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Enterprise 4.0 – the emerging digital transformed enterprise?

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Abstract

Information Systems are at the core of all businesses and cover almost all aspects of organizational life. The convergence of computer capabilities, such as the potential to process large volumes of data in a very short time, the growth in Internet usage and the increase in the ability to capture and leverage knowledge in digital format are, in this context, the main enablers of the so called digital transformation of organizations. While the technology enablers allow the production, sharing and management of information and knowledge within the organization between peers and other stakeholders, besides empowering the improvement and innovation of the organizational processes, they also require the updating of the supporting IS. Thus, using technologies in organizations within the context of Digital Transformation (DT) requires an exercise in understanding how to demonstrate their usefulness in relation to the creation, access and sharing of contents and IS improvements in a safe way. This paper provides a comprehensive view of a new context of labour faced within DT of organizations, which we term Enterprise 4.0 and which we propose to be implemented through the m_CSDIT framework, so as to improve the organizational well-being considering the collective intelligence and agility dimensions.

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1. Introduction

Digital transformation (DT) can be seen as an emerging topic as well as the discussion of its enablers and associated implementation benefits. In fact, it is argued that the integration of technological enablers, such as Big Data and associated analytics, Cloud Computing, Mobile Connectivity, and Social Media, the four acknowledged pillars of DT, with business practice can provide significant organizational competitive advantage [1].

According to Earley Information Science, Inc [2], DT is today a top priority for executives, being that (1) 125000 enterprises expect revenue from their digital initiatives to increase by 80% by 2020; (2) DT initiatives will more than double by 2020, from 22% to almost 50% and, (3) only 27% of businesses have a coherent digital strategy for creating customer value in place.

From the organizations' point of view, DT can be seen as a deep and accelerating transformation with regard to processes, activities, competencies and models, in order to take advantage of the changes and opportunities offered by the inclusion of digital technologies into an organization. However, this advantage is only possible if the information systems of the organizations are also aligned with these new technologies. The main purpose of DT is to redesign the organizational business through the introduction of digital technologies, achieving benefits such as productivity improvements, cost reductions and innovation [3]. Nevertheless, as stated in Miler [4], for these results to be achieved, a total organizational commitment is required. To this extent, Hinchcliffe [5] points out that "*…because digital itself is so intangible…. It's often even harder to understand the diverse needs, perspectives, and skill gaps of the people that have to change along with the technology*". Hence, it may be assumed that continuous education/training is an imperative in this transformation organizational context.

In parallel with DT and often referred as a major opportunity for promoting DT in manufacturing, the paradigm of industry 4.0 has also arisen, whose goal is to achieve a higher level of operational efficiency and productivity, as well as a higher level of automatization [6]. Industry 4.0 facilitates inter-connection and computerization into the traditional industry [7]. Following this line of reasoning, in our research contribution we propose a framework to drive organizational DT, where the former concept applied within the context of manufacturing is applied to any type of organization – Enterprise 4.0.

On the other hand, Information Systems (IS) are the core of every business and cut across almost all aspects of organizational life. They are used to support and improve all aspects of organizational functions and activities. In particular, under this context, the perception of increased product and services customization as a competitive advantage is universally shared [8].

Thus, it can be claimed that in order for DT to be successful in an organization, IS need to be adapted/updated as well. IS must accommodate DT and must be aligned with the business in order to create value for the organization/business.

In this paper, we provide a comprehensive view of the prevalent issues of a new context of labour faced by organizations on a DT process: Enterprise 4.0 supported by mobile IST – m_CSDIT. Furthermore, we argue that this context will improve the well-being of these organizations through the collective intelligence and agility dimensions. The m_CSDT framework was formerly proposed in Ferreira et al. [9], [10]; at that stage, the framework was used as a basis to introduce and/or systematize social business in organizations. We now propose an update of the m_CSDT framework to accommodate DT and leading to Enterprise 4.0.

