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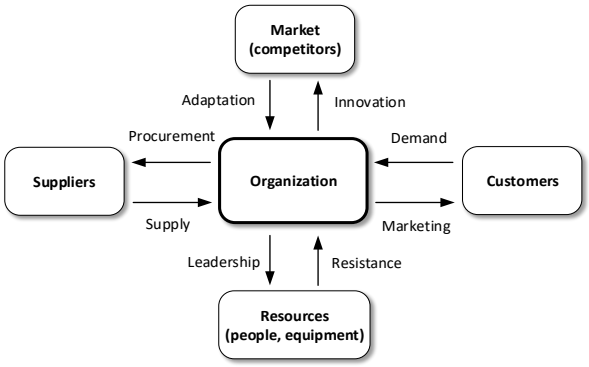

Governance Model for Digital Transformation

Diana Cristina de Figueiredo Delgado

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Information Systems and Computer Engineering

Supervisors: Prof. Miguel Leitão Bignolas Mira da Silva

Prof. Paulo Rupino da Cunha

Examination Committee

Chairperson: Prof. José Luís Brinquete Borbinha

Supervisor: Prof. Miguel Leitão Bignolas Mira da Silva

Member of the Committee: Prof. André Ferreira Ferrão Couto e Vasconcelos

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Resumo

A Transformação Digital é a chave para sobreviver numa era onde a disrupção digital está a impor cada vez mais exigências às organizações e à área das tecnologias de informação. O seu maior foco é a criação de valor, procurando aproveitar as tecnologias digitais para aumentar rentabilidade, eficiência e eficácia. As *frameworks* para implementar a Transformação Digital existentes são demasiado genéricas, apresentando-se essencialmente como um conjunto de boas práticas e conselhos, ao invés de uma abordagem sistemática que estruture e separe aspetos ortogonais. Esta dissertação propõe uma solução para este problema, na qual a *framework* (que descreve o estado da Transformação Digital) está claramente separada da metodologia (que permite escolher e descrever as ações da Transformação Digital) e fornece uma abordagem sistemática de governança para uma organização que enfrenta uma transformação digital, bem como meios para avaliar o resultado dessa transformação. O mecanismo de design da *framework* inicia-se com a visão, estratégia e metas, que se traduzem em indicadores de desempenho que necessitam de ser melhorados. Tal requer o domínio de competências digitais, que são implementadas por iniciativas. O risco, de uma iniciativa falhar ou de um indicador não melhorar o esperado, é uma parte inerente da transformação digital e como tal é também especificado para cada iniciativa. A *framework* e a metodologia foram implementados numa ferramenta de simulação, que serve de demonstrador de conceito. Foram também avaliadas através da comparação do seu poder expressivo com as abordagens existentes e foi executado um estudo da sua aplicabilidade numa organização real.

Palavras-Chave: Transformação Digital, Governança, *Framework*, Metodologia, Competências Digitais, Simulação.

Abstract

Digital Transformation is the key to survive in an era where digital disruption is imposing demands on organizations and information technology. Its main focus is value creation, seeking to take advantage of the digital technologies to increase profitability, efficiency, and effectiveness. The existing frameworks to implement a Digital Transformation are too generic, presented essentially as a set of best practices and advices, instead of a systematic approach that structures and separates orthogonal concerns. This dissertation proposes a solution for this problem, in which a framework (to describe Digital Transformation state) is clearly separated from the methodology (to choose and describe Digital Transformation actions), providing a systematic approach at the level of governance for organizations that undergo the journey of a Digital Transformations and a means to evaluate the outcome of that transformation. The mechanism to design the framework starts with the vision, strategy, and goals, which translate to performance indicators that need to be improved. This requires implementation of digital capabilities, which is accomplished by initiatives. Risks are an inherent part of Digital Transformation, and therefore also specified. The framework and methodology have been implemented in a simulation tool, which served as a concept demonstrator. They were also evaluated by comparing their expressive power with that of existing approaches and by performing a study of their applicability to a real organization.

Keywords: Digital Transformation, Governance, Framework, Methodology, Digital Capabilities, Simulation.

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List of Acronyms

BCG	Boston Consulting Group
BSC	Balanced Scorecard
CMMI	Capability Maturity Model Integration
DSR	Design Science research
DSRM	The Design Science Research Methodology
HBR	Harvard Business Review
IBM	International Business Machines
IDC	International Data Corporation
IEC	International Electrotechnical Commission
IS	Information Systems
ISO	International Organization for Standardization
IT	Information Technology
KPI	Key Performance Indicator
KRI	Key Risk Indicator
MIT	Massachusetts Institute of Technology
PAM	Process Assessment Model
PMS	Project Management Simulation

1 Introduction

Digital Transformation is currently a hot topic, which this dissertation proposes to tackle, from the governance perspective. This section discusses the topic's relevance, its main open problems, and the scope, goals and research method of this dissertation.

1.1 Motivation

Until recently, the emphasis of any organization was on having a well-designed enterprise architecture, a web site as the customer interface, an enterprise integration solution to deal with suppliers, and the business was practically set up, for either products or services.

Then digital technologies, such as cloud computing and mobility, started to become ubiquitous and disruptive. Customers became more acquainted and at ease with digital services, in particular through social networks and smartphones. Now they want everything self-service, anywhere, anytime, with as little effort as possible. The world started spinning much faster. Business-Information Technology (IT) alignment is no longer enough [1].

Now a classical, well-designed enterprise architecture is almost a liability, rather than an asset, due to the inertia regarding change that it entails. This is a time in which a startup can outrun an established organization in a short period, if its business model is innovative enough. A large organizational mass (a complex enterprise architecture), which translates to inertia and lack of agility, ability to innovate, and adaptability, is an organization's worst enemy.

Consider the model in **Figure 1**, in which an organization has to deal with its value chain (customers and suppliers), the market (its competitors) and its internal resources (human and material).

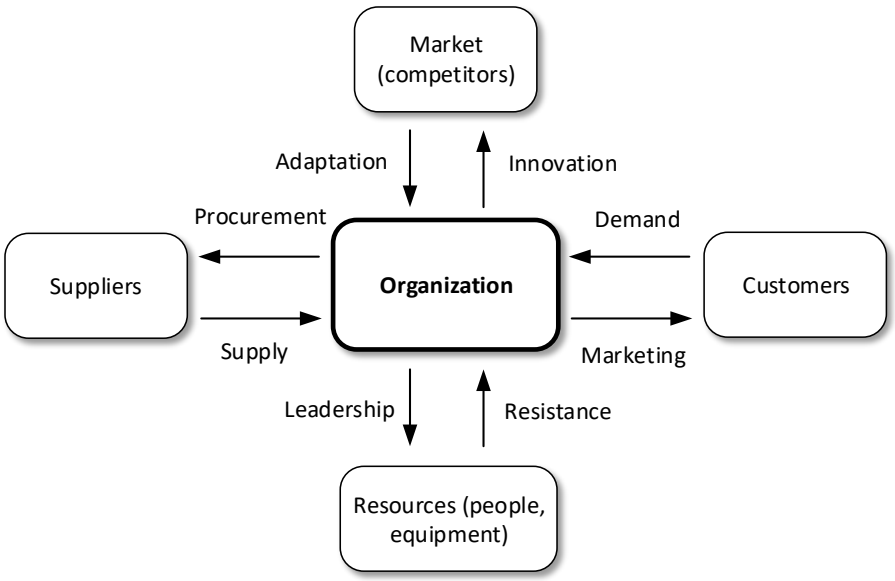


Figure 1 – A simple model of the interaction of an organization with its environment

If these four channels of interaction are considered barriers that the organization needs to continually overcome, to conduct its business, the main goal is to reduce the effort cost of channel interaction, as well as the channel's inertia regarding changes, which can be achieved in the following way:

- **Customer channel** – The effort for a customer to request a product or service must be minimal, for which great care needs to be put into the self-service customer interface during the entire transaction. The customer needs to feel at home. Marketing needs to use low cost and easily reachable communication channels, such as social networks;
- **Supplier channel** – The organization, in the role of customer, will prefer a minimal effort procurement interface and low cost, abundant supply, since this is more efficient and agile, while minimizing risk;
- **Resource channel** – Resource efficacy and efficiency are crucial for streamlined operations. For human resources, a good leadership and training and communication policies will help in overcoming resistance to change. Material resources need to be aligned with business needs and resort to agile digital technologies, by using adequate investment policies;
- **Market channel** – Adaptability is a good feature of any organization, but is no more than reacting to the innovation of others. The organization with innovative business models are those that will lead the market and benefit from the greatest market share.

The customer and market channels are the most important ones, since they are the most dangerous. With a low effort interaction channel, customers will easily flee to competition if the organization is not innovative enough or slow to respond to market innovation pressure. Startup organizations, usually highly innovative and with very little organizational inertia, can easily and quickly disrupt the market.

However, the efficiency and inertia of the other channels is important as well. Digital technologies, and the business models that they enable, are the key factor in today's highly interconnected world. This means that organizations need to become more and more digital, from top to bottom. The business itself must be inherently digital, not just enabled by digital technologies [2].

For an existing company, this does not mean improving the web site, moving the business to the cloud, making business processes more automated, or adding some digital features to existing products or services. This is just a digital makeup, or digital optimization. A true Digital Transformation means reinventing the business model and providing a significant improved value as perceived by customers, while significantly reducing the organizational inertia by taking a light approach on the supplier and resource channels.

Consider some canonical examples, with low organizational mass and inertia thanks to a broker role supported by a digital platform:

- **Uber** – A large transportation company that doesn't own vehicles or employ drivers. They provide added value by interconnecting drivers (suppliers) with passengers (customers);
- **Airbnb** – A large accommodation provider that owns no hotels, but links hosts and guests;
- **Alibaba** – A large, worldwide retailer without warehouses or products. It merely joins sellers and buyers.

In these and in many other cases, the secret of success is an innovative business model that provides a high value to customers, with very light resource needs. The inertia of a platform is much lower than that of an organization with physical stores or a large employee base.

However, not all organizations can completely reinvent themselves and take the market by storm. For those, there is a stringent need to define which are the main aspects to be considered and the correct steps to take towards a more digital status (maturity), a process known as Digital Transformation.

The year of 2016 marked the widespread awareness of the importance of digital at organization level and the urge to transform. According to the 2016 predictions of International Data Corporation (IDC), Digital Transformation has shaped that year and, in the coming years, the biggest focus for organizations will revolve around Digital Transformation. IDC also points out the importance of support from management and executives to Digital Transformation [3].

In an Analytic Services global survey, conducted by the Harvard Business Review (HBR), the pace of digital change is classified as a "*steepening trajectory*". The study also highlights a "*tightening digital race across all industries*" [4]. New competitors are arriving, eager to prove their value and fully prepared to adapt to paradigm shifts and technology disruption, forcing established organizations to evolve or die.

Going digital is such an important trend that, by the end of 2017, two-thirds of the CEOs of Global 2000 companies are expected to have Digital Transformation at the center of their corporate strategy [5]. A 2016 survey, conducted by Loudhouse in conjunction with Progress [6] to more than 700 digital decision makers, is also aligned with these predictions. This survey revealed that 86% of respondents say they have two years to make inroads with Digital Transformation and 55% say they have a year or less before they begin to suffer from financial or competitive threats. The sense of urgency is emphasized by 59% of the respondents, who stated their worries about possibly being too late with their Digital Transformation efforts and falling behind their competitors.

Although a growing number of organizations are planning to have a Digital Transformation strategy, they face barriers that leaders need to overcome. According to the HBR global survey [4], the top-five barriers to Digital Transformation are:

- Inability to experiment quickly;
- Change management capabilities;
- Inability to work across silos;
- Risk-averse culture;
- Legacy systems.

A systematic approach to Digital Transformation is needed, so that a set of best practices, generally applicable instead of just on a case-by-case basis, can be defined for this domain. This dissertation commits itself to contribute to this endeavor.

1.2 What are the Main Problems?

Digital Transformation is a very recent field and available literature is scarce, undetailed, unorganized, inconsistent and mostly describing specific applications or case studies. Organized literature, reflecting standards such as the IT governance standard International Organization for Standardization (ISO)/ International Electrotechnical Commission (IEC) 38500 [7] and best-practices frameworks such as COBIT 5 [8], simply does not exist for Digital Transformation yet.

Even approaches for Digital Transformation with a minimum of details (downgrading from standards or best practices) are hard to find. As usual, innovative market trends are led by consulting companies and bloggers that expose their approaches and opinions in white papers and blog posts, in an effort to attract customer organizations that want to embark in the trend but do not want or do not have the skills to deal with the details. A typical designation for these approaches is “Digital Transformation Frameworks”, with “framework” term including all there is to know about how to perform a Digital Transformation.

More formal, academic literature lags much behind and is mostly dedicated to report specific experiences. As an example, a search in Google Scholar with “Digital Transformation Frameworks” returns just 22 documents in English, most of which describing specific applications.

In such a scenario, the following questions naturally arise:

- Of the existing generic (non application-specific) approaches to Digital Transformation, is there one that is better and the one to choose?
- How can these approaches be compared, so that the previous question can be answered, if each approach is different and there is no systematic way of comparing them?
- Why don’t existing approaches separate analysis of the current state of the Digital Transformation from decision on what do to next and mix everything together?
- Is there an approach that is more complete and systematic than existing ones, eventually by combining the most useful features of the various approaches and even adding some more?

The lack of a systematic approach is currently one of the most relevant problems in the Digital Transformation domain. The main goal of this dissertation is precisely to contribute to the systematization and to the body of knowledge of the Digital Transformation domain, by trying to answering the last question.

Current approaches are more a list of guidelines and advices (do’s and don’ts) than a truly systematic approach to the problem. Naturally, Digital Transformation initiatives are being made and consulting companies know a lot more than they publish, so that customers pay for their expertise.

However, it is notorious that each consulting company has its own approach, with experience grown out of its previous projects. There are no widely accepted best practices yet and one danger is that a consultant providing consulting services on a Digital Transformation project for some organization tries to reuse the solutions adopted in a previous Digital Transformation project, instead of the adequate ones for this case, by lack of a systematic method.

One of the fundamental characteristics that any transformational framework should have is to separate analysis of the current state of the transformation from the decisions regarding what to do in the next step. However, the literature available on current approaches does not mention this distinction. This is one problem that this dissertation will tackle.

There is also an apparent lack of organization of the information on Digital Transformation, and of tools to help in the decision processes, namely in terms of assessment of the current state of the Digital Transformation. Is it the case that typical Digital Transformation approaches seem to be more based on perception than on actual information? The issue is not necessarily bad governance, but rather the lack of concrete and organized information to support informed decisions. This dissertation aims at contributing to solve this problem too.

1.3 Scope

The title of a document should broadly reflect the scope of its content. This section explains the meaning of the words that constitute the title of this dissertation, since is not easy to present disclaimers and define scope boundaries in a title that must be necessarily short.

1.3.1 Governance Model

An efficient governance is a "*key determinant of success in managing Digital Transformation*", without which a Digital Transformation will be riskier and pricier than necessary, due to waste and missed opportunities [9]. A governance that works as a coherent engine is required to drive and steer the Digital Transformation forwards – a Digital Governance [10]. Governance should not be left to chance [9].

During the transformation, the governing bodies have to:

- Decide which is the vision and strategy of the organization;
- Establish the organization goals;
- Establish the roles in the transformation;
- Ensure compliance with the strategy, policies and standards of the organization;
- Monitor performance.

Corporate governance in general [11] is a very complex issue, which entails aspects such as the constitution, organization and functioning of the governing bodies, the mechanisms and procedures to support how decisions are taken, roles and responsibilities, how information (both from the organization itself and from its environment) is obtained and dealt with, how the governing bodies relates with other organizational structures, which policies are acceptable, and so on.

Considering just IT governance [12][13] narrows the scope of the domain, but the inherent complexity is still very high, as evidenced by IT governance standard ISO/IEC 38500 [7] and best-practices framework COBIT 5 [8].

A model is an abridged version of the characteristics and properties of the domain under analysis, and the use of this word in the title means that this dissertation tackles only a narrow-scoped perspective of governance, centered on the needs of Digital Transformation initiatives.

Cognizant [14] defines governance model as "*the interaction of three components:*

- ***Decisioning structures**, providing management control at macro and micro levels;*
- ***Operating procedures**, converting random work efforts into collective results;*
- ***Collaboration enablers**, managing information flowing in an ever-expanding, globalized and virtualized work world*".

Naturally, the leadership and communication cultures, strategy and risk management, the way in which decision processes are organized, and many other aspects are crucial elements of these components. In an informal survey conducted by Cognizant [14], almost 90% of respondents easily recognized that decision structures and operating procedures are part of the governance model definition, but less than 30% included the collaboration enablers, or tools to facilitate the collaboration between governing bodies and to provide adequate data and information upon which informed decisions can be taken.

In a recent context such as Digital Transformation, in which reference sets of best practices have not been defined yet, let alone standards, governing bodies and procedures still need be tuned up and conventional specifications, such as ISO/IEC 38500 [7] and COBIT 5 [8], may not be entirely adequate.

This means that collaboration enablers are even more important in the Digital Transformation context, to compensate for eventual mismatches between existing specifications and the needs of Digital Transformation, in the other components.

Exploratory in nature, this dissertation concentrates on this less established issue, by focusing on the information and mechanisms that should be available to support the governing bodies in their decisions, rather than tackling the way in which these structures should be organized or detailing how the governance procedures should be carried out. This is the part of the governance model that is most relevant to this dissertation.

Although governance is usually more stringent in the productive sector, since competition and profitability are at stake, this dissertation makes no distinction between productive organizations (companies, or enterprises) and those of any other nature, so that everything it discusses can be applied to any type of organization.

1.3.2 Digital Transformation

Recent as it is, the Digital Transformation domain has not yet produced a coherent and widely accepted body of knowledge. There is not even a single definition of what Digital Transformation is. Naturally, different players and actors have different perspectives of what Digital Transformation entails and which aspects are the most important to cater for. This is apparent from the description of the existing approaches, presented by section 2.2.

Nevertheless, and trying to establish a baseline pattern, a Digital Transformation can be likened to a journey, from a classic (or less digital) organization, essentially relying upon on the interaction between real-world resources (including humans), to a more digital organization, essentially based on information and virtual resources. The AS-IS (current organization) is transformed into the TO-BE (the intended organization).

The goal is to eliminate as much as possible the limitations in time and space of physical resources (performance, flexibility, cost, and so on). This enables new possibilities, such as innovative business models, that simply would not possible by only resorting to physical resources.

Any journey obeys the same basic rules, whether it is made in the physical world or in the Digital Transformation context, since there are departure and arrival points, and a path (route) can be established between them with several intermediate points, in which the state of the journey can be assessed and the rest of the route corrected, if needed.

At each point of the journey, governing bodies must perform their role, by assessing how well the journey has progressed so far and planning the rest of the journey. This requires concrete information, such as:

- Where is the current point of the journey (its coordinates, in some classification scheme)?
- Is the journey in the right track or off course?
- How far has it progressed, in the planned route?
- Are the route planning policies (shortest or fastest path, for example) for the rest of the journey the most adequate, according to some criteria?

To illustrate these concepts, a parallel between a Digital Transformation and a physical journey can be established, moving from location A to location B, such as the one depicted in **Figure 2** (provided by Google Maps).

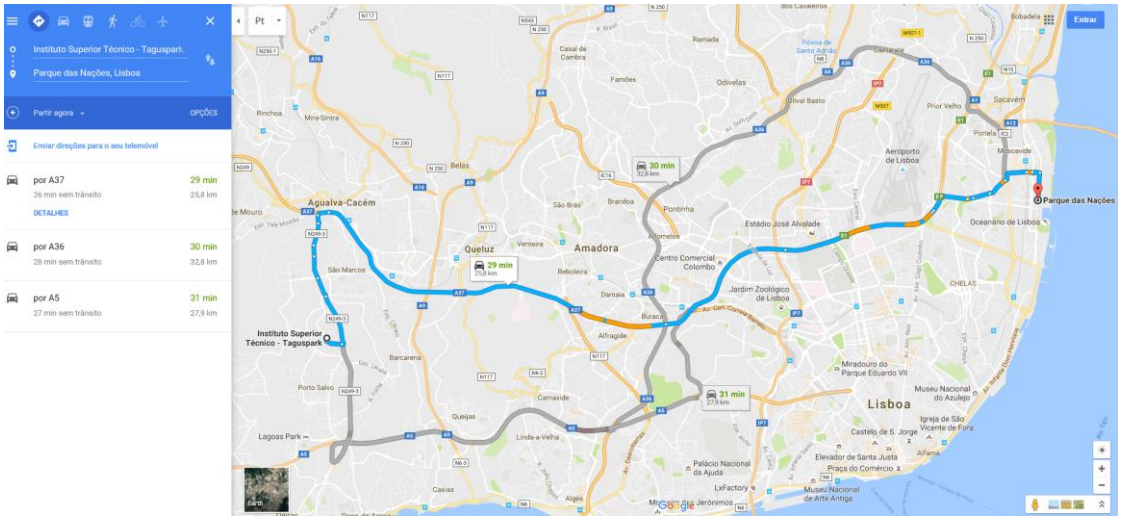


Figure 2 - Example of a physical journey

Much like this physical journey, a Digital Transformation requires a potentially long path, with many intermediate points, some of which be organized into alternative routes. It can also be improved, by repeating the path with a better strategy, policies and/or tools. In the case of the Digital Transformation

journey, the AS-IS and TO-BE can also evolve in each iteration. This means that a Digital Transformation involves a lifecycle.

The various aspects of a physical journey are well understood by everyone. In the case of Digital Transformation, there are still aspects that need to be detailed, and which constitute the focus of this dissertation. Namely, each point in the route, in each iteration of the lifecycle, requires:

- A classification scheme to characterize and systematize the various aspects of the current state of affairs of the journey, namely concerns, capabilities and other indicators. This is the equivalent of a map, without which travelers will be lost, since they will have no idea where they are and which routes are available to take next;
- A procedure to decide where to go next, according to the state of the system (described by the classification scheme) and the strategy that has been decided upon. Different policies, type of organization, or other constraints may lead to different procedures;
- Tools, to support the decisions taken by the procedure. Different procedures can require different sets of tools.

Table 1 compares the fundamental aspects involved in a journey, both in the physical world and in the Digital Transformation context.

Table 1 – Main aspects involved in journey, in the physical world and in a Digital Transformation context

Component	Physical journey	Digital Transformation journey
Description of departure point	Geographic coordinates of point A	Description of the AS-IS (a set of values of indicators relevant to the organization)
Description of arrival point	Geographic coordinates of point B	Description of the TO-BE (a set of values of indicators relevant to the organization)
Description of the domain (features and constraints)	Map (cities, roads, streets, squares, one-way streets)	A graph with a description of all the points between the AS-IS and the TO-BE, and possible transitions
Strategy (policies, choices)	Shortest, fastest, or cheapest route	A set of advices, guidelines and best practices on how to transition from point to point, from AS-IS to TO-BE
Skills	• Driving ability • Knowledge of driving rules	• Leadership culture • Governance processes
Goals	Get to destination	Increase market share, growth, profit
Tools	• GPS (current coordinates) • GPS (driving directions) • Driver, Vehicle	• Information about all relevant indicators • Decision support tools • Resources (human and material)
Assessment	• Did we get to B safely, fast and cheaply enough? • Was the means of transport adequate?	• Have we met TO-BE requirements? • Was the cost/benefit worthwhile? • Were tools and best practices efficient and effective?
Improvement	Repeat the route with better strategy, policies or means of transport	Iterate (from the new AS-IS), tuning up the strategy and tools for increased goal satisfaction

1.4 Goals of the dissertation

The main goal of this dissertation is to contribute to the body of knowledge of the Digital Transformation domain, by proposing a systematic approach to Digital Transformation, essentially based on the following principles:

- Existence of a structured set of indicators that reflect the main digital-oriented concerns and can be used to describe and assess the current state of the transformation, at any time. These indicators are derived from the vision, strategy, goals, and objectives of intended outcome of the Digital Transformation;
- Existence of a methodology that, based on the values of the indicators and on adopted polices, is able to assess and decide at any time which step should be taken next in the Digital Transformation;
- Clear separation of the state of the transformation (the values of the indicators) from the transitions between states (the methodology);
- Existence of tools that are able to take the state of the information as input and suggest courses of action, based on adopted policies, as an aid to the decision process that underlies the methodology;
- Open-ended approach. Framework, methodology and tools are just basic templates that actual Digital Transformation projects can adapt and extend to suits their particular needs.

These principles should be understood within the scope of the dissertation, as described in section 1.2.

1.5 Research Methodology

This dissertation is essentially research, in which an identified problem is analyzed and contributions to its solution proposed. One of the first decisions to make is which research method to use.

Taking into account the problem identified in section 1.2 and the timeframe available for this work, we can classify the research work as:

- **Applied**, in the sense that it deals with concrete systems and real world problems, in this case providing mechanisms to support governance in the context of Digital Transformation;
- **Exploratory**, since the Digital Transformation domain is very recent and not yet well established;
- **Qualitative**, since the problem involves complex systems, for which it is very difficult to obtain analytical data, and involves human-level decisions;
- **Conceptual**, in the sense that the intended outcome is a specification of how to organize a Digital Transformation process for improved results, based on the knowledge of how organizations behave instead of a set of empirical observations.

The following main steps should be present in the process that implements the research method:

- To analyze the problem, so that it can be well understood;
- To analyze current approaches and solutions, so that their limitations and opportunities for further proposals can be identified;
- To define requirements for a solution (what is needed that current approaches do not supply);
- To detail that solution, in both content and form;
- To provide some form of demonstration and evaluation, which shows its validity, usefulness and value, with respect to existing approaches.

This last step is the most difficult one, since the timeframe of this work (one year) is too limited to involve an actual implementation that enables real data to be obtained, which would still have to be compared against other case studies that do not use the proposed solution. Nevertheless, some form of evaluation, at least qualitative, needs to be provided.

The complexity of the context tackled by this dissertation and the limited timeframe do not allow to use practical and participatory methods such as the Action Research Method [15], which in this case would involve working at an actual organization performing a Digital Transformation. However, an interaction with a real case study will be sought.

The Design Science Research Method (DSRM) [16] is better aligned with the research steps enumerated above and it is the research approach chosen to help in developing and validating the work described in this dissertation.

In Design Science Research (DSR), "*knowledge and understanding of a problem domain and its solution are achieved in the building and application of the designed artifact*" [17]. According to Hevner [17], who follows the work of March and Smith [18], DSR artifacts could be constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices) and instantiations (implemented and prototype systems). The chosen DSRM includes and incorporates principles, practices, and procedures required to perform DSR in applied research disciplines, such as information systems (IS).

This dissertation has taken in account the seven guidelines for DSR proposed by Hevner [17] and the DSRM process model advocated by Peffers [16], illustrated by **Figure 3**.

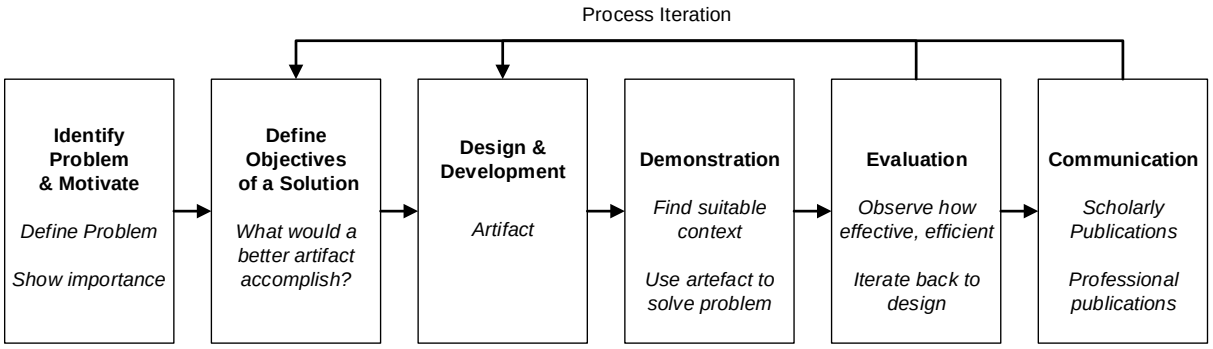


Figure 3 - The DSRM Process Model [16]

The DSRM Process Model was arranged in a nominal sequential order and is composed of six steps: problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation, and communication.

In order to present how the DSRM was used to develop and assess the proposal of this dissertation, **Table 2** correlates the main sections of this dissertation with the DSRM steps.

