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Assessing Italy's maturity in the face of the digital revolution

Master thesis

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"Ogni volta che affronti *una difficoltà* hai l'opportunità di diventare una persona migliore."

Abstract

Better known as the Digital Revolution, the current Fourth Industrial Revolution has changed society and business, prompting a disruptive boost in productivity and efficiency.
At the core of this revolution lies the process of "Digital Transformation", sparked by the increasingly fast progress of Computer Science and its vast and encompassing suite of enabling technologies.
The study reported in this document assumes the Information Technology Infrastructure Library (ITIL) as an effective means to offer organizations best practices to embrace digitalization and the driving forces behind the Digital Transformation.

Wider development of the digital economy is beneficial to qualified labor, with high value added. To further it more effectively, it is essential that governments, institutions, and businesses fully understand the maturity level of their digitalization - digital maturity - to identify critical areas that might impair competitiveness within and outside of national borders.
This understanding led to the need to measure the progress of Digital Transformation, with a variety of indicators created to evaluate digital maturity.
This thesis sampled the digital level - their adoption and integration of digital technologies - of Italian enterprises, within the broader framework of the European Union's Digital Economy and Society Index (DESI) and the digital maturity assessment carried out by Confindustria in the 2018-2022 time period.

That analysis shows that Italy has attained improvements in some areas since the start of measurement in 2017, for example in widespread internet access and availability of digital public services. However, major challenges still persist, above all with regard to developing digital skills and embracing more fully the adoption of advanced technologies, like for example those related to Machine Learning and Big Data analyses.
Raising the level of digital maturity of Italian enterprises would help boost performance beyond the national border, within the wider European context, making single enterprises, and the country, more attractive and competitive on the international scene.

The thesis evaluates how selected Italian enterprises are embracing Digital Transformation, along two specific axes: the adoption of the ITIL framework, and the integration of AI technologies.
Based on a bibliographic analysis and targeted interviews carried out during the research work, the document outlines the state of digitalisation of these companies providing insights about their progress and challenges.

This document is organized as follows: Chapter 1 provides an extensive introduction to Digital Transformation. In order to assess Italy's current situation, Chapter 2 analyzes the country through the Digital Economy and Society Index of the Euro-

pean Commission, with a special focus on the business dimension. Also the results of the assessment made by Confindustria for Italian companies are presented.
To delve deeper in the details, Chapter 3 presents five selected case studies about adoption of the ITIL framework and AI technologies of interviewed companies.
Finally, the thesis concludes by summarizing key findings, which highlight various stages of ITIL adoption and AI integration within large Italian enterprises.
These insights underscore the need for strategic alignment, enhanced training, and cultural change to navigate the evolving digital landscape effectively.

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Chapter 1

Introduction

1.1 Digital Transformation

Industrial *revolutions* have always affected human history, bringing profound transformations.
It is important to appreciate the meaning of the term 'revolution'.
While evolution is seen as a gradual process of improvement and adaptation, revolution implies a radical discontinuity that overturns pre-existing balances [2].
Technological evolution is characterized by incremental change, often driven by continuous innovation and constant refinement of existing solutions.
In contrast, revolution introduces radical novelty, fundamentally changing the technological paradigms, business models, and society as a whole.

The Fourth Industrial Revolution, also known as Digital Revolution, completely changed production, communication and social organization [36].
Recent decades witnessed rapid changes, making the Digital Revolution unprecedented; it was so fast and radical that it challenged our ability to fully grasp its implications.
Moore's Laws prediction of a doubling of transistor density in semiconductors every year, as shown in Figure 1.1, served as a benchmark for technological progress.
However, Moore's Law describes improvement made to hardware, only partially accounting for wider technological transformations.
In this respect, Raymond Kurzweil's "Law of Accelerating Returns" extends Moore's Law to include other areas; according to him "we are not going to have a progress of 100 years in the 21st century – we will be having a progress equivalent to 20,000 years at today's pace" [32].
This happens because new technologies build upon previous ones, leading to significant advancements within increasingly shorter time frames.

In particular, the 'Digital Transformation' phenomenon risen to prominence among businesses in the early 2000s, and, as seen in Figure 1.2, the term then gained growing global interest based on Google Trends. According to Fitzgerald et al. (2014)

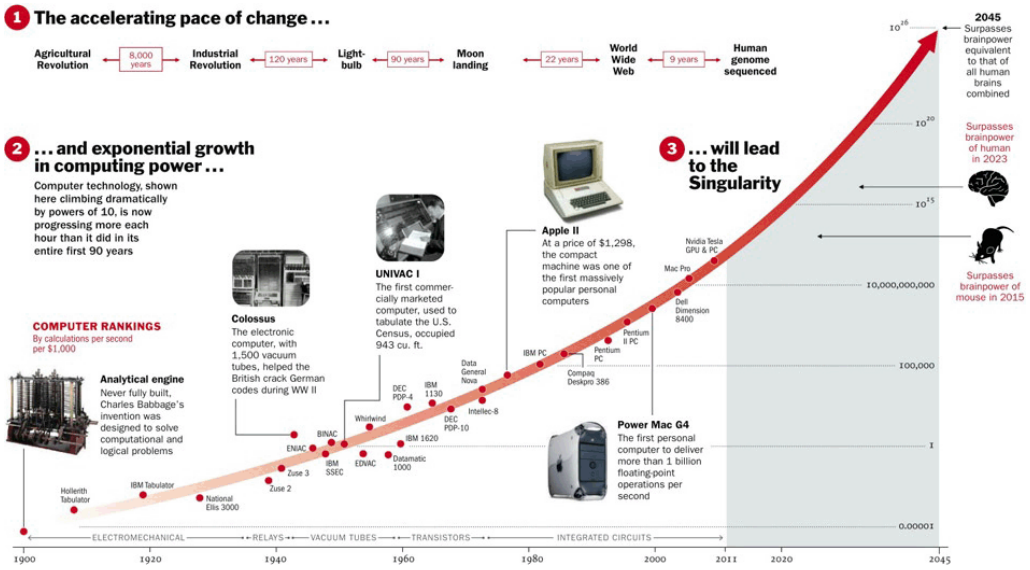

Figure 1.1: Exponential growth . The vertical axis measures the computing power plotted on a logarithmic scale, while the horizontal axis spans from 1900 to 2045. Source: [38]

[40], Digital Transformation is "the use of new technologies [...] to enable major business improvements including enhanced customer experiences, streamlined operations and new business models."
This means figuring out ways to use IT to improve existing services and products, offer new ones, and speed up workflows: Digital Transformation weakens the boundaries between technology and business, providing new tools and concepts that can completely change the way companies face new challenges and gain competitive advantage.

Since Digital Transformation has placed increasing pressure to change, companies became well aware of the importance of aligning IT with their goals.
The Information Technology Infrastructure Library (ITIL) framework emerged as an inevitable tool for managing IT services.

Originally developed during the late 1980s, it took until early 21st century for ITIL to gain widespread acceptance: the framework was meant to offer organizations a set of best practices on IT Service Management [1] to ensure that these were in line with businesses' needs, and to contribute towards enhance operational efficiency and responsiveness by organizations to changing demand patterns.
ITIL provides a systematic and structured approach to the delivery of quality IT services. It is not a prescriptive model, but a library of practices to be adopted and to be adapted according to specific business goals.

[1] IT Service Management (ITSM) refers to the structured processes and practices used to design, deliver, manage, and improve IT services in alignment with business goals [7]

In order to promote Digital Transformation, an efficient operational and service delivery plan that fits the demands of your company is needed. ITIL plays a crucial role in business growth because it brings together a number of elements that foster continual improvement and innovation.
For example, here are some of the roles ITIL plays in businesses:

- By aligning IT processes with business objectives and customer needs, companies can design and deliver services that meet those needs, increasing customers satisfaction;
- By identifying cost-saving opportunities in IT processes and by promoting efficient use of technology to reduce operation expenses, the adoption of ITIL can lead to resources optimization and reduction of waste;
- By monitoring and correctly managing incidents and problems, businesses can review performance, analyze root causes and even prevent future incidents from occurring, thus making the business more reliable.

The key elements of ITIL are the Service Value System and the 'Four dimensions', and these are explored in detail in Chapter 3.

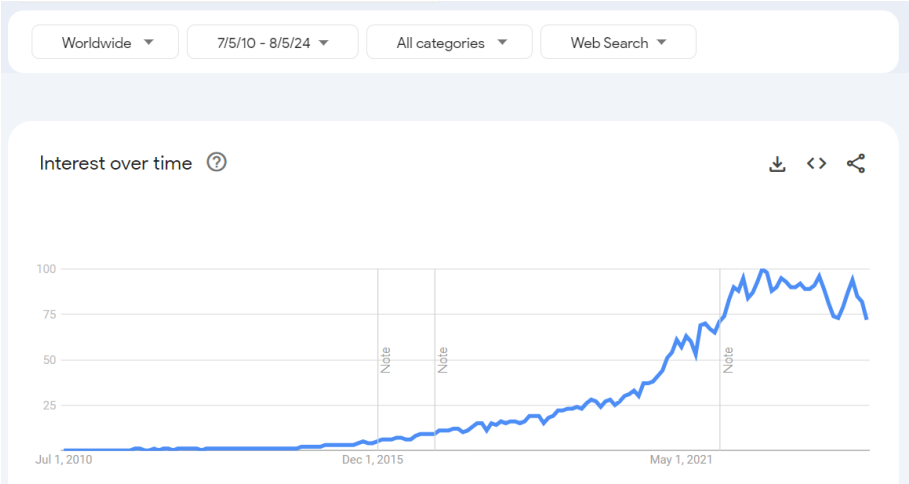

Figure 1.2: Interest in Digital Transformation. Source `https://trends.google.as/`

ITIL guidelines and practices have paved the way for transformative changes as technology continued advancing: as mobile communications, cloud, data analytics, and other information technologies took off, Digital Transformation became a strategic initiative in the mid-2010s [53].
However, the real acceleration was due to the shift of work, commerce, and everyday activities in response to COVID-19 lockdowns [33].
Companies that failed to invest in modern technologies and had to digitalize their processes faced significant challenges, as new business models, Cloud Computing,

real-time access to data, and emerging analytics capabilities disrupted entire industries.

These accessibility and availability lead to companies beginning to use analytics models and intelligence capabilities to analyze data and enhance decision-making, to invest in automation and hyper-automation technologies, where for example Robotic Process Automation and Artificial Intelligence combine together to manage large datasets or improve procedures with lesser human intervention, or to deploy low-code/no-code platforms to support and transform business processes [56].

Figures 1.3 and 1.4 illustrate two bibliometric maps, which highlight the correlation among keywords related to Digital Transformation.
Bibliometric analysis is a powerful tool to understand evolution and trends within a particular research field, so I conducted a comparative analysis using VOSviewer and the same configuration parameters for both the maps. I used 20000 documents extracted from Scopus with the search string shown in Listing 1.1.

```
( TITLE-ABS-KEY ( digital AND transformation ) OR
TITLE-ABS-KEY ( digital AND revolution ) OR
TITLE-ABS-KEY ( business ) OR
TITLE-ABS-KEY ( digital AND maturity ) OR
TITLE-ABS-KEY ( industry AND 4.0 ) )
AND ( LIMIT-TO ( SUBJAREA , "COMP" )
OR LIMIT-TO ( SUBJAREA , "BUSI" )
OR LIMIT-TO ( SUBJAREA , "ENGI" ) )
```

Listing 1.1: Search string used to gather documents in Scopus

For the first map I limited the time range from 2004 to 2014, while for the second I used documents published from 2014 to present.
As we can see, in Figure 1.3 (going from 2004 to 2014) keywords like 'Artificial intelligence' or 'Data mining' create very weak connections. In contrast, Figure 1.4 shows that these keywords now actually represent the heart of the network, which now also includes other disruptive technologies like Big Data, Internet of Things, and Machine Learning, which is a subset of Artificial Intelligence.

These maps show that Digital Transformation is obviously related to technologies but also strategy plays a fundamental role: keywords of the right red cluster in Figure 1.4 like 'Business Models', 'Digital Economy' , 'Competition' or 'Economic and Social effects' evidence that companies must adapt to, and leverage digital innovations in order to improve their competitive positioning and respond to the changing global digital economy.
The term 'transformation' clarifies that this requires much more than just a simple change: it involves shifting the company's culture, strategy, and/or even the business model.
In order to evoke new value, enterprises need to manage IT deployment and organizational transformation.

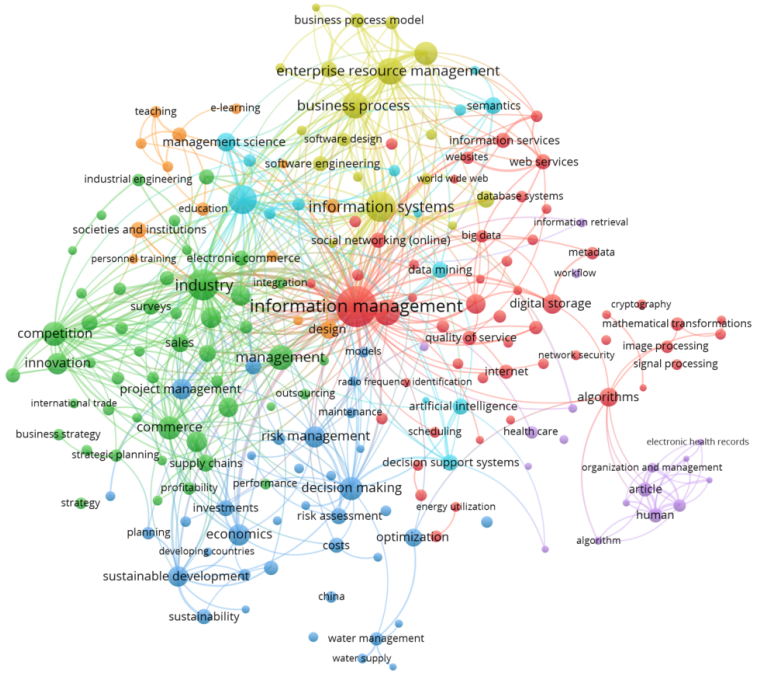

Figure 1.3: Bibliometric map of Digital Transformation (from 2004 to 2014)

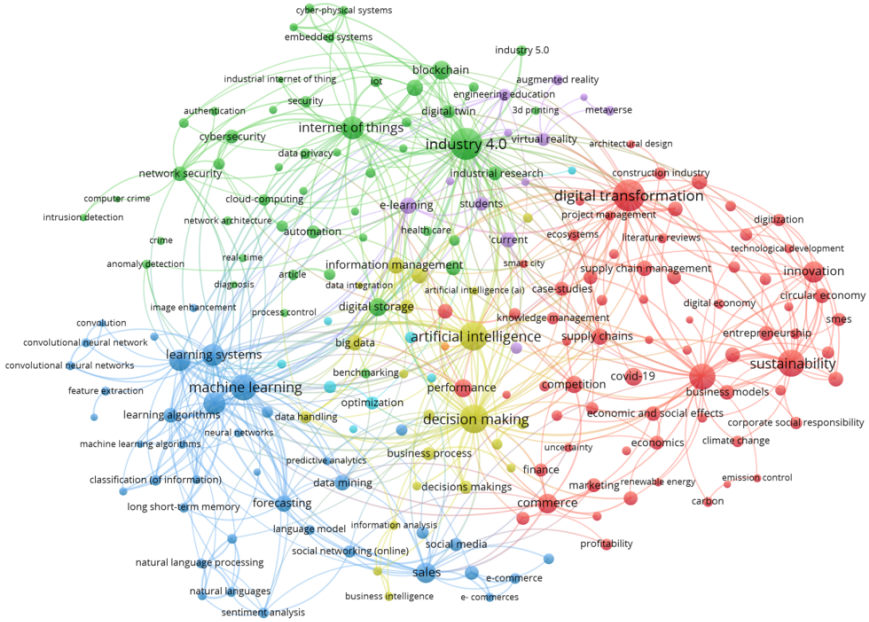

Figure 1.4: Bibliometric map of Digital Transformation (from 2014 to present)

Those who are unable to swiftly adapt to, develop and implement Digital Transformation strategies are unlikely to keep pace and compete with the new digital environment [57].

1.2 The forces behind the Digital Revolution: disruptive technologies

The rapid spread of digital technologies played a fundamental role in enabling the Digital Revolution.
A brief description of the main disruptive technologies is provided in this paragraph.

