de satisfazer as necessidades dos seus membros. Nas cooperativas de produtores de serviços, é satisfazer a necessidade dos seus membros a um trabalho digno, adequadamente retribuído e um trabalho exercido em condições diferenciadas porque veremos que estas cooperativas têm sempre uma dimensão social e econômica no seu objeto.

Estou a ser clara? Está a conseguir acompanhar?

Fábio Couto: Sim, sim.

Deolinda Meira, PhD: As cooperativas têm aquilo a que nós chamamos um fim mutualístico. A cooperativa nasce para satisfazer as necessidades dos seus membros. São os próprios cooperadores que gerem a cooperativa e, portanto, estamos perante uma organização autogestionada. Isto é muito importante porque quem integra o órgão de administração, quem integra o órgão de fiscalização, são os próprios cooperadores e, portanto, a cooperativa é propriedade dos cooperadores.

E essa é uma outra diferença muito importante das cooperativas face às sociedades comerciais. Uma sociedade comercial pode ser gerida por um economista que não é sócio e, portanto, há aqui de facto uma distinção entre a propriedade e a gestão, que não acontece nas cooperativas. Nas cooperativas são os próprios cooperadores que gerem, que administram, que fiscalizam as cooperativas. O órgão mais importante das cooperativas é a assembleia geral, em que os cooperadores têm todos eles assento e a regra de que, independentemente de eu entrar para a cooperativa com mil euros, e o Fábio com cinquenta euros, na assembleia geral o Fábio vai ter um voto como eu, porque se aplica a regra democrática: um cooperador, um voto.

Essa é outra diferença relevantíssima entre as cooperativas e as sociedades comerciais que é a sua gestão democrática e participada. Portanto, é uma gestão democrática e participada. Se não estiver a perceber, interrompa-me Fábio.

Fábio Couto: Até agora, tudo claro.

Deolinda Meira, PhD: As cooperativas têm capital social e isto é comum às sociedades comerciais. O capital social representa a soma das entradas dos sócios. Mas a entrada do cooperador, da entrada de capital é uma entrada completamente instrumental face ao dever e direito que recai sobre todo e qualquer cooperador de participar na atividade da cooperativa, esse é um dever de todo e qualquer cooperador. Como é que numa cooperativa de produtores de serviços o cooperador participa? Trabalhando. E os utentes dos serviços participam como? Adquirindo os serviços. Isto resulta da legislação cooperativa. É o dever de participação na atividade económica da cooperativa.

A este dever, acresce outro dever a que nós chamamos de caráter mais político, é o dever de participar na governação da cooperativa. Todo e qualquer cooperador tem de estar disponível para integrar os órgãos da cooperativa, uma vez que a cooperativa é autogestionada.

Ora, isto não encontra nas sociedades comerciais. Nenhum sócio pode ser obrigado a integrar órgãos da sociedade.

Depois, outra diferença importantíssima entre a cooperativa e uma sociedade comercial, seja cooperativa do ramo dos serviços, ou seja de qualquer outro ramo. Esta diferença prende-se com o objeto. O objeto da cooperativa compreende sempre uma dimensão económica que se traduz na satisfação das necessidades dos seus membros. Neste caso, nas cooperativas de serviços, prestar um serviço ou adquirir um serviço a um preço justo. Essa é a dimensão económica do objeto e, portanto, nessa atividade económica os cooperadores irão participar.

E depois há uma dimensão social no objeto da cooperativa que está evidenciado por um princípio cooperativo, que é o princípio do interesse pela comunidade. As cooperativas não se centram apenas nas necessidades dos seus membros, mas também devem contribuir para o desenvolvimento sustentável da comunidade. E quando nós falamos aqui de sustentabilidade, não estamos a falar apenas da sustentabilidade ambiental. Estamos a falar de um conceito amplo de sustentabilidade, alinhado com os objetivos do desenvolvimento sustentável. Por exemplo, uma das características das cooperativas é de que elas não se deslocalizam. E, portanto, o seu enraizamento na comunidade é muito forte pelo que significa que se os cooperadores forem da comunidade, a cooperativa vai gerar empregos estáveis, não deslocalizáveis e, portanto, aqui está evidenciada a dimensão social da cooperativa.