Table 2 - DSRM steps mapped onto the sections of this dissertation

	DSRM steps					
Report Sections	**Problem and motivation**	**Objectives of a solution**	**Design and Development**	**Demonstration**	**Evaluation**	**Communication**
Introduction	√					
Related Work	√					
The Problem and How to Solve it		√				
Analysis of Potential Solutions			√			
Governance Model Proposed			√			
Demonstration: a Case Study				√		
Evaluation					√	
Conclusion						√

1.6 Structure of the dissertation

The rest of this dissertation flows along the following structure:

- **Section 2** (Related Work) – Describes existing approaches to Digital Transformation and relevant technologies;
- **Section 3** (The Problem and How to Solve it) – Specifies the requirements for a generic and systematic approach to Digital Transformation;
- **Section 4** (Analysis of Potential Solutions) – Gathers ideas from existing approaches that can be used in the proposal;
- **Section 5** (Governance Model Proposed) – Specifies the details of the proposed approach to Digital Transformation;
- **Section 6** (Demonstration: a Case Study) – Tries to demonstrate the approach by performing a case study;
- **Section 7** (Evaluation) – Evaluates the quality of the proposed approach, by performing a comparative study with existing approaches and by resorting to a simulation tool;
- **Section 8** (Conclusion) – Highlights the lessons learned from this dissertation and lays down ideas for future work.

2 Related Work

This section describes existing concepts and approaches in the Digital Transformation domain, which were considered and analyzed due to their potential relevance to this dissertation.

2.1 An Introduction to Digital Transformation

No discussion on a topic can be held before knowing what it is and what it entails. This section provides an introduction to Digital Transformation.

2.1.1 What is Digital Transformation?

There is no universal definition of Digital Transformation, since the domain is recent and each transformation is performed by different actors, is driven by different motivations, and has different solutions and outcomes. In any case, Digital Transformation cannot be seen as a definitive goal, but rather as an incremental journey. Nevertheless, we have selected some Digital Transformation definitions:

- The joint study between the Capgemini and the Massachusetts Institute of Technology (MIT) [19], defines Digital Transformation as the use of technology to radically improve performance or reach of enterprises;
- According to Singh and Hess [20], a Digital Transformation requires the use of new technologies such as social media, mobile access, analytics, or embedded devices and a involves company-wide Digital Transformation strategy that addresses company opportunities and risks that originate from digital technologies;
- IDC [21] defines Digital Transformation as the "*continuous process by which enterprises adapt to or drive disruptive changes in their customers and markets (external ecosystem) by leveraging digital competencies to create new business models, products, and services*";
- The MIT Sloan Management Review [22] defines Digital Transformation as the use of new digital technologies (social media, mobile, analytics or embedded devices) to enable major business improvements (such as enhancing customer experience, streamlining operations or creating new business models).

Interesting enough, three of these definitions mention technology first and business benefits afterwards, leading the reader to think that technology is applied and then benefits will result. Only IDC presents a strategy-first definition, with technology as an implementation tool.

Amidst these and other definitions available, this dissertation would not be complete without presenting its own definition, stated as:

- Digital Transformation is an iterative process, in which each iteration involves delineating a vision and a strategy of an innovative, customer-centered and digital-enabled business model,

setting proper procedures to decide which actions should be taken to evolve towards the new vision, and defining indicators that enable to assess the state of the transformation and to check whether the goals have been achieved.

This is a maximalist definition, in the sense that not all steps may need to be executed in all iterations. For example, governing bodies may decide on some policies and procedures that may be valid for several iterations. Conceptually, at least, all steps should be considered in all iterations.

The value added of this definition, with respect to IDC's, is the clear separation of the information about the state of the transformation from the decision procedures on what to do next. This is one of the fundamental principles enunciated in section 1.4.

Anyway, a shared idea behind all these definitions is that a Digital Transformation requires a profound change in the organization's business strategy, leading to a shift in how the organization understands and uses technology as a means to create new revenue streams and new business models. The Digital Transformation of an organization is not just implementing new technologies but rather transforming the organizations to be able to take advantage of the possibilities that new technologies provide [19].

2.1.2 Digital Transformation vs. Digital Optimization

The adoption of digital technologies to support the business, in some way or another, is not a recent trend. Computers and digital technologies have been the basis for business for several decades now. With the advent of the Internet, and in particular the widespread use of applications based on the World Wide Web, digital business has extended to all sectors, in particular in what concerns the relation with customers.

Any organization can improve its web site, streamline its databases, optimize its internal processes through automation and better information systems, and even add some digital features to its existing products or services. However, this is considered just an optimization [23], not a transformation. Emphasis is put on technology, which essentially means just using digital tools to boost productivity, increase existing revenue streams and improve the existing customer experience [24]. However, this leads to marginal gains only and is not an effective solution to deal with the ever-stronger competition.

The motivational force for change should be strategy, not technology. A true Digital Transformation requires profound changes in the organization, by innovating in its business model, vision and strategy, increasing significantly the perceived value by customers, as well as substantially reducing the inertia regarding change by performing a paradigm shift in internal culture. A truly digital organization must be innovative, easy for customers to deal with, and highly agile and adaptable.

However, there is no clear-cut line separating optimization from transformation. Therefore, optimization can be considered a lower level of transformation, a natural consequence rather than a goal by itself. An organization should aim at Digital Transformation and one of the consequences of that transformation is the optimization of many of the aspects of the organization. Optimization should be strategy driven, not simply technology enabled.

2.1.3 The Drivers for Digital Transformation

Why should organizations undergo a Digital Transformation? Section 1 already tried to answer this question, in particular with **Figure 1**, which shows the various interaction channels between an organization and its environment. The goal is to reduce the effort or cost of channel interaction, including facilitating the access by customers, making market strides through innovation, and accompanying the innovation of competitors through agile adaptations.

Predictions by IDC [5] indicate that, by 2020, as much as 50% of the G2000 companies will see "t*he majority of their business depend on their ability to create digitally-enhanced products, services, and experiences*". In order to adapt to this changing world and the pressure from their competitors, organizations need to start thinking about undergoing a Digital Transformation.

According to George Westerman, principal research scientist with the MIT Sloan Initiative on the Digital Economy and author of the book "Leading Digital" [10], the drivers for Digital Transformation tend to be market disruption from newcomers or innovation from rivals, seizing the opportunity to win new customers. In this book, organizations that use digital technologies to obtain significantly higher levels of profit, productivity, and performance are designated "Digital Masters". These outperform their peers, becoming on average 26% more profitable, generating 9% more revenue, and achieving more efficiency.

2.1.4 What is required for a Digital Transformation

The digital masters described in "Leading Digital" [10] have what it takes to master a Digital Transformation: leadership and digital capabilities. This book is a hallmark in the Digital Transformation domain, resulting from a partnership between scientific researchers at MIT and a reputable management consulting company, Capgemini Consulting. This body of knowledge has grown out of several case studies of leading companies and is well worthwhile referencing.

2.1.4.1 Leadership Capability

This capability reflects the ability of companies to steer everyone in the same direction, by promoting an adequate culture in terms of communication and person management. It is essential to achieve a successful Digital Transformation. The four key elements of the leadership capability are the following [10]:

- **Digital vision:** Requires leaders to become acquainted with new digital practices and to identify opportunities and threats. They can solve blockages in their organization, caused by technology limitations. In addition, it is imperative to be able to identify which strategic assets are still relevant in the digital era. Leading Digital's research shows that a successful Digital Transformation needs to start at the top. Many organizations fail their Digital Transformation initiatives because their leaders fail in crafting their digital vision;
- **Engaging the organization at scale:** Unlike the incremental change that can be achieved by a few human resources, Digital Transformation requires a large part of the company to be

engaged. Steering these many resources requires their leaders' commitment. Engaging the employees at scale can be done by using digital technologies, including collaboration tools;

- **Govern the transformation:** Leaders resort to digital governance to steer the company's digital activities in the right direction. This digital governance requires a digital team, which includes some entity that is in charge of the Digital Transformation (e.g. Chief Digital Officer, or the Chief Information Officer in this role), helped by governance mechanisms (e.g., committees and liaisons) to deal with digital decisions that need to be governed at a higher level;
- **Technology leadership capabilities:** To build technology leadership capabilities, it is important to assess the state of the IT–business relationships and to assess the IT unit's ability to meet the skill and speed requirements of the digital economy.

A successful transformation is driven from the top [19] and requires a change and commitment of the entire organization. No one can transform the organization alone, so it important to realize that the people, the organization's culture, and the experience that the company wants to create are crucial not only for the organization's customers but also to internally drive the transformation.

2.1.4.2 Digital Capabilities

These capabilities lie in the ability of companies to take advantage of the digital technologies, which means differentiating their business through technology. This differentiation can occur on three different fronts [10]:

- **Transform their customer's experience:** Digital technologies are changing the way organizations and brands are interacting with their customers, becoming closer to them. Consequently, customers' expectations are rising. Organizations need to create an engaging customer experience, creating value for both the organization and its customers;
- **Transform their internal architecture:** Optimized operations will create a competitive advantage through superior productivity, efficiency, and agility. The advantages of digital operations are being discovered throughout many industries. For instance, a better understanding of their data will result in better-informed decisions;
- **Transform business models:** Leading Digital enunciates five archetypes of business model reinvention, driven by digital technology:
  - *Reinventing industries:* Involves significant reshaping of the structure of an industry;
  - *Substituting products or services:* The core product or services can be replaced by a new digital format;
  - *Creating new digital businesses:* Involves the generation of new revenues from the creation of new products and services;
  - *Reconfiguring value delivery models:* Involves recombining products, services, and data to revise how a company plays in the value chain;
  - *Rethinking value propositions:* Using new digital capabilities to target new customers and fulfil specific needs.

2.1.4.3 Transformation as the Road to Digital Mastery

Digital masters are the organizations that use digital technologies to drive significantly higher levels of profit, productivity, and performance [10]. The digital mastery has a four-level classification scheme (**Figure 4**), according to how organizations perform in terms of leadership and digital capabilities [10][19]:

- **Beginners**: The beginners are just starting their digital journey. They have an immature digital culture, having only basic digital capabilities and lacking leadership capability to make a transformation happening;
- **Conservatives**: The conservatives have useful leadership capabilities but they are not building strong digital capabilities, due to prudence and lack of concern about technology fashion. They are the opposite of the fashionistas in terms of digital capability profile;
- **Fashionistas**: The fashionistas are building every possible digital capability but due to the lack of a strong leadership capability and governance, they are wasting a lot of their investment;
- **Digital Master**: The digital masters are excelling both in digital and leadership capability. They have a good governance, an overarching digital vision and a solid digital culture that reflects in their profitability and their revenue generation efficiency.

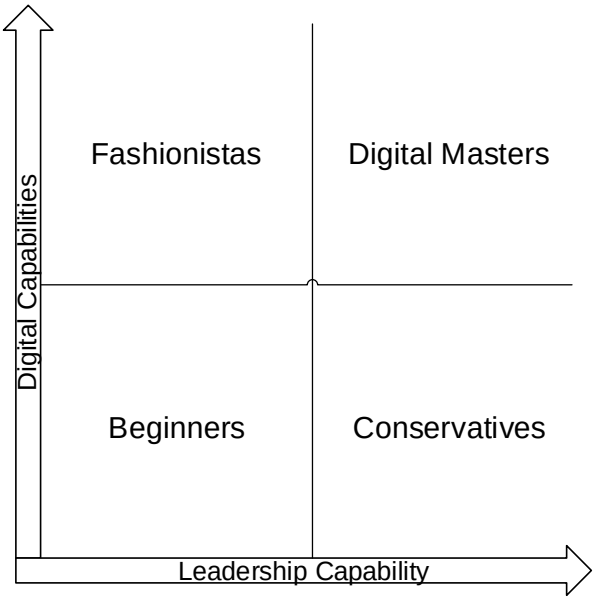


Figure 4 - Four levels of digital mastery [10]

To start a Digital Transformation, an organization has to understand in which of these levels it is, by performing a digital mastery self-assessment [10]. This entails two tables, one to score the digital capabilities (**Table 3**) and another to score the leadership capabilities (**Table 4**).

The scores for digital capabilities range from 10 to 70, with 10 to 41 placing the organization in the bottom half of **Figure 4**, and above that in the top half.

Table 3 – Self-assessment questionnaire regarding digital capabilities [10]

Answer each question, using a scale from 1 to 7, where **1 = strongly disagree; 4 = neutral; and 7 = strongly agree, and then total your digital capability score.**	Score
We are using digital technologies (such as analytics, social media, mobile, and embedded devices) to understand our customers better.	
We use digital channels (such as online, social media, and mobile) to market our products and services.	
We sell our products and services through digital channels.	
We use digital channels to provide customer service.	
Technology is allowing us to link customer-facing and operational processes in new ways.	
Our core processes are automated.	
We have an integrated view of key operational and customer information.	
We use analytics to make better operational decisions.	
We use digital technologies to increase the performance or added value of our existing products and services.	
We have launched new business models based on digital technologies.	
Total	

Table 4 - Self-assessment questionnaire regarding leadership capabilities [10]

Answer each question, using a scale from 1 to 7, where **1 = strongly disagree; 4 = neutral; and 7 = strongly agree, and then total your digital leadership capability score.**	Score
Senior executives have a transformative vision of the digital future of our company.	
Senior executives and middle managers share a common vision of digital transformation.	
There are possibilities for everyone in the company to take part in the conversation around digital transformation.	
The company is promoting the necessary culture changes for digital transformation	
The company is investing in the necessary digital skills.	
Digital initiatives are coordinated across silos such as functions or regions.	
Roles and responsibilities for governing digital initiatives are clearly defined.	
Digital initiatives are assessed through a common set of key performance indicators.	
IT and business leaders work together as partners.	
The IT unit’s performance meets the needs of the company.	
Total	

The scores for leadership capabilities range from 10 to 70, with 10 to 41 placing the organization in the left-hand side of **Figure 4**, and above that in the right-hand side.

By using both the scores of digital and leadership capabilities, the organizations can pinpoint their place in the digital mastery matrix and have an idea of where they stand, before starting their journey.

2.1.5 Digital Transformation as a set of projects

A project can be defined as a "t*emporary endeavor undertaken to create a unique product, service or result*" [25].

This means that a project has a clear beginning and end in time, hence has a defined scope and resources. A project has a defined goal that is accomplished by a specific set of operations, never to be exactly repeated again, contrary to the continued execution of a routine operation.

A transformation, on the other hand, is a process and may actually never end, since there is always room for improvement. However, a transformation implies changes that result from initiatives, or tasks, that are carried out as projects. Therefore, a transformation can be specified as a set of initiatives, each implemented as a project, with beginning, end, resource consumption, inputs, outcomes, dependencies, constraints, etc. Overall, the various initiatives should increase the digital capabilities of an organization.

For each Digital Transformation, we can identify its goals (implementation of digital capabilities, satisfaction of intended indicator values, etc.), the timeframe to reach those goals, resource availability and constraints, the set of initiatives to accomplish these goals, dependencies, etc.

As stated by section 1.3.2, a Digital Transformation is a journey, with many steps that may take a long time to undertake, particularly when the transformation is subject to iteration (new initiatives will be created). Each step corresponds to an initiative, with some specific goals that will bring the organization one step closer to the journey's ultimate goals. The Digital Transformation process corresponds to the orchestration of the execution of the projects that implement the various initiatives. All this requires management, so that projects are executed within temporal and resource (human, material, financial) constraints.

Project management can be defined as "*the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements*" [25] and can be divided into five basic phases [25]:

- **Initiating** – The viability of the project is analyzed, the project manager is appointed and the project scope and objectives are defined;
- **Planning** - A project plan is drawn up, with a risk assessment and the course of action to attain the objectives of the project. The budget, timeframe, and the resources needed are determined;
- **Executing** - The project manager is focused on managing resource allocation, stakeholders' expectations, project scheduling, and productivity, as well as anticipating risks. This is the phase where deliverables are developed and completed;
- **Monitoring and controlling** - Includes controlling changes, monitoring ongoing activities against the project's baseline, controlling the quality of deliverables and monitor whether project objectives are being met;
- **Closing** – All the activities are completed, the customer is required to approve the outcome and to evaluate the project's success. The project is then concluded.

As a project with a particular domain (Digital Transformation), traditional project management cannot capture all the important constraints on the management of a transformation project with a digital motivation. Improving the organization's digital capabilities, as a way of optimizing performance, needs to be included in project management, when applied to the Digital Transformation domain.

Whereas traditional project management is concerned with balancing project variables such as schedule, budget, and resources, the project management in the Digital Transformation domain is concerned with balancing the traditional constraints with the focus on the maximization of digital capabilities, the optimization of the performance of the organization and the avoidance of project risks.

This type of project management is not common today and constitutes another topic that this dissertation needs to tackle.

2.2 Digital Transformation Approaches

The literature review that has been done was unable to find an academic framework that specifically addresses the problem of facing a Digital Transformation, or implementing a digital strategy, in a generic and systematic way. All the research papers found in the Digital Transformation domain contained references to frameworks proposed by consulting companies, such as the Capgemini framework [26]. This is not surprising. In newer topics, driven by market pressure and not by research proposals, whitepapers and blog posts outpace formal, academic papers.

These frameworks, briefly described in the following sections, will be used as a starting point to identify which are the digital capabilities to consider while planning and managing a Digital Transformation.

2.2.1 Capgemini Digital Transformation Framework

Capgemini Digital Transformation Framework, depicted in **Figure 5**, recognizes that executives are digitally transforming three key areas of their organization:

- Customer experience;
- Operational processes;
- Business models.

This framework is composed of the nine elements shown in **Figure 5**, forming a set of building blocks for Digital Transformation. It is presented in a whitepaper with the findings from the Digital Transformation study [19] conducted by Capgemini Consulting and the MIT Center for Digital Business.

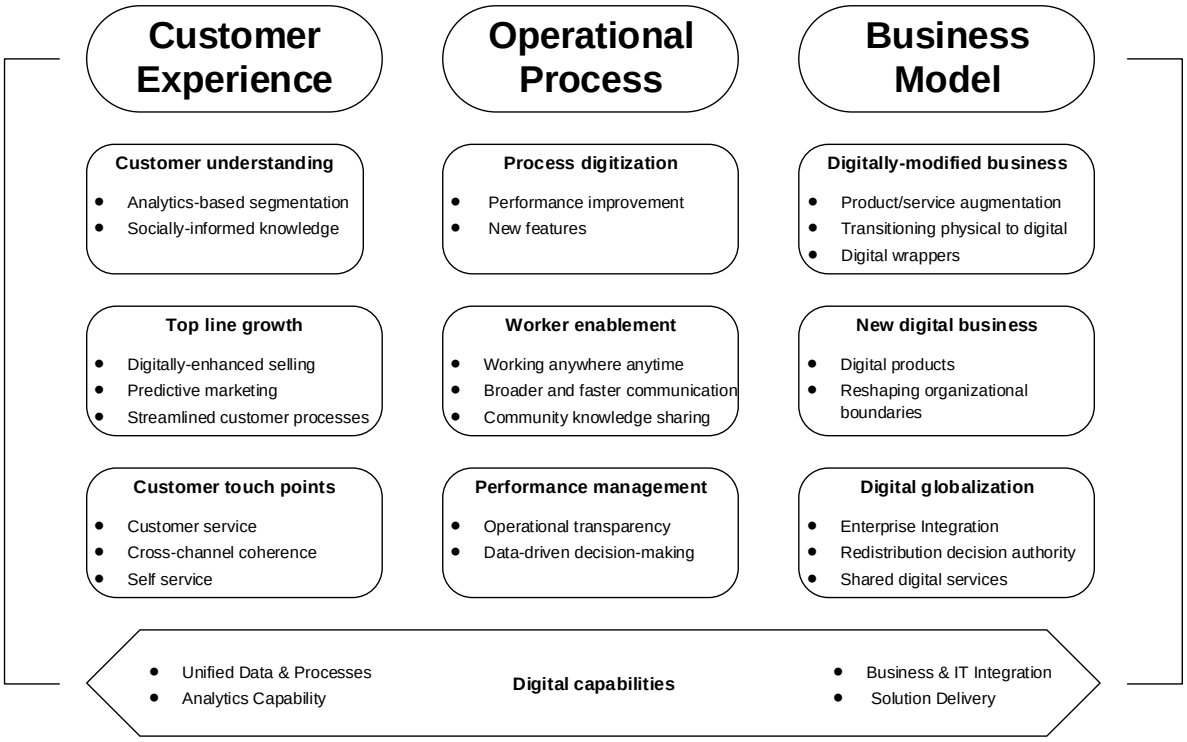


Figure 5 - Capgemini Digital Transformation Framework (adapted from [19])

2.2.2 The Boston Consulting Group's Digitization Strategy Framework

The Boston Consulting Group's (BCG) Digitization Strategy Framework, illustrated by **Figure 6**, intends to provide organizations with tools to capture new digitization opportunities. The framework is used more as a diagnosis method than as a planning framework, which means that they help organizations to set the basis for strategy development by understanding global trends, customer needs, and competitors' activities, and by evaluating current capabilities and gaps. After the initial diagnostic, organizations can resort to a set of building blocks to develop a successful digitization strategy [27].

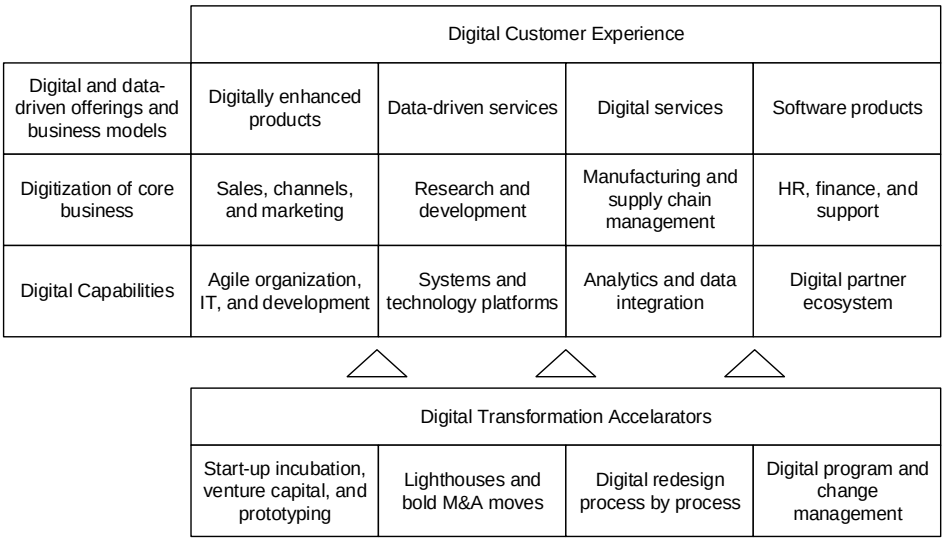


Figure 6 - BCG Digitization Strategy Framework (adapted from [27])

2.2.3 The IBM Digital Transformation Framework

A research from the International Business Machines (IBM) Institute for Business Value realized that organizations with a cohesive strategy for integrating digital and physical elements can successfully transform their business models. They also discovered that organizations focus their transformation on two distinct areas [28]:

- Reshaping their customer value proposition;
- Transforming their operating models.

Unlike the Capgemini Digital Transformation Framework (section 2.2.1), the Digital Transformation of the business model itself does not seem to be recognized as a top-level concern.

Based on the insights of this research, the IBM Institute for Business Value elaborated a Digital Transformation framework, depicted in **Figure 7**.

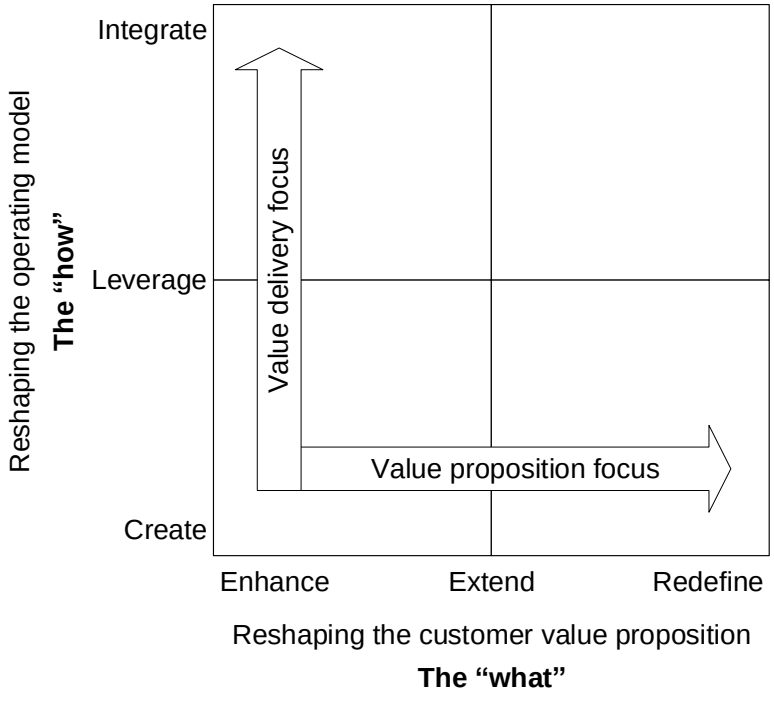


Figure 7 - Elements of the IBM Digital Transformation Framework (adapted from [28])

The framework is composed of two main axes:

- Reshaping the customer value proposition, which consists of the following sequence of stages:
  - **Enhance** or augment physical products or services with digital content, information, insight, and engagement;
  - **Extend** the physical or traditional products and services through digital content, creating new revenue streams;
  - **Redefine** the value delivered to customers, replace physical with digital or build fully integrated digital/physical value and revenue.

- Reshaping the operating model, which consists of the following sequence of stages:
  - **Create** the basic digital delivery capabilities required to improve operations and engage customers across multiple touch-points;
  - **Leverage** by using information across channels and organizational structures, while optimizing capabilities within each element;
  - **Integrate** and fully optimize all elements of the value delivery around customer touch-points and deliver efficiency/effectiveness.

By analyzing the strategies adopted by their customers, IBM identified three basic alternative approaches to their framework [28], illustrated by Figure 8:

- **Path 1:** Create and integrate digital operations first. Then, address the customer value proposition to achieve full transformation;
- **Path 2:** Enhance, extend or reshape the customer value proposition with digital content, insight, and engagement. Then, focus on integrating digital operations;
- **Path 3:** Build a new set of capabilities around the transformed customer value proposition and operating model in lockstep.

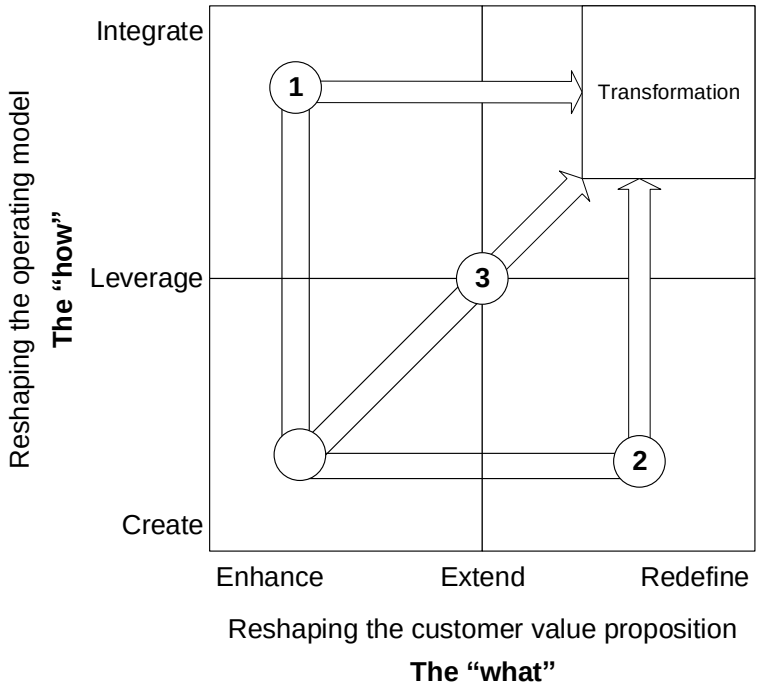


Figure 8 - Different paths to the development of the value proposition and the operating model (adapted from [28])

There is no universally optimal path, since it depends on objectives, industry context, competitive pressures, and customer expectations:

- In industries where the product is mostly physical and customer requirements for information are the most relevant aspect, the suggested path is the one focused on the operational aspect (Path 1);

- In industries that provide services, such as the financial industry, a path mainly focused on the customer value proposition (Path 2) will most likely be the best choice;
- Nevertheless, many organizations will be interested in investing in both reshaping their customer value proposition and transforming their operating models (Path 3).

The most relevant feature of this framework is that it explicitly foresees a way of adapting the scheduling of Digital Transformation activities to the needs and goals of the organization to digitally transform.

2.2.4 The Cognizant Digital Transformation Framework

After analyzing digital developments across several industries and having identified the common elements, Cognizant elaborated a Digital Transformation framework (**Figure 9**), which acts as a blueprint to guide this transformation. The framework must be tailored to ensure a proper fit for each organization or industry.

