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Enterprise Architecture as a Tool for Digital Transformation

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Abstract

Enterprise Architecture (EA) is the holistic expression for the main strategies of an enterprise in terms of business, applications and technologies, and the impact they have on its processes and functions. Currently, the CEOs of most businesses are investigating what opportunities are afforded by digitalization. However, despite the benefits of EA, and its possible role in digital transformation, there is a gap in the research regarding how to take advantage of EA in digital transformation. This article explores the concepts of EA and digital transformation based on a set of publications we selected from the area of IS/IT, and addresses some contributions to a methodology that promotes EA planning as a tool for digital transformation. As such, we refer to the dimensions, the approach, and the two phases of development which will contribute to placing EA as a tool for solving the problems of digital transformation initiatives.

Keywords: Enterprise Architecture; Digital Transformation; Chief Enterprise Architect

1. INTRODUCTION

Enterprise Architecture (EA) is the complete expression of what an enterprise is: a master plan which “acts like a collaborative force” between the aspects of business planning, such as objectives, visions, strategies and principles of governance; aspects of business operations, including business terms, organizational structure, processes and data; aspects of automation, such as information systems and databases; and the technological infrastructure which enables the business to function, including computers, operational systems, and networks. EA is the holistic expression for the main strategies of an enterprise in terms of business, applications and technologies, and the impact they have on its processes and functions. In this article, we will first address the concepts of EA and digital transformation, as well as the role of EA as a tool for digital transformation.

In the second part, we describe the approach and plan the activities related to the development of Digital Business Architecture and Information Systems and Technology Architecture.

2. EA AND DIGITAL TRANSFORMATION

2.1. Enterprise Architecture

Currently, Information Technology (IT) plays an important role in enhancing the competitiveness of many businesses. However, many of the businesses which invest substantial resources in information systems and technologies (IS/IT) do not see the expected rewards. It is often the case that the effectiveness of these investments is affected by the lack of alignment between business plans and the IS/ITs. In order to look at the potential non-alignment between business strategies and the IS/IT strategy, the concept of Information Systems Architecture and, later, that of EA were introduced (Kotusev, 2006). EA is a comprehensive plan which describes an organization from the point of view of integrating the business and the IS/ITs. EA adopts a holistic perspective and shows the relationship between objectives, strategies, business processes, and information technologies and systems. Meeting the needs of the different parts of an enterprise, EA is made up of several dimensions: business, organization, information and technology (Hoogervorst, 2009).

The use of EA helps to fill the communication gap between the interested parties in the business and the IS/IT, enhancing the alignment between the business and IT plans, thus increasing the return on IS/IT investments. The classic approach of EA was inspired by conventional engineering and architectural methods (Spewak & Hill, 1992); it is largely mechanistic; it depends on extensive formal documentation, and strict sequences in its stages must be followed in order to develop and use EA. This traditional approach to EA was hugely influential and molded the theory and practice of EA (Spewak & Tiemann, 2006). In fact, the more modern EA methodologies came from this traditional approach, at the same time recommending the development of a considerable volume of documentation and suggesting the same approximate sequential stages (Bernard, 2012, CIOC, 1999, Open Group, 2018). Many companies who are ready to improve their business and align it with IS/IT adopt the popular formal approaches of EA, such as the TOGAF Architecture Development Method (The Open Group, 2018). Nevertheless, many of these companies do not achieve success with EA due to excessive rigidity and the fact that the approaches selected were not adequate (Holst & Steensen, 2011, Lohe & Legner, 2014). Alternative, lighter and more flexible approaches for the development of EA have been proposed (Ross et al., 2006, Wagter et al., 2005, Gomes, 2015).

According to MIT's approach (Ross et al., 2006), in the initial stage of the development of EA programs, executives have to decide on the organizational operational model, defined as: "The necessary level of integration and standardization of the business processes to provide goods and services for customers". Ross et al. (2006) argue that an operational model provides a clearer base, one that is actionable and more stable for the development of the EA than a business strategy. As a second step, both the business and the IT executives need to collaborate and develop a critical document of the EA detailing the principal business and IT resources, the company's data, its main

customers and key technologies. Finally, the business and IT executives must project and implement the model of IT “engagement”, defined as: “the mechanisms of governance which guarantee that both the business and IT projects satisfy their specific objectives as well as those of the whole company”. This model of IT “engagement” includes three essential elements: IT governance at corporate level, project management and the mechanism which connects decisions made at the business level, and the activities at the project level.

