Digital Transformation Framework

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Abstract

Technological pressures forced organizations to undertake digital transformation initiatives. Due to the increasing demand by business leaders, several consulting firms and researchers have developed maturity assessment models for digital transformation. However, these models, among others, do not explain the research process underlying their design and lack scientific validation. Furthermore, the process angle of the research is often overlooked in the context of digital transformation. To address this gap, we propose a staged digital transformation capability maturity model framework that enables organizations to assess their present digital capability based on processes and establish a plan of improvements to guide them towards higher digital capability level. This framework was developed using a design science research approach, building on the ISO/IEC 330xx family of standards to provide structure to a set of digital transformation processes identified using a systematic literature review. At a time when companies look for orientation to navigate their digital transformation, the contribution of this thesis is a framework, from a process perspective, rooted in solid scientific concepts, to guide practitioners on how to assess digital transformation initiatives.

Keywords: Digital Transformation, Capability Maturity Model, Framework, Process Reference Model, Process Assessment Model, Systematic Literature Review, ISO/IEC 330xx family of standards.

1. Introduction

Initiatives using digital technologies as an enabler have been continuously studied and implemented by organizations in recent years, mainly due to the increasing demand from customers for added-value products and services delivered in a faster and more convenient way [20]. The rapid pace of innovation, the competitive dynamics within industries, and the opportunities and threats created by new digital technologies, fundamentally changed the firms' environment [8] [6]. Consequently, one of the biggest challenges and problems facing companies today, is the integration and exploitation of digital technologies [13]. Thus, appropriate digital transformation (DT) is required as a core strategy for most organizations to compete and survive [9]. Its success represents an utmost for organizations and the implications for those who do not do it is the disruption from the competitors. Competitive pressures and new markets rank as the main drivers of digital transformation, revealing "the urgency within companies to optimize and innovate" [31]. "Companies surveyed in 2017 are simultaneously experiencing increased competitive pressure (54.2%) and growth opportunities in new markets (46%)" [31]. These ranks take a relevant contribution to the at-tention given to digital transformation, considered as the primary concern of corporate leaders in 2019 [31]. Decision-makers seem to be aware of this situation and spend a great deal of money on digital transformation initiatives, although without achieving a positive return on investment. In fact, "70% of all DT initiatives do not reach their goals" and "of the $1.3 trillion that was spent on DT last year, it was estimated that $900 billion went to waste" [32]. Data suggests that companies considered to be of superior digital maturity, in addition to integrating new digital technologies more effectively and efficiently in their platforms, retain a larger number of customers by offering engaging experiences to increasingly demanding customers [29] [30]. Moreover, relentlessly, disruptive innovation performed by incumbents and new entrants have caused the falling out of traditional enterprises that were not capable of reinventing themselves in this new digital ecosystem. Besides the fact that digital transformation is a new buzzword, garnering enough attention from top management, as well as, being widely considered to be one of the CEOs' top concerns, the current state of research indicates that may still exist a shortage of scientific material to address this issue [4] [22] [7]. A literature review performed by

Gerster which consisted of an analysis of 2,833 articles "published in eight leading IS journals between 2007 and 2016 reveals that a mere 0.2% addressed the impact of digital transformation on IT while 2.3% cover topics of digital transformation, innovation, or digital technologies" [4].

Paradoxically, regarding the lack of scientific articles addressing the subject of digital transformation, a study conducted by Fitzgerald [25] stated that 78% of respondents advocate that "achieving digital transformation will become critical to their organizations", but 63% "said the pace of technology change in their organizations is too slow". Furthermore, in another study, 90% of respondents "anticipate that their industries will be disrupted by digital trends to a great or moderate extent, but only 44% say their organizations are adequately preparing for the disruptions to come [18].

Hence, the focus of this thesis consists of creating a process reference model (PRM) and a process assessment model (PAM) which together form the digital transformation framework. Performing a systematic literature review represents the first step in order to create a process reference model by identifying those processes that are closely related with digital transformation. After designing the process reference model, the next step will be the process assessment model whose objective is to assess the capability maturity level of each process encountered by a specific company and then provide some actionable recommendations to support that company in achieving the next digital maturity level. Once the foundation of the framework components is built and well established, we will test the adoption of the framework in a real case scenario, in order to validate our proposal. Note that the digital transformation framework is not to be considered as a final product, rather it should be viewed as a guide that can (and should) be customized to match the actual needs of the company in question. This proposal represents a new digital transformation framework in a structured way following key processes identified in the literature.