Like the Capgemini Digital Transformation Framework (section 2.2.1), the Digital Transformation revolves around a few relevant concerns, detailed into several aspects, but here the business model does not seem to be a top-level concern. Apart from the customer, this framework focus on the organization itself and on the products it produces. Probably, this framework deals more with digital optimization than with Digital Transformation (section 2.1.2).

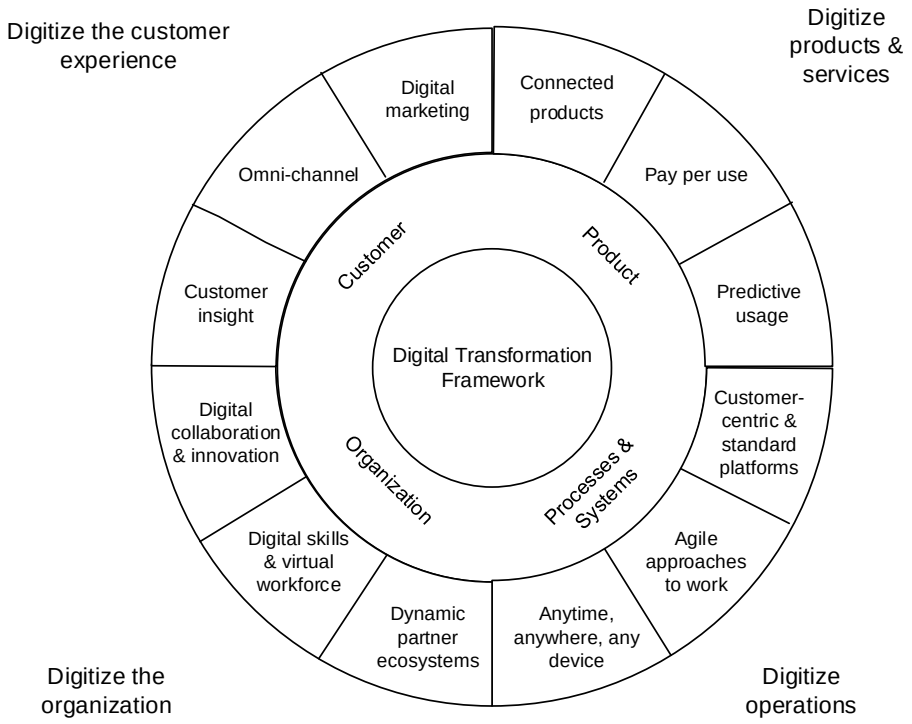


Figure 9 - The Cognizant's Digital Transformation Framework (adapted from [29])

2.3 Governance and Management

Governance and management are two crucial concepts for Digital Transformation. Therefore, it makes sense to analyze existing standards and frameworks that deal with them, particularly in the IT domain, namely ISO/IEC 38500 [7] and COBIT 5 [8].

2.3.1 ISO/IEC 38500

The ISO/IEC 38500:2008 was the first international standard to provide guidelines for governance of IT. It was recently updated by ISO/IEC38500:2015 [7].

This standard "*provides guiding principles for members of governing bodies of organizations (which can comprise owners, directors, partners, executive managers, or similar) on the effective, efficient, and acceptable use of information technology (IT) within their organizations*" [30].

The ISO/IEC 38500 is aligned with the definition of "corporate governance" in the Cadbury report [31] and has six core principles [30] that can be applicable to most organizations (unchanged in the 2015 update):

- **Responsibility:** Individuals and groups within the organization understand and accept their responsibilities with respect to both IT supply and demand. Those with responsibility for actions also have the authority to perform those actions;
- **Strategy:** The organization's business strategy takes into account the current and future capabilities of IT. The strategic plans for IT satisfy the current and ongoing needs of the organization's business strategy;
- **Acquisition:** IT acquisitions are made for valid reasons, based on appropriate and ongoing analysis, with clear and transparent decision-making. There is an appropriate balance between benefits, opportunities, costs, and risks, in both the short term and the long term;
- **Performance:** IT is fit for purpose in supporting the organization, providing the services, levels of service and service quality required to meet current and future business requirements;
- **Conformance:** IT complies with all mandatory legislation and regulations. Policies and practices are clearly defined, implemented and enforced;
- **Human behavior:** IT policies, practices, and decisions demonstrate respect for human behavior, including the current and evolving needs of all the "people in the process".

Figure 10 illustrates the "*final draft (issued November 2014) conceptual model for governance of IT from the proposed update of ISO/IEC 38500 and its relation with IT management*" [7].

In the ISO/IEC 38500, the governing body is defined as "*a generic entity (the individual or group of individuals) responsible and accountable for performance and conformance (through control) of the organization*" and its roles are clearly defined. Besides that, the standard also allows that the governing body could result in a subsidiary entity with the purpose to pay closer attention to the tasks in governance of IT, such as a board committee [7].

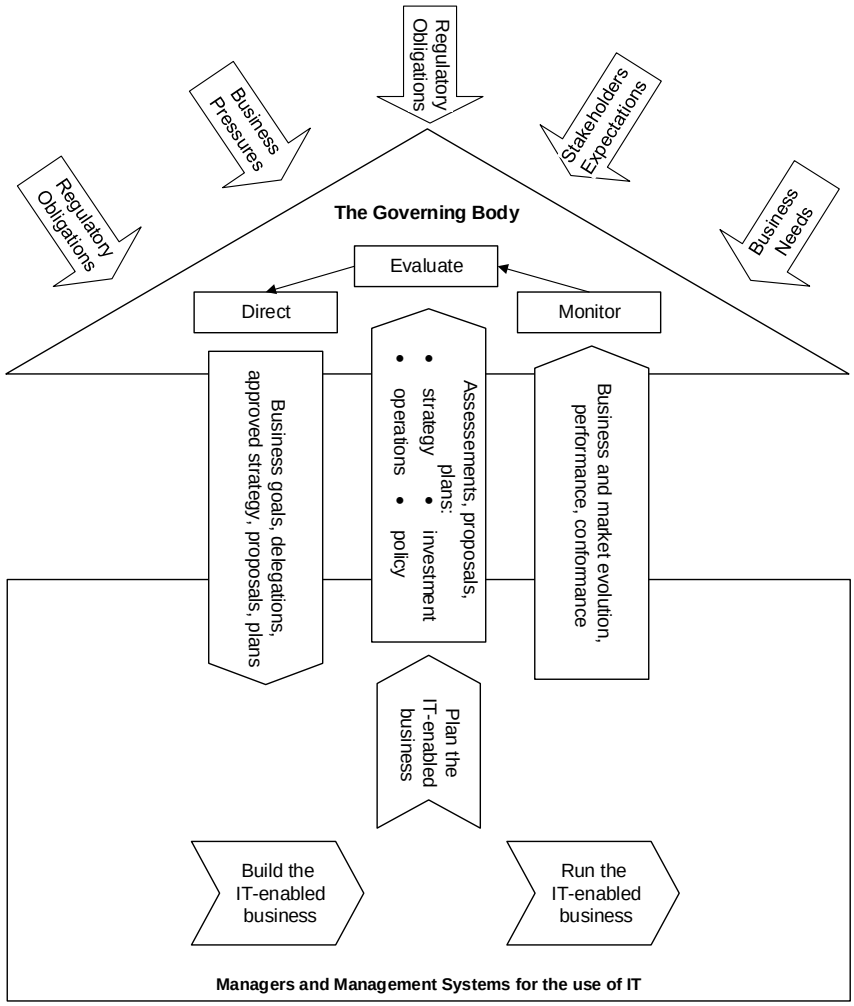


Figure 10 - Model for governance of IT of the cycle of Evaluate-Direct-Monitor derived from the Final Draft International Standard ISO/IEC 38500 (adapted from [7]).

2.3.2 COBIT 5

COBIT 5 provides a comprehensive framework that assists organizations in achieving their objectives for the governance and management of enterprise IT. The COBIT 5 framework is built upon five basic principles, which are covered in detail, and includes extensive guidance on enablers for governance and management of enterprise IT [8]:

- **Principle 1**: Meeting Stakeholder Needs;
- **Principle 2**: Covering the Enterprise End-to-end;
- **Principle 3**: Applying a Single, Integrated Framework;
- **Principle 4**: Enabling a Holistic Approach;
- **Principle 5**: Separating Governance from Management.

Principle 5 is the most relevant principle for this dissertation. Following ISACA's perspective, governance and management can be differentiated by:

- **Governance**: Ensures that stakeholders' needs, conditions, and options are evaluated to determine balanced, agreed-upon enterprise objectives to be achieved; setting direction through prioritization and decision-making; and monitoring performance and compliance against agreed-upon direction and objectives;
- **Management**: Plans, builds, runs, and monitors activities, in alignment with the direction set by the governing bodies to achieve the enterprise objectives.

COBIT 5 is a process-based framework, with a process reference model that includes 37 processes describing a lifecycle for governance and management of enterprise IT. These processes are organized into categories, which distinguish governance from management:

- **Governance category**: Evaluate, Direct, and Monitor (EDM);
- **Management categories**: Align, Plan and Organize (APO), Build, Acquire and Implement (BAI), Deliver, Service and Support (DSS) and Monitor, Evaluate and Assess (MEA).

2.3.3 Assessing the Quality of Processes

Governance and management are implemented by processes and their quality needs to be assessed, by comparing their structure against a set of best practices. The following sections describe briefly two of the most relevant frameworks for process quality assessment, the COBIT 5 Process Assessment Model (PAM) [32] and the Capability Maturity Model Integration (CMMI) [33].

2.3.3.1 COBIT 5 PAM

The COBIT 5 Process Assessment Model (PAM) is a model of process capability, based on COBIT 5. Each of the COBIT processes is assigned a capability level (0 to 5), according to a measurement framework based on ISO/IEC 15504 [32].

The higher the capability level, the better the process quality. Each capability level subsumes all the lower levels and is characterized by process attributes, which describe the requirements that a process must largely (L) achieve to be classified in at least that level. A process must fully (F) achieve the requirements of the attributes of the levels lower than that in which it is classified.

Table 5 lists the classification scale of each process attribute, with a correspondence to the range of percentage of achievement, and Table 6 illustrates each process capability level and respective process attributes that each process must achieve in order to be classified inn that level.

Table 5 - Classification scale of each process attribute [32]

Abbreviation	Description	% Achieved
N	Not achieved	0 to 15%
P	Partially achieved	>15% to 50%
L	Largely achieved	>50% to 85%
F	Fully achieved	>85% to 100%

Table 6 - Capability Levels and Process Attributes [32]

Capability		Process Attribute	
Level	**name**	**ID**	**Name**
0	Incomplete process		
1	Performed process	PA 1.1	Process performance
2	Managed process	PA 2.1	Performance management
		PA 2.2	Work product management
3	Established process	PA 3.1	Process definition
		PA 3.2	Process deployment
4	Predictable process	PA 4.1	Process measurement
		PA 4.2	Process control
5	Optimizing process	PA 5.1	Process innovation
		PA 5.2	Process optimization

2.3.3.2 Capability Maturity Model Integration (CMMI)

CMMI is a "*capability improvement model that can be adapted to solve any performance issue at any level of the organization in any industry*" [33]. This model helps organizations to diagnose problems in their processes with a best-practices framework that serves as a base for an appraisal by experts of the process structure of an organization, which results in guidelines and recommendations for improvement.

Instead of specifying which individual processes an organization should have, CMMI defines several process areas, each covering a set of activities that the organization should implement. Each individual process area under appraisal is assigned one of four capability levels (**Table 7**), from Incomplete to Defined, allowing to identify what needs to be improved in each process area.

Maturity levels (1 to 5, or Initial to Optimizing) are applicable to a set of process areas (or to the entire organization) to express their overall quality, giving an indication of how well the best practices of the various process areas are adopted by the organization.

Table 7 - Capability and maturity levels of process areas

Levels	Capability	Maturity	Typical characteristics of process areas
0	Incomplete		Not all activities are implemented
1	Performed	Initial	Complete, but unpredictable, poorly controlled, reactive
2	Managed	Managed	Planned, performed, measured, and controlled, reactive
3	Defined	Defined	Well characterized , described in standards, procedures, tools, and methods tailored for the organization, proactive
4		Quantitatively Managed	Measured and controlled by quantitative data, statistically analyzed
5		Optimizing	Stable, flexible, focused on continuous improvement

As its characteristics improve, the organization achieves a higher maturity level by "*identifying areas of improvement, working to correct these areas, and integrating solutions across the organization*" [33].

CMMI and COBIT 5 PAM can be considered complementary. CMMI can add by identifying the gaps in the organization's IT governance and management processes, for improved performance capability, whereas COBIT 5 PAM can identify the IT governance and management best practices that the organization should have in place, for operational excellence [33].

3 The Problem and How to Solve it

From their descriptions, existing approaches to Digital Transformation seem to entail more a list of guidelines and advices, heavily dependent on the insight of experienced consultants, than a systematic process. Human expertise is crucial but, without a systematic approach, best practices will not be established and even seasoned consultants can get lost.

3.1 Failing to Plan is Planning to Fail

As referred to in section 2.1.5, Digital Transformation is a process, which can be implemented as an orchestration of projects, each with the goal of improving some digital aspects of the organization.

It is important to recognize that these projects stem from the drivers for Digital Transformation felt by the organization (section 2.1.3) and not from normal, steady-state governance or management processes resulting from best practices that process assessment frameworks such as COBIT 5 PAM and CMMI recommend.

The Digital Transformation projects correspond to improvement processes, which will probably be executed only once and never repeated in the same way. Even if some improvement needs to be reinforced, it is likely that the new process that performs it is not identical to the first one.

Any Digital Transformation is inherently a turbulent process, for which it is not easy to define the best practices, not only because Digital Transformation is a recent field but also because there is no unique recipe that fits all industries and organizations. Each transformation is a unique case, which must be tailored to the specific needs, resources and culture of the organization.

At best, what can be done is to identify basic patterns and techniques that seem general enough, so that they can be applied to most organizations. Still, it is unlikely that all organizations will need these patterns and some will need to apply other patterns, not covered by this dissertation.

What is clear is that a Digital Transformation needs to be well planned and prepared. This is illustrated by an IDC prediction for 2020 that states that the performance of enterprises will be measured by "*a demanding new set of benchmarks in leadership, customer engagement, digitization of new and traditional offerings, operational efficiency and workforce agility*" [5]. However, IDC expects that "*at least one-third of every industry's top 20 companies will fail to reach these new benchmark levels*" [5].

Therefore, before starting transforming, each organization must be able to understand *why* (drivers and goals), *what* (relevant concerns) and *how* (activities to carry out) to perform the Digital Transformation.

This information will allow the organization to develop a map of their desired transformation, with an identified destination. The need of a map is particular important because Digital Transformation is not a light endeavor, which organizations could pursue blindly and unprepared.

The fundamental question, then, is how to build that map in a systematic way, supported by structured mechanisms that cover the various aspects involved, and how to navigate that map in a concrete, measurable way, so that progress can be evaluated and seen to converge as fast and as efficiently as possible. Who starts a journey (**Figure 2**) without a GPS device with a clear map and a planned route?

3.2 The Limitations of Current Approaches

Consider an organization that acknowledges the importance and value of Digital Transformation. If it desires to transform itself towards the digital world, how can it start this journey? More importantly, how can it plan and manage its transformation, in order to be successful?

Since Digital Transformation is an emerging topic, consulting companies are starting to prepare themselves to be able to answer their customers' questions and doubts through frameworks, roadmaps, strategic plans or simply best-practices frameworks. This approach is very customized and dependent on tailoring the frameworks to ensure a proper fit to the organization's needs and its industry.

The Capgemini Digital Transformation Framework (section 2.2.1) asserts that a Digital Transformation has three areas of action: customer experience, operation process and business model.

The Cognizant Digital Transformation Framework (section 2.2.4) follows a similar logic, although with different areas of action (the customer experience, the products and services, the operations and the organization). This framework also uses the term digitization of areas of action instead of digitalization. According to the Gartner glossary, "*digitization is the process of changing from analog to digital form*" [34], contrary to digitalization that is defined as "*the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business*" [35]. Unlike the framework presented by Capgemini, the Cognizant's framework is more centered on shifting from analog to digital than in moving to a true digital business.

The IBM Digital Transformation Framework (section 2.2.3) also does not take innovation of the business model as a primary goal, focusing instead on reshaping the organization's customer value proposition and operating model.

The only area present in all frameworks is the customer experience, which is frequently stated as the most important of all areas of action in Digital Transformation. This leads to the conclusion that most organizations are focusing or even restrict their Digital Transformation to that specific area.

The BCG Digitization Strategy Framework (section 2.2.2) is an excellent example of this, since all their areas of action are related to the area of digital customer experience. This framework also focus on capturing new digitization opportunities. While the Cognizant framework acts as a blueprint to guide the transformation, the BCG's is used as a diagnosis method.

After analyzing these frameworks, it becomes apparent that what they call framework is in fact a methodology. Guidelines, advices, do's and don'ts, and best practices are elements that as a whole define a methodology on how to perform a Digital Transformation. However, there is no clear way to

assess in which state the transformation is at a given time, nor to check whether it is converging to the intended goals.

In the example of a physical journey (**Figure 2**), a set of guidelines and advices such as “avoid congested routes”, “highways are safer”, and so on, seem logical and in any case needed, but do not really give a clear insight on how the journey should be organized, nor whether the destination is near or still far away.

The IBM Digital Transformation Framework (section 2.2.3) provides a limited improvement to this scenario, by separating the map from the route. The map (states in which the transformation of the organization can be) is composed of a matrix along two main axes (concerns):

- The customer value preposition;
- The operation model.

Both axes are discretized into three stages, corresponding to increasing levels of Digital Transformation maturity. The goal is to navigate the map until the highest maturity (best stage in both axes), starting at the lowest maturity level or at whatever level the organization is in when it starts the Digital Transformation effort.

The combination of transitions between stages generates three different path options (methods). A methodology will need to be performed, leading to the choice of optimal path for each industry and/or organization. Each transition should improve the maturity level, and an assessment needs to be carried out to check in which cell of the matrix (**Figure 8**) the organization lies at the end of each transition.

This is an analysis that none of the other three approaches seems to entail. However, the matrix is very limited, since it does not contemplate any detailed indicators nor which aspects to tackle are more crucial or should have a higher priority.

Even though there are several approaches available, none of them seems to constitute a systematic approach, detailing the various aspects to consider and with indication of which concrete steps to take next. They are largely different and there is no way to compare them. The existing approaches are generic and mostly best-practices guides, elaborated from their success cases. These approaches are only providing information regarding the strategic aspects of the transformation and lack information on how to implement and manage the actions required to proceed, once a generic strategy has been set up.

3.3 Distinguishing Evaluation from Evolution

In any journey, the traveler moves from one point in the map to the next. At any time, he or she needs to be able to answer the following questions:

1. Where am I (in the map)?
2. Am I where I should be?
3. How far in the journey have I travelled, or Am I near the end of the journey?

4. Where do I go next, through which road or street?
5. Which resources (transportation means, namely) do I use to get there?

The frameworks discussed in the previous section do not show evidence of being able to answer these questions regarding Digital Transformation, in a concrete, detailed and systematic manner. Largely limited to guidelines and advices, they actually lack (or at least do not make explicit) the necessary tools for any journey, namely:

A. A map, with all possible points through which the journey can be undertaken;
B. A navigation device (GPS), or any other way of assessing where the journey stands at any given time;
C. A route planner, supporting the optimization of some criteria (shortest path, fastest journey, least consumed resources, etc.);
D. An engine, to move from one point in the map to the next, animating the journey.

The journey can be seen as an iterative loop of two main phases:

- **Evaluation**. This corresponds to answering questions 1 to 3 for each travelling point in the map, resorting to tools A and B. During this phase, the traveler is not moving;
- **Evolution**. Once the traveler knows his or her situation, it is time to move on, answering questions 4 and 5 by using tools C and D. It should be noted that at any stopping point the route can be changed (criteria may have evolved from an initial planning). Evaluation takes place again only at the next stopping point.

This perspective calls for a clear separation between *static analysis* (characterization of the various aspects of the journey at a given point – a journey snapshot, or state) and *dynamic evolution* (decisions and steps to move the journey to the next point at which analysis will take place again).

A physical journey (**Figure 2**) can be modeled by a graph, in which the nodes correspond to cities and villages (stages in which the journey can be) and edges correspond to roads and streets through which the journey can progress (transitions from one stage to the next). The traversal of this graph (the map) needs a way of describing and characterizing the nodes (cities and villages) and edges (roads and streets).

In the same way, a Digital Transformation process requires a way of describing the states in which the company being transformed can be (the nodes of the graph, or the Digital Transformation stages) and the transitions from one Digital Transformation stage to the next possible ones (the edges of the graph).

The IBM Digital Transformation Framework (section 2.2.3) takes one step in this direction, but in a way that is too broad and with little or no detail. Clearly, a new approach, more systematic and with more detail, is needed to improve upon the current Digital Transformation panorama.

The basic tools that we need, establishing a parallel with the required tools for the physical journey described above, are the following:

A. Digital Transformation stages are snapshots of the Digital Transformation process (static descriptions of the current state of affairs). We need to define a structured classification,

encompassing the various aspects to take into account in a Digital Transformation, that characterizes each of the possible stages (the map);

B. A set of indicators that, when measured, enables the organization to check in which stage it currently is in (the navigation coordinates);
C. A set of policies and strategic guidelines upon which governance can be based and a methodology performed, so that the best stage transitions are used, in the light of criteria supported by those policies and strategic guidelines (the route planner);
D. A set of resources (human, material, financial) to implement the transitions that have been determined (the engine).

3.4 Clarifying Terminology

In the proposal presented by this dissertation, the following terminology is adopted (according to the Oxford Dictionaries[36]):

- **Framework** – "*A basic structure underlying a system, concept, or text*";
- **Methodology** – "*A system of methods used in a particular area of study or activity*";
- **Method** – "*A particular procedure for accomplishing or approaching something, especially a systematic or established one*".

Methodology and Method are widely used with consistent semantics, but Framework is a heavily overloaded term, with many meanings. In most cases, it is used to designate the full set of concepts, objects, tools, and so on, relevant to some domain.

This is why the Digital Transformation approaches described in section 2.2 are designated frameworks by their proponents. However, these encompass both static analysis and dynamic evolution, which this dissertation clearly separates.

Therefore, this dissertation uses these terms to designate:

- **Framework** – Tools A and B (structured classification of Digital Transformation stages and set of indicators that characterize them). This restricted perspective is consistent with the concept of framework proposed by Zachman [37];
- **Methodology** – Tool C (governance, set of policies, strategic guidelines);
- **Method** – Tool D (the actions that implement the path composed of successive transitions between Digital Transformation stages, from the initial system, AS-IS, to the intended outcome, TO-BE).

The framework describes the state of Digital Transformation stages, by defining the structural set of aspects to consider. The methodology compares what has already been achieved with what is intended, applies policies and guidelines, and decides what to do next, which overall defines the method that implements a particular Digital Transformation process. Governing bodies do not have to intervene in all stages, since many actions may be required to implement some decision. Different governance choices will lead to different methods.

3.5 Requirements for a Framework

The goal of the framework is to describe each of the possible stages of the Digital Transformation process, according to some common classification structure that should be able to organize and catalog the answers to questions such as the following ones:

- Which are the strategic concerns of an organization that may constitute the most relevant driving forces for a Digital Transformation endeavor?
- Can these concerns be organized into broad, orthogonal categories or are they all tightly interdependent?
- If orthogonal categories are possible, which aspects should be included in each category?
- Assuming that each organization is different and answers will vary from organization to organization, is there a core set of concerns and aspects, common to all organizations but open-ended so that it can be extended, tailored and/or customized for each case?
- Which indicators should be used to assess the strategic goals or operational objectives that express the relation between some concern or aspect and the corresponding organizational performance?
- How much should each indicator be improved (or its value, if it did not exist before) by tackling each concern or aspect?
- What needs to be done, so that each indicator reaches its intended value?
- What is the relative importance of each concern, aspect and/or indicator, so that overall, weighted achievement indicators can be determined?
- How can the organization know where does it stand in the overall Digital Transformation process, or how digitally mature has it already become?

Overall, these questions express the evaluation phase, as described in section 3.3. In each Digital Transformation stage, the organization should be able to assess which goals and objectives have already been achieved, fully or partially. This expresses how digitally mature the organization currently is, and an input to the subsequent phase, evolution (which transitions from the current Digital Transformation stage to the next one).

To become more digital (improving the relevant indicators), an organization must acquire digital capabilities (section 2.1.4.2), which can be defined as the characteristics of an organization that support its digital strategy and operations. These characteristics differentiate them from their peers. Organizations that know to take advantage of the digital technologies have more digital capabilities. However, Digital Transformation is not merely about technology and also requires organizations to master organizational capabilities, such as the ability to adapt marketing to the new digital context and digital-oriented leadership (section 2.1.4.1).

Concerns, aspects, and the corresponding indicators therefore translate to requirements to capabilities. For an organization to tackle a concern or aspect, it must possess a digital capability that supports it.

Usually, organizations have already several indicators that enable them to assess their performance. These can be extended with new ones, more digitally oriented, to cater for the digital capabilities.

Given the complexity of organizations' information systems, the several concerns, aspects, indicators and capabilities are not expected to be strictly self-contained. Some aspects may be relevant to several concerns. One capability can support several concerns/aspects, or one concern/aspect may require several digital capabilities. Each indicator may receive contributions from several digital capabilities, and each digital capability can contribute to more than one indicator. Whenever relevant, relative weights can be used to express the importance of each contribution.

Therefore, the framework should include:

- A set of main, orthogonal concerns (if possible) relevant to the Digital Transformation process;
- A set of more detailed aspects, for each concern;
- A set of indicators to assess the digital performance of the organization (to assess whether goals have been achieved);
- A matrix of weights, expressing the relative contribution of each digital capability to improve each indicator and how much each indicator should be improved;
- A maturity model, based on a set of overall, weighted indicators, to express in a more global way how far the Digital Transformation process has advanced. The maturity may be simply a scalar value or a vector one, allowing different maturity levels for different concerns. The alignment between the maturity model and the set of indicators is an inherent aspect of the framework.

All these data can be represented graphically, with time, concerns/aspects, or indicators in the abscissa axis, and constitute the main input to the methodology, described in the next section.

3.6 Requirements for a Methodology

The framework can thus characterize each stage of the Digital Transformation process. The objective is now to decide whether the Digital Transformation goals have been achieved and, if not, decide to which stage to transition next and which actions are needed to achieve it (the evolution phase).

More than a method to do this at each stage, what is required is a methodology, to choose the most adequate method. This dissertation itself also involves a methodology (section 1.5), to choose the research method. However, this is done only once, at the beginning, and then the method is the same until the end.

Digital Transformation is still exploratory in nature and sits on a context that is always changing. Digital Transformation patterns have not settled yet. Therefore, a methodology should be applied at each stage, to choose the method that decides what to do next. Technology may have evolved, policies may have changed, the market environment also changed, and so on. The methodology does not have to produce a method right until the foreseeable end of the Digital Transformation, since the world is very dynamic and that may be too speculative. The method can be changed, whenever needed.

In practice, the methodology needs only be applied whenever significant events have occurred or the steps already defined are nearing completion. Otherwise, the method can proceed executing the decisions that have already been made.

Another, more practical, perspective is to say that governance is weaving the method as it goes along the Digital Transformation, with inflexions whenever justified.

In any case, to make decisions and to implement them, questions such the following ones arise:

- Which policies to adopt? For example, should the organization give more relevance to the business model, to customer relationship, or to internal process optimization?
- Which initiatives should be put in place to implement the intended digital capabilities?
- What are the dependencies between initiatives (some can only start after results from others)?
- What resources (human and material) are needed/made available to implement the initiatives?
- What timeframes should be imposed on initiatives?
- When an initiative implements some digital capability, how much delay can be expected until it produces the intended effect on indicators?
- What is the risk that a given initiative does not implement successfully the corresponding digital capabilities?
- What is the risk that a given digital capability, although correctly implemented, does not produce the intended improvement in the corresponding indicators?
- How to obtain global execution indicators, such as an estimate of the time and resources needed to implement the foreseeable initiatives?
- Is it possible to simulate various scenarios?

An initiative may tackle several digital capabilities, or the same digital capability may be tackled in several initiatives. Things can get pretty tangled, so initiatives should be defined with great care to minimize coupling.

Policies, defined as "*a definite course or method of action selected from among alternatives and in light of given conditions to guide and determine present and future decisions*" [38], are also extremely important. A change in policies, frequently caused by factors external to the organization, may produce significant changes in the whole Digital Transformation process.