Este é o principal princípio que evidencia essa dimensão social, o princípio cooperativo do interesse pela comunidade. Nós reconhecemos sempre no objeto da cooperativa esta dimensão social, sendo certo que esta dimensão social não encontra numa sociedade comercial de forma obrigatória: a lei não obriga as sociedades comerciais a terem uma dimensão social no seu objeto. O objeto da sociedade é o de desenvolver uma atividade que gera lucro.

Isto não significa que a sociedade comercial não possa adotar práticas de responsabilidade social da empresa. Aí já estaremos numa dimensão social do objeto, mas atenção, essas práticas de responsabilidade social da empresa são de adesão voluntária numa sociedade, não são obrigatórias, não fazem parte do ADN.

A dimensão social do objeto da cooperativa faz parte do ADN da cooperativa. Esta solidariedade interna que existe entre os cooperadores e esta solidariedade externa com a comunidade, que se traduz também na obrigação de desenvolver práticas antidiscriminatórias em função do género, em função da raça… há um princípio cooperativo, que é o princípio da adesão voluntária e livre classicamente conhecido por "porta aberta", portanto, qualquer pessoa

que cumpra os requisitos previstos nos estatutos para aderir a uma cooperativa não pode ver a sua adesão rejeitada sem motivo objetivo.

Portanto, esse é um importante princípio que também evidencia esta dimensão social do objeto e que evidencia esta forte ligação da cooperativa à comunidade, portanto, a questão da igualdade também a igualdade, a igualdade no próprio valor cooperativo importantíssimo e que se projeta, por exemplo, na distribuição dos resultados económicos. Os resultados positivos que os cooperadores geram com a sua atividade chamam-se excedentes.

Vamos imaginar que temos uma cooperativa de produtores de serviços. Eu, o Fábio, a pessoa X e a pessoa Z, constituímos uma cooperativa que presta serviços na área dos sistemas de informação e com isso, nós pretendemos exercer a nossa atividade de forma livre. Somos nós que vamos acordar como é que vamos exercer a nossa atividade. Como é que vamos ser remunerados pela nossa atividade e decidimos em assembleia geral que, mensalmente iremos receber cada um de nós os quatro mil e duzentos euros. E no final do exercício económico vamos apurar quais foram os resultados económicos gerados pela nossa atividade.

Imagine, Fábio que chegamos ao fim do exercício económico, ao fim de dois mil e vinte e três, e feitas as contas, os resultados econômicos, se nós dividirmos por nós os quatro, e se dividirmos por doze, permitir-nos-ia recebia em cada mês, não mil e duzentos euros, mas dois mil e duzentos euros. O que é isto? Isto é um resultado económico positivo gerado com a nossa atividade, não é um lucro. Quem gerou esta atividade, quem gerou este resultado económico fomos nós com a nossa atividade. Ele chama-se um excedente.

Fábio Couto: Que tem de ser redistribuído…?

Deolinda Meira, PhD: Que pode retornar aos cooperadores. Pode porquê? Porque são eles cooperadores que, em assembleia geral vão decidir quanto retorna e se retorna. Pois não vai retornar tudo. Uma parte vai ficar para as reservas. Imagine que precisamos de melhorar o equipamento informático. Vamos constituir uma reserva livre e para o ano vamos, com esta reserva livre, comprar equipamento informático.

Mas os cooperadores também podem decidir (nós os quatro) que uma parte vai retornar a nós. Utiliza-se o termo de "retorno de excedentes". Ora, só retorna a uma pessoa aquilo que é seu. Isso não é o lucro, é um resultado económico gerado com a atividade do cooperador. E esta é outra importante diferença das cooperativas face às sociedades económicas, porque o resultado económico da sociedade chama-se lucro. Eu entrei com mil e no fim do exercício

económico, os meus mil valem dez mil sem que eu participe na atividade. Não fui eu que gerei, foi a sociedade com a sua atividade, portanto, é diferente. Não quer dizer que as cooperativas não possam gerar lucro. Vamos imaginar que a cooperativa está a trabalhar muito bem, nós os quatro já não conseguimos dar conta de todas as encomendas de serviços e temos de contratar três informáticos que não querem ser cooperadores.

