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How intelligent is Watson? Enabling digital transformation through artificial intelligence

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Abstract Due to its intrinsic characteristics, artificial intelligence (AI) can be considered a general-purpose technology (GPT) in the digital era. Most studies in the field focus on the ex-post recognition and classification of GPT but in this article, we look at a GPT design ex-ante by reviewing the extreme and inspiring example of IBM's Watson. Our objective is to shed light on how companies can create value through AI. In particular, our longitudinal case study highlights the strategic decisions IBM took to create value in two dimensions: internal development and external collaborations. We offer relevant implications for practitioners and academics eager to know more about AI in the digital world.

1. AI transforms society

We live in a world in which digital solutions are widespread, even if the distinction between digital and nondigital technologies is somewhat complex. Technologies, and especially digital technologies, influence our behaviors, our way of living, and are adopted differently around the world (Williams & Edge, 1996). Scholars and practitioners define this phenomenon as digital transformation, consisting of all the initiatives that leverage digital tools—such as 3-D printing, mobile computing, and artificial intelligence (AI)—to transform processes and organizations (Nambisan, Lyytinen, Majchrzak, & Song, 2017).

Two main dimensions influence the world of digital technologies. The first concerns input. Due to their constant evolution and adaptation, the processes to develop and sustain digital technologies require the involvement of a dynamic set of actors (Boudreau & Lakhani, 2013) whose different

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goals and capabilities yield diverse solutions. The second concerns outcome. As digital technologies increase flexibility in creating end products and services, the outcomes are intentionally incomplete, allowing companies to continuously upgrade their offering even if the solution is already on the market (Garud, Jain, & Tuertscher, 2008).

1.1. Digital technologies redesign the competitive arena

The abundant scholarly debate around the definition of technology (Danneels & Frattini, 2018) has led to difficulties in properly framing digital technologies. Digital technologies include big data (Kaplan & Haenlein, 2010), information knowledge management systems, cloud computing, AI (e.g., machine learning), and rapid prototyping systems (Bughin, McCarthy, & Chui, 2017; Urbinati, Chiaroni, Chiesa, & Frattini, 2018), all of which foster the digital transformation of companies and society. Big data, for example, not only reshapes the way new products and services are designed (Erevelles, Fukawa, & Swayne, 2016) but also has improved the healthcare industry by providing more insights and information than ever before (O'Donovan, Leahy, Bruton, & O'Sullivan, 2015). Furthermore, machine learning profoundly changed the way we create and envision new products. An example is IBM's Watson Chef initiative. Launched in 2016, this digital technology allows the screening and mapping of more than 10,000 recipes to study the ingredients and propose new combinations.

Digital technologies can change the way we innovate and deliver value. People are not always able to perceive the value in all proposed final solutions. Nokia Lumia is just one example of how providing too many options is not always positive. The real value digital technologies generate is not always found in their essence or intended function but it instead can be found in the actions they enable. Netflix does not require big data to understand customer behaviors and create new TV series, but what is important is the outcome from the customers' perspective (i.e., new series more aligned with their expectations). Indeed, when faced with too many options for the same solution, decisions are difficult to make (Verganti, 2017).

1.2. Unlocking opportunities hidden in digital technologies

In an overcrowded and fluid world in which the value of technology is more in the benefit generated for adopters than in the technology itself, discovering opportunities hidden in digital technologies is crucial (Chesbrough, 2003). Accordingly, the perspective suppliers might adopt is twofold. They can develop a unique technology that unveils a new meaning and can be adapted to explore a unique application field (Dell'Era, Altuna, Magistretti, & Verganti, 2017; Magistretti & Dell'Era, 2018) or they can leverage the essence of the digital technology by understanding its intrinsic generalizability. Indeed, digital technologies are inherently *general-purpose technologies* (GPTs) because of their substantial and pervasive effect on society as a whole (Youtie, Iacopetta, & Graham, 2008). Researchers tend to focus on studying and recognizing complex and relevant technologies ex-post. Numerous studies have been published on the underpinning elements of GPT (Gambardella & Giarratana, 2013) but only few attempt to understand and conceptualize the process companies should follow to bring such technologies to market (Gambardella & McGahan, 2010). The development of a new technology may be scattered and not always linear. The open innovation paradigm (Chesbrough, 2006) affirms that this process has evolved over the last decade, thus calling for further research to unveil its dynamics.