Since the methodology is inherently dynamic, involving human-level decisions and highly sensitive to the type and characteristics of the organization and of its environment, it is not at all easy to specify what the methodology should be. That is the role of governance, in particular in the digital domain [10][39].

However, the decision support tools used to help in the process should be able to cater for the questions enumerated above, including the possibility of simulating scenarios.

Many data, pertaining to the methodology and method, can be represented graphically, with time, concerns/aspects, or indicators in the abscissa axis. Examples of useful values are initiative implementation time, resource consumption, global time evolution of indicators and capability

achievement, and risks stemming from initiative and digital capabilities failure to produce the intended results.

3.7 Vision of the Whole Approach

Which steps should be taken by an organization undergoing a Digital Transformation process, according to the approach of this dissertation?

It naturally depends on many factors, such as the type, characteristics and environment of the organization, strategic goals, resources and know-how available, but in generic terms the Digital Transformation process will most likely be iterative and never ending, since there are always aspects to improve. Many initiatives (tasks) will be executed, to implement the required changes in the organization.

The Digital Transformation process corresponds to the orchestration of the execution of the various initiatives. Not all initiatives need to be created initially. Whenever some change is needed, a new initiative is created to implement it.

The rate at which initiatives are created and executed will not be constant. According to how the interaction of the organization with its the partners (**Figure 1**) evolves, the rate can be higher or lower. In fact, two main phases could be used to characterize the dynamic behavior of the Digital Transformation process:

- **Turbulence phase**: This phase is entered as a result of relevant driving forces to undertake changes, coming from any of the interaction channels of **Figure 1** (namely customers and competitors) and implies creating many new initiatives, to implement the required changes. The outcome of some initiatives may require creating new initiatives, to progress the transformation or to correct unsuccessful outcomes. This is the phase on which this dissertation concentrates, since it is the most relevant to the changes that Digital Transformation implies.
- **Steady phase**: This is a phase in which there are no relevant driving forces for more initiatives and the organization conducts business as usual, with just maintenance initiatives.

The Digital Transformation process is thus designed as an iteration loop, in which each iteration can flow along the following steps:

- Define strategic goals;
- Identify indicators to assess goal achievement;
- From the indicators, derive the set of digital capabilities needed to achieve the intended indicator values;
- From the set of digital capabilities, derive the set initiatives that implement them;
- Take into account initiative dependencies and resource needs, as well as resources available;
- Execute initiatives, taking into account policies (that may dictate the order of execution of initiatives) and risks that may prevent intended goals from being achieved;
- As initiatives finish, way until they produce effect on the indicators (the effect of the availability of a digital capability is not immediate);

- Check whether the intended indicator values have been achieved. Decide whether to iterate or to move forward.

These steps are consistent with the definition of Digital Transformation adopted by this dissertation and described in section 2.1.1.

They also constitute an instantiation of the classic transformation of the AS-IS (current state of the organization) into the TO-BE (the intended new state of the organization). Usually, an organization does not start its Digital Transformation from scratch, but the goal is invariably to increase the maturity of the organization in terms of digital capabilities.

The approaches to Digital Transformation described in section 2.2 also have the goal of increasing the digital maturity of an organization. However, they provide little detail, resorting mostly to general principles, advices and guidelines. This dissertation proposes a framework and methodology that includes a reasonably detailed set of concerns and steps, respectively. Digital Transformation is thus better supported.

Figure 11 depicts a conceptual map of the approach to Digital Transformation presented by this dissertation.

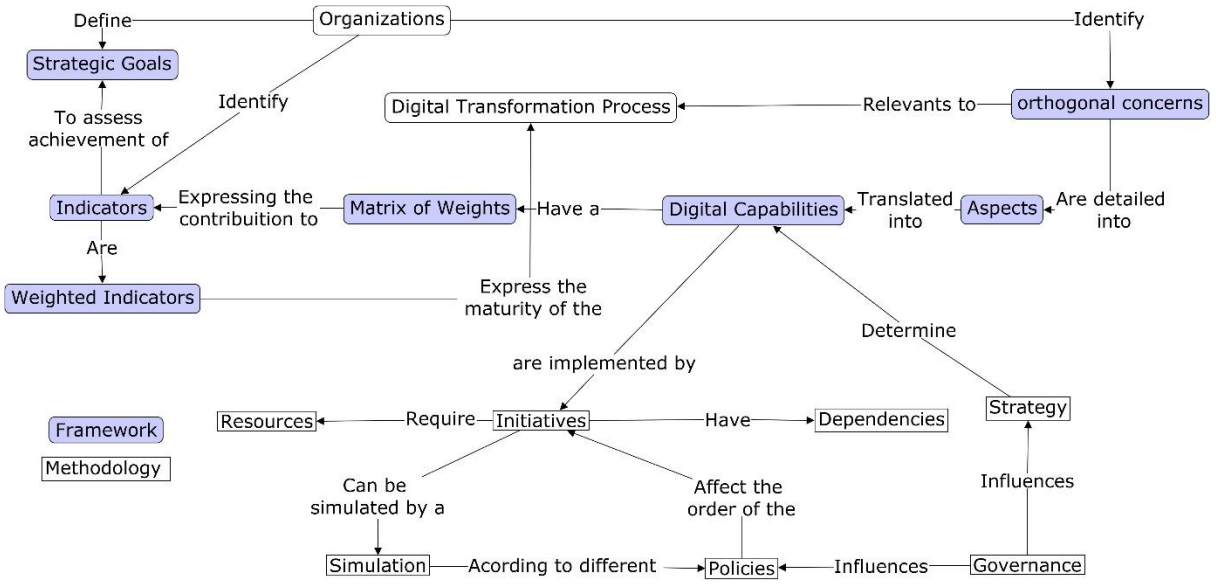


Figure 11 – Conceptual map of this dissertation's approach to Digital Transformation

4 Analysis of Potential Solutions

After establishing the basic requirements for a systematic approach to Digital Transformation, the goal is now to analyze existing techniques, systems and approaches, searching for potential ideas and contributions to elaborate a proposal that satisfies those requirements, namely in terms of the framework and of the methodology.

4.1 Contributions to the Framework

This section analyzes existing approaches and techniques that can serve as the basis for a framework, with the meaning discussed in section 3.4.

4.1.1 Current Digital Transformation Approaches

Section 2.2 described some of the most recognized approaches for Digital Transformation, proposed by leading consulting companies. The public literature about them consists mainly of whitepapers, without enough detail to allow a deep analysis or direct use in this dissertation.

Although these companies are highly reputed in the consulting services area, with great real-world experience and insight, their approaches are described essentially as a set of broad ideas and advices, seemingly elaborated from their success cases and that have to be adapted and customized in each Digital Transformation process.

What is needed is a more detailed and systematic approach, which can be reused and configured in each case, thereby reducing the customization effort.

Nevertheless, they serve as a starting point and some provide interesting ideas, namely:

- Capgemini (section 2.2.1) – The notion of digital capabilities and an initial classification of concerns and aspects (**Figure 5**);
- IBM (section 2.2.3) – Separation of static analysis (**Figure 7**) from dynamic evolution (**Figure 8**), which means separation of framework from method, as defined in section 3.4;
- Cognizant (section 2.2.4) – A classification of concerns and aspects (**Figure 9**), providing an alternative to Capgemini's classification.

These approaches can be the starting point to elaborate a list of concerns and aspects relevant to Digital Transformation, but the list needs to be enhanced by performing a literature search on Digital Transformation approaches, gathering ideas and contributions from many publicly available formal papers, whitepapers and web sites.

4.1.2 Digital Mastery Self-assessment

The “Leading Digital” book [10] is based on several case studies of leading companies and introduces the notion of digital mastery self-assessment. It makes sense to analyze it and understand how and whether it can contribute to the solution of the problem stated by this dissertation.

The self-assessment (section 2.1.4.3) is used to assess the state of an organization in terms of digital mastery before the Digital Transformation, with the objective of pinpointing its level in the digital mastery matrix (**Figure 4**), according to their scores of digital and leadership capabilities.

This raises an important issue, since before any transformation it is important to understand what is the starting point. This self-assessment allows the organization to see which digital and leadership capabilities it is lacking and offers some kind of guidance on what is required to become a digital master.

However, assessing the level of digital mastery at the beginning is necessary but not sufficient. Some important features that are relevant for planning and managing a Digital Transformation are lacking, namely the ability to assess, at any given point of the transformation:

- What is the current state of the transformation;
- How much the organization has improved since the beginning of the transformation;
- Whether the results of the transformation are converging to the intended goals or not.

Even though potentially useful by providing some initial information for planning a Digital Transformation, this tool constitutes essentially no more than a very broad digital maturity assessment, without a concrete classification of the various concerns and aspects to consider, which is the main goal of the framework proposed in this dissertation.

Therefore, it can be more subjective rather than systematic, but in any case it can provide a high-level classification scheme for organizations, somewhat similar to the Gartner’s Magic Quadrant [40]. All that is needed is to define the concrete concerns and aspects to include in the classification, with weights, so that a meaningful overall classification can be made.

Figure 4 only correlates digital with leadership capabilities, but other dimensions of this magic quadrant could be defined, such as correlating business models with customer experience, leading to various forms of comparing the digital maturity of various organizations, according to the most relevant dimensions. This is a potentially interesting idea.

4.1.3 Table-based Frameworks

Detailing a quadrant leads to a table, with several lines and columns, and in fact many frameworks use a tabular form to correlate multivalued concepts and therefore produce a classification structure that enables a more detailed and systematic approach to the study of the relevant domain.

The Zachman Framework, created by Jonh A. Zachman [37], is one of the most widely known table-based frameworks and constitutes a basic tool in the Enterprise Architecture domain. This framework

provides a formal and structured way of viewing and defining an enterprise architecture, as shown in **Table 8**.

Table 8 - Simplification of the Zachman Framework for Enterprise Architecture 2003 Version (adapted from [41])

	Why	**How**	**What**	**Who**	**Where**	**When**
Contextual	Goal List	Process List	Material List	Organisational Unit & Role List	Geografical Location List	Event List
Conceptual	Goal Relationship	Process Model	Entity Relationship Model	Organizational Unit &Role Relationship Model	Locations Model	Event Model
Logical	Rules Diagram	Process Diagram	Data Model Diagram	Role Diagram	Locations Diagram	Event Diagram
Physical	Rules Specification	Process Function Specification	Data Entity Specification	Role Specification	Location Specification	Event Specification
Detailed	Rules Details	Process Details	Data Details	Role Details	Location Details	Event Details
Functioning	Actual Implementation					

This framework is a schema that uses a table based on two classification concepts [37]:

- The primitive interrogatives (What, How, When, Who, Where, and Why);
- The reification transformations (Identification, Definition, Representation, Specification, Configuration and Instantiation), corresponding to the rows, from top to bottom.

This framework provides a holistic view of the enterprise, taking into account that each stakeholder has a different perspective on the same system. Each row of the framework represents a stakeholder with a total view of the system: its goals, its processes, its modelling, its organizational structure, its location and its timeline.

The higher-level perspectives are concerned with governance and strategic management, whereas the lower-level perspectives are concerned with the implementation and operation of the system. Progressing down in the model rows, the level of concreteness and detail increases.

The actual details of the Zachman framework are not particularly relevant to this dissertation, although the enterprise architecture is a natural target for the changes caused by the Digital Transformation process. The most direct contributions are conceptual:

- Correlating multivalued concepts in tabular form is an excellent form of specifying the details of each combination of values from the concepts. Each cell of the table contains information concerning each pair of values of the related concepts;
- There must be a clear separation of the framework (that merely provides a classification scheme, or an ontology, in tabular form) from the methodology (the decisions and actions to make changes to the system) [37]. According to Zachman, the framework is a classification schema, a semantic structure. It implies nothing about processes and methodologies, whether they are top-down, bottom-up, left-to-right, or right-to-left [37][42].

Both contributions are very useful to this dissertation, and in particular the latter is precisely what is advocated by section 3.4, contrary to several existing approaches that mix framework with methodology.

However, this separation does not preclude conjugating the Zachman framework with a methodology [43], much in the same way that this dissertation advocates the combination of a framework (section 3.5) with a methodology (section 3.6) as a systematic approach to perform a Digital Transformation.

4.1.4 Maturity Models for Digital Transformation

Any transformational approach should include a maturity model, which can be defined as a classification scheme that shows how good a system is (its quality), according to some set of criteria. The goal of any transformation is to increase the maturity of a system, by satisfying those criteria in a higher degree. The maturity model can be used to compare organizations or different stages of evolution of the transformation in the same organization.

Although this perspective is consensual and widely accepted, different sets of criteria will produce different maturity models and different types of criteria will produce different maturity model types. This is not always made explicit, which may lead to terminology ambiguities or inconsistencies.

A very important distinction is made by basing the maturity models on different types of entities, namely:

- **Process-based maturity models**, which assess how much the governance and/or management processes comply with the industry's best practices (are processes designed and executed in the right way?);
- I**ndicator-based maturity models**, which assess how much the organization achieves the industry's set of reference indicators, quantitative or qualitative (does the execution of processes achieve results that are good enough?).

Process-based maturity models make more sense when the best practices are well established, which is the case of frameworks such as COBIT 5 PAM (section 2.3.3.1) and CMMI (section 2.3.3.2) that have existed for years.

However, even in this case, we need to bear in mind that these frameworks assess processes with the system in a reasonably steady state, in which changes are not substantial. This is not the case during the turbulence phase of a Digital Transformation (section 3.7), in which many transformation initiatives are being executed and what is relevant is their result and not the processes that implement them, since these are not repetitive (initiatives end when the result is obtained).

Indicator-based maturity models are more useful in young and exploratory domains such as Digital Transformation, in which best practices have not settled in yet and it is easier to define a set of industry-wide goals, objectives and indicators that enable to assess how mature the Digital Transformation state of an organization currently is.

In addition to comparing organizations through their indicators, an organization involved in a transformational process can also compare its set of indicators in different moments in time with the

intended indicators at the end of the transformation and therefore assess how far the organization has gone in that transformation.

Since this dissertation is focused on a transformational rather than on a best-practices context, it clearly adopts the indicator-based maturity model type. This clarification needs to be made explicit because this differs from the typical perspective of the maturity models used in IT governance and management. This means that the COBIT 5 PAM and CMMI models are not adequate to be used, as they are, by this dissertation.

However, if we think of COBIT 5 PAM process attributes (**Table 6**) as the indicators in the framework of this dissertation, and the levels of achievement of those attributes (**Table 5**) as the level of satisfaction of the indicators' target values, then the basic mechanism of COBIT 5 PAM to determine the capability level of each process can be extrapolated to a maturity model based on the level of achievement of several indicators, weighted by their relative importance to the Digital Transformation.

The maturity model of the Digital Mastery Self-assessment described in section 4.1.2 is indicator-based, but it is too simplistic and bears no relation to the set of indicators specified as a requirement for the framework (section 3.5). Therefore, it does not constitute a good basis for a maturity model in the framework proposed by this dissertation.

A new maturity model, based on the indicators and capabilities of the framework (section 3.5), needs to be defined.

4.2 Contributions to the Methodology

It is fundamental that the requirements for a methodology, as discussed in section 3.6, be aligned with those for the framework, described in section 3.5. This means guiding Digital Transformation actions, with the purpose of increasing the organization's digital maturity, by indicators that allow comparing the current performance of the organization with the defined strategic goals and, if not good enough, give an indication of which initiatives need to be put in place to steer the Digital Transformation process in the right track.

Strategic goals and performance indicators hint that the Balanced Scorecard (BSC) [44] may constitute a useful starting point. Since simulation of a Digital Transformation process, and corresponding initiatives, can be a relevant governance support tool, Project Management Simulation (PMS) [45] will also be analyzed.

4.2.1 Balanced Scorecard

The BSC, proposed by Kaplan and Norton in 1992 [44], "*is a strategic planning and management system that organizations use to communicate what they are trying to accomplish, to align the day-to-day work that everyone is doing with strategy to prioritize projects, products, and services, and to measure and monitor progress towards strategic targets*" [46].

The evolution of the BSC throughout the years led it to its third generation (**Figure 12**). The current ensemble includes a destination statement, strategic objectives, strategic linkage model and perspectives, measures and initiatives [47].

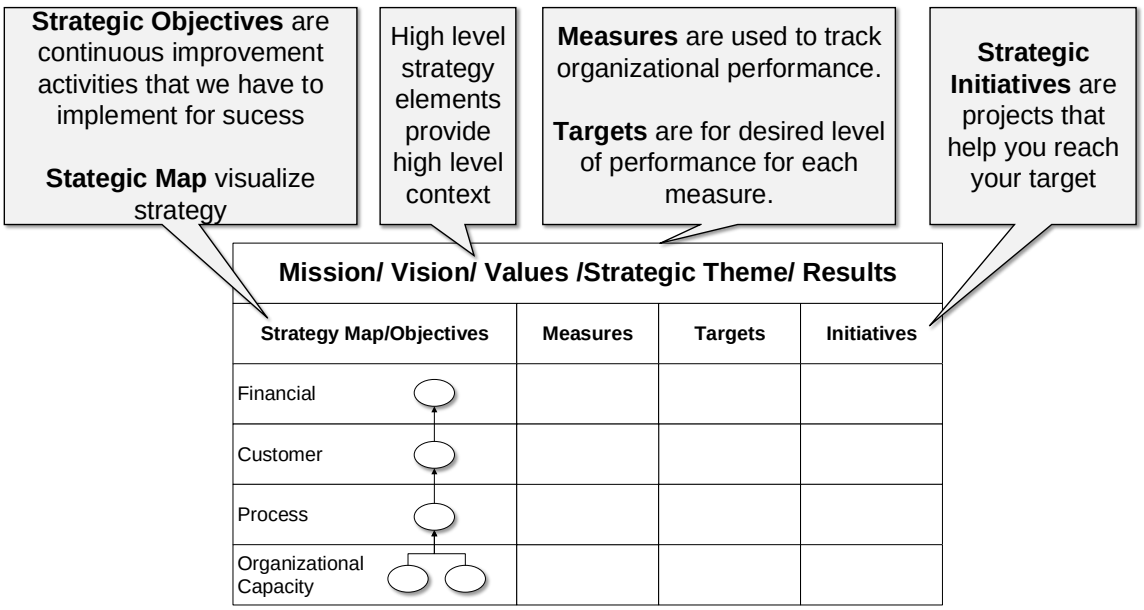


Figure 12 - The elements of the Balanced Scorecard (adapted from [46])

This management system analyzes company performance from four different perspectives [46] (customer/stakeholder, internal process, organizational capacity and financial), as originally presented by Kaplan and Norton [44]:

- **Financial**: This perspective encompasses organizational financial performance and the use of financial resources;
- **Customer/Stakeholder**: This perspective tackles organizational performance from the point of view of the customer or of other key stakeholders that the organization is designed to serve;
- **Internal Process**: This perspective analyzes organizational performance through the lenses of the quality and efficiency related to our product or services or other key business processes;
- **Organizational Capacity (originally called Learning and Growth)**: This perspective analyzes organizational performance through the lenses of human capital, infrastructure, technology, culture and other capacities that are key to breakthrough performance [46].

For each perspective, we can define strategic objectives, measures, targets, and initiatives [46]:

- **Strategic Objectives** are continuous improvement activities that must be done to implement the strategy. They are the breakdown of more abstract concepts, such as mission and vision, into actionable steps;
- **Strategy mapping** is a simple graphic that shows a logical, cause-and-effect connection between strategic objectives[46][46];
- **Measures** or Key Performance Indicators (KPIs) indicate progress towards a desirable outcome. Strategic KPIs monitor the implementation and effectiveness of the organization's

strategies, determine the gap between actual and targeted performance, and determine the organization's effectiveness and operational efficiency:

- The **destination statement** is a description, ideally including quantitative details, which serves to clarify and align the management team around a common definition of strategic success, which facilitates the creation of the Balanced Scorecard.

The BSC is a strategic planning and management tool that essentially measures whether management is achieving the desired goals. The Mission and Vision Statements are translated into a comprehensive set of objectives and performance measures that can be quantified and assessed.

This tool allows the organization to [48]:

- Elaborate a clear business's vision and strategy;
- Identify the performance areas that best link the business's vision and strategy to its results (e.g., customer/stakeholder, internal process, organizational capacity, and financial);
- Establish strategic objectives that support the business's vision and strategy;
- Develop effective measures, establishing both short-term milestones and long-term targets;
- Collect and analyze performance data and compare actual results with the desired performance;
- Take action to close unfavorable gaps.

Digital Transformation aims to improve the digital capabilities of an organization. It is inconceivable to improve these capabilities without assessing whether (and how much) they bring benefits (e.g., increased performance and market share, reduced costs, broader customer base) for the organization, through suitable performance and quality indicators.

By focusing on the result of the transformation and detection of potential deviations from the intended goals, the BSC seems to be much more aligned with this dissertation than governance and management process quality approaches, such as ISO/IEC38500 and COBIT 5.

The goal of this dissertation is not to propose how to assess whether some organization is performing Digital Transformation in the right way, by following a prescribed set of processes (which would be eventually adequate for ISO/IEC38500 or COBIT 5), but rather to propose the mechanisms that can support the decisions taken and policies adopted by the Digital Transformation governance. In this respect, the assessment of the quality of the result is more important than the assessment of the quality of the processes executed to reach that result.

The main potential contributions of BSC stem from its underlying organization in two phases.

- Define a vision, strategy, goals, objectives and indicators;
- Execute the system, measure the value of the indicators, compare them with the intended values and detect eventual divergences.

The first phase actually entails a contribution to the framework (section 4.1), since it validates the need for indicators derived from a strategy.

The second phase corresponds to the assessment and evaluation part of any methodology.

What the BSC does not provide is an explicit contribution to the definition of which actions should be taken to make an indicator converge to its intended value, nor which policies could be adopted to make that convergence faster.

Nevertheless, the ideas of the BSC seem to constitute a good contribution to this dissertation. They just need to be adapted and extended to cater for the concerns and aspects that are most relevant to the context of Digital Transformation.

4.2.2 Project Management Simulation

Any Digital Transformation is a complex endeavor, involving far-reaching and heavily-impacting decisions, with consequences that are potentially very costly and time consuming to backtrack if later deemed wrong. In a complex setting such as a large organization and its environment, it is difficult to correctly assess all the variables and take all the right decisions.

Effective governance requires tools, not only to grasp what is the current state of the organization, in terms of the execution of the Digital Transformation process, but also to anticipate and decide which are the best next steps to take (methodology), considering the various possible paths (methods) along which to proceed.

The methodology can be done with analytical approaches, but these can be very limited when complex contexts such as Digital Transformation are tackled. Simulation is frequently a good solution to try to anticipate how a system will react in different scenarios. This is the motivation to analyze whether project management simulation [45] can provide a contribution to the methodology proposed by this dissertation.

The purpose of project management simulation it to simulate the planning and management of a project and constitutes a technique often used in the training of project managers [45][49][50]. This technique simulates real-world scenarios and allows the trainees to see the effect of their decisions without the potential drawback of actual consequences. Project management students can plan tasks and resources of the project, control the progress of the project, estimate costs and react to typical real-world project management situations created by the professor.

In addition, project management simulation can also be applied in real-life projects to support more informed decision-making processes [51] or to perform what-if analyses. By using these techniques, project managers can understand the different outcomes of their decisions, understand the consequences of eventual risks in order to prepare contingency plans, and help identify the best courses of action for the project.

Since a Digital Transformation process involves decisions that affect which initiatives need to be executed, with resource consumption and implementation time constraints, a project management simulation tool will constitute an invaluable means of assessing the potential impact of those decisions on choosing the best alternatives.

The main goal of any Digital Transformation process is to maximize the organization's performance, by optimizing the digital capabilities, with the minimum possible risk, least resource (human and material) consumption and smallest timeframe. Different approaches can lead to different results. Which are the best ones? Simulation only provides hints, since the simulation results are only as good as the correctness and completeness of the initial data and of the simulation procedures. However, having hints is better than having no hints at all and leaving everything to experience and intuition.

Simulation is also a good way to spot and understand emergent behaviors, arising from the interactions between the different components of the system and that would otherwise be impossible to predict just by considering each component's own behavior. By running simulations of different policies in the domain of Digital Transformation (e.g., maturity, risk, performance), governing bodies can take better and more informed decisions on how to organize a Digital Transformation.

Therefore, project management simulation will be used in this dissertation to illustrate the impact on the overall transformation of using different policies in the methodology, leading to different methods.

5 Governance Model Proposed

This section details the approach proposed by this dissertation to tackle Digital Transformation and its governance. As clarified in section 1.3.1, this dissertation concentrates on the information and mechanisms that should be available to support the governing bodies in their decisions, rather than tackling the way in which these structures should be organized or detailing how the governance procedures should be carried out.

5.1 From Strategy to Action

From the Digital Transformation steps enumerated in section 3.7, forming an iteration loop, three main phases can be identified in each iteration:

- **Definition:** The organization's governing bodies develop a vision of what they intend to reach through the transformation, draw a strategy, and elaborate a strategy mapping to the goals needed to attain the vision. This in turns leads to the definition of which performance indicators should be used to assess the results, of which capabilities are required to support them, and of which initiatives are needed to implement these capabilities;
- **Implementation:** In this phase, initiatives are executed, but nothing is guaranteed. There is the risk that some initiatives do not implement digital capabilities correctly and that some digital capabilities, although correctly implemented, do not reach the intended results;
- **Assessment:** KPIs need to be measured and compared with the intended values, stemming from the strategic goals. If needed, the whole process needs to be iterated. This need may arise due to risks taking their toll or even due to evolution of the strategic goals, which may have occurred in the meantime.

Figure 13 describes this generic mechanism, from the vision until the assessment of whether the desired strategic goals were satisfied, showing the definition, implementation, and assessment phases.

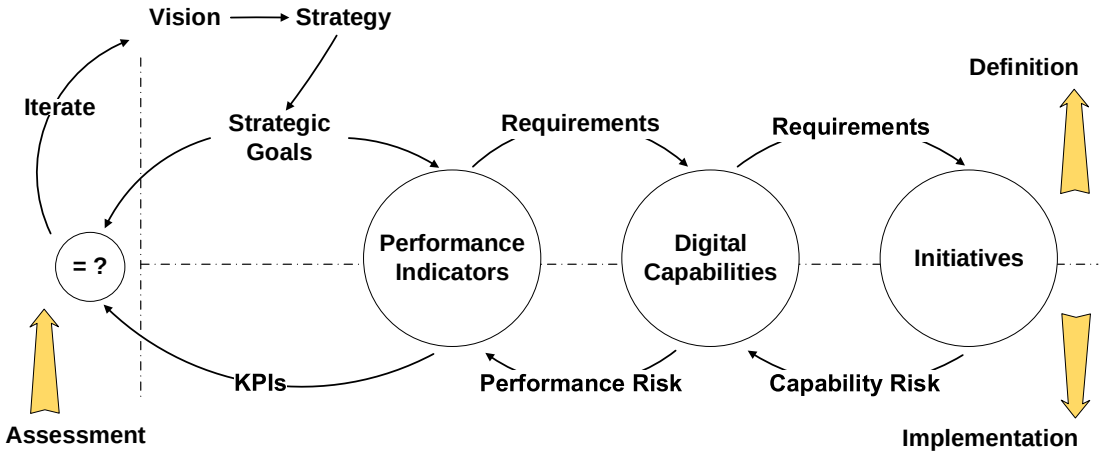


Figure 13 – The generic mechanism underlying the Digital Transformation approach

Each iteration of the loop entails a journey between the AS-IS and the TO-BE architectures. At the final assessment at the left of **Figure 13**, the previous architecture AS-IS, now changed by the initiatives, becomes the new AS-IS and the TO-BE is either the same (more work is needed to reach it) or has also changed, due to an evolution of the vision, strategy and goals.

The iteration can be detailed into the following main steps:

1) (Re)Assessment of the vision, strategy and strategic goals, making changes as governing bodies decide;
2) Goals translate into objectives and these establish requirements for the performance indicators that are used to assess the achievement of these objectives;
3) The intended improvements in the indicators can only occur if new digital capabilities are implemented or existing ones improved. Therefore, indicators produce requirements for the digital capabilities that are needed;
4) Digital capabilities require the execution of a set of initiatives. Each initiative can contribute to one or more digital capabilities. The implementation of a capability can improve one or more indicators;
5) Nevertheless, there are associated risks:
    a. An initiative may not fully implement the digital capability that motivated it;
    b. A capability, even if correctly implemented, may not produce the expected improvement effects on performance indicators;
6) The assessment of the results of the iteration involves comparing the performance indicators achieved with the strategic goals initially established. If they do not satisfy these goals, it is necessary to make adjustments and perform a new iteration, by starting again at step 1).