2. Research Methodology

Our purpose consists of carrying out a research methodology, composed by design science research (described in section 2.1) and systematic literature review (described in section 2.2), that can contribute with a holistic approach to guide companies in their digital transformation strategy.

2.1. Design Science Research

In this ongoing process to develop the framework, we used design science research methodology (DSRM). The reason behind the adoption of this methodology over other options is related to our aim, which is to create an artefact that intends to meet the organization's needs regarding the digital transformation. The main objective of design science research is to offer guidelines that enrich the articulation of a scientific proposal by means of artefacts to a specific problem that is intended to be solved. The fundamental principle intrinsic to the design science research paradigm is the "knowledge and understanding of a design problem and its solution are acquired in the building and application of an artefact" [11]. Peffers et al. proposed a synthesis of the elements that DSRM should contain by creating a process model that resulted in the following 6 activities [26]:

1. Problem identification and motivation - Define the specific research problem and justify the value of a solution.

2. Define the objectives for a solution - Infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible.

3. Design and development - Determine the artefact's desired functionality and its architecture and then creating the actual artefact.

4. Demonstration - Demonstrate the use of the artefact to solve one or more instances of the problem.

5. Evaluation - Observe and measure how well the artefact supports a solution to the problem. This activity involves comparing the objectives of a solution to actual observed results from use of the artefact in the demonstration.

6. Communication - Communicate the problem and its importance, the artefact, its utility and novelty, the rigor of its design, and its effectiveness to researchers and other relevant audiences such as practicing professionals, when appropriate.

The activities described above are represented in the correct order of approach and adopted as a means of an iterative process according to a problem-centered initiation, as shown in Fig. 1.

Note that an additional research method, inside the design development phase – Systematic Literature Review (SLR) – was incorporated with the purpose of achieving a higher reliable result when trying to identify processes related to digital transformation. The method and the associated procedures are described step by step in the section below.

2.2. Systematic Literature Review

A systematic literature review incorporates several procedures that seek to ensure a rigorous and accurate research in order to obtain relevant information
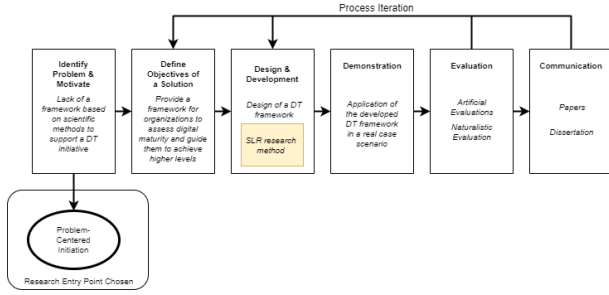
Figure 1: DSRM Process Model. Adapted from [9].

Figure 2: Systematic Literature review process. Adapted from [1] [11].

through empirical studies produced in a certain domain. A straightforward definition of systematic literature is provided by [19] - "a systematic review is a means of evaluating and interpreting all available research relevant to a particular research question, topic area, or phenomenon of interest. Systematic reviews aim to present a fair evaluation of a research topic by using a trustworthy, rigorous, and auditable methodology". Systematic literature reviews "are primarily concerned with the problem of aggregating empirical evidence which may have been obtained using a variety of techniques, and in (potentially) widely differing contexts" [1].

When performing a systematic literature review, an element that takes a fundamental role is a review protocol. This protocol aims to minimize bias in the study by establishing in advance how the systematic review should be conducted [1]. The three phases that correspond to the process of systematic literature review must be executed in order - Plan Review, Conduct Review and Document Review. The steps that constitute each phase are shown in Fig. 2.

The choice of SLR as the research methodology is based on our purpose to identify the practices related to digital transformation already mentioned in existing literature.