1.2.1 Internet of Things

Internet of Things (IoT) has become important over the past years and it is considered one of the most widespread technologies of the 21st century.
The term 'Internet' refers to a virtual and network-oriented visions, while 'things' highlight that objects can be integrated into the technological framework [58]. In other words, IoT describes the "network of physical objects that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet" [50].

As part of IT applications, IoT and digitalization are strongly connected:

- through data collection and analysis, companies using IoT devices can monitor and control critical infrastructure, reducing downtime and preventing failures;
- thanks to the vast amount of generated data by sensors and devices, businesses can gain insights on new opportunities, and support decision-making processes and strategic planning. Moreover, they could also improve quality and productivity while also reducing cost and time.
- in industrial applications, thanks to IoT devices, on can investigate the worth of products and boost up the marketing. This offer companies the chance to sell tailored products and services using more advanced and efficient technologies, thus gaining competitive advantage;

1.2.2 Cloud Computing

Cloud Computing refers to resources such as servers, storage, databases, networks, software and analytics that are machine-driven and given out over the Internet.
This model allows for "on-demand" network access to configurable computing resources from a shared pool with minimal management effort or service provider interaction" [49].
Depending on the type of service and the degree of control and management offered

to users, service providers can be classified as Infrastructure-as-a-Service (IaaS), Platform-as-a-service (Paas), and Software-as-a-Service (SaaS):

- **Infrastructure-as-a-Service**: this solution refers to a Cloud Computing solution where a third party provides you with infrastructure services over the internet.
  Users control operating systems, application programs and data, while the provider takes care of networks, servers, storage, and virtualization.
  IaaS provides data access via APIs or dashboards instead of on-site data centers, thus minimizing expenses and maintenance costs.

- **Platform-as-a-Service**: in contrast with IaaS, this is a more abstracted cloud-based solution, focused on application development and deployment.

- **Software-as-a-Service**: this solution represents the highest level of abstraction: it provides complete software applications, reduces in-house management and promotes a real-time reliable sharing of programs.
  For small businesses or for applications which do not require much customization, it is the best option, because it accommodates different organizational needs.

Amazon Web Services (AWS) is one of the most adopted Cloud Computing platform: it provides many features including computing power, database, storage and content delivery [59].
If we had to categorize AWS into one of the three types described above, AWS is primarily an IaaS provider. However, it also provides both Paas and Saas solutions. As for a business, AWS infrastructure can grow and evolve as necessary, expanding its resources up or down responding to higher or lower demands.
To make more concrete examples, a company might use AWS for:

- building and hosting web applications;
- storing large amount of data, without the need of a physical onsite data center;
- running Machine Learning models;
- developing and deploying server-less applications.

Other examples of Cloud Computing options include Microsoft Azure, leading competitor to AWS; Google Cloud Platform (GCP) widely adopted for its big data processing capabilities; and Oracle Cloud, which focuses on enteprises application and offers a wide range of cloud services.
These all offer SaaS, PaaS and IaaS solutions, providing companies with flexible and scalable resources.

Figure 1.5 summarizes the main types of Cloud Computing options.

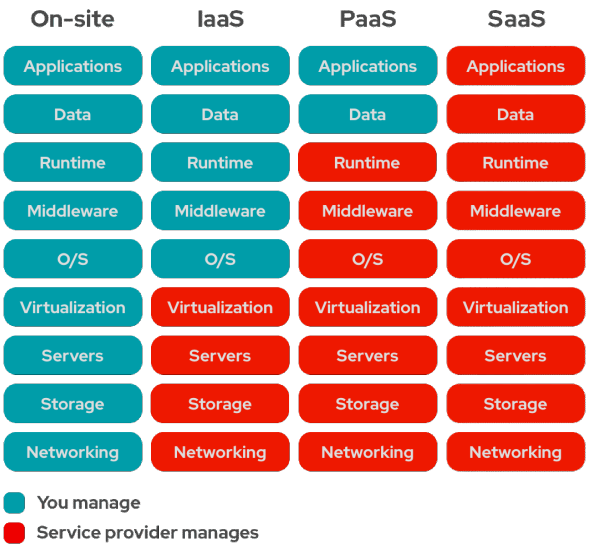

Figure 1.5: Cloud computing options depending on the degree of management. Source [54]

1.2.3 Artificial Intelligence

The term "Artificial Intelligence" was coined in 1995 by the American computer scientist John McCarthy, who defined it as 'the science and engineering of making intelligent machines' [26]. Nowadays, Artificial intelligence is considered as an umbrella term that includes many technologies and approaches, like Machine Learning, Deep Learning, natural language processing, or computer vision.

- **Machine Learning**: Machine Learning algorithms can learn form data and iteratively improve their performance. The three fundamentals blocks that compose a ML learning system are:
  - the decision process, that can be prediction or classification;
  - the error function, that is used to evaluate the model;
  - the optimization process, that allows to iteratively reduce the error, updating the algorithms parameters until the desired level of accuracy has been met.

  Examples of Machine Learning algorithms include Decision Trees, used both for regression and classification tasks, Support Vector Machine (SVM), and Logistic Regression, which can be used to predict customer churn or prevent failures.
  In fact, Machine Learning algorithms can analyze large amount of data, recognize hidden and complex patterns, make predictions or recommendations based on data. This translates into optimization of operations, improvement of resource allocation, and consequently the development of strategies that are aligned with business goals. [8].

- **Deep Learning**: it can be regarded as a sub-set of Machine Learning: the main difference with classic Machine Learning is the structure, the complexity, and thus the application areas.
  Deep Learning algorithms have multiple layers of interconnected nodes, that perform nonlinear transformations. The term 'deep' refers to the number of layers, that typically are hundreds or thousands.
  If on the one hand, Deep Learning models require less human intervention, on the other hand the amount of data and the processing power to achieve the desired level of accuracy is huge. The more the data, the better the performance.
  Convolutional Neural Networks (CNNs), Recurring Neural Networks (RNNs) and Generative Adversarial Networks (GANs) are some of the most adopted algorithms.

- **Natural Language Processing**: NLP uses Deep Learning to make computers and human communicate.
  The algorithms range from sentiment analysis, to keyword extraction, from text summarization to text generation.
  An evidence of the potential of NLP lies in Large Language Models: ever since ChatGPT was launched in November 2022 by OpenAI, it has been widely and successfully applied in many real world scenarios.
  Not being task-specific and being pre-trained[2] on huge datasets , allowed ChatGPT to rise the bar in the field of NLP. Thanks to its underlying transformer architecture, the model can handle both large-scale pre-training and adaptability to different downstream tasks. [61].

Even if the term 'Artificial Intelligence' encompasses a wide variety of technologies, referring to only a subclass of algorithms by this name would be inaccurate. However, as a convention and for ease of reading through this document, from here on the terms 'AI' or 'Artificial Intelligence' will refer strictly to the above subset of technologies.

In particular, Artificial Intelligence is undoubtedly ahead of the curve when it comes to new technologies in Computer Science: its vast and powerful application are generating growing interest.
Despite being a common theme, effective use of AI is more than talking: it is about having a structured and holistic approach. Thus, any company that desires to reap the benefits of Artificial Intelligence needs to have a strong business strategy in place, and it needs to be ready to face technical and organizational challenges.

[2]GPT stands for Generative Pre-trained Transformer.
A transformer is a type of Neural Network characterized by the so called Attention mechanism. This allows weighing the importance of different parts of the input sequence.
'Pre-trained' refers to the fact that the model has been first pre-trained on large datasets, so that it can recognize more nuances in the language, and then fine-tuned on a smaller dataset, making it better fit for specific tasks

First of all, in order to implement or use any Artificial Intelligence algorithms, skilled workforce is required. Because AI is widely accessible to everyone, it is the way it is used that makes the difference.
The personnel must not only be able to understand the company's needs but also translate them into the most suitable, cost-effective, and efficient solution. Only qualified and well-prepared specialists can provide the added value necessary for a company to excel with this technology, which is still not fully understood.
Another important concept to consider is the quality of data: as said before, Machine Learning algorithms require huge amount of data, and the better the data, the better the performance.
Thanks to technologies like IoT companies can gather data, but then a strategic data management plan need to be implemented, since data needs to be considered ad a precious resource that allows to unlock business potential.

However, data is not sufficient alone: as we mentioned for Deep Learning algorithms, also a robust computational infrastructure is needed.
In order to train models, high performance computing resources like GPUs and CPUs are required. Moreover, the overall infrastructure needs to scale as the volume of data grows: cloud solutions here come in handy.

Still, these investments can be significant, and companies must carefully weigh their return on investment and alignment with long-term goals.
While AI presents unparalleled opportunities, overhyping its potential or taking it as an easy way out of complex challenges may only serve to disappoint or misplace resources. The risk here calls to mind the lessons of the dot-com bubble in the late 1990s, when exaggerated expectations about the transformative potential of the internet led to speculative investments, financial instability, and a market crash [44] [24].
Similarly, companies have to be very careful with AI: any adoption strategies should be highly methodical and flexible enough to match the emergent landscape of AI. A balanced approach, with clear goals and continuous assessment, is key to sustainable and meaningful advancement [52].

The following chapters analyze what is the current Italian businesses situation, how enterprises are facing and adapting to new technologies and challenges, as well as if and how they are utilizing the ITIL framework to build their digital capacity.

Chapter 2

Evaluating digital maturity of Italian enterprises

In the previous chapter, we assessed the scope of Digital Transformation and emphasized how disruptive technologies such as Artificial Intelligence, Internet of Things and Cloud Computing have completely altered the business and social environment. As digital technologies continue to spread into every corner of economies and societies, the ability of a country to fully realize the potential of these advances has emerged as one of the most critical factors defining its overall competitiveness and development [41].
Any strategy aimed at the progress of the global digital economy is preconditioned by an understating of the level of digitalization and where a country stands along its digital journey: when facing Digital Transformation, one of the first things to do is comprehend the current digital development status [47].

This translates into the demand for effective measurement systems and methodologies, so that the actual state of digital development can be successfully evaluated and, consequently, strategies can be traced [35].

In response to this need, in the last decade, many indicators have been created.
Below, three prominent indicators that gained global recognition are introduced:

- **World Digital Competitiveness Ranking (WDCR)**: The WDCR is an index created by the IMD World Competitiveness Center at the International Institute for Management Development.
  It was first published in 2017, ranking countries by capacity in terms of adopting and exploring digital technologies as a driver of economic transformation, business innovation, and general competitiveness [9].
  The WDCR measures digital competitiveness along three main dimensions:

  – Knowledge, which looks at the capacity to understand and learn new technologies;

  - Technology, which looks into the infrastructure and regulatory environment for technological development;
  - Readiness for the Future, as a measure of how prepared a country is to exploit Digital Transformation.

  It is a ranking that many governments and business enterprises use to identify areas of digital strength and weakness with the aim to make effective policy actions and strategic decisions.
  Thanks to its all-round approach in understanding how digital technology affects economic competitiveness, it is highly regarded [60].

- **Network Readiness Index (NRI)**: The Network Readiness Index is one global indicator that was first developed in 2002 by the World Economic Forum but currently managed by Portulans Institute.
  It serves as an assessment of the capability of countries in using Information and Communication Technologies to enhance competitiveness and well-being. The index is built on four main pillars:

  - Technology, which assesses infrastructure and access;
  - People, who focus on digital skills and engagement;
  - Governance, that covers policy and regulation;
  - Impact, that evaluates the economic and social outcomes from the use of ICTs.

  The index can be considered as the final word on how prepared countries are to make effective use of digital technologies, not just for achieving economic growth but also societal development. Tracking progress with the NRI, challenges are identified, and good practices in Digital Transformation are exchanged [27].

- **Digital Economy and Society Index (DESI)**: The DESI is an annual index that the European Commission introduced in 2014 to measure the digital performance of each of the EU's member states and track their progress in terms of competitiveness in the digital frontier.
  The DESI groups data into the following four dimensions:

  - Connectivity, which handles questions of Internet access and quality;
  - Human Capital, concerned with digital skills;
  - Integration of Digital Technology, looking at business digitalization;
  - Digital Public Services, concerned with the provision and use of online public services

  DESI serves as a fundamental tool to measure the progress of EU countries towards Digital Transformation and guides EU digital policies to show where

more effort or investment is needed. Therefore, such an index is especially useful for benchmarking between countries in the EU and achieving digital cohesion within the Union [19] [14].

These indices, highlight how countries are not in an equal position [4]: while some speed the way developing a very strong digital infrastructure, other lag because barriers, such as insufficient investments or non-existing internet access, persist [25].

Because of its geographic and political context, the most natural choice among the three indicators to assess Italy's current situation is the Digital Economy and Society Index.
With Italy being part of the European Union (UE), the DESI provides a more representative and relevant comparison for countries with similar regulatory and socio-economic frameworks.
Moreover, DESI reinforces elements of critical prime importance to Italy, such as the integration of digital technology into businesses, which make up a big portion of Italy's economy.
This index is also particularly useful for monitoring the strategic digital goals of UE, hence being particularly detailed in singling out the areas where Italy needs an improvement or further investment.

It is also worth mentioning that obtaining a good result in the ranking drawn up by DESI is reflected in a good result at the global level. For example, Figure 2.1 shows how those countries that rank in the first four positions according to the DESI (Finland, Denmark, Netherlands and Sweden), when considered on a global scale keep attaining top ranking, remaining in the top 10.
This can be explained by the fact that some indicators used within the various indices are overlapping, as for example happens for the Knowledge, People and Human Capital dimensions of the three indices (WDCR, NRI and DESI respectively), where the digital skills of citizens are evaluated, or for the Connectivity dimension of the DESI, which is included in the 'Technology' dimensions of the other two.

Rank	**DESI**	**Network Readiness Index**	**Digital Global Competitivenss Ranking**
1	Finland	United States of America	United States of America
2	Denmark	Singapore	Netherlands
3	Netherlands	Finland	Singapore
4	Sweden	Netherlands	Denmark
5	Ireland	Sweden	Switzerland
6	Malta	Switzerland	Republic of Korea
7	Spain	Republic of Korea	Sweden
8	Luxembourg	Denmark	Finland
9	Estonia	Germany	Taiwan (Chinese Taipei)
10	Austria	United Kingdom	Hong Kong SAR

Figure 2.1: Ranking comparison according to DESI, NRI and WDCR

2.1 Digital Economy and Society Index

The DESI utilizes a bottom-up aggregation approach to evaluate the European Union's digital advancement, and it applies an arithmetic average among four dimensions: Human Capital, Connectivity, Integration of Digital Technology and Digital Public Services.
Each dimension is further broken into sub dimensions for a total of 32 indicators [63].
Each dimension weights 25% of the total score, thus the score achieved by a given country C is calculated as shown in Equation 2.1 [23]:

$$DESI(C) = HC(C) * 0,25 + C(C) * 0,25 + IDT(C) * 0,25 + DPS(C) * 0,25 \quad (2.1)$$

where HC, C, IDT and DPS stand Human Capital, Connectivity, Integration of Digital Technology, and Digital Public Service respectively.

2.1.1 Connectivity

Digital technologies and services heavily rely on connectivity and fast broadband access is so influential nowadays that we would call it an essential infrastructure [62].

In the first chapter we mentioned that Internet of Things is one of the forces behind Digital Transformation, and great connectivity serves as an essential requirement for linking together many different devices along with sensors that produce or send crucial information.
Fast internet is also important for real time data processing that enables comprehensive data analyses and guide decision-making processes within enterprises.
Moreover, with Covid-19 that accelerated Digital Transformation [34], remote working and digital collaboration is now common practice and fast internet access allows easy online interaction.

Analyzing connectivity gives an indication of a nation's ability to utilize digital means as well as its inclination towards new ideas while considering the level at which it is about its digitalization state [16] .

2.1.2 Human Capital

Another crucial dimension is Human Capital.
Studies identified in human capital both the biggest challenge and the key factor of success for Digital Transformation: competency of citizens and employees, difficulties of changing people mindsets and beliefs, and its IT knowledge, skills, and capabilities [20] [39]. It concerns the preparedness of the population to effectively deal with digital technologies, and how well the labor force is able to adapt to technological change.

Considering this dimension helps in the measurement of a country's ability to build and harness digitally skilled human capital, critical for driving and sustaining Digital Transformation that underpins economic competitiveness [16].