1.3. Digging deeper into the discovery and development of AI

This study aims to extend current knowledge on AI as an enabler of value creation in the digital world (Kaplan & Haenlein, 2019). We pose this research question: What managerial practices will help companies discover the opportunities AI offers during its development and integration in the market? In looking for the answer, we adopted a case study methodology. We looked at Watson, the cognitive system launched by IBM in 2011. Results of our investigation are relevant for practitioners and researchers alike, providing some managerial implications on how to unveil opportunities hidden in technologies and develop AI as a GPT that can better support digital transformation. Our study provides unique insights on how to design AI as a GPT, going beyond the existing debate that is more focused on ex-post recognition.

2. AI reshapes product development

The literature on technology management is vast and, considering our focus on AI, we pay particular attention to its intrinsic link with GPT literature. As mentioned, studies on the proliferation of

digital technologies and their link to value creation indicate that the digital era is profoundly reshaping the new product and new technology development fields (Dobusch & Kapeller, 2018).

2.1. AI enables digital transformation

Considering the impact of digital technologies in today's society, some scholars (e.g., Nambisan et al., 2017) argue that they favor more dynamic relations between the people involved and the product outcomes. Moreover, research indicates that innovations that leverage digital technologies can cut across industry and sector boundaries. As such, the digital technology and GPT research fields can benefit from each other. Several studies focus on digital technologies by mapping the specific field of adoption (e.g., Urbinati et al., 2018; Yoo, Boland, Lyytinen, & Majchrzak, 2012) while others attempt to understand specific digital technologies and their influence on new strategies and innovations (Wieland, Hartmann, & Vargo, 2017).

Technologies require the involvement of different people and roles in the innovation process (Bharadwaj & Noble, 2017). The vast amount of data allows different paths for designing new solutions and dealing with management problems (George, Haas, & Pentland, 2014). Other digital technologies instead change the way decisions are made to support and complement existing processes (e.g., 3-D printing is complementary to additive manufacturing). Finally, digital technology researchers point out the growing role of AI as a complementary strategy and a new way of making decisions. The volume of information available in online repositories and fast access to databases can increase the speed and efficiency of the decision-making process exponentially (Van Knippenberg, Dahlander, Haas, & George, 2015). Thus, AI is changing business models in several industries and reshaping markets (Nenonen & Storbacka, 2018). Examples of AI adoption in very different contexts include healthcare in India or the public library system in New York, which suggests new readings based on a customer's history.

2.2. Digital technologies profoundly change new product development processes

Our analysis of the literature related to the technology field identified several studies that deal with the creation of new products and services and value delivery from three different perspectives:

1. Some consider the evolution and development processes (e.g., Cuhls, 2003; Savino, Messeni Petruzzelli, & Albino, 2017; Thomke & Reinertsen, 2012);

2. Others look at unveiling opportunities (e.g., Verganti, 2011; Dell'Era et al., 2017); and

3. Some focus on particular technologies to shed new light on unusual aspects, such as uncertainty or the possibility of recombining knowledge to generate new technologies (e.g., Cohen & Levinthal, 1989; Levinthal, 1998).

Given the focus of our investigation, the second perspective (i.e., unveiling opportunities) is most relevant. Scholars point out that GPTs are core technologies that generate and spread incremental or radical innovations in different fields, activities, and sectors. Some define GPTs as technologies characterized by pervasiveness, inherent potential for technical improvements, and innovative complementarities (Bresnahan & Trajtenberg, 1995).