This three-phase iteration loop is a good match for the distinction between framework, methodology and method, as discussed in section 3.4:

- The definition phase sets the **framework** with all the information that describes the state (a snapshot) of the transformation, namely set of indicators and their current values, set of capabilities and their degree of achievement, set of initiatives and their execution status, and risks;
- The implementation phase corresponds to one step of the **method**, which encompasses the sequencing, or orchestration, of all the steps taken along the transformation;
- The assessment phase is an instantiation of the **methodology**, in which governance has a higher stake. Results are compared with goals in the light of external factors such as technological advances, customer expectations and business models of competitors. Potentially, corrective changes can be made all the way up to the vision. This corresponds to a methodology because these changes can also affect policies and other strategic decisions, thereby changing the method from then onwards.

The initial inspiration for **Figure 13** came from the BSC [44], briefly described in section 4.2.1, since it includes the underlying notion of linking strategy to goals and use the measurement of performance indicators to assess whether these goals are being met.

However, BSC as it stands is not entirely adequate for Digital Transformation, since:

- Its metrics are general purpose and do not contemplate explicitly the aspects most relevant do Digital Transformations;
- There is no indication of how these indicators can be improved, namely which initiatives should be taken and how they contribute to improve the indicators;
- Although BSC can include risk management by measuring Key Risk Indicators (KRIs), again there is no indication of which risks should be assessed in a Digital Transformation, nor of their relation with digital capabilities and initiatives.

Nevertheless, it constituted a good starting point for the approach of this dissertation.

5.2 Framework Proposed

This section describes the Digital Transformation framework of this dissertation´s approach, according to the requirements enunciated by section 3.5 and in the light of the potential contributions from existing technologies considered in section 4.1.

5.2.1 Basic Structure of the Framework

The main purpose of the framework is to be able to describe each possible stage of the Digital Transformation process. At any given time, a snapshot of the state of the transformation must be available to governing bodies, to support informed decisions.

The information in that snapshot must be organized under some classification structure, able to organize and catalog the state of each of the relevant Digital Transformation concepts. The role of a Digital Transformation framework is to provide this classification structure, so that each Digital Transformation snapshot can be characterized and compared with others, enabling the assessment of the Digital Transformation process.

Two things are clear:

- Given the complexity and variability of organizations, a core of common and widely used concepts can be defined, but a complete set is an impossible goal. Each organization is bound to have its own specific and unique features and constraints, which in addition may vary with time;
- Given the dynamics of organizations and of their environment, the structure and definitions of the framework will almost certainly be changed during the course of a Digital Transformation. Each time the assessment phase of **Figure 13** takes place, changes to the framework can be decided upon to take place in the subsequent definition phase. In fact, the framework may need to be tuned up several times during a Digital Transformation.

Therefore, the framework must be a template, open-ended, adaptable and extensible, rather than a prescriptive recipe that must be followed in all cases from start to finish. Any organization must be able

to tailor and extend the framework to suit its particular needs, at any iteration of the Digital Transformation loop of **Figure 13**. It has a starting basis, but must not be constrained or limited by it.

The framework, in this open-ended and adaptable perspective, while trying to comply with the requirements established in section 3.5, is structured along the following concepts:

- **Areas of concern** (*axes*) for Digital Transformation, much in the same way as BSC considers several perspectives to organize indicators. Each axis should be orthogonal to the others (hence the designation) and can be divided into categories of more detailed aspects. Weights can be used to express the relative importance of each axis and category;
- **Performance indicators**, to assess the success of the strategic goals defined for the Digital Transformation, aligned with the axes and categories. An indicator should be defined for each aspect, category and axis. Naturally, not everything has to be detailed and some indicators can be defined in a broader manner (such as for a whole category, instead of aspect by aspect). The weights of aspects, categories and axes can be used to define compound indicators, thus enabling comparison with higher-level goals;
- **Digital capabilities**, which express the skills that the organization must master to achieve the Digital Transformation goals. These capabilities must be aligned with the axes and categories, in the sense that the framework should define how much each implemented capability is expected to contribute to improve each indicator. There is no one-to-one relation between capabilities and indicators. Each capability can improve several indicators, and each indicator can be receive improving contributions from several capabilities. Weights can be used to express relative contributions;
- **Initiatives**, needed to implement and/or acquire digital capabilities. Their execution requires time and resources, both human and material, which are necessarily limited and may hamper the simultaneous execution of many initiatives. Each initiative can contribute to the implementation of several capabilities, and each capability can receive implementation contributions from several initiatives. Weights can be used to express relative contributions;
- **Risks**. The framework can also be used to define the risks inherent to the transformation, thereby enabling a better assessment of which steps to take next in the Digital Transformation. The main risks considered in the basic framework are the following:
  - The execution of initiatives may not endow the organization with the envisaged capabilities, or at least not at the intended levels, due to deficient planning or execution;
  - Even if a given capability is mastered, its effect in the improvement of the indicators may not be as high as expected.

The usefulness of the framework lies mainly in:

- Defining a scaffolding structure that supports a systematic approach to Digital Transformation planning;
- The values of all the details of these concepts at a given time along the transformation, which provide a snapshot of the state of that transformation. This enables a better and more detailed

assessment of how it is progressing, so that more informed decisions on what to do next can be taken.

The following sections provide additional information on these concepts, including examples of axes, categories, performance indicators, digital capabilities and initiatives. These are just examples, which need to be adapted and completed by a concrete Digital Transformation project, taking into account the characteristics of the organization under Digital Transformation.

5.2.2 Areas of Concern (Axes)

Since this is just a template framework, it does not divide categories into individual aspects (which would need to be done when tailoring the framework for a concrete organization), and only areas of concerns (axes) and their division into categories are considered.

In addition, there is no intention of providing a very complete list, but rather to illustrate the mechanism. The categories have been obtained by analyzing the available literature. As customers are central to business, they correspond to the most detailed axis.

The axes considered explicitly in the framework are the following:

- **Customers:** The aim is to improve the organization's customers experience, entailing a better understanding of the customers, management of the organization's digital presence, and promotion of the brand more effectively, increasing customer's engagement. To achieve these goals, organizations must have as much touch points as they can, to clearly understand who their customers are and what they expect from the organization;
- **Processes:** Dedicated to internal digitalization, the goal is to enable the organization to improve the scalability and efficiency of its processes, which could include core processes automation and virtualization of individual worker's processes;
- **Human resources:** Employees can be the best (if well managed) or the worst (if not) assets of an organization. Therefore, it is essential to keep them motivated, well used and informed, taking particular care with human relationships;
- **Suppliers:** This is similar to improving the customer experience, in the sense that involves the interaction of the organization with its environment, but now involves putting the organization itself in the role of customer;
- **Business Model:** This axis is dedicated to digitally transform the organization's business model, which could include adding digital services to its traditional business, a complete shift from traditional services or products to a digital-based ones, reshaping of the business model, or using digital capabilities to target new customers;
- **Finance:** This includes all the financial aspects more related to Digital Transformation.

Other concern areas could be easily included.

Table 9 lists the axes and categories considered in this framework. An instantiation of this template in an actual digital transformation should be trimmed (eliminating the axes or categories not relevant) and adapted and/or extended as required by this organization. This just a checklist and starting point.

Table 9 - List of examples of axes (areas of concern) and categories considered in the framework

Axis	Category
Customers	Streamline the sale's process
	Digital Interactions
	CRM strategy
	Needs of the Digital consumer
	Online presence
	Predictive marketing tools
	Digital Marketing
	Digital Interface with the clients
	Differentiate with digital community
	Customer service
	Touch point integration
	Cross-channel coherence
	Self-service
	Socially-informed knowledge
	Customer-analytics capabilities
	Predictive Usage
Processes	ERP solution
	Process performance
	Operational transparency
	Data-driven decision-making
Human resources	Networked workforce
	Virtualization of the workplace
	Community knowledge sharing
	Dynamic partner ecosystems
	Agile approaches
Suppliers	Digitally-enabled supply chain
	Digital supply chain enablers
Business model	Digitally-modified business
	New digital business
	Business globalization
Finance	Digitally-integrated budgeting
	Digital-related investments
	Revenue from digital assets

The level of detail seems uneven, with some axes more detailed than others, but somehow this reveals the importance given to each axis in the literature. It is not surprising that customers get the best treatment, since they are the ones to conquer. Weights can be used to express the relative importance of each axis and category within its axis.

5.2.3 Performance Indicators

Each category should have at least one performance indicator, but usually it should have more, at least one for each individual aspect part of a category. Again, this level of detail makes sense in an actual instantiation of this framework, in the Digital Transformation of a concrete organization. Here, and to simplify, only one indicator is illustrated for each category of aspects, as described in **Table 10**. These indicators were obtained by analyzing the Digital Transformation literature.

Table 10 - List of examples of axes (areas of concern), categories and performance indicators

Axis	Category	Performance Indicator
Customers	Streamline the sale's process	Printing costs savings
	Digital Interactions	Average time taking an order
	CRM strategy	Customer retention
	Needs of the Digital consumer	Brand image index
	Online presence	Customer satisfaction index
	Predictive marketing tools	Customer loyalty index
	Digital Marketing	Number of new customers
	Digital Interface with the clients	Savings on marketing expenses
	Differentiate with digital community	Number of customers claims
	Customer service	Frequency of direct contacts with customers
	Touch point integration	Customer Engagement
	Cross-channel coherence	Number of cross-channel orders
	Self-service	Average time satisfying an order
	Socially-informed knowledge	Marketing expenses
	Customer-analytics capabilities	Number of sales closed
	Predictive Usage	Customer Lifetime Value
Processes	ERP solution	Administrative expenses
	Process performance	Employee productivity
	Operational transparency	Quality Index
	Data-driven decision-making	Operational profit
Human resources	Networked workforce	Employee motivation index
	Virtualization of the workplace	Employee satisfaction index
	Community knowledge sharing	Leadership index
	Dynamic partner ecosystems	Employee Suggestions Index
	Agile approaches	Employee productivity index
Suppliers	Digitally-enabled supply chain	Resource optimization index
	Digital supply chain enablers	Percentage of digitally tagged products
Business model	Digitally-modified business	Number of digital augmented products
	New digital business	Number of new digital products
	Business globalization	Number of shared services
Finance	Digitally-integrated budgeting	Use of integrated budgeting tools
	Digital-related investments	Digital-related ROI
	Revenue from digital assets	Digital-related market valuation

The framework should register not only the current value of each indicator but also the intended value, so that a comparison can be made.

5.2.4 Digital Capabilities

As mentioned in section 5.2.1, there is no one-to-one mapping from performance indicators onto digital capabilities. Each capability can improve several indicators, and each indicator can be receive improving contributions from several capabilities. The same can be said about the relation between categories of concerns and capabilities.

Since this framework is essentially an example template, this section simplifies the issue and illustrates just one capability, or just a few, for each category. This list would have to be completed or adapted in an actual instantiation of this framework.

Table 11 shows these digital capabilities, obtained by analyzing the Digital Transformation literature.

Table 11 - List of examples of digital capabilities considered in the framework

Axis	Category	Digital Capability
Customers	Streamline the sale's process	Digital presentations
		Computer-Aided Selling
	Digital Interactions	Digital Interactions with customers
		Real-Time Recommendation Services
	CRM strategy	Customer relationship management
	Needs of the Digital consumer	Concept stores
	Online presence	Website
		Online presence management
		Search engine optimization strategy
		Digital reputation management
	Predictive marketing tools	Promotions
	Digital Marketing	Digital advertising
	Digital Interface with the clients	Service accounts
		Digital Commerce
		Cyber security
	Differentiate with digital community	Digital community
	Customer service	Social media
		Expert community online
	Touch point integration	Website and social media integration
	Cross-channel coherence	Omni-channel
	Self-service	Website services
		Mobile App services
	Socially-informed knowledge	Real-time reactions
		Understand social media trends
	Customer-analytics capabilities	Traffic and patterns
		Customer profiling
	Predictive Usage	Anticipate needs
Processes	ERP solution	Global, real-time view of data
	Process performance	Digital processes
		Workflow automation
	Operational transparency	Real-time data
	Data-driven decision-making	Data Analytics
Human resources	Networked workforce	Employee social networks
		Employee self-service system
	Virtualization of the workplace	Teleworking
	Community knowledge sharing	Knowledge system
	Dynamic partner ecosystems	Rewarding system
	Agile approaches	Agile support system
Suppliers	Digitally-enabled supply chain	Digital supplier management
	Digital supply chain enablers	Digital identification tags
Business model	Digitally-modified business	Product/service digitalization
		Digital Wrappers
	New digital business	New business models
		Digital Products/services
	Business globalization	Shared service model
		Cloud platforms
Finance	Digitally-integrated budgeting	Integrated analytics
	Digital-related investments	Business-IT alignment
	Revenue from digital assets	Digital traction & engagement

5.2.5 Initiatives

Initiatives are defined and executed to implement and/or acquire digital capabilities. Each initiative can contribute to the implementation of several capabilities, and each capability can receive implementation contributions from several initiatives, which is the scenario illustrated by this section. **Table 12** presents a list of initiatives, each contributing to one category.

Table 12 - List of examples of initiatives considered in the framework

Axis	Category	Initiative
Customers	Streamline the sale's process	Shift from paper-based information to tablet-based presentation
		Use of mobile tools to help sales people engage in analytics-based planning
	Digital Interactions	Shift from in-person interactions to digital interactions
		Implement recommendation services
	CRM strategy	Setting the destination
		Auditing the current situation
		Mapping the journey
	Needs of the Digital consumer	Concept stores as flagships for their digital selling innovations
	Online presence	Build a website
		Interacting through social media
		Improve our search engine optimization
		Promote digital reputation
	Predictive marketing tools	Products and services personalized promotions
		Integration of customer-purchasing data
	Digital Marketing	Identify the target market
		Optimize your website to convert maximum visitors
		Search Engine Optimization
		Clarifying business objectives for social media
		Paid Advertising
		Email Marketing
		Analytics & Reporting
	Digital Interface with the clients	Account in the business website
		Used of location-based services
		Embedded devices and RFID
		Security platform
	Differentiate with digital community	Customers providing opinions and suggestions
		Interaction with customers across every phase of business activities
		Creation of a virtual community
	Customer service	Expert community online
		Help customers through social media
	Touch point integration	Integration of all online presence
		Integration of the social media information into the website
		Aware of the shopping history through all platforms
	Cross-channel coherence	Use any platform to order and receive the product
		Omni-channel approach
	Self-service	Customer's profile linked to multiple touch points
		All services available in the website/app
	Socially-informed knowledge	Analyze real-time reactions through social media
		Monitoring and analysis of social media trends
		Exploring social media to understand what customers like and dislike
		Understand how to promote the brand through digital media
		Creation of an online community to advise and build loyalty

	Customer-analytics capabilities	Analyze audience traffic and patterns
		Identify complementary products to the ones customers buy
		Identify customer's profile/type accordingly to their purchase history
	Predictive Usage	Understand specific geographies and market segments
		Anticipate customer needs
		Pay per use
Processes	ERP solution	Development of an Enterprise Resource Planning solution
	Process performance	Digitization of operational processes
		Creation of an employee self-service systems
		Processes automation
	Operational transparency	Real data available
		Transactional systems give executives deeper insights
		Big data analytics to track product movements
	Data-driven decision-making	Incorporating Data Analytics into Decision-Making Processes
Human resources	Networked workforce	Social networking among employees
		Employees participating in online communities
	Virtualization of the workplace	Separation of the work process from the location of the work
		Mobile platforms
	Community knowledge sharing	Broad communication channels
		CxOs engaging in two-way communication
		Collaborating across different departments
	Dynamic partner ecosystems	Innovation should be rewarded
	Agile approaches	Agile approaches to work
Suppliers	Digitally-enabled supply chain	Ability to dynamically manage costs
		Flexibility to determine the best inventory allotments
		Using real-time data to find the best transport methods
	Digital supply chain enablers	Implement RFID tagging
Business model	Digitally-modified business	Digital Product/service augmentation
		Complement the traditional products
	New digital business	Design new business model
		Design digital products/services
	Business globalization	Integrate digital services
		Design cloud platform architecture
Finance	Digitally-integrated budgeting	Promote collaboration tools
	Digital-related investments	Increase digital-related investments
	Revenue from digital assets	Increase ratio of digital-related revenue

The framework should define how much each initiative is expected to contribute to each digital capability, as well as the current contribution (if not just all or nothing). Weights can be used to express the relative importance of contributions from different initiatives to the same capability.

Other information (which will probably vary along time) can be included in the definition of initiatives, such as:

- Dependencies on other initiatives (impacts their orchestration);
- Duration;

- Required resources (human, material, financial);
- Cost;
- Delay until it produces effects, after it finishes;
- Risk of not producing the intended effects, in terms of digital capabilities.

5.2.6 Digital Maturity Model

As discussed in section 4.1.4, this dissertation resorts to an indicator-based maturity model, rather than a process-based maturity model, since the Digital Transformation is still a young field, in which best practices have not settled yet and the benefits reaped from the Digital Transformation are the real outcome that organizations want to assess. In this case, state is more relevant than process.

Digital maturity, expressing how digital an organization currently is, as a result of its Digital Transformation, should assess the values of the performance indicators and which digital capabilities are implemented. The better these are, the more digitally mature an organization is.

In any case, the digital maturity model of the framework must be aligned with it, which means assessing the maturity of an organization by using the concepts of the framework, as described in section 5.2.1.

Digital maturity can be used in two senses:

- **Absolute**, to compare two different organizations. This requires that they are evaluated with the same set of performance indicators, digital capabilities, and so on. This is only possible for widely-used indicators and capabilities, part of a common core of the framework;
- **Relative**, to compare different stages of evolution of the Digital Transformation of a given organization. All the indicators and capabilities that are adequate for that organization can be used. In this case, level of maturity means degree of satisfaction of the intended Digital Transformation goals. Maturity can thus be expected to increase when initiatives are executed and digital capabilities implemented, and to decrease when new goals are set, requiring more, or better, capabilities and therefore more initiatives.

Conventional, process-based maturity models are scalar at the process level, with a single value that measures the maturity of each process. Organization-level maturity can be measured by a weighted average of the maturity values of the relevant processes.

In this framework, the basic concepts whose maturity can be measured are the performance indicators (quantitative maturity) and digital capabilities (qualitative maturity). These are intertwined in a graph of dependencies, since each capability can improve several indicators, and each indicator can be receive improving contributions from several capabilities. In addition, both can pertain to different aspects, categories and axes of Digital Transformation.

This means that the maturity model of this framework is inherently vectorial in nature, not scalar. The current maturity of an organization is a vector, considering the value of each variable that the framework contemplates (the value of each performance indicator, the implementation degree of each capability, and so on). This can be seen in absolute terms or relative to a comparable basis, as referred to above.

Compound maturities can be produced by using the weights that specify the relative importance of each of the variables, including of the aspects, categories and concerns to which they correspond. Governing bodies may check the degree of evolution of the Digital Transformation by observing partial or global maturity indicators, most likely in graphical form.

5.3 Methodology Proposed

This section describes the Digital Transformation methodology of this dissertation´s approach, according to the requirements enunciated by section 3.6 and in the light of the potential contributions from existing technologies considered in section 4.2.

5.3.1 Basic Structure of the Methodology and Methods

The methodology corresponds to the assessment phase of **Figure 13**, in which the current state of the transformation is assessed, by comparing it with the set of intended goals, and decisions are taken by the Digital Transformation governing bodies on what to do next.

This is a methodology because what is actually chosen is the method (sequence of steps to reach an intended state) to be taken in the rest of the Digital Transformation iterations of loop of **Figure 13**. Naturally, the method can be changed in each iteration, hence the need for continuous governance. These changes reflect inflexions in the strategy, new indicators, capabilities and initiatives to consider, new risks to factor in, and so on. The implementation phase can also bring some changes, namely concerning risks, which depend on how initiatives are implemented.

Like the framework, the methodology and the chosen methods must not constitute a prescriptive recipe to be blindly applied, but rather templates, open-ended, adaptable and extensible, which organizations can tailor to match their particular needs.

According to the requirements expressed in section 3.6, and without entering the discussion on best practices for Digital Transformation governance (not yet established in such a young field), the main components of the methodology and methods tackled by this dissertation are the following:

- **Initiatives**, the basic blocks of action that are able to implement or acquire digital capabilities that are crucial to support the Digital Transformation. Several constraints (dependencies on other initiatives, timeframe and available resources) influence the orchestration of the execution of the various initiatives;
- **Risks**, which take into account that not all foreseen outcomes will appear as smoothly as planned. Some initiatives will fail their goals and some digital capabilities will not produce the intended improvement on performance indicators. Risk management is needed to give more attention to the most critical issues;
- **Policies**, which indicate the preferred options on many aspects, including the order of implementation of the various aspects of the Digital Transformation. Which ones should be dealt with first? For example, should performance take precedence over minimization of risk?

- **Simulation**, an invaluable technique to decide which is the most favorable out of a set of possible scenarios.

5.3.2 Execution of Initiatives

Once the initiatives are decided upon, as a result of the methodology that sets up a strategy and goals, from which the necessary actions to take are defined, they need to be executed or, better said, orchestrated.

The execution of an initiative depends on the following factors:

- All the initiatives on which outcomes this one is dependent must have already been executed. Initiatives should be defined with care, to minimize dependencies and coupling;
- The necessary resources, both human and material, are available to be committed so that a given maximum duration is not exceeded;
- There is enough budget to support the initiative.

Assuming that the initiative is carried out, some capability will be implemented, fully or partially (if it requires contributions from several initiatives). Even after the capability is mastered, its effects will take some time to become visible, namely in the performance indicators affected by it. This delay needs to be taken into account when comparing results with expectations.

It is also important to realize that a given capability may require several initiatives before it becomes implemented and operational, which means that the delay can only start counting after the last contributing initiative finishes its execution.

When several initiatives are available for execution but there are not enough resources to execute all of them simultaneously, a choice needs to be made and policies are used by the governing bodies to take that decision.

Finally, the method cannot forget that there is the risk that an initiative cannot fully or correctly implement some digital capability, which means that the probability of failure and its potential impact need to be estimated.

5.3.3 Risks

Risks are explicitly contemplated by **Figure 13**. Initiatives may fail implementing capabilities, or these may not produce the intended improvements in performance indicators, impacting the outcome of the Digital Transformation in both cases.

Failures are the result of execution and concern the method, not the framework. However, the risk of each initiative-capability pair and of each capability-indicator pair, defined as the product of the potential failure impact by the perceived failure probability, can vary along time and therefore need to be registered in the framework structure.

In the method, there must be a provision for failure and what needs to be done in case it happens (sort of a plan B). When planning (eventually by resorting to simulation), expectations must be reduced, on average, to take into account that failures will inevitably happen, sooner or later, and therefore the expectation (the goals with what results are compared) cannot simply be the maximum possible (which assume that there will be no failures).

Each initiative should have defined the risk (probability and impact) of not implementing each capability for which it contributes, and each capability should have defined the risk (probability and impact) of not improving each performance indicator for which it contributes through the capabilities it implements.

Risk minimization is one of the possible policies, in which riskier initiatives and capabilities are left to the later stages of the transformation. This enables quicker and less riskier wins at the beginning of the Digital Transformation project.

5.3.4 Initiative Execution Policies

Many policies can be used in the governance processes, but this section deals only the policies regarding the order of execution of initiatives. Assuming that resources are available to start executing initiatives and that initiative dependencies allow several initiatives to start executing, which is the best order to execute them? This naturally assumes that available resources are finite and only a few initiatives can be carried out simultaneously.

One form of defining the initiative execution policies is to consider the axes, or areas of concern (section 5.2.2). For example, should the organization give more relevance to the business model, to customer relationship, or to internal process optimization? Then the following policies would be possible, with the justifications given:

- **Customers-first**. Customers are an organization's most important assets, therefore all initiatives destined to improve the customer experience should be executed first;
- **Processes-first**. Customer experience will be hampered by poorly or inefficiently designed internal processes, which means that internal process automation should be dealt with first and foremost;
- **Employees-first**. No organization can operate in good conditions without motivated and properly trained employees. Therefore, this should be the first aspect to consider in the Digital Transformation;
- **Suppliers-first**. Demand by customers cannot be satisfied without a well-designed supply chain. Therefore, to avoid bottlenecks in the value chain, the relationship with suppliers should take precedence;
- **Business Model-first**. The most rewarding measure is to reinvent the business model, after which customers will see great value in that model and will prefer this organization to its competitors, thereby increasing its market share and profit;
- **Financial-first**. Get the budget relevant for digital-related investments right as a top priority. The rest will follow naturally.

All these are valid reasons to take care of one are of concerns earlier than others, but whether they are effectively the best one will probably vary from case to case, and the choice may not be clear cut.

Another way to define the initiative execution policies is to consider the main components underlying the framework, which leads to policies such as:

- **Performance-first**. The initiatives that maximize the overall performance are executed first. This policy weights the contribution of each initiative to the implementation of capabilities, the contribution of each capability to the improvement of performance indicators, and the relative importance of these in the areas of concern to decide which initiatives improve performance faster and to execute them before the others;
- **Capabilities-first**. This policy considers that the best approach is to give priority to the initiatives that contribute the most to implement digital capabilities, since these are a requirement to make the organization more digitally mature;
- **Risk minimization-first**. The two previous policies do not assume failures, but these will inevitably happen, and their potentially negative effect should be minimized. In a probably less optimized way, but in a more safe way, risk minimization may the best policy to adopt. This means executing the least risky initiatives first. This will ensure quick and sure wins.

Again, all these policies make sense and the best one may vary from case to case. Simulation can provide insight to support decisions, since the effect of various policies can be assessed in various scenarios.

5.3.5 Simulation

To produce the desired effects, initiatives need to be executed and the indicators measured. However, how do governing bodies know whether risks are acceptable, which policies to adopt or even if the capabilities implemented are the right set to produce the intended improvements in the performance indicators?

Trial and error with the actual organization is not a good tactic, and a simulation of the execution of the Digital Transformation initiatives can provide insight on how to best proceed in a Digital Transformation, by taking **Figure 13** as basis and simulating different possible scenarios to help in the governance processes.

A simulation of the execution of the initiatives allows:

- To test various implementation policies, such as maximizing system maturity in terms of digital capabilities, maximizing performance indicators or minimizing risk. The various initiatives are prioritized according to the policies that the organization values the most, and those with higher priority are executed first;
- To discover emerging behaviors, arising from the interaction between the various factors and initiatives involved;
- To have a sense of the consequences of the risks involved;
- To obtain an overview of the evolution and results of Digital Transformation;

- To support governance decisions in a more informed way.

Techniques of Project Management Simulation, briefly described in section 4.2.2, should be applied to simulate the various relevant scenarios.

6 Demonstration: a Case Study

To understand how this dissertation's approach to Digital Transformation can be applied to a real-scenario context, a study was conducted on how to apply that approach to a project already under way at the "Ministério da Justiça", the Portuguese Department of Justice.

This corresponds to the Demonstration step of the Design Science Research Method (DSRM) [16], briefly described in section 1.5.

6.1 Obtaining Information from a Case Study

Applying the Digital Transformation approach proposed in this dissertation to an actual case study requires obtaining the necessary information from the organization to tailor the framework (section 5.2) and the methodology (section 5.3) to the organization performing a Digital Transformation.

The problem is that it is almost never easy to obtain the required information, in particular if the Digital Transformation is governed by consultants external to the organization and the elements of that organization do not have the knowledge on what is relevant to a Digital Transformation project. In addition, in many cases the organization has already taken some measures to improve its digital maturity before it recognizes the need to perform a true Digital Transformation, and that investment cannot be thrown away.

In these situations, a questionnaire may uncover the required information without explicitly requesting it by using Digital Transformation parlance. This is a way to bridge the contexts of consultants, who know how a Digital Transformation should be performed but not the details of the organization, and the organization, with employees that know how the organization is currently organized but may lack the necessary knowledge in the Digital Transformation field.

Table 13 presents a list of relevant questions, merely to illustrate how consultants can proceed to obtain the information they need to setup the framework and methodology without asking too many technical questions. This is not an exhaustive list but merely an example. In any case, the set of questions will have to be adapted to the concrete organization.

These questions must be answered by the organization's CIO, or by someone fulfilling the role of CDO (Chief Digital Officer), or even by someone else with good knowledge of the organization.