2.1.3 Integration of Digital Technology

According to European Commission: "*Digital technology enables companies to gain a competitive advantage, improve their services and products, and expand their markets. The Digital Transformation of enterprises has brought new opportunities and promoted the development of new and reliable technologies*"[16].
This dimension is a vital sign of how businesses are embracing a shift in Digital Transformation reshaping economies across the world, enhancing economic resilience: it not only reflects a company's competitive ability but also its innovativeness and capacity for growth in a fast-changing market.
Productivity levels could be improved considerably by taking up digital tools such as Cloud Computing and Artificial Intelligence .
In addition, digitalization acts as a driver of enterprises, making them capable of competing with other players in the world market with limited resources and expanding markets for selling purposes [1].

2.1.4 Digital Public Services

This dimension catches the degree to which governments are currently modernizing their relations with citizens through digital means [16].
The need for Digital Public Services became all the more pressing during times of crisis, such as the COVID-19 pandemic, since they empowered governments to keep working and deliver essential services to citizens [21].
Digital Public Services increase effectiveness and reduce costs by making government procedures easier and more efficient. These services facilitate transparency and accountability, where accessibility of information and government participation will be given to citizens [51].

Now that the DESI has been further explained, we can look at Italy's strengths and weaknesses according to this index.

2.2 2022 DESI of Italy

According to the 2022 DESI, that is the last available report, Italy ranks 18th out of 27 in terms of overall digitalization level, with a score of 49,25/100. The EU score is 52,3, as shown in Figure 2.2.
The ranking may point out that Italy is still lagging behind most other EU countries in several indicators, but Figure 2.3 shows that recent initiatives and strategic investments are starting to make a difference in the steady gains of the DESI score, and Italy is bridging the gap with its colleagues in Europe, also building a more

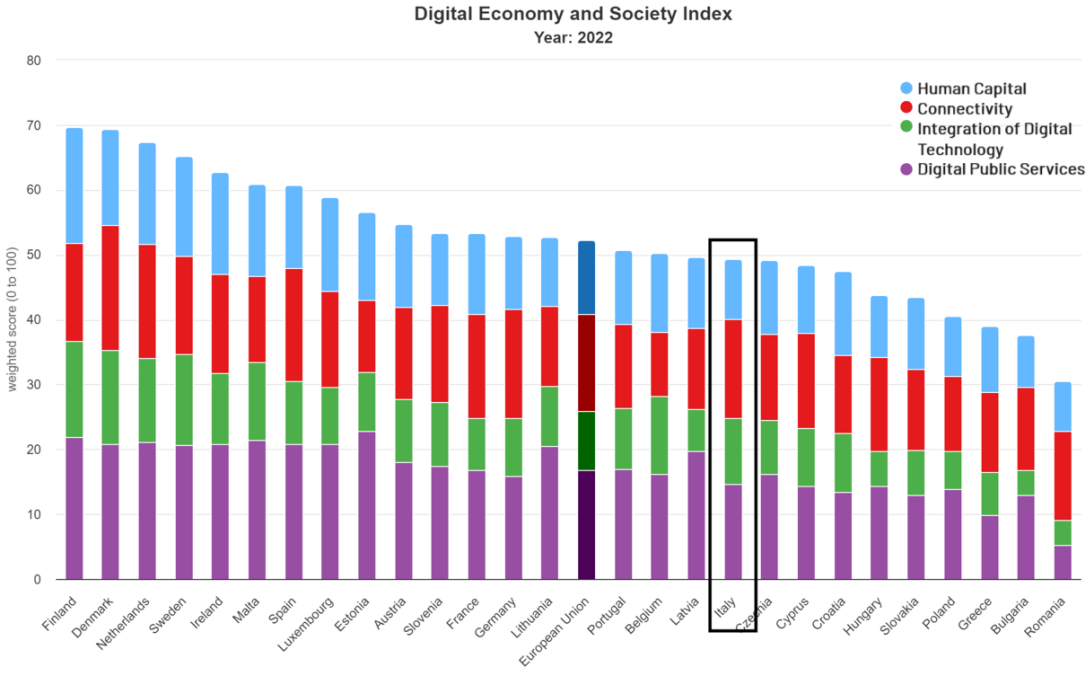

Figure 2.2: 2022 Desi Index of the 27 European Union member states [13]

solid base for future success in digital competitiveness.

Figure 2.3 shows the steady progress by Italy: technically, it has been made on all four main dimensions of the DESI.
The graph presented in Figure 2.4 gives insight into the way progress in Italy differentiates in these dimensions, by presenting the performance of this country in each of these four areas during the same period.

The breakdown of the indices helps to identify which of the dimensions is better off and in which areas Italy still faces challenges.
An understanding of these aspects gives a wider insight into what probably may be driving overall progress in Italy and the selective effort required if it is going to improve its digital competitiveness in the European Union.
As we can see, up to 2022 Connectivity and Digital Public Services are the dimensions that recorded the highest progress, while the other two sill present challenges.
Having already laid out broad trends and performance of the four dimensions, this warrants an elaboration on each of the dimensions with respect to the underpinned factors.

2.2.1 Human Capital

Italy ranks 25th of 27 EU countries and the score is calculated according to the criteria shown in Figure 2.5.

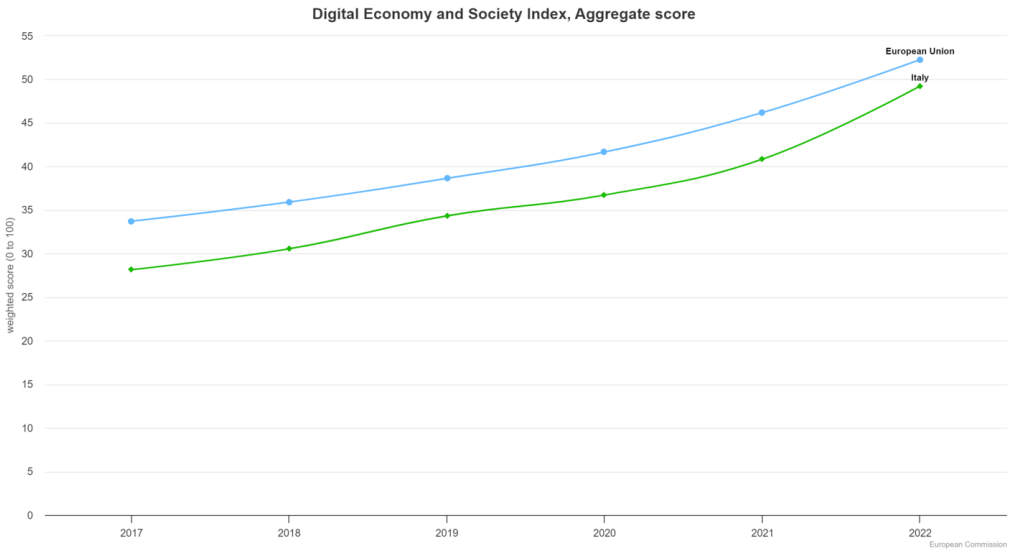

Figure 2.3: Italy's DESI Progress from 2017 to 2022 [13]

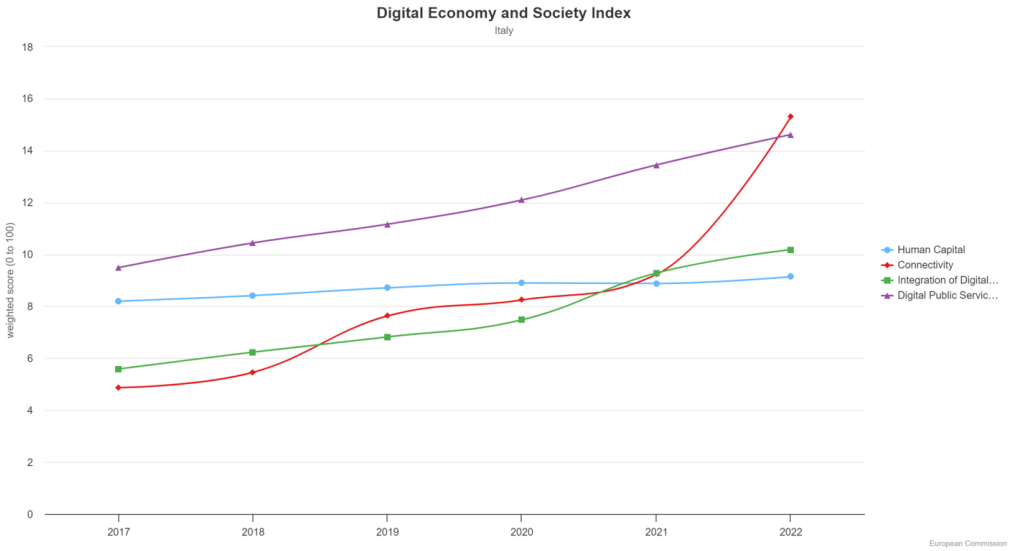

Figure 2.4: Progress of Italy across the four DESI cardinal points from 2017 to 2022 [13]

	Italy			EU
	DESI 2020	DESI 2021	DESI 2022	DESI 2022
1a1 At least basic digital skills % individuals	NA	NA	46% 2021	54% 2021
1a2 Above basic digital skills % individuals	NA	NA	23% 2021	26% 2021
1a3 At least basic digital content creation skills[4] % individuals	NA	NA	58% 2021	66% 2021
1b1 ICT specialists % individuals in employment aged 15-74	3.5% 2019	3.6% 2020	3.8% 2021	4.5% 2021
1b2 Female ICT specialists % ICT specialists	15% 2019	16% 2020	16% 2021	19% 2021
1b3 Enterprises providing ICT training % enterprises	19% 2019	15% 2020	15% 2020	20% 2020
1b4 ICT graduates % graduates	1.3% 2018	1.3% 2019	1.4% 2020	3.9% 2020

Figure 2.5: Italy's DESI criteria for the Human Capital dimension [15]

Only 1,4% of Italian graduates study ICT programs, the percentage of ICT specialist is 3,8% of total employment only 16% of Italian enterprises provide ICT training to their employees.

Such a low number of experts, coupled with a lack of relevant training programs, highly limits the country's ability to acquire, develop, and use transformative technologies such as those mentioned in Section 1.2.3.
Bridging these educational gaps is extremely vital if Italy is to utilize the benefits stemming from AI technologies and reinforce its competitive position within the digital economy.

We can see a slight improvement from the previous year and this proves the fact that Italy is narrowing the gap with the EU: in 2020 it implemented the *Repubblica Digitale* initiative that aims to reduce the digital gap and promote the education on future technologies, supporting the country's development process [43], which concretely results in the *National Strategy for Digital Skills*, aimed to fight the cultural digital divide affecting the Italian population, and to promote key competences development for the future and increase the percentage of ICT specialists [42].
The importance of reinforcing digital skills is well understood, and the development of human capital should remain a key priority for Italy.

2.2.2 Connectivity

With an overall connectivity score of 61,2, Italy ranks 7th among the EU countries. The score is calculated according to the criteria shown in Figure 2.6.
After the Covid-19 breakout, two legislative decrees were approved to simplify the procedures and to facilitate the installation of infrastructures, and these was followed by the adoption of the National Recovery and Resilience Plan (PNNR), with relevant investments and reforms to achieve the ambitious goals set by the 2030

	Italy			EU
	DESI 2020	DESI 2021	DESI 2022	DESI 2022
2a1 Overall fixed broadband take-up % households	61% 2019	61% 2020	66% 2021	78% 2021
2a2 At least 100 Mbps fixed broadband take-up % households	22% 2019	28% 2020	38% 2021	41% 2021
2a3 At least 1 Gbps take-up % households	<0.01% 2019	4.22% 2020	7.06% 2021	7.58% 2021
2b1 Fast broadband (NGA) coverage % households	89% 2019	93% 2020	97% 2021	90% 2021
2b2 Fixed Very High Capacity Network (VHCN) coverage % households	30% 2019	34% 2020	44% 2021	70% 2021
2b3 Fibre to the Premises (FTTP) coverage % households	30% 2019	34% 2020	44% 2021	50% 2021
2c1 5G spectrum Assigned spectrum as a % of total harmonised 5G spectrum	60% 04/2020	60% 09/2021	60% 04/2022	56% 04/2022
2c2 5G coverage[11] % populated areas	NA	8% 2020	99.7% 2021	66% 2021
2c3 Mobile broadband take-up % individuals	70% 2018	70% 2018	80% 2021	87% 2021
2d1 Broadband price index Score (0-100)	74 2019	74 2020	76 2021	73 2021

Figure 2.6: Italy's DESI criteria for the Connectivity dimension [15]

European Digital Compass [1] by 2026.

In terms of connectivity improvement, some broader objectives related to Digital Transformation are at stake. Greater connectivity not only facilitates the easier adoption of the ITIL frameworks but also goes a long way in tapping into Artificial Intelligence technologies: ITIL practices have to be implemented on robust network infrastructures since most of these practices require real-time monitoring and management of IT services over distributed systems, and high-speed internet together with reliable connectivity form the core of AI solution deployments that require huge transfers of data and processing.

2.2.3 Integration of digital technology

With an overall score of 40,7, Italy ranks 8th in the EU in Integration of Digital Technology. The considered criteria are those shown in Figure 2.7.
As we can see, the overall performance is mixed: most of the enterprises uses e-invoices (95%), cloud environments (52%) and has at least a basic level of digital intensity (60%); however, for what concerns the use of Big Data and Artificial Intelligence there are still deep gaps: with the 9% of enterprises that uses Big Data, Italy is below the EU average of 5 percentage points (14%), that lower to 2 when it

[1]The Digital Compass 2030 is a strategic enabler adopted by the European Commission, outlining the expected path of European Union digital ambitions and targets for the year 2030. It focuses on four key areas: boosting digital skills, creating secure and sustainable digital infrastructures, pushing for the Digital Transformation of business, and promoting the digitalization of public services in member states.

	Italy			EU
	DESI 2020	DESI 2021	DESI 2022	DESI 2022
3a1 SMEs with at least a basic level of digital intensity % SMEs	NA	NA	60% 2021	55% 2021
3b1 Electronic information sharing % enterprises	35% 2019	35% 2019	32% 2021	38% 2021
3b2 Social media % enterprises	22% 2019	22% 2019	27% 2021	29% 2021
3b3 Big data % enterprises	7% 2018	9% 2020	9% 2020	14% 2020
3b4 Cloud % enterprises	NA	NA	52% 2021	34% 2021
3b5 AI % enterprises	NA	NA	6% 2021	8% 2021
3b6 ICT for environmental sustainability % enterprises having medium/high intensity of green action through ICT	NA	60% 2021	60% 2021	66% 2021
3b7 e-Invoices % enterprises	42% 2018	95% 2020	95% 2020	32% 2020
3c1 SMEs selling online % SMEs	10% 2019	11% 2020	13% 2021	18% 2021
3c2 e-Commerce turnover % SME turnover	8% 2019	9% 2020	9% 2021	12% 2021
3c3 Selling online cross-border % SMEs	6% 2019	6% 2019	7% 2021	9% 2021

Figure 2.7: Italy's DESI criteria for the Integration of Digital Technology dimension [15]

comes to the use of Artificial Intelligence (6% vs 8%).

Figure 2.8 plot the progress made in each digital technology: while Cloud adoption recorded the highest increase, it is immediately noticeable how AI and Big Data are the technologies that after five years still struggle to gain a foothold in Italian companies.

2.2.4 Digital public services

With a total score of 58,5 Italy ranks 19th of all 27 EU countries.
The points are calculated according to the criteria shown in Figure 2.9.
Despite the progress, only the 40% of the Italian population uses the digital public services, that is well below the EU average of 65%.

However, these data do not reflect yet the boost that the Recovery and Resilience Plan is expected to have on the initiatives for the digitalisation of public administration and its services.

2.3 Italian enterprises

Even if in the 'Integration of digital technologies' dimension Italy occupies a position in the top 10, by looking at Figure 2.4 we notice how that area still has room for improvement, at least when compared to Connectivity and Digital Public Services.