2. New trends for organizations

As already referred, IS are nowadays central to any organization [11] regardless of the organization's type, size, purpose or means; any organization has an IS to support its internal operations and its interactions with the external environment. IS can be defined as "*software systems for business management, encompassing modules supporting organizational functional areas such as planning, manufacturing, sales, marketing, distribution, accounting, financial, human resources management, project management, inventory management, service and maintenance, transportation and e-business*" [12] supported by computers, software, people, processes and data.

Organizations face daily pressures to demonstrate their ability to adapt quickly to unpredictable changes in their dynamics in terms of technology, social, legislative, competitiveness and globalization. Thus, to ensure their place in this difficult context, organizations must always be agile and must ensure their sustainability through continuous improvement of their IS [13]. Therefore, organizational agility should be considered today as one of the main objectives of any organization. As stated in Imache et al. [13], IS have progressed in a constant interaction between a permanent and random change. This context of organizational and ICT evolution can be ensured by DT. Uhl & Gollenia [1] enrich the DT concept, arguing that the adoption of technology-based change is focused on four technology enablers with the following associated advantages: Cloud Computing (*"(i) Increase user mobility by a ubiquitous approval of information on any device; (ii) Flexibility and cost savings by eliminating the need for heavy local installations of end-user applications and high-powered client computers; (iii) Boosts of your business by the shift from fixed to variable costs.*"); Mobile Connectivity (*"(i) Direct connection and communication to stakeholders; (ii) Additional information about customers behavior; (iii) Customers-oriented offers; (iv) Mobile payment and ordering systems.*"); Social Business & Social media ("*(i) Faster information sharing by direct and proactive communication with various stakeholders; (ii) Early brand and consumers' feedback; (iii) Cost saving with the reduction of product lifecycles; and (iv) Transparency of organization processes.*"), and (4) Big data and associated analytics (*"(i) better aimed marketing, (ii) more straight business insights, (iii) client based segmentation, (iv) recognition of sales and (v) market chances*").

Assuming that Industry 4.0 can be considered the 4th Industrial Revolution, it is worth mentioning its predecessors and the evolution of manufacturing and the industrial sector in general. The term "Industry 4.0" [14] was adopted in 2011. The reference to ".0" stems from an analogy to the way software versions are usually called, meaning that the evolution of industry itself is also subjected to the rules of technological evolution of the information technology world. According to the Industry 4.0 Working Group [14], the current convergence between the physical (kinetic) world and the digital or virtual world (also called "cyberspace") makes it possible to create industrial ecosystems in which industrial processes arise from the networked interaction of objects, information and people. Thus, by using integrated digital systems to design, project, prototyping, component manufacturing, assembly and packaging, products can be planned and executed with minimal human intervention. This allows offering to the market a wide range of products adapted to each individual customer, without costs increase. The flow of real-time and networked data between machines, robots and logistics systems will allow to anticipate failures, adapt production to new scenarios and integrate variables into the production process (with information from clients) that would otherwise be impossible. Uhl & Gollenia [1] show that Industry 4.0 can empower organizations in three positive aspects: "*(i) Ad hoc reaction to customer changes (painting, delivery address, etc.) and changes in the supply chain (absent delivery can be replaced promptly); (ii) Optimization of the tasks of the staff members (reprogramming of machines); (iii) Find irregularities in the production process and correct them automatically.*"

3. Innovation accelerators: New DT directions

The results of introducing, among others, social media tools in business were very positive and resulted in the revitalization of many businesses and reference companies (Starbucks, Hummel and LEGO) in their areas of intervention. However, the rapid evolution of technology has led to the emergence of new solutions (cloud computing, increased use of mobile devices, etc.) that led to the emergence of the so called 3rd technology platform (early 2010), which is based, as previously described in four technology enablers or pillars (mobile devices, cloud computing, social networking and Big Data and associated analytics). This platform is the result of the evolution of

the 1st platform (late 1950s), based on mainframes, and the 2nd platform (mid-1980s) based on the client-server model.