3. Research Problem

Following the DSRM approach this section represents the first step to the identification of the problem and motivation. Nowadays, the integration and exploitation of new digital technologies is one of the biggest challenges that companies face and no sector or organization is immune to the effects of digital transformation [10]. Indeed, business leaders in general are more concerned with the implications that new technologies have for the current and future state of the work environment, as well as the important role they play in the everyday activities of consumers, championing for digital transformation within their enterprises. "Senior leaders realize what the stakes are (. . .) just 33% of executives in our 2007 survey said their CEO was a champion for digital; that number has doubled to more than 68%
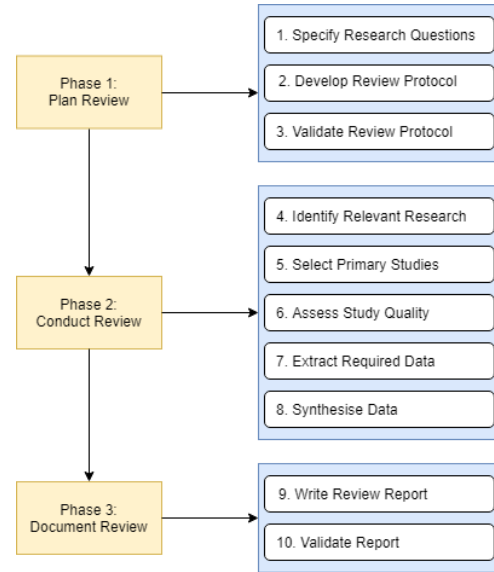
today." [28]. Nonetheless, some companies are left behind despite of their efforts to undertake a digital transformation. In turn, companies want to act according to their business strategy convictions, but several obstacles sometimes block the intended path to perform a digital innovation. "Several obstacles stand in the way of digital maturity; lack of strategy and competing priorities lead the list of speed bumps. Lack of digital strategy is the biggest barrier to digital maturity for companies in the early stages according to more than 50% of respondents from early-stage organizations" [17]. Due to the increasing demand by business leaders, several consulting firms and researchers have developed maturity assessment models for digital transformation. For example, Deloitte, in collaboration with TM Forum, created a digital maturity assessment tool [3]. Another example is the Forrester Research digital maturity model that seeks "to help companies assess their overall digital readiness" [5]. However, these models, among others, do not explain the research process underlying their design and lack scientific validation. We propose to address this gap by developing a scientifically sound digital transformation capability maturity model framework, capable of helping organizations assess their current digital maturity and define a plan to increase it.

Succinctly, the problem that we aim to address **is the lack of a framework with a scientifically based research to guide a digital transformation, by helping the organizations to assess their current digital maturity and move them to the next digital maturity level.**

3

4. Theoretical Background

The clarification of concepts and definitions, related to our topic and derived from existing theories and empirical studies available in the academic literature, is provided in this section. The scientific literature review may be considered an integral part of the theoretical background since it gathers relevant academic work.

4.1. Digital Transformation

Ubiquitous digital technologies are increasingly impacting organizations' businesses. Many incumbents have felt the pressure to change the way they do business. Entrant start-ups and other companies with a digital-savvy mentality have attracted customers with their digital platforms that offer higher speed and convenience in the use of products and services. Across industries, companies feel the urgency to become digital in a fast pace, otherwise they know that competitors and new entrants are willing to disrupt and take their places [21]. Corroborating with this concern digital transformation has arisen in companies' business agendas where according to a study "80% of respondents regard digital transformation as being important for their company's overall business strategy" [12]. Moreover, the challenges essentially come from the pressure customers have placed on the companies to always come up with innovative products and services incorporating technology of high level. "As technology change accelerates and new digital solutions emerge, many companies feel the pressure to perform a digital transformation. This pressure increases due to changing preferences and expectations of customers and users." [14].

Digital transformation has been considered a buzzword which has attracted the attention of researchers and practitioners. Likewise, Fig. 3 suggests that, in recent years, the topic has gained importance for researchers and practitioners. The need to adopt digital transformation in organizations and the interest of executive leaders in the subject reinforced the interest of the researchers in providing informational knowledge and solutions.

Despite garnering special attention, there continues to be little consensus regarding digital transformation explicit meaning.

4.2. Process Reference Model (PRM)

When it comes to introducing the concept of Process Reference Model (PRM), it is pertinent to also cover the clarification of reference model. Regarding its explanation, "a reference model is an abstract framework for understanding significant relationships among the entities of some environment that enables the development of specific architectures using consistent standards or specifications supporting that environment. A reference model
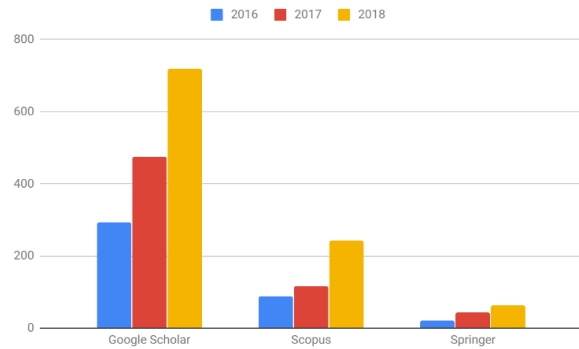