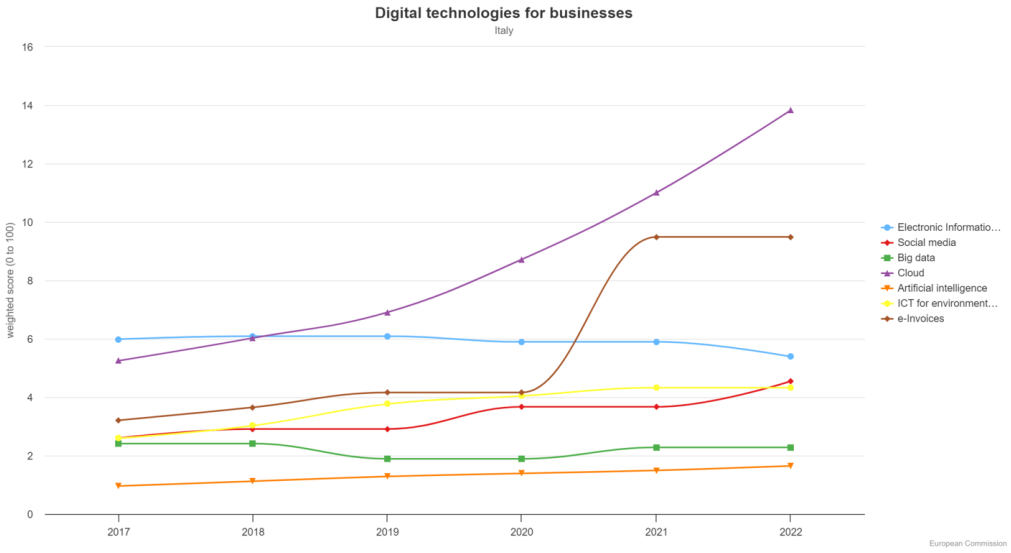

Figure 2.8: Progress of Digital technologies for businesses 2017-2022 [13]

	Italy			EU
	DESI 2020	DESI 2021	DESI 2022	DESI 2022
4a1 e-Government users % internet users	**30%** 2019	**36%** 2020	**40%** 2021	**65%** 2021
4a2 Pre-filled forms Score (0 to 100)	**NA**	**NA**	**48** 2021	**64** 2021
4a3 Digital public services for citizens Score (0 to 100)	**NA**	**NA**	**67** 2021	**75** 2021
4a4 Digital public services for businesses Score (0 to 100)	**NA**	**NA**	**79** 2021	**82** 2021
4a5 Open data % maximum score	**NA**	**NA**	**92%** 2021	**81%** 2021

Figure 2.9: Italy's DESI criteria for the Digital Public Services dimension [15]

Since the overall DESI index is given by the arithmetic average of the four dimensions, in order to gain positions and climb the European ranking, it is necessary to improve each dimensions and reach an homogeneous score across these. One of the key drivers of economic growth in Italy, directly related to its competitive edge, hinges on enterprises.

Taking these considerations into account, enterprises emerge as crucial actors for propelling national economic development [65] and the key to unlocking this potential lies in harnessing the power of Digital Transformation, which holds the capacity to enable companies to unleash their untapped potential and strengthen their competitiveness in a market increasingly driven by digital forces.

Secondly, enterprises have a pivotal role in the creation of jobs and the development of workers. By embracing Digital Transformation, businesses create new demand for skills [11] and, henceforth, contribute to labor market evolution that would reflect in an improvement in the Human Capital dimension as well.

Enterprises are one of the leading drivers of innovation, alongside governments, public institutions, universities and startups [48] [10] [5]: by focusing on enterprises' Digital Transformation, we delve deeper into how digital innovations are being adopted, scaled, and transformed to improve the country's economic status.
The question now is, what is the current state of digital adoption among Italian enterprises?

Enteprises in Italy are very heterogeneous from a structural, organizational and type of activity perspective, and they often approach the innovation path in a way that is not structured or organic: they are not able to develop a strategic plan to follow and typically even the times when they approach to digital, it is just in response temporary needs or financing opportunities.

Since enterprises struggle to undertake a digitalization transition alone, various associations have been created with the aim of supporting companies during this process, like for example Innovation Manager, the Competence Center, the 'Punto Impresa Digitale'[2] and Digital Innovation Hubs.

In particular, Digital Innovation Hubs are incubators and business accelerators that have the mission to promote innovation inside the enterprise and to strengthen the awareness and the acknowledgment level among enterprises in terms of digitalization and 4.0 Industry.

The Digital Economy and Society Index provides an overall perspective on digitalization in Europe but does not have the details needed to address the individual

[2]The 'Punto Impresa Digitale' is a service structure located in the Chambers of Commerce and dedicated to the diffusion of digital culture and practice in enteprises of all economic sectors.

challenges and opportunities of an enterprise, which is the goal of this research.

2.4 Digital Maturity Assessment of enterprises - Confindustria

As a complementary indicator to the DESI overall snapshot, the Digital Innovation Hub promoted by Confindustria-Assoconsult, together with the Politecnico of Milano, developed a 'Industry 4.0 Test' to assess the digitalization level of enterprises [18].

Confindustria is the main association representing manufacturing and service companies in Italy: its activities aim at "guaranteeing the central importance of companies, the driver's of Italy's economic, social and civil development. By representing companies and their values at institutions of all levels, Confindustria contributes to social well-being and progress, and from this standpoint guarantees increasingly diversified, efficient and modern services" [17].
Assoconsult is a close partner of Confindustria, and it represents Management consulting companies. It aims to visibly and effectively support organizations in all public and private sectors in order to enhance Italy's global competitiveness.
In particular, thanks to the development of the role and image of the consultants, it spreads the knowledge of the top managers in order to improve efficiency and competitiveness [6].

This test measures the digitalization level in different areas: these include both operational aspects and strategic concerns.
We might say they represent the most critical functions of an enterprise influenced by digital transformation: The level of digital maturity within these processes and functions forms the basis of competing effectively in today's digital economy. The macro areas are the following:

- **Production**: it is the heart of so many businesses, particularly in the manufacturing sector. When production is digitally transformed for example with integration of Internet of Things solutions, it results to more effective processes with minimized waste, high quality products as well as an high degree of flexibility;
- **Maintenance**: Minimizing down times and ensuring that the production lines run smoothly are dependent upon maintenance.For example, predictive maintenance can increase efficiency while lowering costs;
- **Human Resources**: Digital transformation necessitates new skills and constant learning. HR's role in promoting digital abilities and coping with change is crucial for corporate digital growth;

- **Design and Engineering**: This area concerns joining design with production based on aspects like digital twins making easy transition from ideas into actual items faster than ever before. To support design processes and enable innovation, companies can make extensive use Computer-Aided Design (CAD), simulation software or AI platforms;
- **Quality**: quality assurance is of prime importance to maintain the product standards and satisfy the customers. Digital tools , like Big Data and AI,enable real-time monitoring and analytics, which ensure the high standard of products consistently;
- **Logistic**: Digital maturity in this field very often includes AI and machine learning, together with real-time data, in order to manage and optimize logistic operations, ranging from inventory management to supply chain optimization;
- **Marketing, Customer Care and Sales**: The essence of the digital growth is reflected in its ability to create an environment that maintains a client-centered approach, this is significant in today's marketplace. Companies can use internet platforms for analyzing data, targeting customers as well as improving customer relations.

Then the results of the test are analyzed across four dimensions:

- **Execution**: enterprises are judged based on how effective the processes are in bringing results, and how repeatable and in line they are with the company objectives;
- **Process Monitoring and Control**: this dimension gives indications on how a company process is measured and has implementable parameters for its control;
- **Technologies**: it indicates how much digital technologies, hardware, and software have been used in the process.
- **Organizational Structure**: this dimension evaluates how structured the organization is;

The level of digital maturity provided by the test is expressed with a value from 1 to 5, as for the Capability Maturity Model [12]. The Capability Maturity Model Integration is a framework that can empower an organization through ways that improve processes and performance on the basis of maturity. It allows them to apply systematic approaches in the identification of avenues for performance improvement within the spheres of project management, product development, and service delivery.
The five levels are the following:

- **Level 1 - Initial**: This level indicates that processes are not monitored and are reactively managed, the company is not prepared to change, and the technologies and systems used are basic;

- **Level 2 - Managed**: Processes are partially controlled and developed with less advanced or non-integrated technologies and systems. These are managed by the CEO or the area manager, who exclusively act according to their experience. Companies with this level of digital maturity, are slightly prepared to change and report a limited digital maturity;
- **Level 3 - Defined**: Companies with this level of digital maturity present discretely controlled processes, developed with partially integrated and automated technologies and systems and managed in a partially integrated manner across the various company functions; Digital maturity and preparedness are discrete;
- **Level 4 - Integrated and interoperable**: Most of the processes are controlled, developed with mostly integrated and automated technologies and systems, and managed in an integrated way across the various company functions; These companies present good digital maturity and preparation for change;
- **Level 5 - Digitalization oriented**: Processes are systematically controlled, developed with advanced technologies and managed in an integrated manner across the various company functions; Digital maturity and preparedness for change are excellent.

Figure 2.10 summarizes the 5 levels according to the Capability Maturity Model Integration.

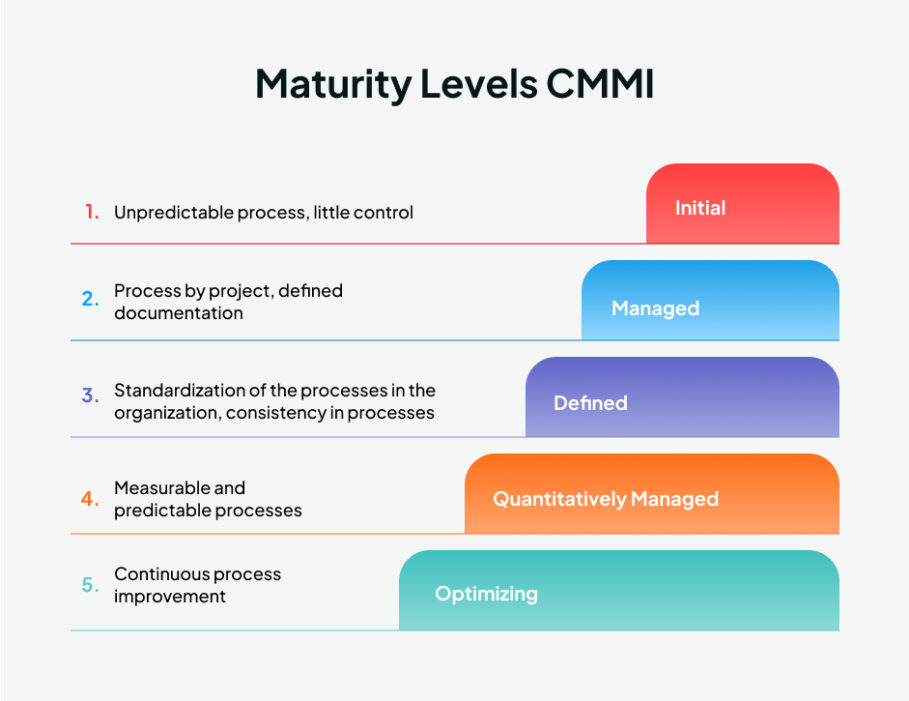

Figure 2.10: The 5 levels of the Capability Maturity Model Integration (CMMI)

The test involved 1802 companies located across Italy in a time range going from 2018 to 2022: of these, 58% were micro-small businesses while the remaining 42% were medium-large companies.
The average maturity level recorded by the questionnaire is 2,85. Figure 2.11 shows how the distribution of enterprises recalls a Gaussian distribution: most of the companies (56%) places between 2,50 and 3,49.

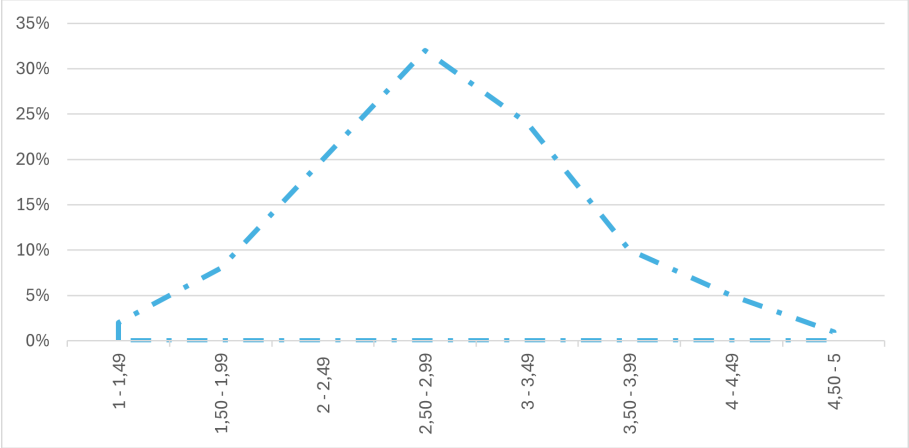

Figure 2.11: Gaussian distribution of the considered enterprises. Source: [22]

Considering the four dimensions cited above, if we visualize them separately as shown in Figure 2.12 we see that these differ from the lowest to the highest by only 0,73, highlighting how the considered enterprises are overall homogeneous.

Pursuing a digital transformation path that is transversal to these 4 dimensions is crucial for companies, as it allows them to fully grasp the advantages of digitalisation.
Conversely, very different averages among the four dimensions would lead to greater difficulties since it is important to obtain benefits if the underlying structure is not appropriate.

Moreover, it emerges that the size of the company is an important feature to consider: as the size increases, so does the level of digitalization as shown in Figure 2.13, a sign that for smaller companies the innovation process is slower.
Figure 2.14 shows how the maturity level changes according to the macro area being considered.
In the following sections a more detailed analysis of some of the considered area will be provided.

Production. In the Production area, the processes result to be controlled and monitored and enterprises score an average score of 3,21/5.
More than two-thirds of companies present a production process moderately digital-

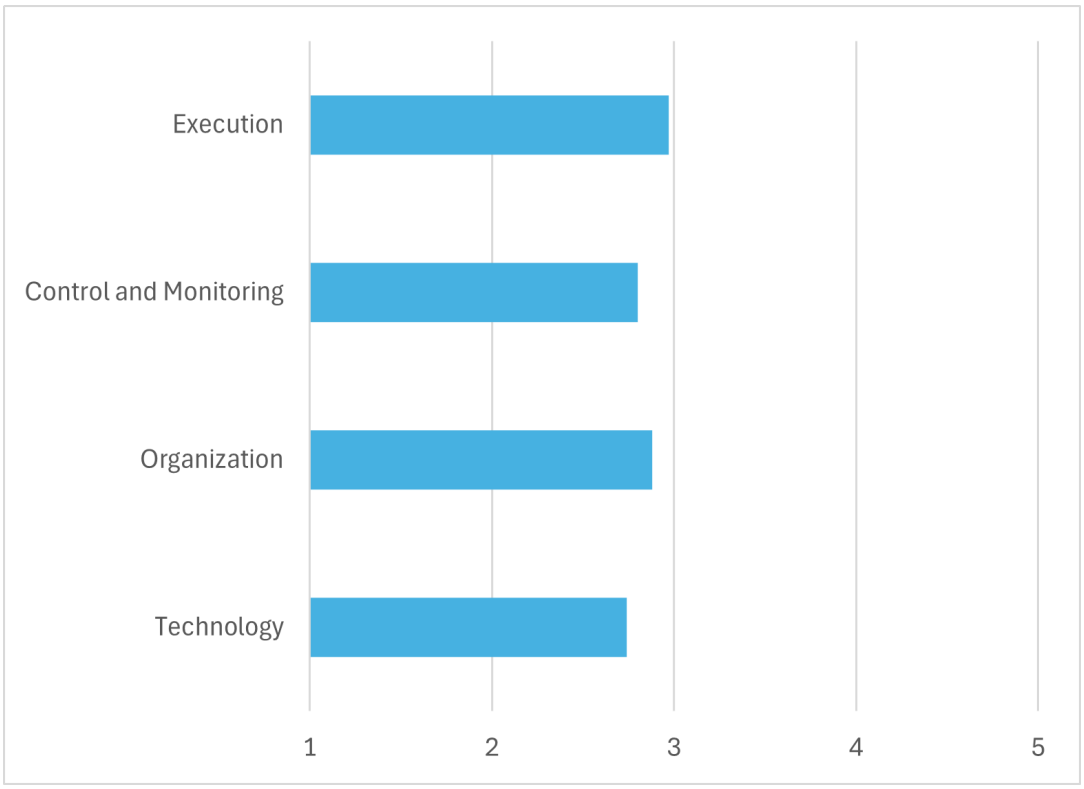

Figure 2.12: Average score obtained in the different dimensions considered. Source: [22]