2.2. EA as a tool for digital transformation

Digital Transformation is defined as the deep transformation of activities, processes, competences, and business and organizational models to leverage the changes and opportunities of a mix of digital technologies and their accelerated impact on society in a strategic and prioritized way with the present and the future. Digital Transformation became possible with the development of specific technologies: cloud computing, the internet of things, social networking, mobile technology, big data and data analysis. The digital promise for businesses has to do with the ability to use information, to gradually and continuously shift and optimize themselves. This incremental transformation of businesses (large and small) is not easy, and that is why without a set of tools to help to facilitate the transformation, the cost of technologies and their rapid evolution would be difficult to manage. Despite the simplicity brought by digitalization to business processes and structures, technological systems have become more and more complex over time. In order to manage these systems more optimally, EA emerged as a discipline, providing a bridge between IT departments and the businesses themselves. EA covers the complexity of such information systems and technologies, and the need to integrate new resources with the existing legacy in heterogeneous environments. EA was initially justified as being a tool that would save costs. Since then, it has been recognized not only as a way to control costs but also as an incentive to develop new competencies. EA is very good at defining and clarifying (bringing a sense of order to) the complex ecosystems which make up a business, particularly from a technological perspective (Mark, 2016).

To fully achieve the promise of digital transformation, business models and value flows which provide these results have to be clearly defined and tested based on the needs of the customers/stakeholders, before developing the technological platform that will support them, so EA will have a very significant impact on digital transformation initiatives.

Taking into consideration the fact that businesses need to adopt the “drivers” of digital transformation and that a well-defined EA offers support to the integration of the company, thus allowing a common vision in terms of processes, data and business systems of the company and its partners (Vernadat, 2007, Kosanke et al., 1999, Bernus et al, 2003), it can be said that EA is one of the “tracks” that make digital transformation predictable.

Nevertheless, the “frameworks” of EA do not give relevance to the activities that contribute most to digital transformation (of the business). For that reason, this article aims to clarify the dimensions and activities related to the development of an EA, and the points of contact with other processes in the company, to guarantee that the requirements of digital transformation within it are met. Thus, a proposal is presented supported by two dimensions as well as an approach to, and activities for, the development of Digital Business and Information Systems and Technology Architectures.

3. EA DIMENSIONS

Meeting the needs of the different interested parties in a company, this section looks at the Business and Information Systems and Technology (IST) Dimensions, from the EA’s point of view, as they are considered to be of great importance for Digital Transformation.

3.1. The Business dimension

The Business Dimension is related to the definition of the Digital Business Strategy (DBS). The digitalization of products and services requires a strong alignment of business models and digital technologies to develop creative digital strategies and solutions, as well as for their digital transformation.

Today, the innovation originated by business transformation (Tilson et al., 2010, Yoo et al., 2010) has caused an evolution in business due to the fusion of IT with Business Strategy to give rise to the term "Digital Business Strategy" (Bharadwaj et al., 2013). Therefore, the DBS is the alignment between the IT Strategy and the Business Strategy (Woodard et al. 2013, Mithas et al., 2013). The DBS has given rise to the strategic alignment, and this alignment cannot be achieved instantly; it involves careful implementation and a series of adjustments until the desired strategy is achieved. The DBS is unique when compared to other strategies because it accommodates all the functional strategies, as well as the process strategies (Yoo et al., 2010). Consequently, Bharadwaj et al. (2013) put forward four themes which complete the concept of DBS: environment, scale, time (speed), and capture and creation of value.

3.2. Information systems and technology dimension

Digital transformation demands an IT architecture that allows organizations to have visibility when carrying out digital initiatives, and infrastructure to improve performance.

Successful digital transformation demands a ‘two-speed’ bimodal approach to support both tactical and strategic capabilities: to maintain legacy systems in a stable, high-quality environment that maximizes day-to-day performance, while simultaneously driving flexibility and innovation. To address these very different business and technology goals, traditional and agile IT need to operate

side by side, balancing efficiency, stability, governance and price-for-performance with rapid prototyping and iterative development (Oracle, 2016). Although this is a significant technical challenge, the key to discovering the real value for a company will be to guarantee that the platforms and integrations are aligned with companies' strategic aims and that they support value flows.