Numerous studies discuss the role of technology substitution and how firms typically develop a new version or a new technology just to increase the performance of an existing technology (Smith & Reinertsen, 1992) instead of searching for new opportunities and identifying new application fields (Dell'Era et al., 2017). An initial slowdown of GPTs is caused by the rapid depreciation of skills that are specific to older technologies (Helpman & Rangel, 1999). The prolonged slowdown of GPT in the early phases usually is followed by fast acceleration (Helpman, 1998). GPT commercialization and diffusion is not always linear and straightforward (Ardito, Petruzzelli, & Albino, 2016) due to its substantial and pervasive effect on society as a whole (Youtie et al., 2008). Scholars indicate that, in the past, GPT was traditionally developed and integrated via licensing (Gambardella & Giarratana, 2013). Therefore, the ex-post recognition of how companies can effectively exploit AI after adoption is no longer relevant and it becomes important to enhance ex-ante development knowledge. Little is known about how tech suppliers can develop such technologies to foster their pervasiveness and adopt them in order to create value. As scholars and practitioners seek to understand how to create value from GPTs beyond licensing, management practices concerning knowledge search and recombination, as well as initiatives they can implement to foster the development and commercialization of AI as a GPT, become vital.

This literature review shows that research on digital technology is evolving. Following this line of inquiry, we investigate the methods companies

can put in place to develop and commercialize a digital GPT such as AI to create value.

3. As a GPT, IBM Watson offers infinite opportunities

Considering the multifaceted aspect of this topic, the case study methodology—which is particularly suited to answering 'how' questions and investigating complex phenomena (Yin, 2011)—is the most appropriate to explore our research problem. Considering the limitation of the methodology in terms of generalizability (Harrison & Kjellberg, 2010), the selection of the case is crucial. Following prior studies (Yin, 2011), we adopt theoretical and convenience sampling. In particular, considering GPT and its commercialization, and relying on the theoretical definition of GPT, we wanted to study a digital technology case that is facing an integration moment: AI. AI respects all the previously defined features (Bresnahan & Trajtenberg, 1995) of pervasiveness and innovation spawning. Given the convenience sampling and the difficulties in collecting sufficient data on such an emerging and growing technology, we selected a globally famous case with a considerable number of related articles and records that proved an excellent start to data collection. In addition, due to our connection with the company, we were able to interview key informants in the development of this sophisticated technology. Finally, given the complexity of the phenomenon, we selected an extreme case that could simultaneously shed light on the inputs, outcomes, and organizational changes (Pettigrew, 1990) to understand the longitudinal perspective of the development and commercialization of a GPT in the digital era.

These considerations led to selecting IBM Watson as an eye-opening case of an emerging GPT. Watson meets the aforementioned sampling requirements, both theoretically and empirically. Table 1 summarizes all the main sources of data gathered.

We analyzed Watson with an inductive and iterative approach (Strauss & Corbin, 1998). This allowed us to shed light on the phenomenon by theorizing the evidence emerging from the longitudinal case study (Eisenhardt, 1989). First, we created the database by tagging different data and positioning them in a longitudinal perspective in order to understand the technology's development and commercialization. Then, each author individually read through the information to start analyzing the data. We created different visualization schemas, charts, and tables to allow comparing the different information and data sources. Finally, we internally discussed the interpretation of the data and how the data could suggest ways to commercialize and unveil the opportunities within the AI technology.

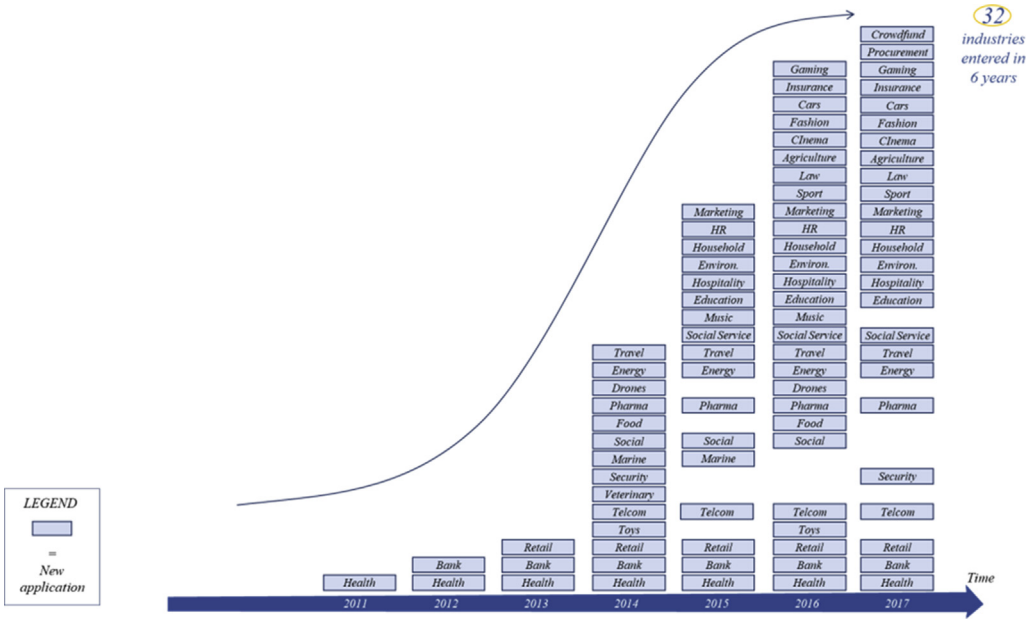
3.1. IBM Watson is everywhere: From 0 to 270 applications in 6 years