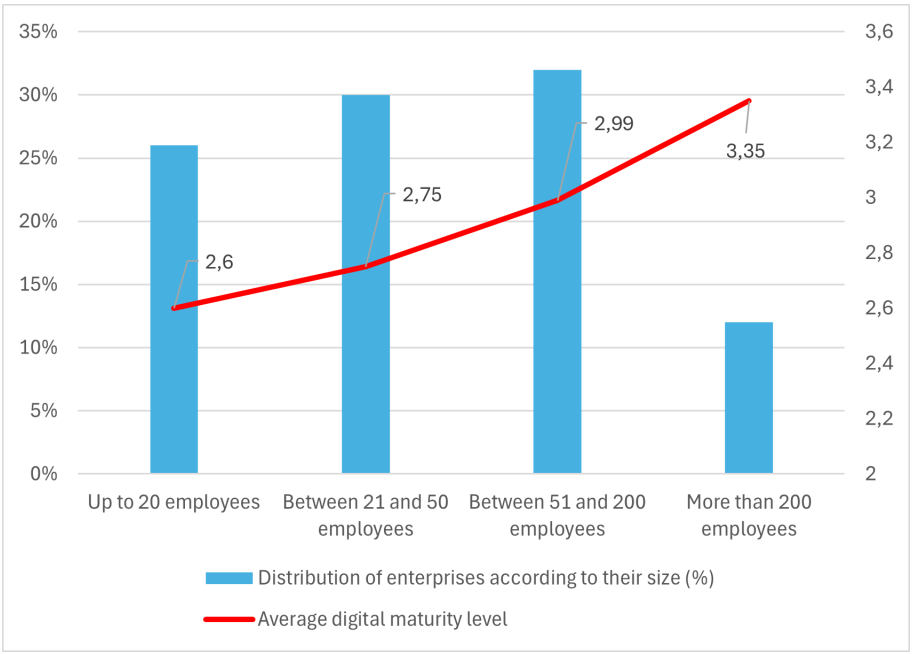

Figure 2.13: Correlation between the size of the company (X axis) and the digital maturity level assessed by the test (Right axis). Source: [22]

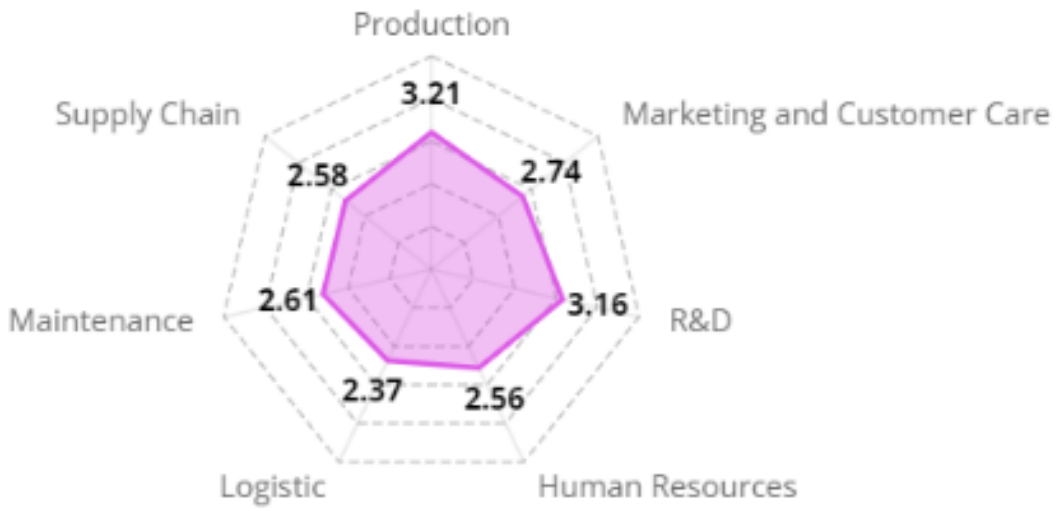

Figure 2.14: Kiviat chart of the digital level assessed across the 8 macro areas. Source: [22]

ized, developed with advanced technologies and systems among the different business functions.
However, only the 15% have reached the medium-high digital maturity level, and this is a sign that despite the good performance in the Production area, most of the companies are still in the middle of the digitalization process.
On the other hand, it is also worth noting that only 5% of enterprises is positioned at a level lower than 2, underlining that particular attention is being given to this area.

Design and Engineering. Almost three quarters of the analyzed companies present a Design and engineering process at least discreetly digitalized.
Differently from what occurred within the Production area, here the differences among the four dimensions increase, and Execution is the one which scores the lowest.
As before, only the 16% have reached the medium-high level, and likewise only the 7% obtain a score lower than 2/5.

Most of the companies are focused on this area, but many weaknesses arise.
These lie in the integration of the main processes with the other related processes (i.e. Marketing, Production, Maintenance, etc): the separation between those who design and those who produce is still very common.
Adopting Product Lifecycle Management systems would help in leveraging the information and it would become the heart around which the Digital Transformation revolves.

Maintenance. With an average score of 2,61/5, the Maintenance process is one of the less performing.
It emerges there is still poor propensity to tackle maintenance in a scientific and rigorous way: skills that are not always adequate, combined with a poor data culture lead to maintenance processes which are still largely based on experiential and individual approaches: predictive, preventive and condition-based maintenance are timidly approached. This general unpreparedness reflects in the inability to adopt emerging technologies like Artificial Intelligence.
In our sample, only 6% of the respondents indicated that they apply a digitally mature process, and more than a fifth have minimum digital maintenance levels, below 2.

Human Resources. As mentioned in Section 2.2.1, one of the areas in which Italy lacks most when it comes to digitalization is human capital. Thus, it is to be expected that the score achieved in this area is low. In fact, with a level of 2,51/5, Human Resources is the second to last area.
Even if for what concerns the Technology dimension the process has a discrete level, it is the digital strategy orientation that is missing.
Very few enterprises have specialized team or figures dedicated to a digital strategy and even fewer has tools to measure the level of digital competencies or has actually started up-skilling or re-skilling programs.
Only 4 out of 10 companies recognize, develop, and reward Industry 4.0 skills.

The results also suggest the reasons behind these gaps: first of all, many opportunities flounder due to the lack of competencies of people, which perfectly reflects the shortage of qualified individuals, as also highlighted by the DESI index.
Moreover, if we consider the volatile dynamics in the job market, the other difficulty many companies experience is the loss of established competencies. The challenge then is not only to find or create additional skills, but also retain existing ones.

Although both the DESI index and Confindustria's assessment tool are valuable sources of information, these indicators allow just a 'bird's-eye view' of the Italian situation. Macro-level indicators may be useful for benchmarking and arguing general trends, but they are not fine-grained enough to effectively capture how Digital Transformation is playing out within specific confines of an organization.

The next chapter brings case studies to the forefront in an attempt to bridge the gap between broad national indicators and ground-level realities. It provides a closer view of the ways Italian enterprises are dealing with the digital challenge, embracing new technologies such as Artificial Intelligence, and reconfiguring their internal operations and processes in reaction to the forces of Digital Transformation. It is in these individual stories and sector-specific trends that we obtain a better understanding of the real-life implications of Digital Transformation and be able to point out successes and complications marking progress in the digital realm in Italy.

Chapter 3

Case studies

As the analysis of Italy's performance according to the DESI Index in Section 2.2 has shown, there are both points of excellence and several challenges still to be overcome in the digital maturity of Italian enterprises.
The DESI Index and the data provided by Confindustria are useful tools for a general overview of Italian enterprises' digital maturity, but it is fundamental to integrate this with a more detailed analysis of the concrete experiences and challenges that businesses face along their paths of Digital Transformation.
To this end, and with the aim of illustrating digital maturity in greater depth, this Chapter makes use of insights gathered from direct interviews carried out with large companies operating in the Italian territory.

3.1 Research methodology

Italian economy is largely driven by Small and Medium Enterprises (SME) - according to ISTAT, in a total of 4,4 Millions of active enterprises, only the 0,09% are large firms [28]. Despite this fact, this research has chosen to pay particular attention to large enterprises.

Focus on large enterprises is justified by several key considerations.
Most SMEs are understaffed in IT, both in terms of personnel and resources [66]. Because of this, they are constantly striving to keep up with simple, operational activities instead, of working on more advanced and innovative projects that might change the way they operate. This reactive attitude does not allow them to make paradigm-shifting changes but positions them in a mere maintenance circle rather than strategic growth [3].
Large enterprises have a disproportionate influence on the national economy, from the contribution to GDP and their role as a big employer, to being a pivot in the broader digital landscape of the country [28].
Furthermore, they often play leadership roles in innovation, setting industry standards and driving technological trends with vast implications outside of their oper-

ational boundaries [45]. Their capacity enables them to invest intensively in state-of-the-art digital technologies and, therefore, to offer a very complete picture of how such innovations are actually being adopted within complex business processes [28]. The results of the analysis conducted by Confindustria underline the importance of focusing on such enterprises because they are often more advanced in digital adoption and integration, as the maturity level increases with the number of employees (Figure 2.13).
Large enterprises are also more likely to fall under stringent regulatory frameworks and compliance needs, thus offering a unique vantage point from which to explore the interplay between Digital Transformation and regulatory obligations.

In paying close attention to these actors, this research tries to achieve a more fine-grained and detailed understanding of digital maturity of some Italian enterprises and hence complements broader, more aggregated insights provided by indices such as the DESI and specific enterprise-focused data coming from Confindustria.

The research is a qualitative analysis based on five case studies.
While not providing statistically generalizable results, this approach remains valuable.
Whereas quantitative analyses provide a broad, numerical overview, qualitative research offers a chance to deeply and richly understand complexities inherent to Digital Transformation.
This research aims to develop deep knowledge regarding the chosen large enterprises: what specific challenges, strategies, and innovations lead their path toward digital maturity.
Qualitative data emerged from the case studies is rich, and it allows an investigation of contextual factors, organizational dynamics, and unique practices that are usually hidden in larger statistical analyses. These case studies also complement and place quantitative findings into context - such as the DESI Index and Confindustria - providing further meaning to trends and data.
Since statistical generalization is not achievable from the selected case studies, they provide important detail and context that enrich the overall understanding of the Digital Transformation landscape in Italy.

This research involved five large companies. These are all involved in the metal-working sector and, for the sake of privacy and confidentiality, they will be referred to as 'E1', 'E2', 'E3', 'E4', and 'E5'.
These companies have big legal departments that oversee the disclosure of such specific information. Revealing this data linked to their names would have required extensive effort and approval procedure not congruent with the thesis schedule.
Anonymizing them allows more objective analysis of the dynamics and development of those firms to be made objectively, without compromising confidentiality about sensitive information.
Moreover, selection of enterprises from the same sector guarantees more consistency

and homogeneity in the results, and in the effects produced in productive processes. The metalworking sector traditionally employs automation, robotics, and other technologies from Industry 4.0; therefore, it constitutes a proper case for a study in the integration of technologies [30].
The interlocutors in these interviews were all key figures in the IT domain, such as IT Managers, IT Directors, and Chief Information Officers (CIOs).

As mentioned in Chapter 1, specific focus is placed on IT Service Management, mainly the adoption of the ITIL framework, along with Artificial Intelligence.

Although ITIL was not originally designed to measure digital maturity, it is very helpful in the process of checking the quality and efficiency of the provided services within IT. ITIL's guiding principles and practices ensure that the path the organization takes to higher digital maturity is along the line of standardization and optimization of the IT service management.

For this reasons, the key elements of ITIL already introduced in §1.1, which are the Service Value System (SVS) and the 'Four Dimensions', were used to design the questions of the survey.
In particular, the Service Value System (SVS) facilitates the integration and the coordination of different activities inside an organizations, with the aim to make the latter more efficient and reliable. The SVS consists in:

- **Service Value Chain (SVC)**: how all organization's components and activities work together to create value;
- **ITIL practices**: recommended guidelines for completing tasks and achieving objectives.
  They are organized into three categories that cover different areas of service management: General Management Practices, Service Management Practices and Technical Management Practices.
  The objective is to encourage systematic management oriented towards continuous improvement, while ensuring alignment of IT services with strategic objectives of the organization.
  ITIL 4 presents 34 different practices.
- **Guiding principles**: seven universal recommendations that guide an organization in all circumstances. These are:
  - Focus on value;
  - Start where you are;
  - Progress iteratively with feedback;
  - Collaborate and promote visibility;
  - Think and work holistically;

  - Keep it simple and practical;
  - Optimize and automate.

- **Governance**: set of processes, policies, and procedures that are put in place to ensure that IT services are managed effectively and efficiently.

- **Continual Improvement**: model that puts focus on customer value and makes sure that all improvement initiatives are linked to the organization's vision. It is used to drive ongoing improvements in IT services, processes, and practices to meet changing business needs, enhance efficiency, and deliver value to customers.

On the other hand, the Four Dimensions serve as a reference and they need to be taken into account by each component of the SVS to ensure an holistic and well-balanced approach to IT service management. The four dimensions, as shown in Figure 3.1, are:

- **Organizations and people**: this dimension refers to the human capital, the people who carry out and manage the work. Organizations need to consider how the people work together to create value. This dimension includes organizational culture, structure, skills, and predisposition to change;

- **Information and technology**: this dimension concerns the technologies used in the management of services, for example the tools and the knowledge bases, as well as the management of information that companies generate, store, manage and use in provision of an IT service;

- **Partners and suppliers**: this dimension is about relationships with other organizations that are involved in the design, development, delivery and improvement of services.
  This may include suppliers, business partners, external organizations and other parties contributing to the provision of services;

- **Value streams and processes**: this dimension provides a definition of all activities, workflows and processes necessary to achieve business objectives. It also examines the interaction of different business components and how they are involved in the process of value creation.

Questions addressed responsibilities for ITIL implementation, the number of ITIL-certified staff, and what measurements are utilized to calculate the success of the framework.
Moreover, the perception of the organization's commitment to continuous improvement and the application of practices and principles of ITIL indicated further the depth to which ITIL was infused in the organization, and the efficiency level expected in operations.
The assessment of Artificial Intelligence maturity looked at organizational awareness and training in Artificial Intelligence technologies, the strategic approach towards

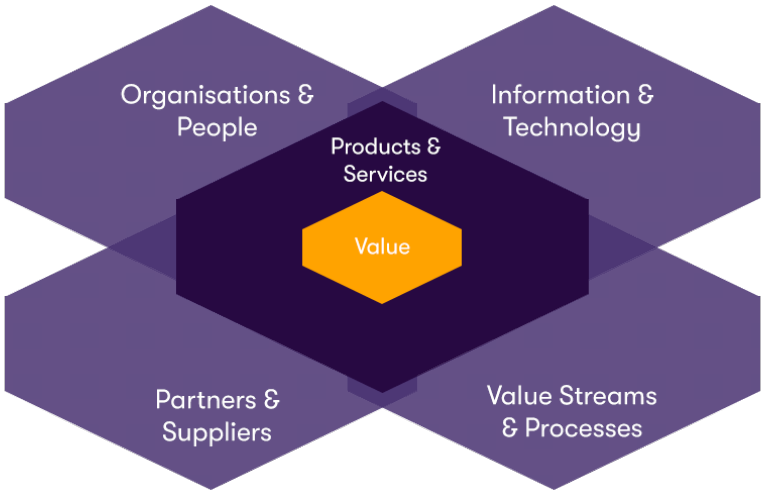

Figure 3.1: Four dimensions of ITIL. Source: [37]

the adoption of Artificial Intelligence, and technological infrastructure. Besides, it researched maturity about Artificial Intelligence projects and initiatives, policies on innovation, and governance to understand how Artificial Intelligence is integrated into business processes; the effectiveness of organizations in leveraging Artificial Intelligence for competitive advantage.
Specific questions posed to each company can be found in Appendix A.

3.2 Enterprise E1

3.2.1 Company Profile

Product category: Manufacturing of non-domestic refrigeration and ventilation equipment.
Number of employees: 3500 in the whole group, 900 working in the parent company.
Annual revenue: €1 Billion for the whole group, €315 Million just for the parent company.