Figure 3: Number of articles containing "Digital Transformation" in title's publication by year and database.

consists of a minimal set of unifying concepts, axioms and relationships within a particular problem domain, and is independent of specific standards, technologies, implementations, or other concrete details." [23]. Academics have been using the ISO 15504/330xx family definition of PRM, which consists of "a model comprising definitions of processes described in terms of process purpose and outcomes, together with an architecture describing the relationships between the processes"

With regards to the state of the art, PRM has been attracting increased interest in the literature, specifically in its design. Many PRMs were designed for multiple and varied domains such as automotive sector, enterprise processes and regulation compliance, as it is referred to in [24]. Beyond these, an important international standard for process reference model and process assessment model were developed in the field of information security management which was used as the basis for many PRMs designed later.

4.3. Process Assessment Model (PAM)

Judging by the amount of publications by academics and practitioners, maturity models have been growing in considerable numbers [2] [34]. The business world has also adopted maturity models to improve its business processes considering the quality management required by stakeholders and for reasons of competitiveness.

When it comes to standards, ISO/IEC 15504 was apparently the first consensual standard that proposed a reference model for maturity models. The associated and updated standard now for ISO/IEC 15504 is the ISO/IEC 330xx family. Within the objective of performing an assessment, the document ISO/IEC 33002 defines the minimum set of requirements that form a structure for the assessment of process and the application of process assessment.

The process assessment model (PAM) "supports

the performance of an assessment of process capability by providing indicators for guidance on the interpretation of the process purposes and outcomes as defined in ISO/IEC TS 33052 and the process attributes as defined in ISO/IEC 33020" [16]. In short, "a PAM comprises a set of indicators of process performance and process capability. These serve as a basis for collecting the objective evidence that enables an assessor to assign ratings." [16].

5. Research Proposal

Moving to the second and third phases of DSRM, we will now respectively discuss the objectives of the solution and its design and development.

The main objective of our proposal solution is to provide a framework to assess the current state of digital transformation in an organization and provide guidance to achieve higher levels of digital maturity.

In order to substantiate the validity of the artefacts produced, they will have the support of standards, procedures and methods accepted by the community.

5.1. Systematic Literature Review: Planning the Review

In this section, associated with the first phase of SLR methodology, we present the objectives of conducting this review, the research question, and the protocol review.

5.1.1 Objectives

Our aim regarding the SLR is to simplify the digital transformation that organizations operate through the identification of reference processes related to digital transformation.

5.1.2 Research Question

The research question addressed by this study is:

- RQ1: What are the reference processes for digital transformation?

5.1.3 Protocol Review

The search process was performed through a manual search that consisted of the use of a search string in multiple data sets. The respective search string and data sets are mentioned below:

- Search string: Title("Digital Transformation" AND (Process OR Method OR Framework OR Methodology OR Activity))

- Data sets: ACM Digital Library, Google Scholar, IEEE Digital Library, Science@Direct, Scopus and Springer Link

The search intended to select relevant articles since 2004 up to March 2019. Our search string just takes into consideration the title of the articles, considering we wanted to especially focus only on relevant literature, avoiding waste, as much as possible.

5.2. Systematic Literature Review: Conducting the Review

This section covers the second phase of the SLR methodology in which we will address the study selection, according to the protocol review defined above, and provide the data extracted from the respective selected studies.

5.2.1 Study Selection

Once we applied our search string, the number of articles collected corresponded to 138 through the whole data sets in use. Although, from those 138 articles, 45 were duplicated. Then by applying the inclusion and exclusion criteria the number of articles decrease considerable until a final number of 37 articles. Regarding the inclusion and exclusion criteria, articles written in English published between 2004 and March 2019, and containing the following topics were included:

- Meta-analyses

- Digital transformation practical area i.e. literature that approaches a digital transformation in a specific domain.

Articles whose topics do not show content related to digital transformation were excluded. From the initial collected articles, 56 of them were put on the rejected category for not accomplishing the inclusion and exclusion criteria.