Table 13 - Questions to obtain information to tailor the framework and methodology

Q#	Question	Relevance and justification
1	What is the name of this project and how does it fit in the organization?	Context questions for project understanding.
2	What is the project scope?	
3	What are the main difficulties and problems that you intend to solve with the project?	Context question for project understanding. Could be useful to gather or infer relevant derivate data.
4	What are the main motivations for the development of the project?	
5	What are the areas of impact of the project?	Identification of the areas of action of the project (Customers, Processes, Human resources, Suppliers, Business Model).
6	What services does the organization offer?	Context question for project understanding, namely to identify potential silos and risks.
7	How transversal is the project in the organization?	
8	Which are the success criteria of the project?	Context question for project understanding, namely the relevant policies for the methodology and the performance indicators relevant to measure the organization's performance
9	Which are the strategic goals of the project?	
10	Which are the performance indicators most relevant to the project?	
11	Which are the digital capabilities that the organization's strategy has deemed relevant?	Gathering of the digital capabilities that the organization aims to implement. If necessary, add new relevant digital capabilities specific of the business.
12	What is the expected impact of each digital capability in each performance indicator?	Information relevant to determine how digital capabilities impact performance indicators
13	What is the current state of the project? Non-existing, in planning, in progress, or in conclusion phase?	Information for understanding the project status.
14	If in progress, what is the state of the project against the initial strategic goals?	Information for understand how complete the project is and its performance.
15	Which are the initiatives that have already been implemented and which ones are being planned?	Information for understand how complete the project is and which are the initiatives that were planned.
16	What is the estimated number of employees allocated to the project?	Required information for establish the number of workers available.
17	What are the eventual problems and risks that could affect the project success?	Relevant information to identify risks.
18	Which digital capabilities could suffer more resistance by employees and stakeholders?	Relevant information for capability risks. Resistance by employees and stakeholders lead to poor implementation of digital capabilities.
19	What are the project's temporal constraints?	Relevant information for decisions in the methodology. Could lead to the realization that more resources are needed to satisfy the temporal constraints.
20	Is there any additional constraint?	To collect any additional information not contemplated by the questionnaire.

6.2 The Case Study: "Ministério da Justiça"

Governments all over the globe realized the benefits of Digital Transformation and are trying to apply it to their public administrations, mainly to create digital services that are simpler, clearer and faster to use. Portugal is no exception.

The public services are now more digital than ever and the investment will continue. The Portuguese government expects to invest up to 477 million euros in the next four years, with expected benefits of 1.3 billion of euros [52].

Some of the recent Digital Transformation initiatives that aim to bridge the gap between the public administration and citizens, to reduce bureaucracy and to streamline the public sector processes, are Simplex+ 2017 [53] , the “e-factura” (electronic invoice) portal and “Plataforma Digital da Justiça” (Justice Digital Platform) [54]. This platform has brought together in one location, for the first time, a plethora of justice-related digital services.

The “Plataforma Digital da Justiça” project is being carried out by the “Ministério da Justiça”, the Portuguese Department of Justice, and constitutes the case study analyzed by this dissertation.

6.3 Interview at the “Ministério da Justiça”

There was no actual contribution from this dissertation to the “Plataforma Digital da Justiça”. The project has essentially finished one phase and has not yet started the next phase. The main objective of considering it in this dissertation is to check whether its approach to Digital Transformation subsumes what has been done in the “Plataforma Digital da Justiça” project or, on the other hand, lacks coverage of topics addressed by that project.

To collect the information required for this objective, the 20 questions of the questionnaire of **Table 13** were put to the project manager of the “Plataforma Digital da Justiça” project, Dr. Hugo de Sousa, an Advisor to the State Secretary for Justice, during a guided interview conducted at the “Ministério da Justiça”.

His answers were not always completely revealing, and in any case the project is essentially between phases (phase 1 is complete and not many details regarding its execution are still available, and details regarding phase 2 are not decided upon yet), but nevertheless a summarized transcription of his answers are presented below.

1. What is the name of this project and how does it fit in the organization?

The project selected was the “Plataforma Digital da Justiça – justiça.gov.pt” [55].

2. What is the problem scope?

The project is a digital platform that will allow citizens, the State, and companies, among others, to use justice services online. This platform will make available citizen data, statistics [56] *(in order to provide data transparency to the justice system), an explanation of how to use each of the offered services, of the legal jargon* [57]*, and of the statistics presented in a clear and comprehensible language. This platform can also be used to fill in requests and perform registrations.*

3. What are the main difficulties and problems that you intend to solve with the project?

This project aims to minimize the time and bureaucracy required to use services of the justice system, through the centralization of the many services available in one platform, and by being able to do the services online instead of through face-to-face interactions.

4. **What are the main motivations for the development of the project?**

There are many justice services that are online. However, the citizens and companies do not use them, either because they do not find the service useful (e.g. the services offered do not offer the solution required or the service is not properly designed) or are unaware of the service's existence.

5. **What are the areas of impact of the project?**

The area of impact is mostly the area of interaction with the user.

6. **What services does the organization offer?**

There are currently 69 available in the platform [58].

7. **How transversal is the project in the organization?**

The project is transversal to the entire "Ministério da Justiça", including other departments and Ministries.

8. **Which are the success criteria of the project?**

The success criteria of the project are the adherence of citizens and companies to the services and whether the services are well designed and implemented.

9. **Which are the strategic goals of the project?**

The strategic goals of the project are:

- *The improvement of the digital relationship between the citizens and the justice system;*
- *The improvement of the user experience in the justice digital services by the citizens, State, and companies, among others;*
- *The improvement of the level of operational excellence of the serviced offered;*
- *To potentiate the redesign of existent business models.*

10. **Which are the performance indicators most relevant to the project?**

The performance indicators of the project are:

- *How much the services are used;*
- *User satisfaction.*

In the future, the "Ministério da Justiça" plans on being able to understand the completeness rate of services, which means assessing whether users that start to use a service end up completing the use of the service instead of giving up, and use this as a performance indicator.

11. **Which are the digital capabilities that the organization's strategy has deemed relevant?**

Currently the project is at the end of its first phase. This phase resulted in a website with a plethora of services digitally enhanced. The digital capabilities implemented in that phase are presented in ***Table 14*** *(already converted to a format compatible with* ***Table 11****, to provide a common terminology):*

***Table 14** - Digital capabilities implemented by the first phase of the project*

Axis	*Category*	*Capability*
Customers	*Digital Interactions*	*Digital Interactions with customers*
	CRM strategy	*Customer relationship management*
	Online presence	*Website*
	Digital Interface with the clients	*Cyber security*
	Cross-channel coherence	*Omni-channel*
	Self-service	*Website services*
Processes	*Operational transparency*	*Real-time data*
	Process performance	*Digital processes*
Business model	*Digitally-modified business*	*Digital Products/services*
		Cloud platforms

Used cloud platforms are hybrid due to data confidentiality. Sensitive data are still stored locally in the "Ministério the Justiça", whereas the less sensitive data are stored in public cloud platforms.

In its second phase, the project aims to improve the services offered (including feedback from its users), to redesign all the justice services (some of the services were not updated since 2004, when they were launched), and to use a social media communication strategy.

***Table 15** expresses the digital capabilities to tackle in the second phase, anew or improved.*

***Table 15** - Digital capabilities to implement or to improve in the second phase of the project*

Axis	*Category*	*Capability*
Customers	*Digital Marketing*	*Digital advertising*
	Customer service	*Social media*
	Online presence	*Website*
	Touch point integration	*Website and social media integration*
	Cross-channel coherence	*Omni-channel*
	Self-service	*Website services*
	Socially-informed knowledge	*Real-time reactions*
	Socially-informed knowledge	*Understand social media trends*
Processes	*Operational transparency*	*Real-time data*
	Process performance	*Digital processes*
Business model	*Digitally-modify the business*	*Digital Products/services*
	Digitally-modify the business	*Cloud platforms*

In addition, there were other digital capabilities used for specific services but not the whole project, such as customer profiling, for improving knowledge of the citizen, and omni-channel between public services, without compromising data privacy protection.

12. **What is the expected impact of each digital capability in each performance indicator?**

Did not answer, for lack of information.

13. **What is the current state of the project? Non-existing, in planning, in progress, or in conclusion phase?**

The project is concluding its first phase. At the time of the interview (July 2017), the website and the services were developed but were still offline for further testing. Since August the website has been launched, more specifically its beta version.

14. **If in progress, what is the state of the project against the initial strategic goals?**

This information will only be available in January 2018.

15. **Which are the initiatives that have already been implemented and which ones are being planned?**

All planned initiatives have already been implemented.

16. **What is the estimated number of employees allocated to the project?**

Did not answer, for lack of information.

17. **What are the eventual problems and risks that could affect the project success?**

Resistance to change from all the people related to the justice system.

18. **Which digital capabilities could suffer more resistance by employees and stakeholders?**

Did not answer, for lack of information.

19. **What are the project's temporal constraints?**

Did not answer, for lack of information about phase two.

20. **Is there any additional constraint?**

Did not answer, for lack of information about phase two.

6.4 Analysis of the case study

The goal of considering this case study could not be to actually contribute to it, since in any case the interview described in the previous section occurred practically in the end of the timeframe allotted for the work that led to this dissertation, but rather to check whether the approach covered all the aspects tackled by the "Plataforma Digital da Justiça" project.

The main conclusions from this study are the following:

- All the main areas of concern and more detailed categories of aspects mentioned by the project manager were contemplated in the framework proposed in section 5.2.2, **Table 9**. A few specific aspects were mentioned for some selected services, which shows the advantage of having an extensible framework;

- The same can be said about digital capabilities, although the project manager sees them more as objectives (functionality provided by services) than as tools or necessary steps to achieve the intended values of performance indicators;
- The indicators defined by the project manager were very few and subjective. Clearly, the project is driven by functionality and not by performance improvement, which is not alien to the fact that the organization provides public services and does not operate on a market with competitors. Its main goal regarding Digital Transformation is to provide more and better services, not increase its market share or profit;
- Risk and project management seem to have been dealt with implicitly in the usual way, not specifically with a Digital Transformation mindset;
- Services seem to be based on a best-effort approach, although following basic Digital Transformation tenets such as adopting a customer-centric philosophy, improvement of internal processes, and a business model based on service integration, transparency and self-service, have been adopted right from the beginning of the project.

In the current context, in which established methods and best practices do not yet exist, it is no surprise that the project could not have used a systematic approach to Digital Transformation such as the one proposed by this dissertation, involving a detailed framework and a methodology. A concrete problem, with the need of a solution as fast as possible, leave almost no margin to invent innovative approaches and to build adequate tools.

One of the goals of considering this case study was the possibility of classifying the maturity of its Digital Transformation. However, when considering the possibilities for the digital maturity model (section 5.2.6), the following problems arose:

- **Absolute**, to compare two different organizations. There is no standard or at least a common set of capabilities that can be used as basis for comparison. Each Digital Transformation case is different and therefore any comparison of maturities would not be meaningful;
- **Relative**, to compare different stages of evolution of the Digital Transformation of the "Plataforma Digital da Justiça" project. Here, the difficulty lies in obtained the detailed information, since phase 1 of the project has not been executed with this dissertation's framework in mind, namely explicitly considering digital capabilities and iterative assessment, and phase 2 has not started yet. In addition, not all capabilities defined by the framework in **Table 11** are being considered, since they are not part of the strategy. The digital capabilities actually considered are described in ***Table 14*** (phase 1) and ***Table 15*** (phase 2), and at least at the end of phase 1 all the digital capabilities of ***Table 14*** had been implemented.

Nevertheless, the author of this dissertation felt that the experience was very enlightening and instructive, since it provided contact with an actual Digital Transformation project and gave a strong feeling that the framework, methodology and simulation tool (section 7.2.2) proposed in this dissertation could provide a more structured and systematic way of approaching future Digital Transformation projects.

7 Evaluation

According to the Design Science Research Method (DSRM) [16], briefly described in section 1.5, the acceptance of any proposal or research work requires that its efficacy and effectiveness are evaluated (Evaluation step of **Figure 3**).

Unfortunately, the complexity and breadth of the theme of this dissertation preclude an evaluation based on results from actually concluded Digital Transformation projects, namely the case study described in section 6, at least not in the available timeframe (one year).

Therefore, this dissertation evaluates the proposed approach in two different ways:

- A comparative study between this dissertation's proposal and existing approaches;
- Presentation of a Digital Transformation simulation tool and of the obtained results, in the line of section 5.3.5.

7.1 Comparison with Current Approaches

As stated in section 4.1.1, the existing Digital Transformation approaches were the starting point to elaborate a list of areas of concern and categories of aspects (section 5.2.2), as well as a list of digital capabilities (section 5.2.4), relevant to Digital Transformations. These lists have been completed with ideas and contributions from many publicly available formal papers, whitepapers and web sites. **Table 16** compares the coverage of areas of concern (axes of the framework), of categories of aspects, and of digital capabilities by each of the main existing approaches with that of this dissertation's framework.

Table 16 – Coverage of the capabilities of the proposed framework by existing Digital Transformation approaches

Axis	Category	Digital capability	Capgemini (section 2.2.1)	BCG (section 2.2.2)	IBM (section 2.2.3)	Cognizant (section 2.2.4)
Customers	Streamline the sale's process	Digital presentations	√			
		Computer-Aided Selling	√			
	Digital Interactions	Digital Interactions with customers	√			
		Real-Time Recommendation Services	√			
	CRM strategy	Customer relationship management	√			√
	Needs of the Digital consumer	Concept stores	√		√	
	Online presence	Website	√		√	
		Online presence management				
		Search engine optimization strategy				
		Digital reputation management	√			
	Predictive marketing tools	Promotions	√		√	√
	Digital Marketing	Digital advertising	√	√	√	√
	Digital Interface with the clients	Service accounts				
		Digital Commerce	√		√	√
		Cyber security				

	Differentiate with digital community	Digital community	√		√	√
	Customer service	Social media	√		√	√
		Expert community online	√			
	Touch point integration	Website and social media integration	√		√	√
	Cross-channel coherence	Omni-channel	√		√	√
	Self-service	Website services	√		√	√
		Mobile App services	√		√	√
	Socially-informed knowledge	Real-time reactions			√	
		Understand social media trends				√
	Customer-analytics capabilities	Traffic and patterns	√		√	
		Customer profiling	√			√
	Predictive Usage	Anticipate needs			√	√
Processes	ERP solution	Global, real-time view of data	√		√	√
	Process performance	Digital processes	√			√
		Workflow automation	√			√
	Operational transparency	Real-time data	√		√	
	Data-driven decision-making	Data Analytics	√	√		√
Human resources	Networked workforce	Employee social networks			√	
		Employee self-service system	√		√	
	Virtualization of the workplace	Teleworking	√			√
	Community knowledge sharing	Knowledge system	√		√	√
	Dynamic partner ecosystems	Rewarding system		√	√	√
	Agile approaches	Agile support system		√		√
Suppliers	Digitally-enabled supply chain	Digital supplier management		√	√	
	Digital supply chain enablers	Digital identification tags		√	√	
Business model	Digitally-modified business	Product/service digitalization	√	√	√	√
		Digital Wrappers	√	√	√	√
	New digital business	New business models	√	√	√	√
		Digital Products/services	√	√	√	√
	Business globalization	Shared service model	√		√	
		Cloud platforms				√
Finance	Digitally-integrated budgeting	Integrated analytics				
	Digital-related investments	Business-IT alignment				
	Revenue from digital assets	Digital traction & engagement				

The comparison of the coverage of the different capabilities of this dissertation framework by the four existing approaches can also be expressed in graphical form, as shown in **Figure 14**.

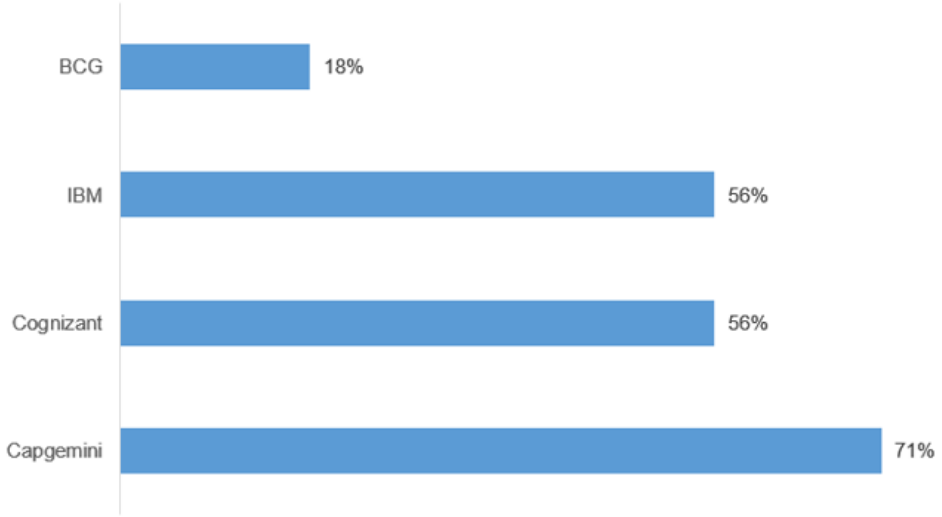


Figure 14 – Coverage of digital capabilities by existing approaches

The Capgemini approach is the most comprehensive (lacking 29% of capabilities), with IBM's and Cognizant's somewhat behind (missing 44%). The BCG framework seems to be the least complete (not catering for 82% of capabilities), but the only existing one that takes into account the possibility of different departments within the organization being digitalized separately and in different areas. This dissertation also caters for this possibility, by defining initiatives accordingly, but in any case a Digital Transformation project needs to take an as much transversal perspective as possible, including all departments the organization, to avoid asymmetries that hamper reaping the benefits from the organization.

In any case, the list of relevant digital capabilities of **Table 16** is not an exhaustive one (the framework is open-ended), and there are aspects and capabilities that are not covered by any approach, such as:

- Search engine optimization strategy;
- Online presence management;
- Service accounts;
- Cyber security.

It is just impossible to cater for all conceivable digital capabilities. In addition, the evolution of technology implies that new relevant digital capabilities keep popping up.

Besides general coverage of digital capabilities, these Digital Transformation approaches can also be compared by the coverage of areas of concern, or axes of this dissertation's framework (section 5.2.2). **Figure 15** expresses this comparison, in which in fact is a set of several versions **Figure 14**, one for the set of categories of each area of concern. Finance is not included, since neither of the existing approaches consider it explicitly.

However, the most interesting evaluation is the comparison of the principles underlying a Digital Transformation approach, as advocated by this dissertation. Which principles and basic features do existing approaches support? **Table 17** expresses the answer to this question. Only the IBM approach covers some of this dissertation's underlying principles.

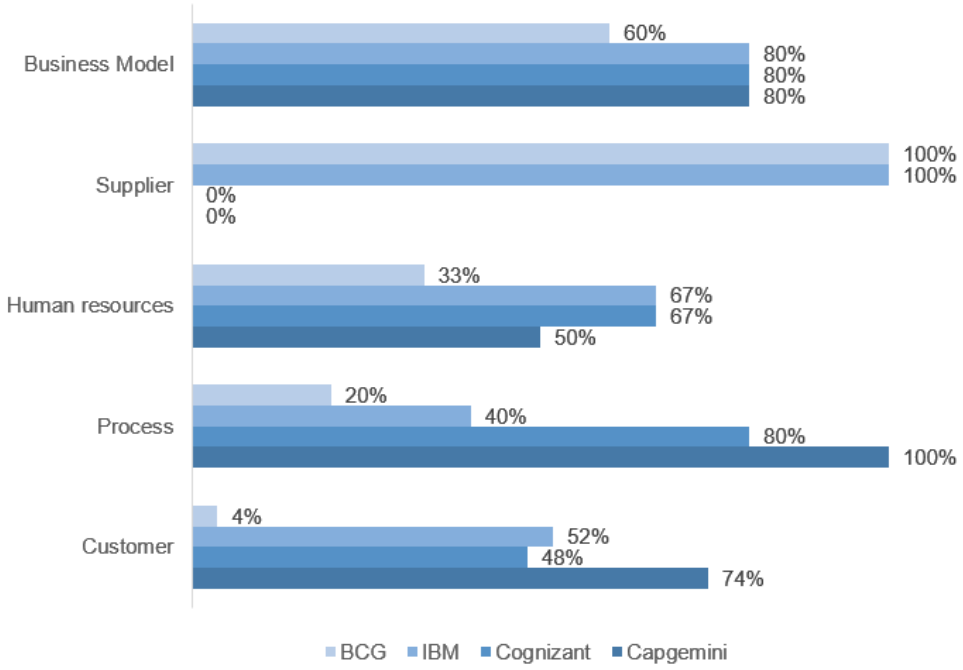


Figure 15 – Coverage of areas of concern by existing approaches

Table 17 – Comparison of coverage of principles and features supported by the Digital Transformation approaches

	This dissertation	Capgemini (section 2.2.1)	BCG (section 2.2.2)	IBM (section 2.2.3)	Cognizant (section 2.2.4)
Separation Framework/Method	Yes	No	No	Yes	No
Methodology	Yes	No	No	Yes	No
Detailed stages of the Digital Transformation	Yes	No	No	Yes	No
Identification of the current stage of the Digital Transformation	Yes	No	No	Yes	No
Allows different polices	Yes	No	No	No	No
Maturity Model	Yes	No	No	No	No
Explicit support for governance	Yes	No	No	No	No
Has performance indicators	Yes	No	No	No	No
Simulation tool	Yes	No	No	No	No

The overall conclusion of this section is that the approach proposed by this dissertation is more complete and provides better support to the relevant Digital Transformation principles than the existing approaches, at least according to the documentation that is publicly available.

It is expectable that many of the issues presented in this dissertation's approach will have to be dealt with when performing a Digital Transformation using an existing approach, but having them laid out explicitly, in an open-ended but systematic approach, seems to constitute a better path towards the development of best practices in the Digital Transformation field.

7.2 Digital Transformation Simulation

Simulation has the advantage of quickly getting results without the effort, time delays and risks of an actual implementation. How meaningful these results are depend on the underlying simulation algorithm and how faithfully the features covered reproduce real-life Digital Transformations, but in any case they favor the organization of information and the graphics they typically produce are helpful to understand how the various factors involved interact.

7.2.1 Are Balanced Scorecard Simulators Useful in this Context?

BSC simulators exist and have been used as a valuable strategic management tool. Since this dissertation proposal takes the performance indicators of BSC as one of its roots, these simulators were initially considered as the tool this dissertation needed.

It turns out that these simulators are only adapted for their purpose, supporting only the definition of performance indicators. They are unable to cater for the multitude of information needed for Digital Transformation, including digital capabilities and policies concerning the order of execution of initiatives. For example, the simulator of the Harvard Business School [59] is merely used for teaching strategic management and [60] performs simulations with just statistical business data.

In any case, BSC is focused on the strategic goals of the organization and whether the operation is meeting the organization's strategy and goals. It does not specify which are the steps required to reach the established strategic goals, and risks can only be tackled by specifying additional indicators, instead of assigning a risk factor to each performance indicator.

The proposal of this dissertation is focused precisely on what should be done to reach those goals, through Digital Transformation. The performance indicators are included, but the proposal also contemplates digital capabilities and the digital maturity they bring, which initiatives need to be carried out and risks throughout the framework.

With this assessment, the conclusion has been that a specific simulator for Digital Transformation was needed. It should be stressed out that a search for simulators in this field revealed no existing tools or even papers on them.

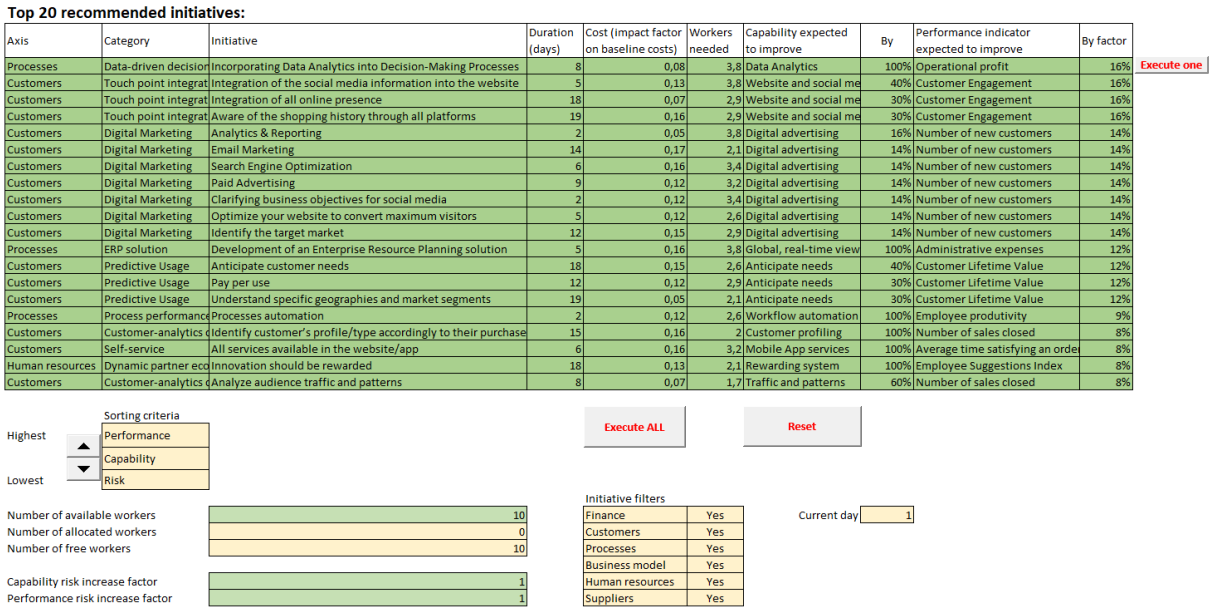
7.2.2 A Digital Transformation Simulator

This section describes a simple Digital Transformation simulation tool, based on Microsoft Excel, which implements the various principles and features proposed by this dissertation and described in previous sections.

The Excel file has several worksheets, described in more detail in Appendix A. The basic use of this tool can be described by the following sequence:

1. The framework information needs to be provided. This means filling in the areas of concern (axes), categories of aspects, performance indicators, digital capabilities, initiatives, and risks, including detailed information on each of these items;
2. Global data needs to be provided, such as the number of people available to execute the initiatives and the policy regarding initiative execution (performance-first, customer-first, or risk minimization-first);
3. Execute all the initiatives as a batch, by pressing a button (which executes Excel macros);
4. Analyze the various graphics produced;
5. If needed, reset the system to its state before the execution, again by pressing a button, and start again from step 2, if a new execution policy is to be tested, or even from step 1, if any definition needs to be changed.

The main worksheet is the Dashboard, shown in **Figure 16**, seen before starting the simulation.



Top 20 recommended initiatives:

Axis	Category	Initiative	Duration (days)	Cost (impact factor on baseline costs)	Workers needed	Capability expected to improve	By	Performance indicator expected to improve	By factor
Processes	Data-driven decision	Incorporating Data Analytics into Decision-Making Processes	8	0,08	3,8	Data Analytics	100%	Operational profit	16%
Customers	Touch point integrat	Integration of the social media information into the website	5	0,13	3,8	Website and social me	40%	Customer Engagement	16%
Customers	Touch point integrat	Integration of all online presence	18	0,07	2,9	Website and social me	30%	Customer Engagement	16%
Customers	Touch point integrat	Aware of the shopping history through all platforms	19	0,16	2,9	Website and social me	30%	Customer Engagement	16%
Customers	Digital Marketing	Analytics & Reporting	2	0,05	3,8	Digital advertising	16%	Number of new customers	14%
Customers	Digital Marketing	Email Marketing	14	0,17	2,1	Digital advertising	14%	Number of new customers	14%
Customers	Digital Marketing	Search Engine Optimization	6	0,16	3,4	Digital advertising	14%	Number of new customers	14%
Customers	Digital Marketing	Paid Advertising	9	0,12	3,2	Digital advertising	14%	Number of new customers	14%
Customers	Digital Marketing	Clarifying business objectives for social media	2	0,12	3,4	Digital advertising	14%	Number of new customers	14%
Customers	Digital Marketing	Optimize your website to convert maximum visitors	5	0,12	2,6	Digital advertising	14%	Number of new customers	14%
Customers	Digital Marketing	Identify the target market	12	0,15	2,9	Digital advertising	14%	Number of new customers	14%
Processes	ERP solution	Development of an Enterprise Resource Planning solution	5	0,16	3,8	Global, real-time view	100%	Administrative expenses	12%
Customers	Predictive Usage	Anticipate customer needs	18	0,15	2,6	Anticipate needs	40%	Customer Lifetime Value	12%
Customers	Predictive Usage	Pay per use	12	0,12	2,9	Anticipate needs	30%	Customer Lifetime Value	12%
Customers	Predictive Usage	Understand specific geographies and market segments	19	0,05	2,1	Anticipate needs	30%	Customer Lifetime Value	12%
Processes	Process performance	Processes automation	2	0,12	2,6	Workflow automation	100%	Employee produtivity	9%
Customers	Customer-analytics c	Identify customer's profile/type accordingly to their purchase	15	0,16	2	Customer profiling	100%	Number of sales closed	8%
Customers	Self-service	All services available in the website/app	6	0,16	3,2	Mobile App services	100%	Average time satisfying an orde	8%
Human resources	Dynamic partner eco	Innovation should be rewarded	18	0,13	2,1	Rewarding system	100%	Employee Suggestions Index	8%
Customers	Customer-analytics c	Analyze audience traffic and patterns	8	0,07	1,7	Traffic and patterns	60%	Number of sales closed	8%

Execute one

Sorting criteria

Highest

Performance

Capability

Risk

Lowest

Execute ALL

Reset

Number of available workers	10
Number of allocated workers	0
Number of free workers	10
Capability risk increase factor	1
Performance risk increase factor	1

Initiative filters

Finance	Yes
Customers	Yes
Processes	Yes
Business model	Yes
Human resources	Yes
Suppliers	Yes

Current day 1

Figure 16 - The dashboard of the simulator

This worksheet shows relevant information on the 20 highest priority initiatives, according to the sorting criteria for the execution of initiatives. This expresses the policy adopted (section 5.3.4), which can execute first the initiatives that have higher performance gains, improve digital capabilities faster or minimize risk. This list of initiatives is presented as a suggestion to support governance decisions.