3.2.2 IT Service Management and ITIL Best Practices

Company E1 is currently in the implementation phase of ITIL principles and practices: in the previous years they adopted the framework in a non-structured way, but once they realized that ITIL was the correct framework to support their business, E1 commissioned a formal ITIL adoption project.
In this regard, E1 performed an initial assessment of their ITIL maturity using the ITIL Maturity Model[1]. This assessment suggested that their maturity level was

[1]ITIL Maturity Model is a management maturity model devoted to assessing and improving the management of an organization's IT services. It focuses on the capability of an organization's

between 2 and 3, thus providing them with a good baseline for their improvement efforts as they embarked on the project.
E1's former Chief Information Officer had held that position for quite a long time and, consequently, the company was shaped according to his vision; he had profound knowledge, as he was instrumental in developing many of the current systems at the company; however, his many years also represented a limitation for his innovating capability. Only once he had left, E1 was able to move out of some of the restrictions and push its methodology forward through innovation.
For E1, the CIO is the main responsible person for ITIL: it manages and monitors the implementation project. The Chief Executive Officer (CEO) is just informed but he does not actively take part to strategic decisions.

Under its guidance, the 15 people who take care of IT services are all *ITIL v4 Foundations* certified. In addition, the CIO has the *Direct Plan Improve* module, and plans to take the *Digital and IT strategy* in order to get the *Stategic Leader* certification; some of the other people will get the *Create Deliver Support* certification.
This information is descriptive of the nature and depth of competency, and certification attained are proof that the company has indeed stepped towards making the IT organization capable and certified, a good signal for the technological maturity and quality IT services commitment of the company.

As regards ITIL practices, since company E1 is still in the first phase of the implementation, they still have to be defined.
Among the 34 practices that ITIL provides, they identified 4 clusters, that group some of them together, and three single practices which are transversal are kept separated, for a total of 22 practices out of 34.
These details suggest that the organization is being thoughtful and methodical in its ITIL implementation, focusing on process design and the selective adoption of the ITIL framework. E1 is committed to laying good foundations for ITIL, even if they may not have fully implemented the full set of practices so far.

Along with the processes defined for these cluster and practices, also metrics and key performance indicators (KPIs) will be created, so that practices can be rigorously followed.
Moreover, since E1 manages information security through the ISO/IEC 27001[2] standard, some of these metrics will be incorporated.

One of the key concepts of ITIL is Continual Improvement. In company E1 this is not yet properly formalized but it is implemented and integrated across different business functions. Their approach can be defined as *Kaizen*[3], meaning that small

IT service management, and on the maturity of its service value system.

[2]ISO/IEC 27001 is the world's best-known standard for information security management systems

[3]Kaizen is a Japanese term that indicates continuous, incremental, small, and ongoing ad-

and manageable improvement are preferred to big disruptive changes.
Even if the process is not structured, qualitative analyses which involve other business roles are carried out when it comes to measure the progress made.

ITIL also provides seven guiding principles, which offer a strategic framework in decision-making and operational efficiencies.
Even if some are followed and considered in any strategic decisions, some others are still difficult to integrate. E1 still lacks in the *Collaborate and promote visibility* and *Think and work holistically* principles: they admit having some silos that hinder collaboration, and this lead to missing the general overview necessary to make the business work properly.

3.2.3 Artificial Intelligence adoption and strategy

In Company E1, awareness about Artificial Intelligence is limited to a few people and the knowledge remains superficial and restricted to only a few of the main trends, such as Machine Learning or Natural Language Processing.. There are no training programs about Artificial Intelligence but in the past months the company has hired qualified personnel to be able to develop internal skills.

As regards the strategy, even if they have a general idea of where to apply Artificial Intelligence and where they can really benefit from it, there is still no real formalization of a structured strategy. Artificial Intelligence is still of marginal consideration, and investments on new technologies and project are minimal and occasional.

However, it emerges that the company loosely encourages the adoption of Artificial Intelligence and some pilot projects have started for experimentation. They cover different business areas, like production, legal, administration and information security, after sales and marketing, and they range from ML algorithms for predictive analysis to NLP for extracting useful information from huge sets of documents.

3.3 Enterprise E2

3.3.1 Company Profile

Product category: Merchant bars, beams and other steel products.
Number of employees: 3000 in the whole group, 865 working in the headquarter.
Annual revenue: €2,2 Billions.

justments in the process. The term originates from the Toyota Production System (TPS) and represents a continuous improvement approach. Later adopted by Lean methodology, it now permeates all organizational disciplines, including frameworks like ITIL, to optimize processes and enhance efficiency. [64]

3.3.2 IT Service Management and ITIL Best Practices

Enteprise E2 started adopting ITIL back in 2015: after having considered different methodologies for IT Service Management, the choice fell on ITIL because it was considered the most complete and suited framework to their needs.

It emerges that in the last 10 years the enterprise has grown significantly both in terms of annual revenue and, consequently, in terms of number of employees.
It was therefore necessary to adopt a structured methodology to support the business also through internal functions, such as IT services.

Even if the actual responsible for ITIL implementation is the Group IT Operations manager, there is also moderate involvement on the part of the CIO, with whom strategic decisions are shared and discussed, together with the progress of the projects.This collaboration ensures that ITIL implementation is aligned with the company's strategic goals.
Considering that the core of the enterprise is the product and the production processes, the enterprise does not define itself as completely digitally mature. When asked to give themselves a score from 1 to 5, they rated 3.
As regards human capital, considering the whole group there are 40 full-time-equivalent (FTE) employees dedicated to IT Service management, of which 20 actually operate in the Italian headquarter. Among these 20 people, only 4 or 5 followed the *ITIL v4 Foundations* course, and not all of them took the certification exam.
This seems to be a field in which E2 could grow in: additional training and certification may increase the effectiveness of ITIL practices within the company.
In any case, the limited commitment of E2 to the adoption of ITIL constitutes a challenge: it only makes further training programs hard to be enforced. This means that although an improvement could be achieved, the organizational culture and priorities don't permit the full development of the benefits of ITIL.

As for the adoption of ITIL practices, those rigorously adopted according to the framework are few and revolve around Service Desk, Incident Management, Service Request and Change Enablement.
Several other practices are implemented, but not according to the ITIL guidelines.
As noted earlier, E2 is resistant to change, and since IT is not a core function for them, the right attention is not given to ITIL by other business functions outside of IT, which instead would like to push for a broader and more rigorous adoption of ITIL practices and guidelines.

Regarding the concept of continual improvement, it emerges that the enterprise E2 has a team dedicated to it on the various business functions, in particular for the part of production processes. For IT the process is not so structured but they try to do it with a *Kaizen* approach.
Often improvements are made in conjunction with changes that require the revision of some process: taking advantage of the redesign, the opportunity is seized to im-

prove.
To measure the progress made, and therefore the results of the improvement process, KPIs are monitored daily, and then are discussed every month through meetings to discuss the progress status.

Finally, regarding the seven guiding principles, the interview shows that almost all of them are pursued, not without difficulty.
For example, as regards the 'Focus on value' principle, the analysis to understand where the added value is, is not always done in a structured way, because of lack of time and availability.

3.3.3 Artificial Intelligence adoption and strategy

Regarding Artificial Intelligence and its adoption, we could say that, as for E1, knowledge is limited to a few individuals and in any case reduced to the essential when it comes to the main technological trends.
The company does not have structured training programs on the subject, and it is mainly the IT team that deals with deepening these topics.

The use of Artificial Intelligence is not yet considered a priority within the company, and consequently there is no documented strategy regarding its adoption, nor formal governance policies.
This approach is in line with what was said before, that there is not a sufficient degree of knowledge of Artificial Intelligence and its practical applications, since enterprise E2 is still in the phase of understanding the opportunities and the available tools.

To better understand the benefits that the adoption of Artificial Intelligence solutions can bring, some pilot projects that make use of image recognition algorithms have recently been implemented.
These projects found application in the production area or are closely linked to increasing output or reduction of costs, given that the focus of the enterprise is mainly in the production process.
Expanding Artificial Intelligence use into non-production areas, like Marketing or Human Resources, will likely take much more time, as benefits may be harder to quantify, and thus full commitment by companies is hindered.
One of the pilot projects is applied to logistics, and concerns the recognition of vehicles within the factory: through webcams that follow the vehicles, enterprise E2 is able to obtain information regarding station times.
In the production area, and in particular in the selection of raw material, a project was born that sought to automatically recognize the scrap in order to use it later for the most suitable function. This work is currently carried out by operators, who deal with distinguishing the material manually, however, the lack of high quality data has forced the company to temporarily stop the progress of the project.

For both projects, the algorithms run in-house, meaning that the company has the necessary infrastructure.

3.4 Enterprise E3

3.4.1 Company Profile

Product category: Products and services for the movement and management of water.
Number of employees: 1700 all around the world.
Annual revenue: €430 Million.

3.4.2 IT Service Management and ITIL Best Practices

Enterprise E3 chose ITIL as the framework to adopt for IT Service Management. It was considered as the most suited for their needs, the most manageable and at the same time the most complete. Moreover, since enterprise E3 belongs to a bigger group, which also adopts ITIL principles and practices, the choice was further encouraged.
Some other frameworks were considered, like for example COBIT[4] but then no further action was taken.

The main figure responsible for ITIL is the Head of IT, but also higher levels of management are involved in strategic decisions.
Business strategy is well aligned with ITIL principles and practices, even if further improvement in some areas could be achieved.
When asked to give themselves a rating from 1 to 5, answer stands between 3 and 4.
In the digital context, Enterprise E3 considers itself slightly more mature than its competitors: the way they structured their IT services in order to support the business places them "at least five years ahead".

In the headquarter, 18 people are dedicated to IT operations and aside from recent hires, they are all *ITIL v4 Foundations* certified.

Of the 34 ITIL practices, E3 rigorously adopts 11 - and also adequate metrics have been defined -, while 12 others still have plenty room for improvement.
The fact that the practices in question span across all three types of practices defined by ITIL (Service Management, General Management, and Technical Management)

[4]Control Objectives for Information and Related Technologies (COBIT) is another framework created to manage enterprise IT. It consists of the best practices, tools, and principles to facilitate organizations in ascertaining that their IT processes supplement business objectives by accomplishing necessary risk levels and giving assurance on compliance.

indicates that the enterprise understands the benefits that adopting ITIL can bring. As my interlocutor also reported, a rigorously followed framework like ITIL helps them to be more efficient and better support other business functions, such as Business Intelligence.

When asked to give an example of how a process has been improved through ITIL, the first one that comes up is Service Desk.
Before the rigorous application of ITIL, the closing times for a ticket were around 250 days. Now, also through the sharing of KPIs and metrics, these have been reduced to - at most - 25 days.
Moreover, a Frequently Asked Questions (FAQ) section has been opened, which acts as a Knowledge base, and often allows users to independently resolve a ticket.
It also emerges that making metrics and KPIs visible, such as the number of open tickets, is important to have objective data. This helps the company make strategic decisions, and understand where more resources are needed. In addition, although it may seem that sharing certain KPIs at company level may put pressure on staff, in reality this is appreciated by employees, who feel more part of the company and therefore encourage improvement.

Speaking of improvement, the enterprise has a department dedicated to Continual Improvement that operates with Agile methodology[5]. The process is well structured and formalized, and weekly Scrums [6] are performed to discuss the progress of the project or any obstacles.

Finally, regarding the seven Guiding Principles, enterprise E3 tries to follow them rigorously. For example, as mentioned before, sharing metrics falls squarely within the principle 'Collaborate and promote visibility'.
Again, it is difficult to always succeed, but it is clear that the company is committed and interested in putting them into practice.

3.4.3 Artificial Intelligence adoption and strategy

About 6 months ago, an Artificial Intelligence committee was formed within E3, to establish guidelines on how Artificial Intelligence tools should be used.
It turns out that there is the idea of adopting advanced solutions, but it is hindered by the lack of knowledge about what the actual fields of application are.
There is no full awareness and people do not realize the risks.
To overcome this problem, the enterprise will hold training courses that aim to raise

[5]Agile is an iterative and adaptive approach based on collaboration, customer feedback, and small, fast-paced releases.

[6]Scrum is a framework within Agile that refers to the organization of work into time-boxed sprints through which teams can deliver incremental improvements via regular planning, review, and adaptation.

awareness on the adoption of Artificial Intelligence.

Even if E3 does not currently have any projects in place - except for the adoption of generative Artificial Intelligence tools such as GitHub Copilot for writing code - thanks to the committee mentioned above, there is an embryonic strategy for Artificial Intelligence adoption and policies on the correct use of Artificial Intelligence have already been well defined.
In any case, the adoption of Artificial Intelligence still has a marginal consideration and therefore even any investments are minimal and sporadic.

It must also be said that the parent company does not encourage the adoption of Artificial Intelligence and in some cases even prohibits its use, especially for possible negative impacts at a legal and social level.

3.5 Enterprise E4

3.5.1 Company Profile

Product category: Ground power transmission systems and vehicles.
Number of employees: 3779
Annual revenue: €845 Million.

3.5.2 IT Service Management and ITIL Best Practices

Enterprise E4 uses ITIL in parallel with the adoption of other standards, such those created by ISO.
The adoption of ITIL is limited to some practices, such as the Service Desk, which however must be included within the ISO/IEC 27001 standard.
Although the IT director is primarily responsible for IT services, the CEO has the final word and is updated daily. There is therefore a high level of involvement also from top management.

It emerges that the adoption of ITIL is having difficulty taking hold within the company: my interlocutor himself does not know the framework very well, is not certified - nor is any of the employees - and does not even show interest in learning more about it.
In fact, since the enterprise has acquired quality certifications that fall within the ISO standards, it emerges that it is much easier to understand a scheme that is already known and comprehensible, rather than dedicating resources to understanding a new one such as ITIL.
Staff is not prepared for change and therefore prefer to remain in the comfort zone of an already known framework.

ITIL aside, E4 considers itself digitally mature, and on a scale of 1 to 5 it would give itself a score of 3.5.
This is because for some years now the company has a team of Digital Enablers, whose task is to bring digital culture into the various company functions.
Compared to their competitors, however, they consider themselves a little further behind, mainly because competitors operate on much larger scales and, therefore, need to adopt more efficient and cutting-edge solutions.

As for ITIL practices, the company implements in a moderately rigorous way the practices of Service Desk, Incident Management, Service Request, Change Enablement and IT Asset Management. After more than 10 years of adoption, company E4 did not implement the Problem Management practice yet.
There are other practices foreseen by ITIL that the enterprise puts into practice, but not according to the guidelines of the framework. As said before, these are inserted within the ISO standard and therefore also the KPIs and metrics are defined through it.

As for the continuous improvement process, the approach followed is definitely *Kaizen*.
There is a five-years strategic plan planned by the business, in collaboration with the top management and with the digital enablers, in which predictions are made and KPIs are established that then push the enterprise to improve.
It seems that the level of involvement is high, also motivated by the fact that periodic assessment meetings are held.

Finally, as regards the seven guiding principles, these are pursued, even if not entirely consciously.

3.5.3 Artificial Intelligence adoption and strategy

In terms of awareness on Artificial Intelligence, through Digital Enablers and an awareness path wanted by the top management, the company E4 considers itself quite prepared on the subject, it understands the main trends and has set up some pilot projects to experiment with the actual benefits.
There are no periodic training programs, and the strategy is still in an embryonic and non-formalized state. This is because the adoption of Artificial Intelligence, for E4 has not yet demonstrated all its potential.
However, it can be said that the integration of Artificial Intelligence solutions has constituted one of the enterprise's priorities.

The infrastructure is well developed, possibly ready to host in-house solutions and, given the presence of a Business Intelligence team, the data is also of good quality.

To experiment with Artificial Intelligence technologies, some pilot projects were born, in collaboration with external entities, such as the University of Venice.
For example, one project concerns document management: through Natural Language Processing algorithms the objective is to find information from the enterprise's Knowledge Base in a practical and fast way.
Another project instead is declined in the production process, and concerns planning algorithms.

3.5.4 Regulatory and IT Infrastructure Challenges

From the interview with E4 it emerges that obtaining quality certifications such as those defined by ISO is becoming a mandatory choice for companies, given that in the absence of such certifications both customers and suppliers tend to leave negative audits.
Furthermore, other regulations at European level, such as the General Data Protection Regulation (GDPR), push the company and the IT to structure themselves differently, but the internal infrastructure is often obsolete and not resilient.