The more significant use of the pillars of DT has been driven by innovation accelerators, which include, among other solutions, IoT, Robotics, 3D Printing, Artificial Intelligence, Augmented and Virtual Reality, Cognitive Systems and Next Generation (NextGen) Security. To this extent, IDC expects that in, 2019, 3rd platform technologies and services will account for about 75% of IT spending [15].

Thus, for companies to stay competitive in the market, ensuring more agility, efficiency and productivity in business, it is no longer enough to just invest in IT. It is necessary to recognize the strategic value of the innovation accelerators and to plan the IT infrastructure to support DT.

One of the main advantages of DT is the possibility of expanding physical to digital business. For example, one of the innovation accelerators, virtual reality technology, can be applied to the real estate market to conduct visits to fully digital properties, whereas in the medical field, the same resource can be applied to offer virtual training of surgeries and study of organisms.

4. Enterprise 4.0 supported by Digital Transformation

DT in organizations is already a reality that needs to be implemented and even, in some cases improved, as already discussed. Acknowledging this context, the m_CSDT framework was formerly proposed in Ferreira et al. [10]; at that stage, the framework was used to introduce and/or systematize social business in organizations. We now propose an extension of the framework to accommodate DT leading to the Enterprise 4.0.

The following subsections present the updated approach, renamed as mobile Create, Share, Document, Improve and Training (m_CSDIT) and the rationale for its use, under a context of organizational DT.

4.1. Mobile_Create, Share, Document, Improve and Training: m_CSDIT

The relevance of conducting DT supported by the four technology enablers - Big Data and associated analytics, Cloud Computing, Mobile Connectivity, and Social Media tools is widely acknowledged and recognized by the scientific community and organizations, as discussed throughout the previous sections. However, there is a lack of approaches that allow the systematization and that guide its implementation within an organization, while improving IS and organizational processes.

To address this end, we propose the m_CSDIT approach as a three-layer framework targeting the following issues:

1. Creation, sharing documentation of information and knowledge in and out of an organization, and improvement of organizational processes based on information and knowledge;
2. training of organizational workers – driven by the ToOW model [16]; and
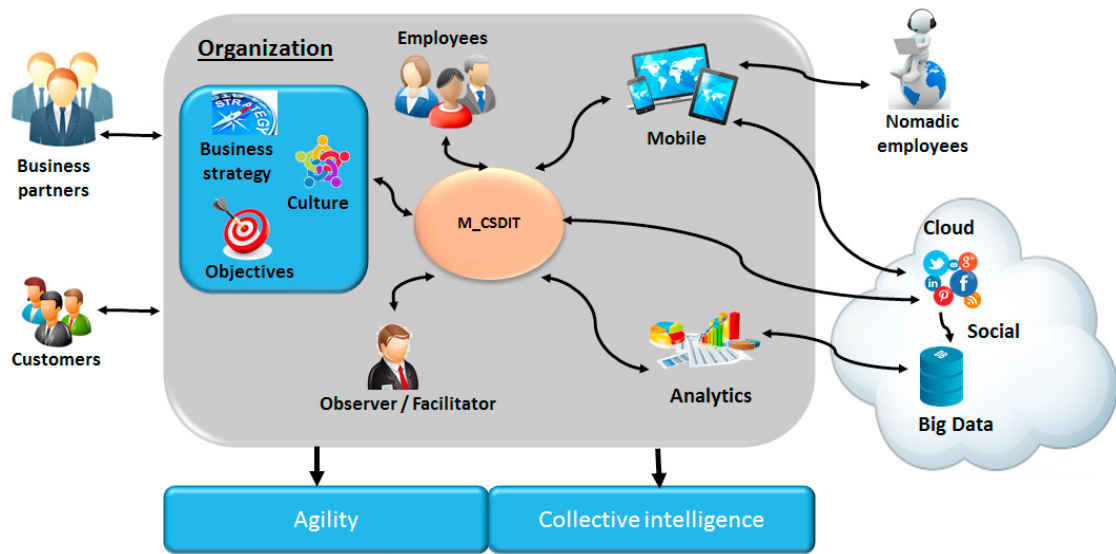3. Promotion of ad-hoc discussion.

Fig. 1. The m_CSDIT framework.