Generally speaking, a digital business is supported by technological platforms in five areas (Oracle, 2016, LeHong et al., 2016):

- Information Systems Platform – This supports the back office and operations, such as ERP and core systems.
- Customer Experience Platform – This contains the main elements related to the customer, such as customer and citizen portals, multi-channel commerce, and customer applications.
- Analytical and Data Platform – this includes analytical and information management resources. Data management programs and analytical applications stimulate decision making that is oriented by data, and algorithms automate discovery and action.
- IoT Platform – This connects physical assets for monitorization, optimization, control and monetization. The resources include connectivity, analysis, and integration for core and OT systems.
- Ecosystems Platform – This supports the creation and connection for ecosystems, markets, and external communities. Its main elements are the management, control and security of APIs.

In the actual implementation and integration of this platform, it is necessary to have several layers related to: the perspectives of infrastructure and operations, data management and storage, security, risk and conformity, besides an encompassing integration strategy and the best sourcing strategies for each component of the platform (Oracle, 2016).

3.3. Approach

Although EA has been signaled as a facilitator of business transformation, the focus has always been on the standardization and integration of processes, not on the continuous adaptation to the business and to the technological scenario, which are in constant flux. The digitalization of products and services requires a strong alignment of the business model and digital technologies, for creative digital strategies and solutions as well as for its digital transformation.

A systemic approach by itself is not enough for business design (Lapalme, 2012) as it is necessary to reach coevolution with the environment and companies, thus deliberately altering the environment, and systematically designing the business and its relationship with the environment.

In order to do this, it is necessary to broaden the previous approaches of static EA to adjust the flexible and adaptable digitalization of new products and services, introducing suitable EA mechanisms and support for the collaborative decision to effect swift change in business models and in information technologies and systems.

To follow this approach and plan an EA, Digital Business (DB) and Information Systems and Technology (IST) Architectures should be defined. To define what is considered to be DB Architecture, the following activities are proposed: analyze the current company strategy and business model; define the digital strategy; define the business model; and implement the new or modified business model. Generally speaking, in this first stage, the decision should be made regarding the organizational operating model. This model is the necessary level of business process integration and standardization for delivering goods and services to customers (Ross et al., 2006). To define IST Architecture, the evaluation of the enterprise operational backbone and the development of digital services platform are recommended. The digital services platform represents the technology and business resources that will facilitate the rapid development and implementation of digital innovations.

To develop an EA that is adjustable and flexible, this process has to be cyclical and adaptable. The organization must sense and respond to the shifting context in all phases of the adaptive loop: 1) real-time surveillance of external and internal environments (sense); 2) continuous evaluation of the organization's value proposition, value creation, and value appropriation (interpret); 3) ability to make decisions (decide); 4) ability to reconfigure and orchestrate infrastructure and services across the ecosystem (Haeckel, 1999). So, the activities proposed in this approach must provide a systematic means for early identification and fast response to important trends and events both inside and outside an enterprise. In fact, sustainable competitive advantage in highly turbulent environments calls for built-in organizational flexibility and resilience. This requires an up-front design of adaptive capabilities and respective enabling structures and mechanisms (Korhonen & Halén, 2017).

To follow this approach, increasingly specialized resources, more dynamic capabilities, and built-in resilience are all required in the face of change. The top management must focus on the highest order capabilities (the sensing, seizing, and transforming competencies that aggregate and direct the various ordinary capabilities and the second-order dynamic capabilities) as they are the most relevant for the innovation and selection of business models that address the problems and opportunities the company is endeavoring to solve/exploit. The design and operation of business models are dependent on a firm's capabilities. The strength of a firm's dynamic capabilities is vital in many ways to its ability to maintain profitability over the long term, including the ability to design and adjust business models (Teece, 2018).

Besides the need to strengthen these dynamic capabilities, in order to develop this approach, a group that is dedicated to the EA has to be formed. This group can help the CEO, be responsible in the main for the DBS, and work with other members of the top management team to redesign the EA and IST Architectures of the company so that it can compete more efficiently in the digital era (Sawy et. al., 2016). In this group, the Chief Enterprise Architect (CEA), who will have good technological knowledge, can also play an important part in determining what the EA should be, and should have the necessary skills to also be the Chief Digital Officer (CDO). The CDO, an additional position in top management, orchestrates the digital transformation of a company, though this has more often been created in companies under great market pressure to carry out digital transformation, and with complex coordination of digital transformation activities. The role of the CDO, therefore, includes supporting top management in the formulation and execution of a dedicated digital transformation strategy (Singh & Hess, 2017). Nowadays, CEOs need to think about implanting the CEA function, along with the function of the IT and CIO, at the right level of authority.