Nós até propomos a esses três informáticos que entrem na cooperativa como cooperadores, mas eles não querem. Portanto, celebramos com eles um contrato de trabalho. Eles trabalham para a cooperativa. Nós os quatro, eu, o Fábio, X e Z trabalhamos na cooperativa. É diferente trabalhar "na" ou trabalhar "para".

Se com esse trabalho gerado pelos três informáticos, a cooperativa obtiver um resultado positivo, ou seja, pagou todos os meses novecentos e cinquenta euros aos informáticos, e o trabalho que eles geraram gerou um lucro. Portanto, efetivamente aquele trabalho gerou resultados muito superiores, temos um lucro, mas esse lucro, atenção, não pode ser repartido entre os cooperadores. É um lucro objetivo que nunca pode ser repartido. Ele é reinvestido, é realocado a reservas obrigatórias que não são repartidas entre os cooperadores, designadamente na reserva legal, que só tem como propósito cobrir perdas e a reserva de educação, formação e informação.

Esta reserva de educação, formação e informação é outra importante especificidade das cooperativas face às sociedades comerciais. A cooperativa tem a obrigação de educar e formar os seus membros, os seus trabalhadores, os seus representantes eleitos, educar para que se consiga uma profissionalização da gestão, educar para que o cooperador saiba de forma adequada participar na atividade da cooperativa, seja na atividade económica, seja na dimensão política, ou seja, na dimensão da governação. E ainda o dever de informar, que se dirige à comunidade. A cooperativa vai informar a comunidade quanto às vantagens do modelo cooperativo. Isto pode gerar mais adesões na cooperativa e, sobretudo, adesões conscientes. Portanto, esta é uma importantíssima reserva da cooperativa, que só existe nas cooperativas. Não existe nas sociedades comerciais e que, por exemplo, eu encaro como muito importante para, por exemplo, dar formação aos cooperadores na dimensão digital.

Hoje, em que esta realidade digital está em todas as organizações, de forma a combater a iliteracia digital que eventualmente poderá existir, a cooperativa pode utilizar esta reserva da educação e informação com esse propósito de educar e informar no contexto digital. Devidamente aproveitada, pode potenciar a transformação digital.

Depois há outra questão muito importante, que é a questão da comunicação interna e externa. Se a cooperativa tem uma dupla dimensão do seu objeto, económica e social, e se a cooperativa tem uma íntima ligação à comunidade, isso quer dizer que a cooperativa tem de saber comunicar devidamente internamente (com os cooperadores, desde logo para que eles participem de forma adequada na cooperativa), porque a transparência é um valor importantíssimo na gestão destas entidades, porque estamos a falar de entidades geridas democraticamente, não há democracia sem transparência e, portanto, a transparência implica uma adequada comunicação, quer quanto a atividade econômica, quer quanto a dimensão social da cooperativa e, neste caso, os meios digitais podem potenciar, podem facilitar essa transparência e depois a relação com a comunidade.

Portanto, utilizar o website para disponibilizar informação, para dinamizar atividades com a comunidade, para trabalhar em rede com as outras organizações. Essa questão da transparência, da "accountability" que é uma imposição legal para as cooperativas porque são organizações democráticas, é uma outra dimensão. Repare, nas sociedades comerciais, a transparência existe se a sociedade quiser, porque só as sociedades cotadas em bolsa é que divulgam ao mercado quantos lucros tiveram, quantas trabalhadoras têm a ocupar cargos de direção e porquê? Porque isso pode influenciar o valor das ações no mercado, porque as demais não têm obrigação de divulgar esse tipo de informação. Podem fazê-lo desde logo ao abrigo de políticas de responsabilidade social, mas não existe uma obrigação legal. No caso das cooperativas, isto é obrigatório por lei, porque estamos a falar de organizações geridas democraticamente e elas têm de ser obrigatoriamente transparentes.