As shown in Figure 1, a context for an Enterprise 4.0 implementation can be settled through the use of the four pillars of DT, so as to achieve the well-being of the organization considering the agility and collective intelligence dimensions. Thus, emphasis is given in the production of value for the organizational ecosystem.

Creating value often occurs in different social contexts. This approach includes individual and organizational contextual factors. It identifies the crucial role that an organization plays in promoting a culture of lifelong learning, collaboration and innovation, in order to achieve the organization's strategic objectives. The model identifies and presents the relationships and interactions namely between employees, technology and tools, the business strategy and business processes.

The approach highlights the collaboration issue and its relation with the accomplishment of the organizational goals. The employees are at the center of the collaboration and are mostly members of social networks. Figure 1 illustrates the nature of the proposed collaboration in the workplace, where mobile devices are used, IS and underlying processes are largely organized and conducted by the organization, and which is based on the social context.

The approach may be briefly described as the collaboration in the workplace based on the four pillars of DT. This means that the organization learns through the participation and involvement of its stakeholders, namely employees, through a network, connecting, interacting and collaborating to obtain or share information and/or knowledge, in order to improve its organizational processes/IS. We propose that the collaboration in the workplace is achieved through the integration of suitable social media tools to the needs of organizational development and learning. To that end, we suggest a mixed form of peer tutoring with an instructor who acts as observer/facilitator. To achieve the potential benefits of collaboration, we recommend that the organization supports rather than restricts the adequate use of tools in the workplace. Thus, organizations have to define the best long-term strategies and implement action plans to take advantage of collaboration based on the DT pillars.

4.2. The rationale for the framework proposal

As discussed throughout this paper, the need for DT of organizations, and consequently the need to introduce changes in the conduction of business and process improvement, are now recognized within the scientific community and by organizations. However, new approaches to address this paradigm are needed, so that guidance may be provided for its implementation within an organization.

Hence, a new contribution is hereby presented, originating from the work reported in [10]. The former approach was focused only on the changes introduced by social business, supported by social media tools. However, DT, as discussed earlier, is based on four pillars: social media, mobile, cloud and big data and associated analytics.

Thus, to address this objective – taking into account these four pillars and not just one – the former approach was extended; it consists of a three-layer framework (*m_CSDIT*), covering: (i) the creation, sharing, documentation of information and knowledge in and out of an organization in order to improving the business processes (that must be aligned to the organization strategy); (ii) training of organizational workers, and (iii) promotion of ad-hoc discussion.

As shown in Fig. 1, it is possible to consider a generic approach for the implementation of DT and IS improvements, based on the four DT pillars as well as in the Agility and Collective Intelligence dimensions.

The first layer of the *m_CSDIT* framework is presented in Fig. 2 as a cyclic sequence of stages, aiming to use the four DT pillars in the definition of the creation, sharing, documentation of information and knowledge in and out of an organization and improving the business processes, in alignment with the organizational strategy.
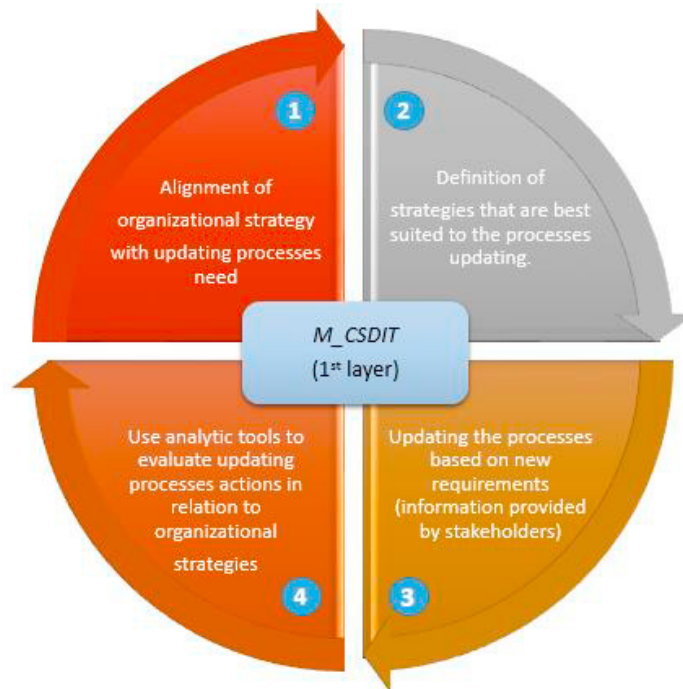

Fig. 2. First layer of the *m_CSDIT* framework.