5.2.2 Data Extraction

The publication of articles was considerably larger in conferences than in journals and the years of the publications on the selected articles has grown in size in recent years, suggesting a greater interest in the topic. Regarding the sources of the papers in our pool, within the Conferences, Journals and Books, those who contributed the most were the book "Digitalization Cases" with 3 papers, the International Journal of Corporate Learning, and the following conferences, Hawaii International Conference and International Conference MLSD contributed with 2 papers. Note that the category of 2019 just covers articles publish until March 2019.

5.3. Systematic Literature Review: Reporting the Review

In this section, which covers the last phase of SLR methodology, we will present the results from the analysis of the articles selected and answer the approached research question.

5.3.1 Processes

The processes documented in the selected articles were identified by us based on some quotations uttered by the authors.
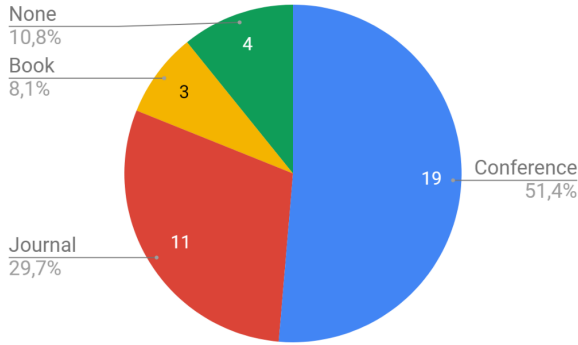
Figure 4: The articles type distribution

The identified processes present a broad scope of what could involve a digital transformation. When analysing the identified processes, it is possible to conclude that the execution of these processes will have to involve several departments, as well as numerous stakeholders, connoting a trans-functional property of the digital transformation. The interconnection between processes can also be predicted through the analysis of the list of processes. The dependence of results between processes may possibly exist, and the output of some processes can be considered as the input of other processes. However, there are processes that appear to be feasible to be carried out in parallel, not demonstrating dependence on its completion. Figure 5 shows the number of articles that mention each identified process, allowing a better perception of the focus that has been channelled in terms of processes in the context of digital transformation. The selected literature thus suggest a special emphasis on the processes of manage digital strategy, manage business processes and manage innovation, giving the high frequency of different articles that mentioned these processes.
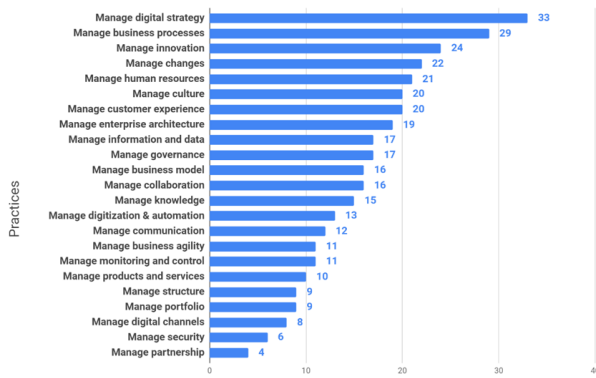

Figure 5: Number of articles that mention each process

5.4. PAM for Digital Transformation

In this section, we will cover one process detailed regarding the process assessment model adopted and what are the conditions to achieve a certain capability level.

Our proposal to assess the digital transformation processes in organizations is based on ISO/IEC 330xx. We chose this family of standards because it is a global reference for process capability assessments, containing, for example, specific requirements for process reference models and process assessment models. Our process assessment model follows the example of ISO/IEC 33072, the process capability assessment model for information security management, and is structured in accordance with the requirements of ISO/IEC 33004, also used by ISO/IEC 33072.

The representation of what constitutes the process dimension of the PAM for one specific process are presented in Fig. 6.

Figure 6: Manage Customer Experience (original content from the authors using the ISO/IEC 33072 structure [15]).

6. Demonstration

This section covers the description of the completion of the demonstration stage of DSRM.

The solution presented should be called into question in order to prove its effectiveness in solving the problem mentioned in the research problem section. The objective behind demonstrating the validity and usefulness of our proposal is to lead the adoption of the digital transformation framework in a real-case scenario.

Following procedure, we will present the results of applying our framework, specifically to the assessment of manage digital strategy process, in Company A (for privacy reasons we cannot give the exact name of the company, so we will simply refer to it as "Company A").

6.1. Context

The framework was applied with the manage digital strategy process assessment at Company A. This company is present in countries such as the United Kingdom, Germany, France, Spain and Portugal.