The origin of Watson dates back to May 1997 when a group of researchers started to develop Deep Blue, an AI solution that can solve complex problems, adapt to the context, and analyze new information.

Table 1. Data gathering

Sources	Description	Details
Interviews (semi-structured)	First wave with an exploratory perspective. Second wave with the aim of triangulating information to pursue a longitudinal perspective.	• 6 in-depth interviews • 3 managers • 16 hours of recorded material
Bluemix Platform	Bluemix developers can use IBM services to create, manage, run, and deploy various types of applications for the public cloud, as well as for local or on-premise environments.	• 25 solutions • 3 different models: public, dedicated, and hybrid
Videos	Records of events regarding Watson such as the World of Watson event that summarizes the initiatives related to the technology and presented live by the CEO Ginny Rometty.	• > 100 videos
News	From websites: *New York Times*, *The Economist*, *Fortune*, and *Wired*, public press releases, sectorial studies, Gartner, *Business Insider* reports, and company websites.	• 300 websites • 38% IBM press releases • 35% IBM web pages • 27% external sources

Figure 1. The evolution of the IBM Watson application fields over time



Since Deep Blue, the development of the AI solution grew within the company and led IBM to introduce the first version of Watson on *Jeopardy!* in 2011, where the AI solution revealed its potential to the world. In particular, it demonstrated how the machine-learning algorithm can search a massive database to find answers to common questions. The outcome was Watson's victory over human participants and this event confirmed that having access to large amounts of data, such as preloaded documents, and the ability to make fast inquiries could improve the scouting of relevant information. It also showed the market the initial potential of this technology. Wherever these two aspects are relevant, the technology can play a crucial role in the future decision-making process.

Moreover, one interviewee defined the IBM Watson technology as a combination of different technologies. In particular, the two most important are natural language processing (NLP) and machine learning. NLP is the process through which deconstructing and reconstructing sentences allows a computer to understand and process the information captured by the speakers. Machine learning is a technique in which a machine spots connections between a particular pattern and the most likely outcomes. The system receives feedback from regular use, learning from every interaction. Every prediction it makes, whether right or wrong, is considered for the next prediction until it can reliably spot meaningful patterns throughout the massive amount of data it searches. The combination of these two technologies gave rise to the creation of AI and, ultimately, IBM Watson.

After 2011, IBM started to significantly invest in the research and development of this technology, which then was studied by a few employees to learn its potential. Today, more than 12 Watson research centers house more than 100 IBM researchers in six continents. In these facilities, employees work on developing and advancing the AI technology and supporting firms in adopting this solution.

The technology evolved year after year and now accounts for over 270 different applications across more than 30 industries. This clearly shows the pervasiveness of AI and its innovativeness—critical elements of any GPT. Figure 1 shows the evolution of IBM Watson application fields since 2011.

Figure 1 illustrates that, at the beginning, the focus was on a few application fields such as healthcare and banks. As demonstrated in our database analysis—which we created by combining more than 300 web sources—the experimentation in healthcare and banks in 2011 and 2012 allowed researchers to understand the technology's potential and that Watson was capable of processing a vast amount of data and propose accurate answers. From 2013 onward, the company started suggesting the technology's adoption in diverse application fields, exploring different opportunities including fast image recognition, sound detection, and text mining. The process IBM adopted to nurture this expansion and

exploration followed different initiatives; some were internal while others had external partners.