As depicted in Fig. 2, the *m_CSDIT* framework is designed to improve organizational processes based on information and knowledge provided in and out of organization (3). The processes updating strategies of the organization (2) are aligned with the organizational strategy (1) and analytical tools are used to evaluate the updating of processes, on the basis of their performance, according to the defined organizational strategy (4).

In order to enable a more flexible updating scheme, the model also considers updating actions proposed by employees; however, updating will always be compulsory according to the defined updating processes strategies (3). The definition/adjustment of the updating processes strategies (2) should be made in a periodical basis, so as to pace with the evolution / needs of the organization.

Regarding the use of DT enablers, the model considers a complete set of tools to be used within the updating processes activities, which can be undertaken inside and outside the organization, that is, in different transformation (update) contexts. The model is designed in such a way so as to enable the updating, at distance or in workplace context, in a formal or informal way. In the case of an informal context, an Observer/Facilitator will always be considered, as shown in Figure 2, who will have a role of moderator on the ongoing activities.

As cloud is one of the pillars of DT and social media is one of the others, the use of social media tools located in the cloud, will allow to consider the *CSDIT* approach under collaborative work, as it enables internal transformation (Fig. 1 – Employees) as well as external transformation (Fig. 1 – Nomadic employees), enabling the interaction and collaboration among the participants, stakeholders, and, thus, the sharing of information and/or knowledge.

All the updates carried out will have to be evaluated so that it can be understood if the investment made meets the needs of the organization and the impact it may have on organizational processes' improvement. Hence, analytics tools – one of the pillars of DT – will be used to monitor and compare updating results with the defined metrics goals to improve organizational processes.

The absence of a collaborative culture embedded in the organization's ecosystem may lead to the failure of strategies set for the organization in general. In order to avoid this failure scenario, the model hereby proposed aims to promote the development of a culture of lifelong training, adding value to organizational development and being central to achieve the objectives defined in the alignment of the organizational strategy with the organization needs.

5. Conclusions and future work

DT, as discussed, may be considered essential for organizations to be competitive. However, this transformation cannot be undertaken through an ad-hoc process but by a strategically defined and planned process as its results have impact throughout the organization, from processes and activities to business models. Furthermore, any organization is supported by information systems, which have also to be aligned with the organizational strategies.

Within the organizational transformation context hereby presented and realizing the need for updated approaches to address business processes improvement and organizational workers' training, we extended the m_CSDT framework to accommodate DT enabled by the four technology pillars (Big Data and associated analytics, Cloud Computing, Mobile Connectivity, and Social Media) and leading to a new enterprise environment, that we termed Enterprise 4.0.

This paper aimed to give an overview of the key issues underlying the DT efforts undertaken by organizations. It then proposes the extended m_CSDIT approach consisting in a three-layer framework that covers the systematization of (i) the creation, sharing and documentation of information and knowledge in and out of an organization and improvement of organizational processes based on information and knowledge, (ii) the education and training of organizational workers and (iii) ad-hoc discussion.

We envisage that the m_CSDIT approach will allow the implementation of a new context of labour, which we term Enterprise 4.0, offering a new context to the traditional way of doing business - the context of DT, in order to achieve the organizational well-being considering the agility and collective intelligence dimensions.

In spite of this, the approach is still in a conceptual stage and needs to accomplish a greater degree of formalization.

Thus, future work will target the revision of the framework so that it can be instantiated according to the needs of a given organization, followed by an initial validation within a case study context and a subsequent validation within a real business context.

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