Initiatives can be filtered by area of concern (customers, processes, business model, and so on), so that only the improvements from that area of concern are analyzed.

The total number of available workers (a global limitation that prevents all initiatives from executing simultaneously) is also specified here. An initiative only starts to be executed once there are enough workers available to execute it and if no higher priority initiative is ready for execution.

It is possible to execute one initiative at a time (there is another button for that), but this usually does not produce identical results as executing all initiatives in batch (subject to workers' availability and other constraints), since in the former case an initiative executes completely before any other starts. In batch

execution, the initiative execution periods overlap and the order of execution can vary with execution policy.

After executing all the activities in batch, the simulation ends and the “Current day” cell reflects the last day of simulation, which corresponds to the project duration.

Appendix A provides more information on this tool.

7.2.3 Setting up the Simulation Definitions

To provide an example of what a simulation tool can do with the approach to Digital Transformation presented in this dissertation (framework and methodology), the Excel file was setup according to **Table 10**, **Table 11**, **Table 12**, and everything that has been proposed for the framework, as described in section 5.2. This entails the following:

- 33 categories of aspects, 33 performance indicators (one for each category, for simplicity), 49 digital capabilities, and 78 initiatives were defined;
- Weights were defined for the contribution of each initiative to the capabilities that it helps implement and for the contribution of each digital capability to improve the performance indicators that it affects;
- Risks were also defined, with a given probability and impact, for each initiative (failure in implementing a digital capability) and for each digital capability (failure in improving a performance indicator);
- In addition, for each initiative, the number of workers required to execute it, a duration, and a delay (until its result produces effects) were also defined. The tool supports the specification of a cost and of dependencies on up to two other initiatives, but for simplicity these features were not used in the simulation;
- 10 people were specified as working full time on the Digital Transformation project. As soon as enough manpower is free, the next initiative can start being executed;
- Finally, the relative order of relevance of initiative execution policies (Performance-first, Capability-first or Risk minimization-first) is specified. These are the main variability factors in the simulation, assuming that everything else stays the same. In a real project, all information items can be treated as variables, such as for example risk. To avoid changing risk individually in each initiative, the dashboard allows to provide a factor that is multiplied by all risks (separately for performance risks and capability risks), thereby enabling experimenting with higher risks in an easy way.

All this is a lot of information, but any Digital Transformation is a complex project. To extract insightful information from the simulation tool, it is necessary to populate its definitions with meaningful, detailed, and appropriate information on that project. The quality of the simulation results is only as good as its input. If difficulties arise in obtaining this information, a questionnaire such as the one described in **Table 13** can be used to ease the process.

In any case, it should be stressed that any organization not able to provide the information required by the simulator should probably not embark on a Digital Transformation but rather tackle a mere digital optimization (section 2.1.2) project. An actual implementation of a Digital Transformation project will require even much more detail than the information required by the simulator.

7.2.4 Simulation Results

Once the simulator has been set up with the necessary information, the simulator is able to give an estimation of several parameters, such as the total duration of the execution of the initiatives and the use of available manpower.

Figure 17 shows the evolution of the use of manpower along the project, with a limit of 10 simultaneous workers. There are some inefficiencies, resulting from the fact that enough human resources must be free to start a new initiative. The duration of the project (execution of all the initiatives) in the simulation of this example was 267 days. With less manpower, it would take naturally longer. Note the absence of manpower in the last days. The initiatives finish around day 230, but there are delays until the performance indicators can be read (to allow the outcomes of initiatives to take effect), and therefore only after these the Digital Transformation simulation can be considered complete.

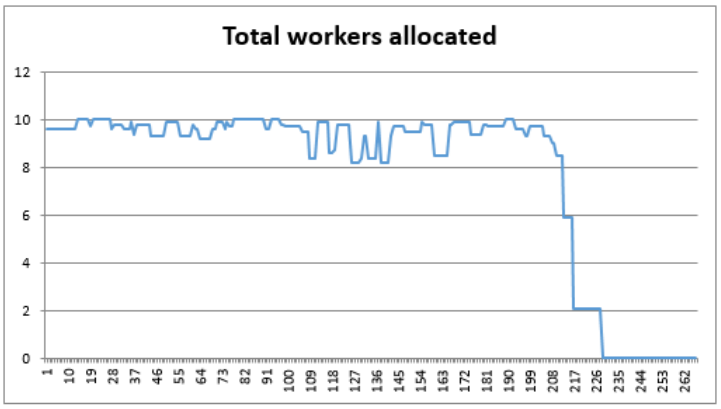


Figure 17 – Evolution of the allocated workers along the simulation time

Several simulations were performed, by varying the relative order of relevance of initiative execution policies, as described above. The duration of the project can vary slightly with the order of execution of the initiatives.

Figure 18 shows what happens if the priority (relevance) of risk minimization is the lowest (**Figure 18**, left), middle (center) or the highest (right).

If risk is not a big concern, then quick-win initiatives get executed first, and those with greatest improving potential tend to also be the riskier. This means that the risk is initially higher, as shown in the left of **Figure 18**. The problem with this policy is that initiatives fail more in the early stages of the Digital Transformation, which may constitute a demotivating factor.

If, on the contrary, risk minimization is a very important factor, then probably the best is to execute initiatives with lower risk first, so that the Digital Transformation project gets an easier start. This is why the risk accumulates at the end of the project, in the right part of **Figure 18**.

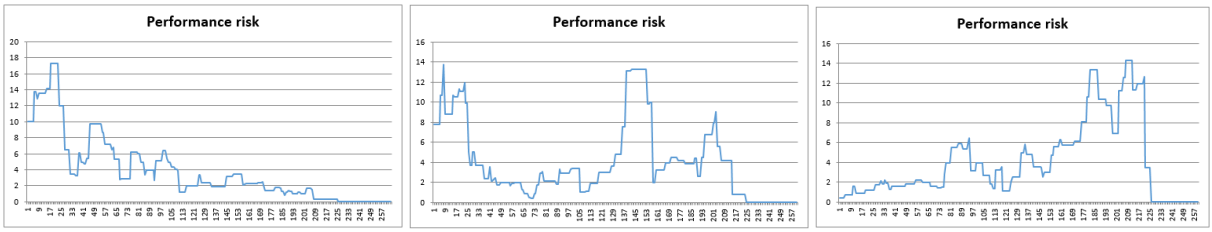


Figure 18 – Daily evolution of the performance risk, with increasing care (from left to right) of risk minimization

Figure 19 presents a similar perspective, but now concerning an overall performance indicator, by performing a weighted average of all the performance indicators, using the relative weights of categories of aspects within areas of concern and between areas of concern themselves.

The underlying idea is that using the performance optimization policy at an increasing priority increases overall performance faster, as **Figure 19** shows. Note that the final values will be similar, since these policies only affect the order of execution of the initiatives.

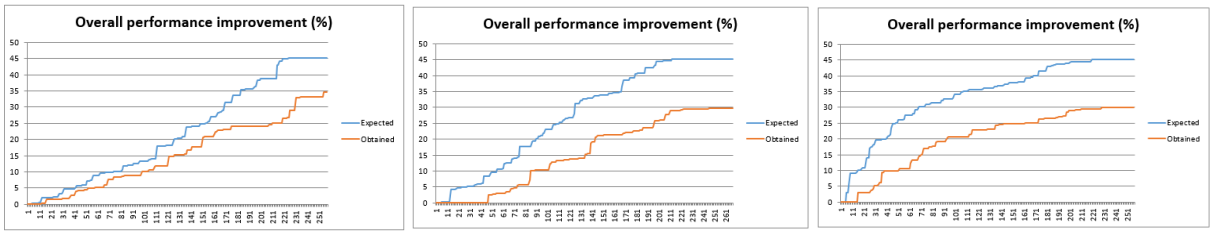


Figure 19 - Daily evolution of overall performance, with increasing priority (from left to right) given to performance optimization

Note that the lower curves, which express the obtained indicators, exhibit lower performance values than those expected, shown by the higher curve. This is due to the assumed risks. Some initiatives may fail implementing capabilities or some capabilities may not produce the intended effects. The fact is that some performance indicators are not as improved as intended, as shown by **Figure 20** (left), in which performance indicators 10 and 25 were not improved at all, and several others were only partially improved (some contributions to the improvement worked, others didn't). In fact, in this example only the financial indicators performed as expected, as **Figure 20** (right) shows in radar form, by axis.

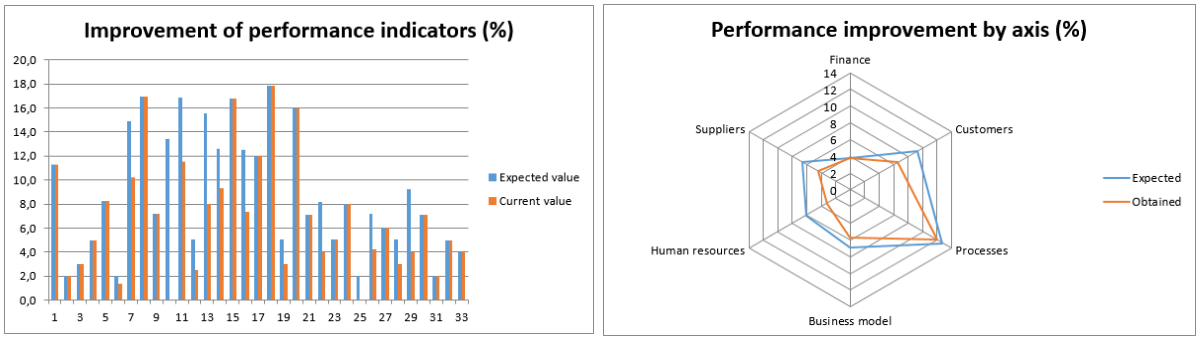


Figure 20 – Improvement in performance indicators, expected and obtained

Figure 21 is similar to **Figure 19**, but now concerning an overall capability achievement indicator, obtained by performing a weighted average of all the indicators that express how much of a digital

capability has already been implemented (from 0 to 100%), using the relative weights of digital capabilities, categories of aspects and areas of concern.

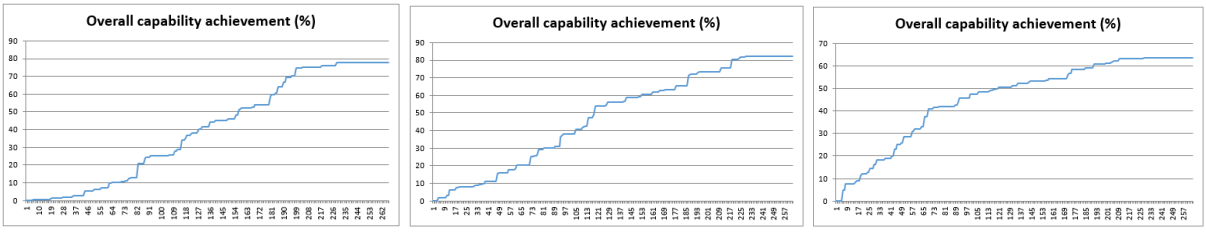


Figure 21 - Daily evolution of overall digital capability achievement, with increasing priority (from left to right) given to digital capability implementation

Again, implementation of digital capabilities progresses faster if this is the topmost priority (right of **Figure 21**), but performance and risk may be affected by this.

Risks are precisely the cause of not achieving 100% in all digital capabilities, as shown by **Figure 22** (left), in which several capabilities were implemented with just partial success and others failed completely. In fact, in this example only the human resources capabilities were implemented successfully as expected, as **Figure 22** (right) shows in radar form, by axis.

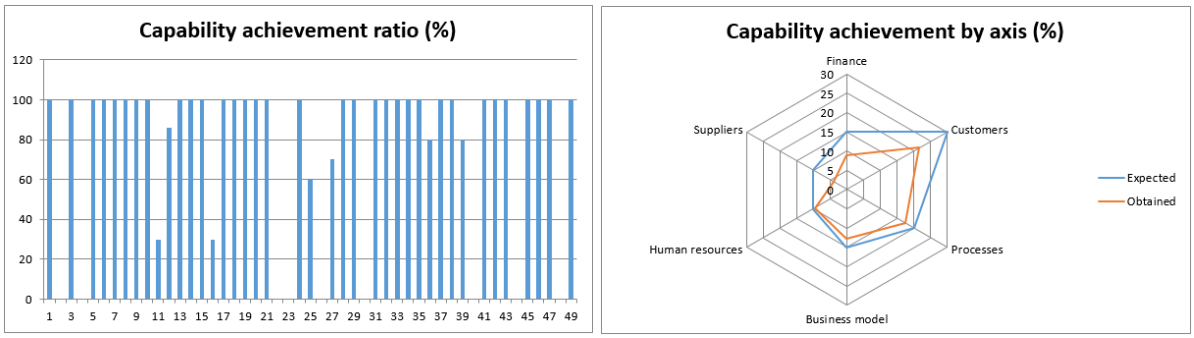


Figure 22 – Capability achievement, expected and obtained

Finally, the simulator is also able to express the expected contribution of each capability to overall performance, as shown in **Figure 23**, thereby visually identifying the most relevant digital capabilities.

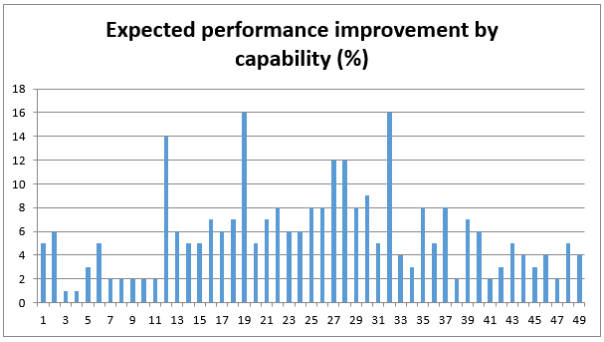


Figure 23 – Expected contribution of each digital capability to overall performance

Naturally, all this is just simulation and analysis material for the governing bodies that are responsible for taking decisions. Nevertheless, all these results are consistent and not unexpected, which not only contributes to assess the validity of the algorithms used but also the usefulness of simulation as a decision-support tool.

8 Conclusion

The work underlying this dissertation has been long but rewarding, and knowledge has been accumulated. It was definitely worthwhile taking on the challenge of working in the Digital Transformation field.

8.1 Lessons Learned

The goals of someone embracing the challenge of producing a dissertation are essentially acquiring more knowledge and, if possible, contributing in some way to the development of the field under study.

Potential contributions are enumerated in the following section and only the future can determine the true practical value of the proposals made, but certainly there were some lessons learned, in particular:

- Digital Transformation is a complex field. It deals with organizations and their environments, governance and strategic management, not to mention the alignment between business, technology, processes and people. It is not a matter to take lightly;
- Young a field as it is, there is a clear lack of common terminology and best practices. Naturally, only time and experience will allow these issues to settle by general acceptance;
- Existing approaches to Digital Transformation are widely varied, with each approach concentrated on partial views of the problem. It is very difficult to establish a common set of aspects to consider on a Digital Transformation project;
- Existing approaches seem to constitute more a list of general advices and guidelines than a methodic and systematic list of steps to take and a set of parameters that describe in detail how the transformation is progressing;
- None of the existing approaches defines in detail which information should be used to describe the current state of the transformation. Maturity models are too general for this;
- Most of the existing approaches do not separate state from behavior, in what the Digital Transformation is concerned. One thing is the state of the transformation, with all the information that it implies. Another is the decisional mechanisms of governance, based on that information, and still another is the management of the actions deemed necessary to execute. Clearly, framework (in the definition of section 3.4) must be separated from methodology;
- Classic governance and management standards and frameworks, such as ISO/IEC 38500 and COBIT 5, are process based. What they evaluate is the quality of processes, not of the result. The problem is that well-designed processes require the existence of best practices, which is not the case of Digital Transformation processes, which are still largely dependent on the consultants that help performing the Digital Transformation. This means that, at least for now, improvement of performance indicators are a better way of assessing whether and how much the Digital Transformation succeeded;

- Project management simulation is a common technique to assess whether projects are being executed in the right way, which is something that Digital Transformation projects also need. However, this is not classical project management, since the goal is not simply to optimize execution time and resource use, under constraints. The main goal of Digital Transformation is to improve performance by improving digital capabilities, and these concepts need to be introduced in the project simulation. Currently, there are no simulators that do this, which constitutes a relevant limitation.

8.2 Contributions of this dissertation

The purpose of this dissertation has been to tackle all these issues, in a necessarily limited and exploratory way. It is the hope of the author of this dissertation that some contributions have been made to the systematization and to the body of knowledge of the Digital Transformation field that fulfil the initial goals enunciated in section 1.4, namely:

- The principle of a systematic and reproducible approach to Digital Transformation, with separation of framework (describing state) from methodology (describing behavior, and choice thereof);
- The principle of a structured, strategy-oriented and extensible framework, defined from the vision, strategy and goals by converting goals into objectives and performance indicators, these into requirements for digital capabilities and these into requirements for initiatives, not forgetting risk. All these concepts can be extended and tailored for the case at hand;
- The principle of maturity assessment by indicators, rather than processes, justified by the turbulent nature of a transformation, in which transforming best practices have not matured yet;
- Demonstration that the proposed framework subsumed all relevant digital transformation aspects considered by a real digital transformation project, providing some indication that it can be effective in a real-case scenario;
- Demonstration of the basic features that a tool for Digital Transformation simulation should possess, and of the type of results it can produce.

Hopefully, these contributions can help governance and management to produce better and more informed strategy and decisions, supporting Digital Transformation actions with a greater probability of success.

8.3 Communication

This is the last guideline of the Design Science Research Method (DSRM) [16], as described in section 1.5 (**Figure 3**), and ideally would involve at least a research or professional publication, which would have constituted another contribution of this dissertation.

However, and although all the topics discussed and proposed in this dissertation could provide enough material for a research publication, the sort timeframe of the dissertation development and the time

needed to submit and have accepted a publication in a journal or conference precluded achieving this goal.

This means that the Communication guideline of DSRM is limited to this dissertation and to the accompanying article.

8.4 Limitations of the approach

Open-ended as it is, the proposed framework does not constrain which areas of concerns, aspects, indicators, capabilities, initiatives or risks should be considered. The principles and mechanisms seem general enough, starting by considering performance indicators as detailing goals, derived from strategy, from indicators deriving required digital capabilities, and from those define the necessary initiatives to implement them.

At the moment, there seems to be no need of another concept in this pipeline of development of a Digital Transformation framework. Although the case study described in section 6 gave no hint of such need, since everything done in that transformation project was contemplated by this dissertation's Digital Transformation framework, the fact is that this framework was not actually used to support a real Digital Transformation project, and this in itself constitutes a limitation that only future work can overcome.

In terms of methodology, this dissertation did not go as far as in the case of the framework, which constitutes another limitation of this work. However, this dissertation cannot cover everything, and clearly the framework needs to be developed first, so that the methodology has the basic information structure on which to base its decisions.

The simulation tool is limited, in not only its possibilities but most of all in its interface. A true Digital Transformation support tool should store its information in a database and include functionality to remove the limitations of the Excel file, in terms of the relations of indicators, capabilities and initiatives, specification of the properties and features of each of these concepts, the way in risks are specified, user interface, and so on. The Excel file was a (not so) simple solution to be able to perform simulations without having to program a full-fledged Digital Transformation simulator.

However, the limitations of the simulator are not limitations of the approach, but merely of one slant of its implementation.

Hopefully, many of these limitations will be overcome by future work, namely more dissertations in the Digital Transformation field.

8.5 Future Work

Digital Transformation is such a young field that simply there is no shortage of innovations to tackle and things to do. In what this dissertation is concerned, the work now started can progress along the following lines of research:

- Analyze more case studies, preferably in companies in the private sector, in which many factors are more stringent, such as competition and market share. There is the need to validate and complete the information of the framework, namely areas of concern, categories of aspects, individual aspects, indicators and capabilities. The ideal would be to use this approach as a decision-support system of an actual Digital Transformation project;
- Elaborate a set of best practices for Digital Transformation, for both governance and management, in an effort to evolve from the simple methodology proposed in this dissertation;
- Continue to analyze the relevant literature, both formal and online (whitepapers, blog posts, webinars, etc.) since more and more complete Digital Transformation approaches will appear, as the field develops;
- Design and develop a better simulation tool for Digital Transformation, now converted into a decision-support tool for Digital Transformation. This can take what has been developed with the Excel file as a starting point, but now with a database and a proper user interface;
- Develop a global maturity model for Digital Transformation, which enables to classify organizations under a common classification scheme, and improve the relative maturity model that enables an organization to assess the evolution of its Digital Transformation projects and identify the areas that need most attention;
- Define magical quadrants, Gartner style [40], to express the rating of organizations regarding the correlation between Digital Transformation concepts (for example, correlating business models with customer experience), as hinted in section 4.1.2.

In the meantime, until this future work can be tackled, the author of this dissertation hopes to have made a small contribution to the Digital Transformation field, by providing a systematic basis to structure and compare the various Digital Transformation approaches. The underlying goal is to make it easier to understand what is really involved and to better match the most adequate approach to each organization, improving the effectiveness and efficiency of its Digital Transformation endeavor.

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A. Appendix

The following sections describe the various worksheets of the Excel file on which the digital transformation simulator, described in section 7.2.2, is based.

A.1 Dashboard

The dashboard is the main worksheet, reflecting an overview of the most relevant information. Section 7.2.2 describes this worksheet and shows it in **Figure 16**, at the beginning of the simulation.

A.2 Performance indicators

This worksheet contains the definition of the performance indicators and is illustrated by **Figure 24**, at the end of a simulation. For simplicity, only one indicator is defined for each area of concern (axis) and category of aspects. Therefore, the relative weight of each indicator in its category is 1 for all indicators.

Quantitative assessment indicators (performance)

Unique ID	Axis	Category	Indicator	weight (in category)	Relative to baseline		Fulfillment ratio
					Current value	Expected value	
1	Customers	Streamline the sale's process	Printing costs savings	1	1,0500	1,1130	0,94
2	Customers	Digital Interactions	Average time taking an order	1	1,0100	1,0201	0,99
3	Customers	CRM strategy	Customer retention	1	1,0000	1,0303	0,97
4	Customers	Needs of the Digital consumer	Brand image index	1	1,0500	1,0500	1,00
5	Customers	Online presence	Customer satisfaction index	1	1,0824	1,0824	1,00
6	Customers	Predictive marketing tools	Customer loyalty index	1	1,0201	1,0201	1,00
7	Customers	Digital Marketing	Number of new customers	1	1,1019	1,1487	0,96
8	Customers	Digital Interface with the clients	Savings on marketing expenses	1	1,1408	1,1693	0,98
9	Customers	Differentiate with digital community	Number of customers claims	1	1,0716	1,0716	1,00
10	Customers	Customer service	Frequency of direct contacts with customers	1	1,0700	1,1342	0,94
11	Customers	Touch point integration	Customer Engagement	1	1,0480	1,1686	0,90
12	Customers	Cross-channel coherence	Number of cross-channel orders	1	1,0250	1,0506	0,98
13	Customers	Self-service	Average time satisfying an order	1	1,1556	1,1556	1,00
14	Customers	Socially-informed knowledge	Marketing expenses	1	1,1258	1,1258	1,00
15	Customers	Customer-analytics capabilities	Number of sales closed	1	1,1681	1,1681	1,00
16	Customers	Predictive Usage	Customer Lifetime Value	1	1,0857	1,1248	0,97
17	Processes	ERP solution	Administrative expenses	1	1,1200	1,1200	1,00
18	Processes	Process performance	Employee produtivity	1	1,1789	1,1789	1,00
19	Processes	Operational transparency	Quality Index	1	1,0150	1,0508	0,97
20	Processes	Data-driven decision-making	Operational profit	1	1,1600	1,1600	1,00
21	Human resources	Networked workforce	Employee motivation index	1	1,0712	1,0712	1,00
22	Human resources	Virtualization of the workplace	Employee satisfaction index	1	1,0400	1,0816	0,96
23	Human resources	Community knowledge sharing	Leadership index	1	1,0508	1,0508	1,00
24	Human resources	Dynamic partner ecosystems	Employee Suggestions Index	1	1,0800	1,0800	1,00
25	Human resources	Agile approaches	Employee productivity index	1	1,0000	1,0200	0,98
26	Suppliers	Digitally-enabled supply chain	Resource optimization index	1	1,0280	1,0716	0,96
27	Suppliers	Digital supply chain enablers	Percentage of digitally tagged products	1	1,0600	1,0600	1,00
28	Business model	Digitally-modified business	Number of digital augmented products	1	1,0200	1,0506	0,97
29	Business model	New digital business	Number of new digital products	1	1,0920	1,0920	1,00
30	Business model	Business globalization	Number of shared services	1	1,0712	1,0712	1,00
31	Finance	Digitally-integrated budgeting	Usage of integrated budgeting tools	1	1,0200	1,0200	1,00
32	Finance	Digital-related investments	Digital-related ROI	1	1,0500	1,0500	1,00
33	Finance	Revenue from digital assets	Digital-related market valuation	1	1,0400	1,0400	1,00

Figure 24 – The worksheet describing the performance indicators

The rightmost three columns show, for each indictor, the current and expected value, as well as the fulfillment ratio (current/expected). These values reflect relative improvements over initial values, which abstracts the fact that not all indicators are expressed in the same units.

Color is used to highlight the indicators that did not reach the expected values. This is due to the risks specified for each capability in its contribution to each performance indicator, which is described in the following section. The simulation exercises risks by randomly failing that contribution, with the probability of failure specified in the worksheet of the next section.

A.3 Digital capabilities

This worksheet specifies the digital capabilities that the transformation project aims at implementing and is illustrated by **Figure 25**, at the end of a simulation. Each capability belongs to a category of aspects and an axis. The sum of the weights of the capabilities belonging to a given category must be 1.