4. PLANNING THE DIGITAL BUSINESS AND INFORMATION SYSTEMS AND TECHNOLOGY ARCHITECTURES

In this part, the activities related to the development of digital business and IST architectures are presented, along with the points of contact with other business processes, in order to guarantee the requirements of digital transformation.

4.1. Define the digital business architecture

EA is a discipline which captures and communicates how an organization uses its key competencies to carry out its intentions and strategic objectives. It is applied in two situations: decision making or operating design in relation to business transformations and changes.

Digital Business Architecture consumes and captures the strategy and ensures its communication so as to guarantee the most effective and efficient applications during business transformations and programs of transformation or change. The following steps are proposed in the development of the digital business architecture: analysis of the current company strategy and business model, definition of the digital strategy (strategy positing), definition of the business model, and implementation of the business model.

4.1.1 Analysis of Current Company Strategy and Business Model

In this stage, an internal analysis of the firm's situation is carried out in order to describe the current strategy of the firm, taking into consideration that the resources and competencies that are available are essential. An external analysis would include the business environment and, in particular, the market trends.

4.1.2 Define the digital strategy (strategy positing)

The key word in “digital business strategy” is strategy, not digital. As in previous technological revolutions, technology must be used at the service of strategy, and not the opposite. One digital strategy - “Bolt-on”- means that the company is simply opening up new digital channels to offer their clients other ways and means of contacting the company. This usually takes the form of adding social media and mobile platforms. On the other hand, one of digital transformation’s “full scale” strategies implies redesigning the business model (globally) in order to take advantage of digital opportunities.

After analyzing the current positioning of the company, it is necessary to adapt its vision and strategy to reach the desired position (Rohmera et al., 2016). The aim of adapting the strategy (bolt-on or digital transformation “full scale) is to strengthen competitive advantages. When comparing internal conditions with external demand, it is possible to identify a gap in the market – the potential for a competitive position. This is the stage when the focus can be put mainly on digital challenges and opportunities. It implies an inspection of the respective market, including the digital business initiatives of competitors and changes in customers’ expectations in the digital economy.

Our aim is to see how effectively the company uses the digital technology (cloud computing, the internet of things, social networking, mobile technology, big data and data analysis) to transform its business and gain competitive advantage. To achieve transformation, each digital technology that we want to explore has to be visualized in light of each of the five forces framework of Michael Porter for the construction of a business strategy. These are: 1. The threat of substitute products or services; 2. The threat of competitive rivalry; 3. The threat of new entrants; 4. The bargaining power of suppliers; and 5. The bargaining power of customers (Porter & Heppelmann, 2014, Porter, 2015). In the strategic initiative related to the company’s future position in the ecosystem, the three dimensions of strategy must be considered: value, imitation, and perimeter.

Based on the results, a design challenge is formulated, which can be inspired by certain areas of the strategic focus but must definitely be related with digital businesses. This creates a new strategy and, later, its feasibility has to be analysed in order to consider the company and the new business strategy holistically.

4.1.3 Define the business model

This stage focuses on putting the strategic position in place, and this can only happen when a suitable and appropriate business model is defined. This business model is a high-level representation of the specific way in which an organization generates added value for its customers and maintains it. The objective of this representation is to illustrate the principal logic of the company’s business. It has to explain how the company meets the needs of its customers in comparison with other companies that are pursuing the same objective.

In order to project these digital business models, we are interested in how digital capabilities generate value so we propose the use of “digital value drivers” developed by Marco Cigaina and Uwe Riss (Cigaina & Uwe, 2017). The digital drivers mean specific value-generating effects that come along with digital key elements in a business context. These digital value drivers are elements of a matrix that holds the business model canvas components (value proposition, key activities, key resources, key partners, customer relationships, channels, customer segments, costs, and revenues) as one matrix dimension, and the digital key elements (People, Businesses, Things, Data and Cloud) as the other matrix dimension.