Uma outra questão importante tem a ver com os resultados económicos. Há pouco disse que os resultados económicos gerados pela participação do cooperador na atividade se chamavam excedentes. Se a assembleia geral decidir fazer retornar uma parte dos excedentes ou a totalidade, depois de feitas as deduções para as reservas, aos cooperadores, como é que eles participam nos excedentes? Eles participam nos excedentes em função da sua participação na atividade. Quem mais trabalhou recebe mais. Se o Fábio trabalhar só meio tempo na cooperativa e eu trabalhar o tempo inteiro, quando é feito o retorno dos excedentes, o retorno é feito em proporção à minha participação na atividade.

Nas sociedades, quando são distribuídos lucros entre sócios, esses lucros são distribuídos em função da minha participação no capital social. Quanto mais eu participar no capital, mais lucros tenho direito a receber. Essa é a regra nas sociedades comerciais.

E há aqui uma outra diferença muito importante, que eu não mencionei há pouco. A regra de voto nas sociedades é a de que o número de votos depende da participação no capital. Quanto mais eu participar no capital, maior número de votos eu detenho nas assembleias gerais. É por isso que nas sociedades encontra os sócios minoritários e os sócios maioritários. Na cooperativa é impossível um cooperador sozinho ou dois cooperadores sozinhos controlarem a cooperativa.

Nas sociedades comerciais é possível que dois ou três sócios controlem a sociedade. Basta que tenham a maioria do capital social, porque significa que terão a maioria dos votos na assembleia. Essa é outra diferença muito importante.

São estas as principais dimensões que eu identifico quando confronto as cooperativas com as sociedades comerciais.

Fábio Couto: Muito interessante a questão da transparência e dos canais de comunicação digitais… e a influência da literacia digital dos membros…

Deolinda Meira, PhD: Repare, a nossa cooperativa fictícia tem quatro cooperadores. Agora imagine uma grande cooperativa agrícola, que tem oitocentos cooperadores. Comunicar adequadamente, disponibilizando informação no website da cooperativa ou noutras ferramentas digitais, é fundamental… e definir circuitos de comunicação. Se eu quiser aceder a determinados documentos: a cooperativa vai comprar um terreno e eu cooperador tenho dúvidas se isso é ou não é interessante e benéfico para a vida da cooperativa e quiser aceder a essa informação, deve haver circuitos que rapidamente me permitam aceder a essa informação. Porquê? Porque as cooperativas estão obrigadas à transparência. A lei reconhece aos cooperadores um amplo direito à informação e, portanto, este amplo direito à informação pode ser potencializado pelos meios digitais.

A participação nas assembleias gerais também poderá ser afetada positivamente.

Durante o COVID, surgiu esta problemática das assembleias gerais virtuais. Bom, se os cooperadores estiverem devidamente preparados para nelas participarem, poderá ser uma forma muito interessante de combater o problema nalgumas cooperativas, sobretudo cooperativas de média e grande dimensão, que é a baixa participação nas assembleias. Ora, se houver um uso adequado das ferramentas digitais para potenciar essa participação ou criando assembleias híbridas ou totalmente virtuais, isso poderá ser muito interessante para a cooperativa.

A cooperativa Mútua dos Pescadores tem cooperadores de todo o território continental, dos Açores e da Madeira e faz assembleias setoriais por causa disso. Realizam assembleias na Madeira, no Norte e no Centro, e no Sul. Porquê? Porque os cooperadores não se deslocam a Lisboa para uma Assembleia Geral. Se a Assembleia geral se socorrer de meios digitais, isso poderá resolver estes problemas e, portanto, haverá uma assembleia geral com a participação de todos os cooperadores. Portanto, isso é claramente hoje apontada como uma forma de tornar mais intenso este princípio da gestão democrática e transparente que caracteriza as cooperativas.

O Fábio tem alguma questão?

Fábio Couto: Não. Fiquei esclarecido. As dúvidas que tinha foram sendo esclarecidas ao longo desta conversa, pelo que apenas me resta agradecer novamente pelo tempo despendido. O seu contributo será muito valioso para o meu trabalho final de mestrado.

Deolinda Meira, PhD: Ora essa. Fico sempre feliz por poder contribuir e qualquer dúvida, disponha. Não hesite em entrar em contacto se necessitar.