As in all other industries, the Company A industry has increasingly been more competitive, where companies must be creative and flexible to succeed. Company A to this end has been successfully implementing digital transformation initiatives.

Regarding the assessment, we met with the Company A's IT director in order to perform the assessment following our PAM with the focus on the manage digital strategy process.

Our demonstration counted on the assessment of manage digital strategy process performed to conclude whether the company was at capability level 0 or 1. At this stage of the study, superior levels were considered out of the scope of this assessment.

To determine whether this manage digital strategy process was implemented or not, the classification used by the ISO/IEC 330XX family of standards was adopted. That is, with the Company A IT Director's self-assessment within the respective standard scale (Not Achieved, Partially Achieved, Largely Achieved and Fully Achieved) for the process purpose and outcomes supported by the base practices, inputs and outputs. It works as follows:

- If the Process Purpose rating is lower than Largely Achieved, i.e. Not Achieved or Partially Achieved, the capability level is immediately considered 0 (however the rating continues for outcomes).

- For outcomes, each is independently evaluated. After all are evaluated, a median of the results is made to arrive at a representative value of the outcomes.

- Finally, we compare the process purpose classification with the outcomes classification where the inferior classification is the one that persists. If the final rating is Largely Achieved or Fully Achieved it means that capability level 1 has been reached. Otherwise, the capability level is 0.

For the purpose of making the framework assessment experience simple and more interactive, we developed a web-based software tool to assess the capability maturity level of digital transformation processes.

This tool allows us to collect all information in a digitized way, store the data in the cloud and keep track of the evolution of each process. Additionally, as it is a digital tool it allows for updates, new versions of the framework, to be aligned with the technological evolution and behaviour of the industries.

Thus, organizations can gain access to a framework that is constantly evolving and not standing still in time.

6.2. Results

Our meeting took about 45 minutes, in which a brief presentation was initially made by both parties. On our side, the framework construction procedure was made known, detailing at a high level the steps taken. In the case of Company A, the company context was introduced and then focused essentially on the new Company A's digital service, with the aim of reducing waiting times.

In a second phase, the framework assessment was done by the IT Director with our proper support. The results obtained are described in the Figures 7, 8, 9, 10, that show the digital strategy assessment process performed by Company A's IT Director with the respectively rating answers according to the scale used.

Figure 7: Digital strategy process purpose assessment and process capability level achieved from last assessment results.
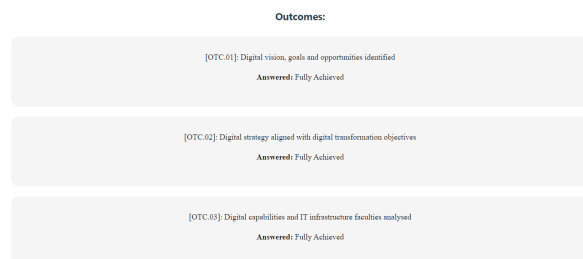

Figure 8: Digital strategy assessment from outcomes 1 to 3.

Through analysis of the results, we can see that Company A already demonstrates a significant digital maturity and is already in an advanced process of digital transformation where several solutions have been defined and implemented. The only outcome that was considered to have a lower percentage of compliance was outcome 7, which refers to the alignment between functional and operational strategies.
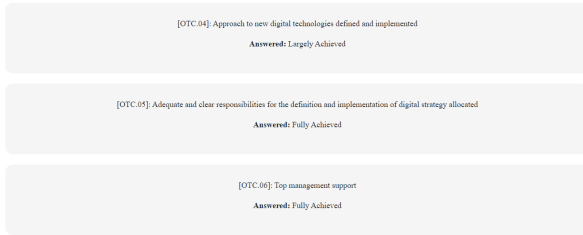
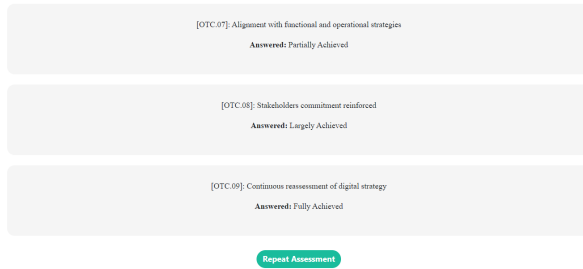Figure 9: Digital strategy assessment from outcomes 4 to 6.

Figure 10: Digital strategy assessment from outcomes 7 to 9.