Although Cloud Computing was not directly addressed in the questions of my interviews, an interesting point arose during the interview with E4. Since Cloud Computing is among the enablers of Digital Transformation, as discussed in Section 1.2.2, it is, therefore, important to underline E4's experience in Cloud migration. It emerges that since the world of IT is increasingly moving towards Cloud solutions, also suppliers are starting to no longer provide support on on-premise products.
While some companies embrace this migration, others instead experience it with difficulties: E4 carried out an analysis to understand how appropriate the migration to Cloud of their ERP was for the company, and it turned out that, despite being a mandatory and very expensive choice, it will not actually bring any benefit.

3.6 Enterprise E5

3.6.1 Company Profile

Product category: Boilers, heat pumps and cooling systems.
Number of employees: 1000.
Annual revenue: €424 Millions.

3.6.2 IT Service Management and ITIL Best Practices

E5 has been adopting the ITIL framework for more than 5 years now. It was recognized as the best known and trending framework for IT Service Management, and being considered the most complete, they have chosen to adopt it. Some aspects of ITIL are integrated with other regulations, such as ISO/IEC 27001.

The sponsorship for ITIL comes from the IT Director, but the level of involvement of the top management, e.g. the CEO, is high and complete.
The company's strategy is aligned with ITIL guidelines, and it is clear how the E5 is adopting a proactive approach to situations.
Being up to date with information security standards and machinery regulations - its assets and systems satisfy modern security and operational requirements, including the operating systems for their fleet - allows them to be always ready, flexible and prepared to change.
As for ITIL maturity, they would give themselves a 3 out of 5, but if we extend the maturity to digital in general, "rarely they found someone better than them".

Within the IT team, there are currently 12 people, and only 2 are *ITIL v4 Foundations* certified.
The other 10, despite implementing the ITIL guidelines and being informed about the framework, do not have certification because there is a difficulty in keeping up with the training courses mainly due to lack of time. The importance of certified personnel is recognized, but is not currently a priority.

As regards ITIL practices, even in this case they are almost all implemented, but not in a rigorous and formal manner as ITIL indicates.
The most structured practices are those of Service Desk, Incident Management, Service Request, Change Enablement and IT Asset management.

The continual improvement process cuts across all enterprise functions, there are dashboards with well-defined metrics and KPIs, and at least once a month the Operations Committee meets to discuss the direction they want to give to the business. Here, ideas, projects and initiatives arising both from business and IT needs are discussed, and then a careful selection process is carried out to budget for the following year those considered most important and strategic for the enterprise.
E5 defines itself as *Kaizen*. However, pursuing this approach is not always possible, and although it remains the first choice, sometimes *Kaikaku*[7] is also necessary.

Finally, as for the seven Guiding Principles of ITIL, E5 still lacks in the *Collaborate and promote visibility* and *Think and work holistically* principles.
In particular, given that each department has its own metrics and dashboards, it emerges that during meetings it is often difficult to understand other people's points of view, and this lead to missing the general overview necessary to make the business work properly.

[7]The term Kaikaku means radical transformation designed to change drastically the way things are done in an organization. The pressure from outside or a requirement of revolutionary change usually triggers this. Kaikaku, unlike Kaizen, entails major changes within a short period.

3.6.3 Artificial Intelligence adoption and strategy

Regarding awareness and corporate culture around Artificial Intelligence algorithms, it is widespread and there is a good understanding of the main trends and tools.
Pilot projects have started to test Artificial Intelligence in business, and some products enterprise E5 already uses have integrated Artificial Intelligence solutions.
The strategy for Artificial Intelligence adoption is still embryonic and not perfectly documented: the results of the ongoing pilot projects will be collected and, through the selection process mentioned above, it will be evaluated whether to proceed in more detail with some of them.
Adoption of Artificial Intelligence is still of marginal consideration and thus even the investments made are minimal and sporadic.
This reflects the will of the parent company, who absolutely does not encourage the adoption of Artificial Intelligence solutions, and indeed tools such as ChatGPT have been absolutely prohibited due to the risks to information security.

At present, the pilot projects concern the use of generative Artificial Intelligence and the use of predictive Machine Learning algorithms: the former are deployed in the Marketing, After sales and R&D areas, the latter concern logistics, production and financial planning.
In the event that these projects prove useful and strategic for the company, outsourced solutions would be used, possibly integrated with in-house development, proof of the fact that the enterprise's IT infrastructure is well developed.

3.7 Interpretation of the results

All in all, these large enterprises are all on a different journey toward Digital Transformation, at a different level of maturity and technology adoption. Some have achieved a great level of advancement, while for others the struggle is still real, especially concerning the implementation of ITIL and Artificial Intelligence.
This means that there is a long way ahead for improvements to be made, especially in overcoming challenges with new technologies and regulatory compliance.
Overview of interview results are presented in Table 3.2, showing key findings of the research.

The selected enterprises show a very fragmented picture regarding the ITIL framework adoption. While some companies made large steps in the ITIL implementation, other enterprises faced various problems: lack of awareness, organizational resistance, and fighting for priorities.
There is also a big variance in the level of ITIL adoption: some enterprises focus on a few ITIL practices, while other enterprises tried to implement it broader.
There seems to be a strong link between leadership involvement and ITIL adoption: when leadership support is very strong, so is the ITIL implementation and strategy.

Aspect	Assessment	
Digital Transformation Maturity	E1	2,5 / 5
	E2	3 / 5
	E3	3,5 / 5
	E4	3,5 / 5
	E5	3 / 5
ITIL Adoption	E1, E4	Selective adoption, integration with other standards
	E2	Limited rigor in the adoption
	E3, E5	Varying degrees of adoption, rigor and involvement
ITIL Best Practices	Common practices: Service Desk, Incident Management, Change Enablement, Service Request	
	E1	22 adopted practices out of 34
	E2, E4, E5	Selective adoption
	E3	11 practices rigorously adopted out of 34
Artificial Intelligence Adoption	E2, E3, E4	Actively exploring AI with dedicated committes and pilot projects
	E1,E5	Earlier stages of AI adoption, limited formal stategies
	E2, E5	Sporadic AI investments with varying degrees of strategic planning
Threats	E1	Limited expertise
	E2	Limited committment to ITIL, difficulty enforcing training
	E3, E5	Limited encouragment from the holding company, concerns about information security
	E4	Organizational resistance to adopting ITIL

Figure 3.2: Key findings in the results of the interviews

Most enterprises focus their ITIL adoption on basic practices, mainly related to Service Desk, Incident Management, Service Request and IT Asset Management.
These practices are indeed considered part of the foundational elements of IT Service Management, and hence, it is easy to understand why they top the preferences list, since they can quickly affect operational efficiency and user satisfaction.
Moreover, such selective adoption indicates that enterprises believe these practices are easier to implement and necessary for keeping IT performance adequate, and it reflects a pragmatic approach whereby companies address immediate operational needs first while deferring the more complex or strategic elements of the ITIL framework.
Broader ITIL maturity is a struggle for many organizations.

Almost all respondents assessed their digital maturity as 3 on a scale of 5.
This is a common situation, since moving from level 3 to level 4 is considered as the steepest challenge when climbing the digital maturity scale. In fact, moving beyond level 3 requires a long-term commitment, significant resource allocation, a strategic overhaul, and a driving cultural change. Achieving higher maturity is, therefore, an involving process in terms of both time and focus on innovation and adaptability [55][31].
Moreover, while their scores were the same, it is evident that these firms are different when it came to their proper digital capabilities and strategies.The consistent rating is indicative of the tendency of self-assessment to inherently be subjective and perhaps self-referential, whereby companies might view themselves in better light than actually deserved from an actual practice point of view.
It is this self-referential assessment that may skew their understanding of their real digital maturity and suggests there is a need for objective, external assessments.

For most enterprises, Artificial Intelligence adoption and integration is still in an exploratory phase, and practical experiences in the application of Artificial Intelligence are very limited.
Artificial Intelligence adoption is usually driven by specific business needs, but most of the time it stays within pilot projects or experimental initiatives. Probably the biggest barriers to a wider Artificial Intelligence diffusion relate to a lack of Artificial Intelligence expertise, both among technical staff and management, which perfectly reflects the Human Capital situation highlighted in Section 2.2.1. The innovation capability of a company's employees particularly dictates the corporate response to Artificial Intelligence: since enterprises consist of people, their inherent conservative nature or comfort zone can stand in the way.
In addition, there seems to be a general fear of losing control over proprietary data, and that other companies could access or exploit it.

Other insights that emerged from the interviews but were not highlighted in Table 3.2 indicate that regulatory compliance plays a key role in driving the pace of digital transformation efforts among the selected enterprises. Specifically, frameworks

such as the General Data Protection Regulation (GDPR) and ISO standards are accelerating the push for change.
Moreover, other recent European regulations further improve the pace of transformation.
The Digital Operational Resilience Act (DORA) focuses on the digital operational resilience of financial entities with comprehensive requirements on how to manage ICT risks, report incidents, and maintain adequate business continuity plans [46]. Its full compliance is expected by mid-January 2025.
In addition, the Network and Information Systems Directive 2 (NIS2) expands its predecessor's reach (NIS) into more sectors, thus making its scope of application wider than just to critical infrastructure, essential and important entities. NIS2 is channeled toward ensuring network and information systems have enhanced cybersecurity and resilience to ensure general business continuity. It will be effective from October 17, 2024.
Both DORA and NIS2 can ensure that the growth is very high in the presence of digital resilience and cybersecurity of the highest possible standards, thus improving the pace of Digital Transformation in industries.

Another critical point emerged in Section 3.5.4 relates to the transition towards Cloud-based solutions. The cloud is turning into an increasingly adopted platform that can provide access to advanced technologies and highly scalable infrastructures. Many companies present several challenges either related to the presence of legacy systems or to the complication of data migration.
Despite these challenges, as already mentioned in Section 1.2.2, Cloud adoption can accelerate the pace at which Digital Transformation takes place; it lays a flexible foundation for further innovations and generally allows companies to leverage emerging technologies better.

Chapter 4

Conclusions

4.1 Research overview and methodology

This study assessed aspects of digital maturity across a small and specific subset of Italian enterprises in light of the Digital Revolution, specifically regarding their present and intended incorporation of ITIL and AI technologies.
The primary question that directed this investigation was to understand how far Italian enterprises have come along their path towards Digital Transformation, particularly with the implementation of ITIL framework and AI integration.
A corresponding hypothesis proposed that bigger businesses, which enjoy more resources, will have higher levels of digital maturity as compared to smaller firms.

The research methodology combined bibliographic analysis of existing reports about Italy's digital maturity - like DESI and Confindustria studies - with detailed case studies on selected firms.
Such a mixed method enabled both an extensive analysis of the overall trends in digitalization as well as an in-depth examination into individual companies' experiences concerning digitization.
Through targeted interviews conducted with key personnel from five companies, this study qualitatively assessed the current state of ITIL practices and use cases for AI thereby establishing difficulties these organizations face when aiming at achieving complete digitization.

4.2 Weaknesses and limitations

The study's greatest limitation is that it only focused on large firms, which are not representative of the Italian reality, constituting only 0.09% of the entrepreneurial fabric.
Although these firms employ 23,8% [29] of the workforce and often have more resources and formalized strategies, most Italian businesses are Small, Micro, and Medium-sized Enterprises (SMMEs), which employ the remaining 76,2% and dom-

inate the country's economic landscape.
These smaller companies, whose representation in this research is minimal, likely have different challenges that warrant further inquiry. Given the results from the large firms, it was not feasible to extend the study to smaller companies, as data availability and relevance would have been significantly limited.
Moreover, while the case studies provided rich qualitative insights, they do not offer an account of the Italian economy that could be generalised statistically.
This limitation is also exacerbated by the fact that much of the data was self-reported by the firms themselves, which may bias the interpretation of their digital maturity.

4.3 Key findings

Despite the fact that Italian enterprises have progressed in terms of Digital Transformation, as emerged in Section 2.2.3, their current level is still uneven.
Although many studied firms utilize the ITIL framework, its implementation is often only partial and not incorporated into their strategic planning.

Successful ITIL implementation is linked to strong leadership support, most enterprises focus on basic ITIL practices, which provide tangible immediate operational benefits, while broader ITIL adoption remains a challenge.

Moreover, human capital emerged from DESI and Confindustria reports as core factor determining the level of digital maturity among Italian firms.
One claim challenges both ITIL and AI: there is a shortage of advanced digital skills in the labor market. This experience gap not only delays the adoption process but also restricts the possible advantages that can be derived from full utilization of these tools.

This study also suggests that Digital Transformation is heavily influenced in its pace by regulations like GDPR, ISO standards, DORA, and NIS2. These bring about a needed change and improvement for resilience and cybersecurity.

4.4 Outlook

Consideration should be given to the extension of future research in order for it to incorporate a wider sample of SMMEs, which constitute a considerable portion of the Italian economy.
A quantitative approach, such as survey data collected and statistical analysis, would enable to have a more extensive and representative comprehending of digital maturity across various sectors.

Additionally, future studies could also venture into other disruptive technologies, including Cloud Computing as well as Internet of Things, that are also influencing on-going trends in Digital Transformation.
Finally, longitudinal studies would particularly be useful since they allow tracking companies over time thus offering information about long-term effects of Digital Transformation initiatives besides helping unearth best practices for sustained progression.

These elements can help understand Italy's Digital Transformation better in future research. Such information could be beneficial to understand how to deal with technological development challenges and associated opportunities.

Appendix A

Interview questions

A.1 General questions

- What is the type of your company?
- What are the main products or services offered?
- What is the main industry category?
- Have you obtained any certifications or quality standards?
- How many offices does the company have? In which countries? And how are the employees distributed?
- What is the annual revenue?
- How are the innovation and IT components structured within the company?

A.2 ITIL questions

Strategy and Governance

- Which ITSM framework or best practice has your company adopted? If ITIL, why ITIL specifically?
- Do you also adopt other frameworks or best practices besides ITIL? For example, COBIT, TOGAF, ISO 20000, etc.
- What is responsible for ITIL implementation?
- What is the level of involvement of top management in adopting and supporting the ITIL methodology?
- How aligned is the company strategy with ITIL guidelines?

- On a scale from 1 to 5 indicating maturity regarding ITIL adoption, what score would you give yourselves?
- Can you estimate your position compared to your industry type and, consequently, compared to your competitors?

Human capital

- How many FTEs (Full-Time Equivalents) are dedicated to IT Service Management?
- Is there ITIL-certified staff?

Practices

- To what extent have you adopted ITIL practices?
- Which practices have you implemented?
- How do you ensure that ITIL practices are rigorously followed? What metrics and performance indicators have you introduced for measurement?

Continual improvement

- How is the concept of continual improvement structured within the company?
- Are you more Kaizen or Kaikaku?
- What is the level of employee involvement?
- How do you measure progress in the continual improvement process?
- Can you give me an example of how a process was improved using the ITIL methodology, and what benefits it brought?

Guiding principles

- What ITIL principles are applied by the company, and how integrated are they?

A.3 Artificial Intelligence questions

- What is the level of awareness of AI in your company?
- To what extent are you familiar with the main AI technology trends, such as Machine Learning, Deep Learning, Robotic Process Automation, NLP, and Generative AI?
- Does the company offer training programs on AI and its applications?

Strategy and Governance Dimension

- Does your company have a defined strategy for AI adoption?
- Are there specific governance policies for AI? What criteria guide the development of functional requirements?
- Is AI adoption considered a strategic priority for your company?
- How much does your company invest in AI technologies?

Technology and Infrastructure

- Does your company have the necessary technological infrastructure for AI?
- How do you assess the quality of the data used for AI?

Projects and Initiatives

- How many AI-based projects are currently underway in the company?
- In which operational areas has your company implemented AI solutions?
- Does your company encourage innovation and experimentation in AI?
- How integrated is AI in the business processes?

References

[1] Chiara Ancillai et al. "Digital technology and business model innovation: A systematic literature review and future research agenda". In: *Technological Forecasting and Social Change* 188 (2023), p. 122307. ISSN: 0040-1625. DOI: https://doi.org/10.1016/j.techfore.2022.122307. URL: https://www.sciencedirect.com/science/article/pii/S0040162522008289.

[2] Philip Anderson and Michael Tushman. "Technological Discontinuities and Organizational Environments". In: *Administrative Science Quarterly* 31 (Sept. 1986). DOI: 10.2307/2392832.