A specific adaptation of this business model canvas is the enterprise view (see Figure 1). We will mainly use the term “business model canvas” as the more general term, as we do not refer to the specific features of the enterprise view.

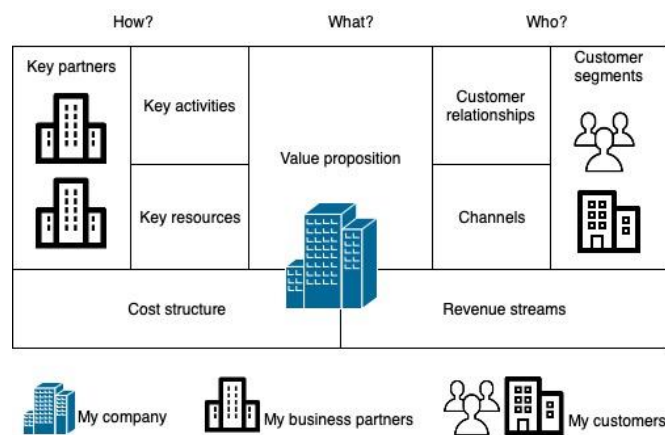


Fig. 1: The Enterprise View (based on (Cigaina & Uwe, 2017, p. 5))

The key component of the enterprise view is the company’s value proposition (indicated by “What?” in the figure). It joins the customer focus (indicated by “Who?”) and the company focus (indicated by “How?”) (Gassmann et al., 2015). The former focus describes the value delivery and includes:

- Customer segments describing which customers are addressed by the value proposition;
- Channels (for communication and delivery);
- Customer relationships describing the means by which the connection to customers is maintained.

The latter focus describes the value generation and consists of:

- Key activities describing the essential activities in the company that contribute to the value proposition;
- Key resources as the crucial resources to conduct these activities;

- Key partners as the collaborating organizations, which may be logistic partners or suppliers that provide essential resources or services for the solution that do not come from the company itself.
- Value creation and value delivery are supplemented by value capturing, which completes the description considering costs and revenues.

The other dimension contains the key digital elements that do not regard digital capabilities from a mere technology perspective but, first of all, take a business perspective:

- People as an abbreviation for digitally connected individuals and communities who leave their marks (data) in the digital world.
- Businesses as an abbreviation for digitally connected businesses or groups of businesses that combine their digital capabilities to create new solutions.
- Things as an abbreviation for digitally connected objects, or smart things.
- Data as an abbreviation for real-time, complete, detailed, consistent, and accessible information and any algorithms employing this data for analysis, planning, and prediction – including cognitive computing. This includes sophisticated analytics procedures that process small or large amounts of data and generate consumable information.
- Cloud, from a technology perspective, is just an infrastructure, but we suggest looking at it as a value-creating service type with specific characteristics. In this way the cloud becomes a service model and a logical shared environment in which people, businesses, and things connect in order to exchange and accumulate data as well as to offer and consume digital services.

Figure 2 shows the value drivers and their respective description for the component of the business model, the “Value Proposition” (Cigaina & Uwe, 2017):

Business Model Component	Data	Cloud	People	Businesses	Things
Value Proposition	Data-based Solutions	On-demand Services	People network-based solutions	Integrated Solutions	Smart Solutions

Fig. 2: Digital Value Drivers

- Data-based solutions - Data collection and processing can be an essential component of new as well as enhanced solutions. Such data can be an addition to a material product or constitute the complete solution. This may also concern the use of customer data that help tailor customer-specific solutions. Data-based solutions may also include the use of machine learning and high-performance computation to process relevant data.
- On-demand services - Cloud services make on-demand services available. Since digitalization moves the information-related parts of physical products to abstract resources

(dematerialization), this makes it possible to offer digitalized resources and services everywhere and at any time.

- People network-based solutions – Connections between digitally connected individuals or communities, or both, can be leveraged to create new services.
- Integrated solutions - Cloud-based networks enable scenarios based on data-sharing and composition of services, which are usually provided by digitally connected business networks.
- Smart solutions - Smart things make it easier to collect information that is necessary to provide the customer with an optimal solution.

Once these value drivers are analysed for the components of the business model (value proposition, customer segments, revenue streams, channels, customer relationships, key partnerships, key resources, key activities, and cost structure), this will allow us to identify a digital business model.