Qualitative assessment indicators (digital capabilities)

						Improved performance indicator (expected value)			
Unique ID	Axis	Category	Digital capability	weight (in category)	Achievement ratio	Performance indicator	Expected improvement (success)	Expected improvement (failure)	Failure probability
1	Customers	Streamline the sale's process	Digital presentations	0,5	100%	Printing costs savings	5%	0%	0,077
2	Customers	Streamline the sale's process	Computer-Aided Selling	0,5	0%	Printing costs savings	6%	0%	0,248
3	Customers	Digital Interactions	Digital Interactions with customers	0,5	100%	Average time taking an order	1%	0%	0,466
4	Customers	Digital Interactions	Real-Time Recommendation Services	0,5	0%	Average time taking an order	1%	0%	0,148
5	Customers	CRM strategy	Customer relationship management	1	100%	Customer retention	3%	0%	0,089
6	Customers	Needs of the Digital consumer	Concept stores	1	100%	Brand image index	5%	0%	0,033
7	Customers	Online presence	Website	0,25	0%	Customer satisfaction index	2%	0%	0,020
8	Customers	Online presence	Search engine optimization strategy	0,25	100%	Customer satisfaction index	2%	0%	0,036
9	Customers	Online presence	Online presence management	0,25	100%	Customer satisfaction index	2%	0%	0,054
10	Customers	Online presence	Digital reputation management	0,25	100%	Customer satisfaction index	2%	0%	0,020
11	Customers	Predictive marketing tools	Promotions	1	70%	Customer loyalty index	2%	0%	0,150
12	Customers	Digital Marketing	Digital advertising	1	72%	Number of new customers	14%	0%	0,286
13	Customers	Digital Interface with the clients	Service accounts	0,5	0%	Savings on marketing expenses	6%	0%	0,547
14	Customers	Digital Interface with the clients	Digital Commerce	0,25	50%	Savings on marketing expenses	5%	0%	0,106
15	Customers	Digital Interface with the clients	Cyber security	0,25	100%	Savings on marketing expenses	5%	0%	0,028
16	Customers	Differentiate with digital community	Digital community	1	60%	Number of customers claims	7%	0%	0,056
17	Customers	Customer service	Social media	0,5	100%	Frequency of direct contacts with customers	6%	0%	0,502
18	Customers	Customer service	Expert community online	0,5	100%	Frequency of direct contacts with customers	7%	0%	0,361
19	Customers	Touch point integration	Website and social media integration	1	100%	Customer Engagement	16%	0%	0,574
20	Customers	Cross-channel coherence	Omni-channel	1	50%	Number of cross-channel orders	5%	0%	0,544
21	Customers	Self-service	Website services	0,5	0%	Average time satisfying an order	7%	0%	0,491
22	Customers	Self-service	Mobile App services	0,5	100%	Average time satisfying an order	8%	0%	0,077
23	Customers	Socially-informed knowledge	Real-time reactions	0,5	50%	Marketing expenses	6%	0%	0,315
24	Customers	Socially-informed knowledge	Understand social media trends	0,5	100%	Marketing expenses	6%	0%	0,150
25	Customers	Customer-analytics capabilities	Traffic and patterns	0,5	100%	Number of sales closed	8%	0%	0,106
26	Customers	Customer-analytics capabilities	Customer profiling	0,5	100%	Number of sales closed	8%	0%	0,089
27	Customers	Predictive Usage	Anticipate needs	1	100%	Customer Lifetime Value	12%	0%	0,248
28	Processes	ERP solution	Global, real-time view of data	1	100%	Administrative expenses	12%	0%	0,109
29	Processes	Process performance	Digital processes	0,5	60%	Employee produtivity	8%	0%	0,028
30	Processes	Process performance	Workflow automation	0,5	100%	Employee produtivity	9%	0%	0,103
31	Processes	Operational transparency	Real-time data	1	100%	Quality Index	5%	0%	0,431
32	Processes	Data-driven decision-making	Data Analytics	1	0%	Operational profit	16%	0%	0,361
33	Human resources	Networked workforce	Employee social networks	0,5	100%	Employee motivation index	4%	0%	0,429
34	Human resources	Networked workforce	Employee self-service system	0,5	100%	Employee motivation index	3%	0%	0,361
35	Human resources	Virtualization of the workplace	Teleworking	1	100%	Employee satisfaction index	8%	0%	0,326
36	Human resources	Community knowledge sharing	Knowledge system	1	60%	Leadership index	5%	0%	0,056
37	Human resources	Dynamic partner ecosystems	Rewarding system	1	100%	Employee Suggestions Index	8%	0%	0,502
38	Human resources	Agile approaches	Agile support system	1	100%	Employee productivity index	2%	0%	0,574
39	Suppliers	Digitally-enabled supply chain	Digital supplier management	1	20%	Resource optimization index	7%	0%	0,544
40	Suppliers	Digital supply chain enablers	Digital identification tags	1	100%	Percentage of digitally tagged products	6%	0%	0,097
41	Business model	Digitally-modified business	Product/service digitalization	0,6	100%	Number of digital augmented products	2%	0%	0,215
42	Business model	Digitally-modified business	Digital Wrappers	0,4	0%	Number of digital augmented products	3%	0%	0,170
43	Business model	New digital business	New business models	0,5	100%	Number of new digital products	5%	0%	0,345
44	Business model	New digital business	Digital Products/services	0,5	100%	Number of new digital products	4%	0%	0,200
45	Business model	Business globalization	Shared service model	0,6	0%	Number of shared services	3%	0%	0,186
46	Business model	Business globalization	Cloud platforms	0,4	0%	Number of shared services	4%	0%	0,248
47	Finance	Digitally-integrated budgeting	Integrated analytics	1	100%	Usage of integrated budgeting tools	2%	0%	0,129
48	Finance	Digital-related investments	Business-IT alignment	1	100%	Digital-related ROI	5%	0%	0,073
49	Finance	Revenue from digital assets	Digital traction & engagement	1	100%	Digital-related market valuation	4%	0%	0,188

Figure 25 - The worksheet describing the digital capabilities

Each capability exhibits an achievement ratio, 0% to 100%, reflecting the fact that several initiatives (described in the next section) can contribute to implement that capability and that one of more of these initiatives can fail, due to inherent risks. The simulation exercises risks by randomly failing that contribution, with the probability of failure specified in the worksheet of the next section.

The rightmost four columns express:

- The performance indicator to which this capability contributes. For simplicity, the simulator allows each capability to contribute to just one indicator, but there may be several capabilities contributing to the same indicator;

- The expected improvement (relative to the base value of the indicator, in percentage), both in case of success and failure. This allows to express the impact of the risk. Although in the example all impacts of failure consist of simply not improving the indicator, the failure improvement value can be negative, to show that the indicator can actually get worse;
- The probability of failure. In the simulation example, these probabilities were assigned somewhat randomly, but this is a case in which the digital transformation project manager should be able to provide estimates, in a good management practice. The failure expresses that a digital capability did not improve the performance indicator, contrary to what has been expected. This is just real life. Sometimes expectations pay off, sometimes they do not.

A.4 Initiatives

This is the most complex worksheet and specifies information on the initiatives that need to be executed to carry out the implementation of the capabilities required to improve the performance indicators. **Figure 26** illustrates this worksheet, at the end of a simulation. Each initiative belongs to a category of aspects and an axis. The sum of the weights of the initiatives belonging to a given category must be 1.

The information specified for each initiative is the following:

- There is the possibility of specifying a dependency on up to two other initiatives (which means that these must finish before this one can start its execution), although for simplicity this feature has not been used in the simulation example;
- The duration in days that its execution is expected to take and the delay in days between the date in which the initiative finishes and the date in which it should start to producing effects. A recently implemented capability needs time for its effects to become noticeable;
- The status column is specified initially as “Not started”. During the execution, Excel macros turn the status cell to “Executing”, “Finished”, and finally to “In effect”, respectively when the initiative starts to be executed, finishes and, after the delay, starts to produce effects on the system;
- The cost of the initiative, as a fraction of some baseline cost (not used, for simplicity);
- The number of workers required to execute the initiative, working fulltime during the expected duration of the initiative. Partial time workers count as worker fractions;
- The capability that this initiative helps implement. The simulator allows each initiative to contribute to just one capability, but in general several initiatives can contribute to one capability;
- The expected relative contribution (from 0% to 100%) to the implemented capability, both in case of success and failure. This allows to express the impact of the risk. The sum of the contributing percentages of initiatives that contribute to the same capability must be 100%;
- The probability of failure. In the simulation example, these probabilities were assigned somewhat randomly, but this is a case in which the digital transformation project manager should be able to provide estimates, in a good management practice. Failure expresses that this initiative was unable to implement the contribution to a capability. This could be due to bad management, too optimistic planning, a technology that did not work, etc.

Initiatives to implement Digital Transformation

					Depends on								Improved capability (in Achievement ratio)			
Unique ID	Axis	Category	Initiative	weight (in category)	Initiative A	Initiative B	Status	Duration (days)	Delay until effect (days)	Cost (impact factor on baseline costs)	Workers needed	Capability	Capability improvement (success)	Capability improvement (failure)	Failure probability
1	Customers	Streamline the sale's process	Shift from paper-based information to tablet-based	0,4			In effect	5	10	0,11	2,3	Digital presentations	100%	0%	0,06
2	Customers	Streamline the sale's process	Use of mobile tools to help sales people engage in	0,6			In effect	4	8	0,02	2,1	Computer-Aided Selling	100%	0%	0,39
3	Customers	Digital Interactions	Shift from in-person interactions to digital interacti	0,4			In effect	19	38	0,03	2,1	Digital Interactions with customers	100%	0%	0,07
4	Customers	Digital Interactions	Implement recommendation services	0,6			In effect	10	20	0,07	1,1	Real-Time Recommendation Services	100%	0%	0,21
5	Customers	CRM strategy	Setting the destination	0,3			In effect	4	8	0,05	3,8	Customer relationship management	30%	0%	0,03
6	Customers	CRM strategy	Auditing the current situation	0,4			In effect	12	24	0,08	2,7	Customer relationship management	40%	0%	0,02
7	Customers	CRM strategy	Mapping the journey	0,3			In effect	13	26	0,02	1,7	Customer relationship management	30%	0%	0,12
8	Customers	Needs of the Digital consumer	Concept stores as flagships for their digital selling	1			In effect	17	34	0,14	1,9	Concept stores	100%	0%	0,24
9	Customers	Online presence	Build a website	0,4			In effect	4	8	0,16	2	Website	100%	0%	0,46
10	Customers	Online presence	Interacting through social media	0,2			In effect	18	36	0,07	2,1	Online presence management	100%	0%	0,05
11	Customers	Online presence	Improve our search engine optimization	0,2			In effect	5	10	0,13	2,6	Search engine optimization strategy	100%	0%	0,42
12	Customers	Online presence	Promote digital reputation	0,2			In effect	8	16	0,08	3	Digital reputation management	100%	0%	0,27
13	Customers	Predictive marketing tools	Products and services personalized promotions	0,4			In effect	19	38	0,16	2,9	Promotions	70%	0%	0,48
14	Customers	Predictive marketing tools	Integration of customer-purchasing data	0,6			In effect	18	36	0,05	3,8	Promotions	30%	0%	0,45
15	Customers	Digital Marketing	Identify the target market	0,1			In effect	12	24	0,15	2,9	Digital advertising	14%	0%	0,41
16	Customers	Digital Marketing	Optimize your website to convert maximum visitors	0,15			In effect	5	10	0,12	2,6	Digital advertising	14%	0%	0,26
17	Customers	Digital Marketing	Search Engine Optimization	0,15			In effect	6	12	0,16	3,4	Digital advertising	14%	0%	0,09
18	Customers	Digital Marketing	Clarifying business objectives for social media	0,15			In effect	2	4	0,12	3,4	Digital advertising	14%	0%	0,21
19	Customers	Digital Marketing	Paid Advertising	0,15			In effect	9	18	0,12	3,2	Digital advertising	14%	0%	0,09
20	Customers	Digital Marketing	Email Marketing	0,15			In effect	14	28	0,17	2,1	Digital advertising	14%	0%	0,02
21	Customers	Digital Marketing	Analytics & Reporting	0,15			In effect	2	4	0,05	3,8	Digital advertising	16%	0%	0,36
22	Customers	Digital Interface with the clients	Account in the business website	0,25			In effect	14	28	0,16	1,6	Service accounts	100%	0%	0,30
23	Customers	Digital Interface with the clients	Used of location-based services	0,25			In effect	8	16	0,07	3,3	Digital Commerce	50%	0%	0,36
24	Customers	Digital Interface with the clients	Embedded devices and RFID	0,25			In effect	5	10	0,08	3,6	Digital Commerce	50%	0%	0,27
25	Customers	Digital Interface with the clients	Security platform	0,25			In effect	15	30	0,12	2,3	Cyber security	100%	0%	0,15
26	Customers	Differentiate with digital commu	Customers providing opinions and suggestions	0,4			In effect	15	30	0,12	2,3	Digital community	30%	0%	0,15
27	Customers	Differentiate with digital commu	Interaction with customers across every phase of bu	0,5			In effect	12	24	0,08	1,9	Digital community	40%	0%	0,39
28	Customers	Differentiate with digital commu	Creation of a virtual community	0,1			In effect	13	26	0,02	2	Digital community	30%	0%	0,07
29	Customers	Customer service	Expert community online	0,5			In effect	17	34	0,14	2,1	Social media	100%	0%	0,03
30	Customers	Customer service	Help customers through social media	0,5			In effect	4	8	0,16	2,6	Expert community online	100%	0%	0,02
31	Customers	Touch point integration	Integration of all online presence	0,3			In effect	18	36	0,07	2,9	Website and social media integration	30%	0%	0,12
32	Customers	Touch point integration	Integration of the social media information into th	0,5			In effect	5	10	0,13	3,8	Website and social media integration	40%	0%	0,24
33	Customers	Touch point integration	Aware of the shopping history through all platforms	0,2			In effect	19	38	0,16	2,9	Website and social media integration	30%	0%	0,46
34	Customers	Cross-channel coherence	Use any platform to order and receive the product	0,7			In effect	18	36	0,05	2,6	Omni-channel	50%	0%	0,05
35	Customers	Cross-channel coherence	Omni-channel approach	0,3			In effect	12	24	0,15	3,4	Omni-channel	50%	0%	0,42
36	Customers	Self-service	Customer's profile linked to multiple touch points	0,5			In effect	5	10	0,12	3,4	Website services	100%	0%	0,48
37	Customers	Self-service	All services available in the website/app	0,5			In effect	6	12	0,16	3,2	Mobile App services	100%	0%	0,45
38	Customers	Socially-informed knowledge	Analyze real-time reactions through social media	0,2			In effect	2	4	0,12	2,1	Real-time reactions	50%	0%	0,41
39	Customers	Socially-informed knowledge	Monitoring and analysis of social media trends	0,2			In effect	9	18	0,12	3,8	Real-time reactions	50%	0%	0,26
40	Customers	Socially-informed knowledge	Exploring social media to understand what custom	0,2			In effect	14	28	0,17	1,6	Understand social media trends	30%	0%	0,09
41	Customers	Socially-informed knowledge	Understand how to promote the brand through digi	0,2			In effect	2	4	0,05	3,8	Understand social media trends	40%	0%	0,21
42	Customers	Socially-informed knowledge	Creation of an online community to advise and bui	0,2			In effect	14	28	0,16	2,7	Understand social media trends	30%	0%	0,09
43	Customers	Customer-analytics capabilities	Analyze audience traffic and patterns	0,3			In effect	8	16	0,07	1,7	Traffic and patterns	60%	0%	0,02

Figure 26 - The worksheet describing the initiatives (not all are shown, for legibility)

A.5 Graphics by Day

This worksheet shows several graphics of the simulation results, using the simulation days as the abscissa axis, so that the evolution of several indicators can be seen:

- **Overall capability achievement (%)**. This is computed from the weighted average (using the relative weights of the axis and category of each capability) of the achievement ratios of the several capabilities. Without risk, this should be 100% at the end of the simulation. With risk, some initiatives fail to implement their contribution to a given capability;
- **Capability risk**. Weighted sum of capability risks (relative to 100% achievement rate);
- **Overall performance improvement (%).** Weighted sum of the improvement of indicators;
- **Performance risk**. Weighted sum of performance risks (of not achieving full improvement);
- **Total workers allocated**. Sum of workers allocated to all initiatives in execution.

Figure 27 illustrates these graphics.

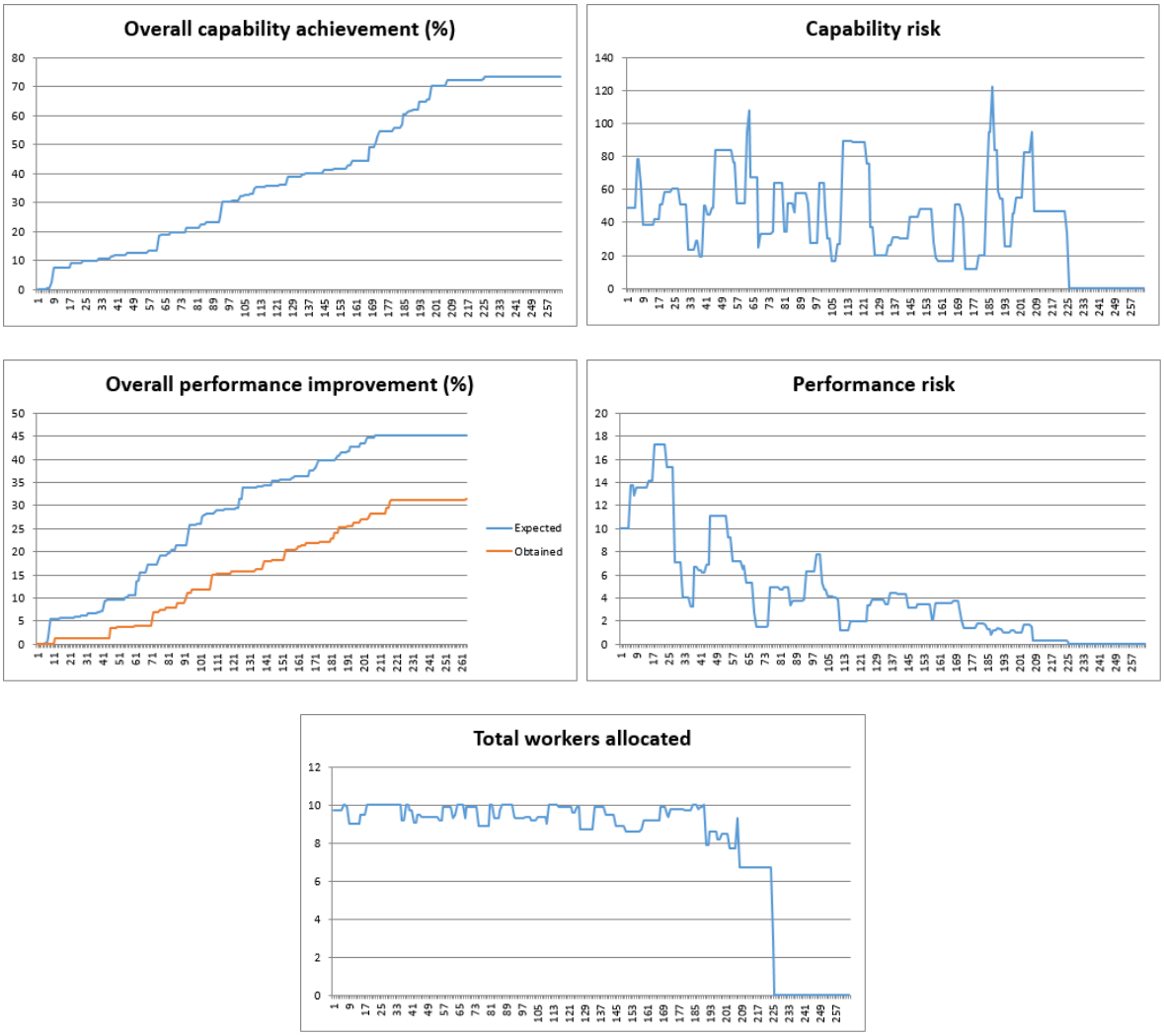

Figure 27 – Graphics expressing simulation results by day

A.6 Graphics by Initiative

This worksheet shows several graphics of the simulation results, using the initiative number (78 in total) as the abscissa axis, so that the characteristics of the several initiatives can be compared:

- **Initiative duration**. Number of days that the execution of each initiative is expected to take;
- **Initiative effect delay**. Number of days between the end of execution of an initiative and its effects become noticeable;
- **Initiative workers needed.** Number of workers required for the execution of each initiative;
- **Initiatives that failed capability**. Visualization of which initiatives failed to contribute to their associated capability;
- **Initiatives that failed performance**. Visualization of which initiatives contributed to the implementation of capabilities that failed their intended contribution to the improvement of a performance indicator.

Figure 28 illustrates these graphics.

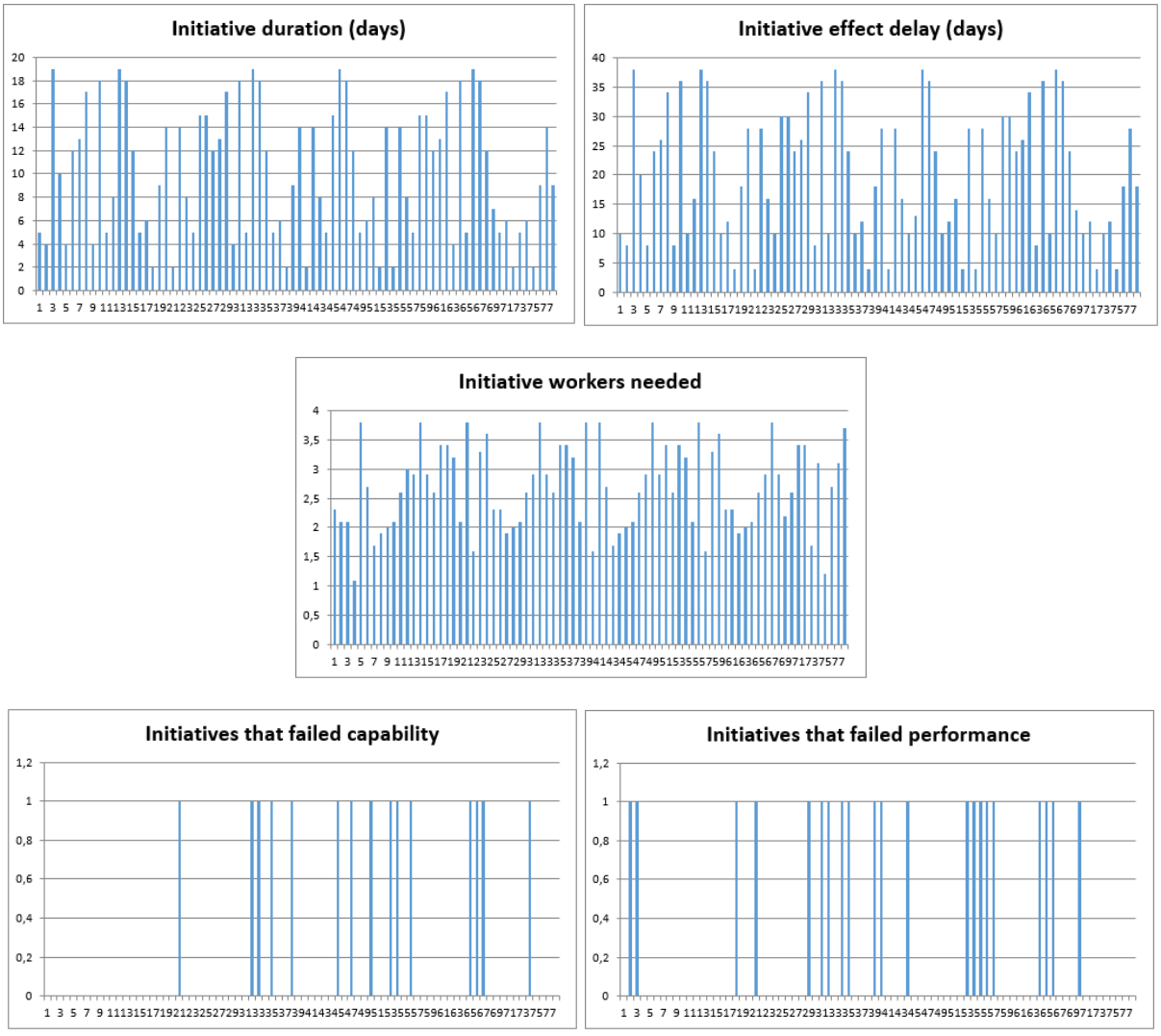

Figure 28 - Graphics expressing simulation results by initiative

A.7 Graphics by Digital Capability

This worksheet shows several graphics of the simulation results, using the capability number (49 in total) as the abscissa axis, so that the characteristics of the several capabilities can be compared:

- **Capability achievement ratio (%)**. Indicates how much each capability has been achieved. Without risk, this should be 100% for all capabilities, at the end of the simulation. With risk, some initiatives fail to implement their contribution to a given capability and achievement is partial or even null;
- **Capability achievement by axis (%)**. Expected and obtained capability achievement in each axis.
- **Capability failure probability.** This graphic just reflects the probability of failure of each capability (in improving its associated performance indicator);
- **Expected performance improvement by capability (%)**. Indicates by how much each capability will improve the performance indicator for which it contributes.

Figure 29 illustrates these graphics.

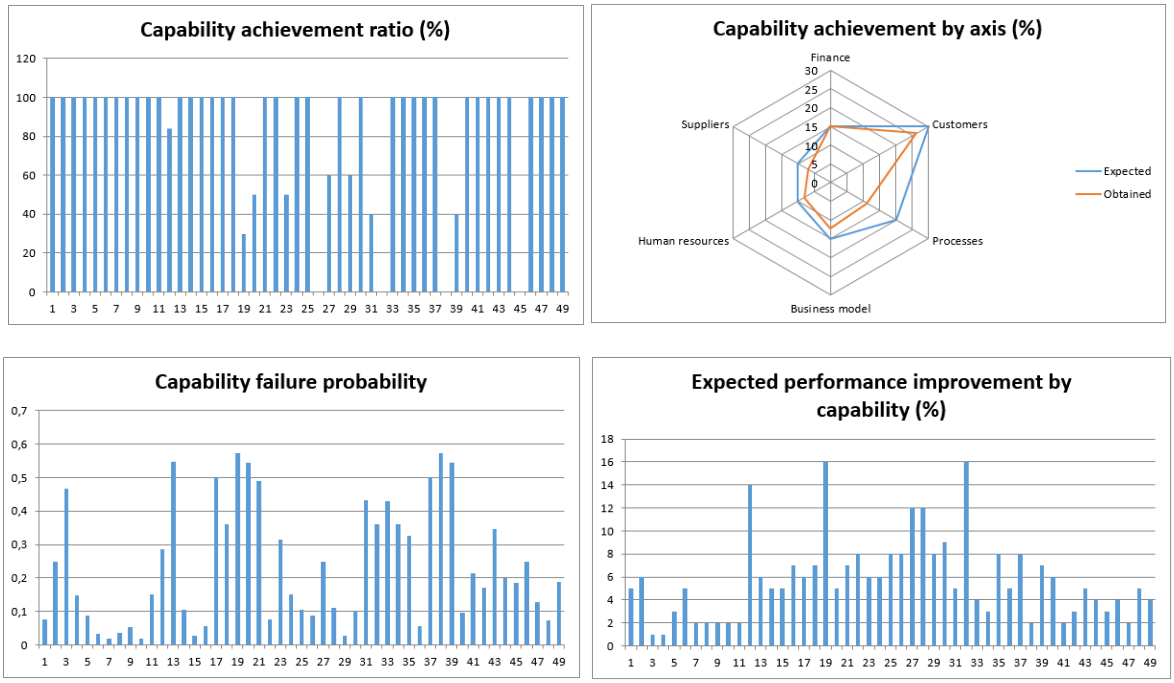

Figure 29 - Graphics expressing simulation results by digital capability

A.8 Graphics by Performance Indicator

This worksheet shows two graphics that compare the obtained with the expected value of each of the performance indicators (33 in total), so that the degree of improvement in performance indicators can be seen.

In principle, all indicators should obtain the expected values. However, there are several risk factors that will most certainly hamper the achievement of that goal:

- Some initiatives will fail implementing, fully or partially, the associated digital capabilities. Since these are the support for improving performance indicators, some indicators will not improve as planned;
- Even is a capability is fully implemented, there is no guarantee that it will actually improve the performance indicators that it should support. Things not always work according to plan. For example, customers may not react in the way they were expected to.

Figure 30 illustrates this graphic in bar form, for all performance indicators. Some were improved as expected, others were only improved by a fraction of that, and some were even not improved at all. All this is consequence of the risks introduced in the definition of the capabilities and of the initiatives.

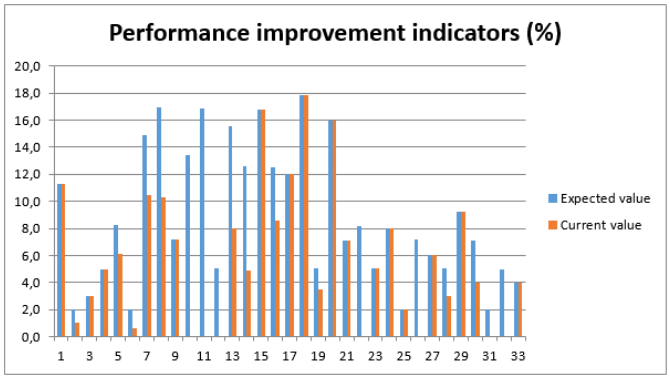

Figure 30 - Graphic comparing the expected and obtained values of performance indicators

Figure 31 presents the same information, but now in radar form and condensing all indicators of the same axis. In this example, only the axis concerning processes had all its performance indicators improved as expected. All others had some underperforming indicators.

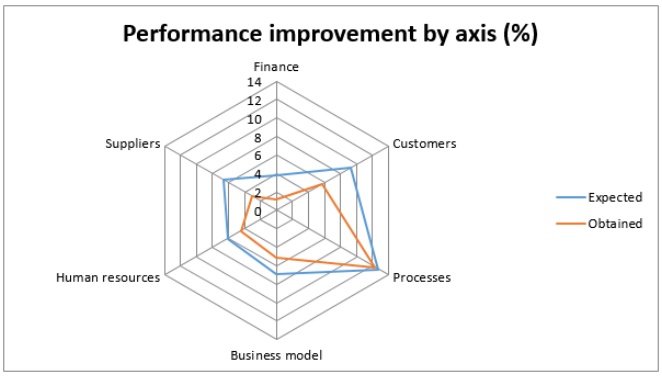

Figure 31 - Graphic comparing the expected and obtained values of performance indicators