[3] R. A. Anderson and F. Ullah. "The condition of smallness: how what it means to be small deters firms from getting bigger". In: *Management Decision* 52.2 (2014), pp. 326–349. DOI: https://doi.org/10.1108/MD-10-2012-0734.

[4] Bob Anderton et al. *Virtually everywhere? Digitalisation and the euro area and EU economies: Degree, effects, and key issues*. ECB Occasional Paper 244. Frankfurt a. M.: European Central Bank (ECB), 2020. DOI: 10.2866/339471. URL: https://doi.org/10.2866/339471.

[5] European University Association. *Innovation in European Higher Education: A New Framework for the Future*. 2021. URL: https://www.eua.eu/images/innovation_report.pdf.

[6] Assoconsult. *Assoconsult Brochure 2023*. Accessed: 2024-08-28. 2023. URL: https://www.assoconsult.org/uploads/pages/attachments/6_assoconsult_brochure-2023-web.pdf.

[7] Atlassian. *What is IT Service Management?* Accessed: 2024-11-16. URL: https://www.atlassian.com/itsm.

[8] Jasmin Praful Bharadiya. "Machine Learning and AI in Business Intelligence: Trends and Opportunities". In: *International Journal of Computer (IJC)* 48.1 (2023), pp. 123–134. ISSN: 2307-4523. URL: https://ijcjournal.org/index.php/InternationalJournalOfComputer/index.

[9] IMD World Competitiveness Center. *IMD World Digital Competitiveness Ranking 2023*. Accessed: 2024-08-24. Lausanne, Switzerland, 2023. URL: https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-digital-competitiveness-ranking/.

[10] Jin Chen, Eric Viardot, and Alexander Brem. "Innovation and innovation management". In: Feb. 2019, pp. 3–16. ISBN: 9781315276670. DOI: 10.4324/9781315276670-1.

[11] Tommaso Ciarli et al. "Digital technologies, innovation, and skills: Emerging trajectories and challenges". In: *Research Policy* 50.7 (2021), p. 104289. ISSN: 0048-7333. DOI: https://doi.org/10.1016/j.respol.2021.104289. URL: https://www.sciencedirect.com/science/article/pii/S0048733321000913.

[12] CMMI Institute. *CMMI Levels of Capability and Performance*. Accessed: 2024-08-28. 2024. URL: https://cmmiinstitute.com/learning/appraisals/levels.

[13] European Commission. *DESI Composite Index 2022*. https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/desi-2022/charts/desi-composite?indicator=desi_sliders&breakdownGroup=desi&period=2022&unit=pc_desi_sliders&desi_hc=5&desi_conn=5&desi_idt=5&desi_dps=5. Accessed: 2024-08-22. 2022.

[14] European Commission. *Digital Economy and Society Index (DESI)*. Accessed: 2024-08-24. Brussels, Belgium, 2023. URL: https://digital-strategy.ec.europa.eu/en/policies/desi.

[15] European Commission. *Digital Economy and Society Index (DESI) 2022 - Italy*. URL: https://www.astrid-online.it/static/upload/desi/desi_2022__italy__eng.pdf.

[16] European Commission. *Internation Digital Economy and Society Index (DESI)*. URL: https://www.sipotra.it/wp-content/uploads/2013/12/8.5.1.pdf.

[17] Confindustria. *About Us*. Accessed: 2024-08-28. 2024. URL: https://www.confindustria.it/en/about-us.

[18] Confindustria. *Are you ready for Industry 4.0?* URL: https://preparatialfuturo.confindustria.it/digital-innovation-hub/check-aziendale-online/.

[19] Wikipedia contributors. *Digital Economy and Society Index*. Accessed: 2024-08-24. 2023. URL: https://en.wikipedia.org/wiki/Digital_Economy_and_Society_Index.

[20] Laura Cortellazzo, Elena Bruni, and Rita Zampieri. "The Role of Leadership in a Digitalized World: A Review". In: *Frontiers in Psychology* 10 (2019). ISSN: 1664-1078. DOI: 10.3389/fpsyg.2019.01938. URL: https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2019.01938.

[21] Michela Arnaboldi Deborah Agostino and Melisa Diaz Lema. "New development: COVID-19 as an accelerator of digital transformation in public service delivery". In: *Public Money & Management* 41.1 (2021), pp. 69–72. DOI: 10.1080/09540962.2020.1764206. eprint: https://doi.org/10.1080/09540962.2020.1764206. URL: https://doi.org/10.1080/09540962.2020.1764206.

[22] Politecnico di Milano Digital Innovation Hub Confindustria. *Elaborazioni dati su Test 4.0*.

[23] European Commission. *Digital Economy and Society Index (DESI) 2022: Methodological Note*. Tech. rep. European Commission, 2022. URL: https://ec.europa.eu/newsroom/dae/redirection/document/88557.

[24] Luciano Floridi. "Why the AI Hype is Another Tech Bubble". In: *SSRN Electronic Journal* (2024). Available at SSRN: https://ssrn.com/abstract=4960826. DOI: 10.2139/ssrn.4960826. URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4960826.

[25] World Economic Forum. *The Global Competitiveness Report 2019*. Tech. rep. World Economic Forum, 2019. URL: https://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf.

[26] Stanford HAI. *AI Definitions - HAI*. Tech. rep. Stanford University, 2020. URL: https://hai.stanford.edu/sites/default/files/2020-09/AI-Definitions-HAI.pdf.

[27] Portulans Institute. *Network Readiness Index 2023*. Accessed: 2024-08-24. Washington, D.C., 2023. URL: https://networkreadinessindex.org/.

[28] Italian National Institute of Statistics (ISTAT). *Economic Contribution of Large Firms*. Accessed: 2024-08-29. 2024. URL: https://esploradati.istat.it/databrowser/#/it/dw/categories/IT1,Z0900ENT,1.0/ENT_COMP/DCSP_SBSNAZ/IT1,161_267_DF_DCSP_SBSNAZ_1,1.0.

[29] Italian National Institute of Statistics (ISTAT). *Enterprises and Enterprise Groups - Year 2021*. Tech. rep. ISTAT, 2023. URL: https://www.istat.it/it/files//2023/11/Enterprises-and-enterprise-groups-2021.pdf.

[30] Edina Karabegović. "Implementation of industry 4.0 and robots in production processes of the metal industry". In: *Int. J. Adv. Eng. Res. Sci.(IJAERS)* 7.12 (2020), pp. 169–176.

[31] Ginger Korsten et al. "Understanding Capability Progression: A Model for Defining Maturity Levels for Organizational Capabilities". In: *Enterprise, Business-Process and Information Systems Modeling*. Ed. by Han van der Aa et al. Cham: Springer Nature Switzerland, 2024, pp. 355–371.

[32] Raymond Kurzweil. *The Singularity is Near: When Humans Transcend Biology*. Viking, 2005.

[33] Ana Kutnjak. "Covid-19 Accelerates Digital Transformation in Industries: Challenges, Issues, Barriers and Problems in Transformation". In: *2021 IEEE 9th International Conference on Information and Communication Technology (ICoICT)*. 2021, pp. 17–22. DOI: 10.1109/ICoICT52021.2021.9443090. URL: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9443090.

[34] Ana Kutnjak. "Covid-19 Accelerates Digital Transformation in Industries: Challenges, Issues, Barriers and Problems in Transformation". In: *IEEE Access* 9 (2021), pp. 79373–79388. DOI: 10.1109/ACCESS.2021.3084801.

[35] Tatyana Kuzovkova, Dmitriy Kuzovkov, and Olga Sharavova. "Transformation of criteria and indicators of digital development of economy and information society". In: *Conference of Open Innovations Association, FRUCT*. 24. FRUCT Oy. 2019, pp. 682–687.

[36] Heiner Lasi et al. "Industry 4.0". In: *Business and Information Systems Engineering* 6 (Aug. 2014), pp. 239–242. DOI: 10.1007/s12599-014-0334-4.

[37] James Lawless. *What Is ITIL 4? Framework, Process And Principles*. 2023. URL: https://purplegriffon.com/blog/what-is-itil-4-framework.

[38] Gregory Leal. *Exponential Growth of Information Technology*. 2017. URL: https://www.gregschool.org/gregschoollessons/2017/3/14/exponential-growth-of-information-technology-1-hkykf.

[39] Christine Legner et al. "Digitalization: Opportunity and Challenge for the Business and Information Systems Engineering Community". In: *Business and Information Systems Engineering* 59 (Aug. 2017), pp. 301–308. DOI: 10.1007/s12599-017-0484-2.

[40] Fitzgerald M. et al. "Embracing digital technology: A new startegic imperative." In: *MIT Sloan Management Review* (2014).

[41] James Manyika et al. *Disruptive technologies: Advances that will transform life, business, and the global economy*. McKinsey Global Institute, 2013. URL: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/disruptive-technologies.

[42] Ministero per l'Innovazione Tecnologica e la Transizione Digitale. *National Strategy for Digital Skills*. Report. Accessed: 2024-08-23. 2022. URL: https://repubblicadigitale.gov.it/portale/documents/20122/992735/National+Strategy+for+Digital+Skills.pdf/c3ff7732-e9ce-498e-71b3-f441ae55afcd?t=1666000144226.

[43] Ministero per l'Innovazione Tecnologica e la Transizione Digitale. *Repubblica Digitale*. Accessed: 2024-08-23. 2024. URL: https://repubblicadigitale.innovazione.gov.it/it/.

[44] John J. Morris and Pervaiz Alam. "Value relevance and the dot-com bubble of the 1990s". In: *The Quarterly Review of Economics and Finance* 52.2 (2012), pp. 243–255. ISSN: 1062-9769. DOI: https://doi.org/10.1016/j.qref.2012.04.001. URL: https://www.sciencedirect.com/science/article/pii/S1062976912000245.

[45] Julian M. Müller, Oana Buliga, and Kai-Ingo Voigt. "The role of absorptive capacity and innovation strategy in the design of industry 4.0 business Models - A comparison between SMEs and large enterprises". In: *European Management Journal* 39.3 (2021). Technologies 4.0: Understanding the evolution of ICT and its role for business development, pp. 333–343. ISSN: 0263-2373. DOI: https://doi.org/10.1016/j.emj.2020.01.002. URL: https://www.sciencedirect.com/science/article/pii/S0263237320300190.

[46] Anita Neumannová, Edward W. N. Bernroider, and Christoph Elshuber. "The Digital Operational Resilience Act for Financial Services: A Comparative Gap Analysis and Literature Review". In: *Information Systems*. Ed. by Maria Papadaki et al. Cham: Springer Nature Switzerland, 2023, pp. 570–585. ISBN: 978-3-031-30694-5.

[47] Rafael-Leonardo Ochoa-Urrego and Jose Ismael Pena Reyes. "Digital Maturity Models: A Systematic Literature Review". In: May 2021, pp. 71–85. ISBN: 978-3-030-69379-4. DOI: 10.1007/978-3-030-69380-0_5.

[48] OECD. *The Innovation Imperative*. 2015, p. 268. DOI: https://doi.org/https://doi.org/10.1787/9789264239814-en. URL: https://www.oecd-ilibrary.org/content/publication/9789264239814-en.

[49] Mine Omurgonulsen et al. "Cloud Computing: A Systematic Literature Review and Future Agenda". In: *Journal of Global Information Management* 29.6 (2021). Open Access article distributed under the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), pp. 1–18. URL: https://www.igi-global.com/pdf.aspx?tid=277852&ptid=262210&ctid=4&oa=true&isxn=9781799872627.

[50] Oracle. *What Is the Internet of Things?* Accessed: 2024-08-05. 2024. URL: https://www.oracle.com/internet-of-things/.

[51] Stephen P. Osborne et al. "Digital transformation, artificial intelligence and effective public services: challenges and opportunities". In: *Global Public Policy and Governance* 2.4 (2022), pp. 377–380. ISSN: 2730-6305. DOI: 10.1007/s43508-022-00058-7. URL: https://doi.org/10.1007/s43508-022-00058-7.

[52] Kaushikkumar Patel. "Ethical reflections on data-centric AI: balancing benefits and risks". In: *International Journal of Artificial Intelligence Research and Development* 2.1 (2024), pp. 1–17.

[53] Michael E. Raynor and Mumtaz Ahmed. "The Digital Dividend: First-Mover Advantage". In: *MIT Sloan Management Review* 52.4 (2011), pp. 55–62. URL: https://sloanreview.mit.edu/article/the-digital-dividend-first-mover-advantage/.

[54] Red Hat. *IaaS vs PaaS vs SaaS*. Accessed: 2024-08-06. 2024. URL: https://www.redhat.com/en/topics/cloud-computing/iaas-vs-paas-vs-saas.

[55] Thalita Laua Reis, Maria Augusta Siqueira Mathias, and Otavio Jose de Oliveira. "Maturity models: identifying the state-of-the-art and the scientific gaps from a bibliometric study". In: *Scientometrics* 110.2 (2017), pp. 643–672. ISSN: 1588-2861. DOI: 10.1007/s11192-016-2182-0. URL: https://doi.org/10.1007/s11192-016-2182-0.

[56] Jorge Ribeiro et al. "Robotic Process Automation and Artificial Intelligence in Industry 4.0 – A Literature review". In: *Procedia Computer Science* 181 (2021), pp. 51–58. ISSN: 1877-0509. DOI: https://doi.org/10.1016/j.procs.2021.01.104. URL: https://www.sciencedirect.com/science/article/pii/S1877050921001393.

[57] Kraus S. et al. "Digital transformation: An overview of the Current State of the Art of Research". In: *SAGE Open* (2021).

[58] Andrea Sestino et al. "Internet of Things and Big Data as enablers for business digitalization strategies". In: *Technovation* 98 (2020), p. 102173. ISSN: 0166-4972. DOI: https://doi.org/10.1016/j.technovation.2020.102173.

[59] A. Sharma and P. Jain. *A Review on AWS Cloud Computing Technology*. Accessed: 2024-11-16. 2022. URL: https://d1wqtxts1xzle7.cloudfront.net/78931904/A_Review_on_AWS_Cloud_Computing_Technology-libre.pdf?1642395395=&response-content-disposition=inline%3B+filename%3DA_Review_on_AWS_Cloud_Computing_Technolo.pdf&Expires=1731861130&Signature=D6Wq3i1S9FzPF6pbEkn4jPdg3GhDAPU2rPfyLGRcpfFwdmZpljvJ9SfwZRvVz9-dZToYYoQEA8XF~rLurliGHMdPGj37gIYmC~owdwAy4Yix0QLeDOATnEins7ImoGCehQD~TQLxCy0c~hkCq1U4aVNfu96unHxR2rInHnnhuetDiwBNJ1X79HKmC26d8BljtnGGz2pv0LWZLGagpijSHWkK-swmRozKHkpOlTp4XherRHHXBon2PL75JaAYxb6F5L3A2eg~4WTNioN2uPgAEImlw__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA.

[60] Jelena J Stankovic et al. "The digital competitiveness of European countries: A multiple-criteria approach." In: *Journal of Competitiveness* 2 (2021).

[61] Lichao Sun et al. *Unlocking the Potential of ChatGPT: A Comprehensive Exploration of its Applications, Advantages, Limitations, and Future Directions in Natural Language Processing*. 2023. arXiv: 2304.02017 [cs.CL].

[62] Adie Tomer et al. *Digital Prosperity: How Broadband Can Deliver Health and Equity to All Communities*. Accessed: 2024-08-20. Brookings Institution, 2024. URL: https://www.brookings.edu/articles/digital-prosperity-how-broadband-can-deliver-health-and-equity-to-all-communities/.

[63] Wikipedia. *Digital Economy and Society Index*. URL: https://en.wikipedia.org/wiki/Digital_Economy_and_Society_Index.

[64] Wikipedia. *Kaizen*. URL: https://it.wikipedia.org/wiki/Kaizen.

[65] Li Yang et al. "Adoption of information and digital technologies for sustainable smart manufacturing systems for industry 4.0 in small, medium, and micro enterprises (SMMEs)". In: *Technological Forecasting and Social Change* 188 (2023), p. 122308. ISSN: 0040-1625. DOI: https://doi.org/10.1016/j.techfore.2022.122308. URL: https://www.sciencedirect.com/science/article/pii/S0040162522008290.

[66] Tri Yuwono, Agus Suroso, and Weni Novandari. "Information and communication technology in SMEs: a systematic literature review". In: *Journal of Innovation and Entrepreneurship* 13.1 (May 2024), p. 31.