For this, it is necessary to do a feasibility analysis in order to reveal the resources which are available and those which are necessary. The impact of the structural changes of digital transformation must be identified. The structural dimension of the Digital Transformation refers to those who will be responsible for the transformation effort. In addition, the administration has to decide whether the new operations that are now carried out digitally should be integrated in the existing structures or placed in independent entities, separate from the main business of the company. The company may also have to acquire specialized know-how, or new competencies. Finally, the managers must consider the types of operational changes that must be expected while digital technologies are being used.

Another significant aspect to take into account in digital transformation is the financial dimension. The increase in financial pressure on the current core business can be the trigger that convinces management of the need to take action. Moreover, financial resources are necessary in order to carry out transformational initiatives.

After this analysis, unsuitable ideas and prototypes of business models can be rejected. Then, business cases need to be created and evaluated in relation to their economic efficiency, taking into account the whole business case of the company. Based on this analysis, and after additional identification of unsuitable business models, scenarios are developed for the remaining concepts.

4.1.4 Implementation of new or modified business model

This stage focuses on the implementation of a new or modified business model. In the planning stage, possible organizational adjustments and changes in the corporate culture should be addressed.

Once the business model has been implemented, the control and monitoring processes follow. If there are any inconsistencies during the review stage, cycles of iteration must be carried out, and there may be an option to adapt the strategy.

4.2. Define the information systems and technology architecture

In order to support the resources and the new digital business model, it is important to identify which technological components are needed to prompt the following activities:

4.2.1. Evaluate the enterprise operational backbone

For an organization to be successful in the digital economy, it must have a strong operational backbone that provides automated transaction processing and visibility into master and transactional data. This backbone must have the basic resources necessary to enable the digital services platform to provide transparency in the transactions (Sebastian et al., 2017).

One of the extraordinary challenges of leadership has to do with identifying which are the most critical operating resources. To begin in a significant way, senior management must concentrate on the creation of one essential resource for the company's digital strategy. This task of renovating the main information systems is often the first stage in the company's digital transformation, and it will be a continuous effort as part of the construction of the technological platform of digital business. The missing parts, or those which need to be improved or modernized, must be determined. The results serve as fundamental elements in the script for the digital business technologies that will be created (or updated) by the team.

4.2.2. Define a digital services platform

The digital services platform represents the technology and business resources which facilitate the rapid development and implementation of digital innovations. The CIOs, the EA team, and the IT leaders must determine which of the platforms (customer experience platform, data and data analysis platform, IoT platform, ecosystems platform) need to be implemented or renovated – and when. Thus, according to the strategy, the following must be done:

- The IT leaders must define the architecture of the digital services platform, focusing on a small set of digital innovations which they believe to be fundamental (or critical) for the success of the business. When a company establishes the data requirements for a small set of components that are critical for the business, and configures APIs in order to access the data, then it can build (or the technological partners can help to build) the infrastructure necessary to protect, connect, analyse and support innovate digital services.
- The digital services platform must be projected, taking into account the extensions to their partners.

A service culture must be adopted by means of the business and IT teams, who will define, project, deliver, price, prioritize, implement, spruce up, and reject new business services.

5. CONCLUSION

The aim of this article is to clarify the dimensions and activities related to the development of an EA in order to ensure that companies catered for the requirements of digital transformation. The focus is on the role that EA can bring to digital transformation, through the development of business and information technology architectures, respectively. A set of tools was also proposed that would allow the evaluation of the topics considered in terms of their efficiency in digital transformation.

This proposal differs from other frameworks of EA planning because it gives relevance to the activities that contribute most to digital transformation, particularly in businesses, through the following:

- Considering an operating model supported in EA with a fundamental focus on the digital business strategy (DBS);
- Considering an IT architecture supported on digital service platforms;
- Considering an ecological adaptation approach. This occurs because the systemic approach alone is not enough for the corporate project; it is necessary to achieve environmental and business co-evolution deliberately altering the environment, systematically projecting the company as well as its relationship with its environment;
- Giving relevance to the role of the CDO as an integral part of the role of the CEA as well as an autonomous role in the case that the digital transformation is great.

This proposal is being tested in the digital transformation process of ten SMEs of Alto-Minho Portuguese region, in the scope of the “ALTO MINHO 4.0” project, which seeks to leverage competitiveness, training and digitization of SMEs in the region.

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