The third and final phase of the meeting discussed possible improvements and recommendations to the current state of the framework, where the main points to keep in mind were:

- Comparisons between companies, preferably by sector.

- Feedback at the end of the assessment. Details of next steps to be performed for processes/outcomes with lowest score.

7. Evaluation

In accordance with the DSRM evaluation step, here we evaluate the proposed artifacts in order to prove their relevance and applicability to the research problem. For assessing and judging the proposed artifact, we followed the Pries-Hege et al. approach, in which the author presents the importance of an ex-ante perspective, with the evaluation occurring both prior to the construction of an artifact IS, and an ex-post evaluation, that is, evaluations that take place after the artifact has been built [27].

Another important reference is the classification of Venable, who identifies two main forms for the DSRM evaluation [33]:

- Artificial evaluation evaluates a solution technology in a contrived, non-real way.

- Naturalistic evaluation enables a researcher to explore how well or poorly a solution technology works in its real environment – the organization.

In our study, an artificial evaluation was performed by applying the ISO/IEC 330xx family of standards to prove that it is possible to build a capability maturity model specifically for digital transformation, using a scientific approach based on design science research. Feasibility was demonstrated here for the processes of manage digital strategy but feasibility for manage digital channels, manage customer experience, manage business processes and manage business model were also previously demonstrated, suggesting that it is feasible to follow the same steps for all other processes included in our PRM. A second artificial evaluation was conducted by checking the applicability of our framework into a web-based software tool.

A naturalistic evaluation was equally applied, in this case in a company, Company A, where it was possible to dispute the use of the framework in a real context, as well as its usefulness in conducting a digital transformation program.

In a nutshell, the results prove that it is possible to build a capability maturity model for digital transformation grounded in scientific well known standards and methodologies, in a digital form with a web based software tool, and finally can be used by organizations to help them guide their digital transformation initiatives.

8. Communication

In harmony with the DSRM's communication proposal, we aim to communicate our artefacts to the applicable audience.

To reach a broader communication in our work, a paper entitled "Digital Transformation Practices based on a systematic literature review" was submitted to the ISACA Journal, which contributed to the identification of reference processes for digital transformation. This paper still awaits confirmation of acceptance.

The second paper, "Digital Transformation Capability Maturity Model Framework", consists of the detailed realization of a specific process - manage digital strategy - which was identified in the previous article. The contribution of this paper is a framework, from a process perspective, rooted in solid scientific concepts, to guide practitioners on how to assess digital transformation initiatives. The paper was already accepted and presented at the 2019 IEEE 23rd International Enterprise Distributed Object Computing (EDOC 2019).

Finally, the final dissertation report, containing all the content related to digital transformation framework, will be presented to, discussed with and evaluated by a qualified jury to ensure its reliability and the quality of the scientific contribution. Subsequently, the work will be shared with the public.

9. Conclusion

Digital transformation attracts a lot of attention nowadays. In recent years, the number of publications has grown steadily, as researchers broaden the spectrum of the study for different industries. On the other hand, maturity models have been extensively researched and applied in several domains, and the importance of benchmark processes in the form of standards is well-accepted by the community. However, there is a lack of research and artifact proposals for maturity models in terms of digital transformation, more specifically, created using scientific methods. Thereby, in the design of the proposed framework, we resorted to design science research methodology and used the ISO/IEC 330xx family of standards for structure. The lack of research studies on a recent topic, such as digital transformation, and in particular on the process side, has proven to be a barrier in identifying reference processes for digital transformation.

For this reason, although process identification has been supported by a systematic literature review, the lack of a considerable number of evaluations by digital transformation experts to validate PRM is considered by us to be a limitation.

The deepening of knowledge, as well as the contribution of new discoveries, are essential to understand the behavior of a true digital transformation. For future work, we have defined a few preliminary objectives:

- Detail all processes in PRM.

- Conduct questionnaires to digital transformation experts and practitioners that intend to validate, reject or add processes corresponding to the digital transformation.

- Improve the web-based software tool for a better engagement.

- Demonstrate and evaluate the framework in its entirety, i.e. evaluate all processes separately or together in at least one company.

- Demonstrate and evaluate the framework to a substantially larger number of companies, ideally in companies that differ in size and industry, with the ultimate goal of being able to benchmark effectively.

- Provide, after an assessment, the next steps to take, with a particular focus on those processes/outcomes that denote worst ratings, to help the company perform better in the business and achieve higher levels of digital maturity.

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