Spreading the solution over different application fields allowed the company to achieve $18 billion in revenues in 2017 from Watson cognitive solutions (Source IBM Annual Report). In other words, Watson covered around 22% of IBM's entire revenues and in 2017 there were more than 1,400 patents awarded for AI solutions. It is clear from these numbers and the description that the AI solution is a GPT, an extreme case that can provide powerful insights on how opportunities hidden within a technology can be unveiled to create pervasive digital solutions.

4. How can you create value through AI? Elementary, my dear Watson

Our aim in studying the evolution of the Watson technology is to depict a path that companies seeking to develop and create value through AI in the digital world can follow. Our key informants stressed that knowledge of the opportunities the technology offers was not explicit from the beginning. They indicated that the technology was able to grow and expand into different markets by leveraging two aspects: (1) its ability to process and analyze a large amount of data and (2) the creation of a platform and an application programming interface (API) ecosystem able to share the technology more efficiently. Initially, the focus was more on internal development while, in later years, they diversified the focus to create a network of external collaborations with different players.

4.1. First, understand what you are able to do

Our analysis of documentary data and the interviews indicates that internal development was strategically conducted around two main initiatives: the data and the API. In particular, the use of data is key in the digital world and big data are starting to show their potential in terms of enhanced decision making and better designed products and services. IBM understood this importance and was convinced that AI would show its greater potential when a considerable amount of data was included, speeding up the search for useful information 60-fold. As the following quotes indicate, this knowledge allowed the company to start developing solutions for an industry in which the data repository is enormous and the time for searching is not enough. Strategically, healthcare became the primary industry for the technology:

> Watson is instrumentally useful when lots of data are available. So [we looked to] markets where big data are predominant and where this data can provide value to different stakeholders. For example, in healthcare where many studies are published, and doctors do not have time to read all the articles, Watson is amazing. He can read and process 4 billion pages in a minute, so then he can support doctors in understanding which studies are relevant for the disease they are facing. (IBM Human-Centric Practice Manager)

Thus, the company leveraged some crucial aspects of the technology to better explore the opportunities it offers. By understanding the most essential elements of the technology, they started to adopt it in sectors in which these elements—big data, different stakeholders, and time pressure to process a great deal of information—are present. The process of understanding the technology initially was performed internally, where IBM researchers started to frame the technology's essential features and components to understand the opportunities.

The second element concerning internal development was leveraging the API. IBM employees realized that an exclusively internal team could not develop a multifaceted and powerful technology such as AI. They decided to build the technology's core to allow others to develop solutions by exploiting the API. This strategic decision was taken to support the technology's growth. The technological feature the researchers introduced through the API led to the protocol to build software programs by adding features and not coding every single end solution from scratch. Indeed, the underlying assumption is that people can create a software solution by adding different components developed by others and called on demand by the software. To support this, the firm launched the Bluemix platform to allow different adopters to leverage this API repository:

> Bluemix can be seen as an API marketplace where different companies can buy different features that, through Watson, can allow them to perform the work they need. I share with you just a quick example. Inside Bluemix, we have an API for image recognition. This API is useful for Watson developers when the input of the information is not a voice or a written document but a set of images. This is valuable in the medical industry for

> analyzing radiographs or in marketing for recognizing products. If you are in a hospital, you can use the same API as a fashion company, reducing the amount of work needed to have a working solution. (IBM Research Ecosystem Manager)

The intuition to leverage the API economy to sustain the technology's development was a way to rapidly and pervasively spread the use of Watson in different applications. In this sense, players in different markets could use the same piece of code to add the same features to their system and speed up the technology's adoption:

> The cloud platform and the API enable everyone to adopt a do-it-yourself approach while planning and developing a new application or a new concept. In this direction, IBM can help them by providing software and not always by coding it on demand. This helps the growth of Watson by facilitating its spread. (IBM Cognitive Solutions Leader)

These two strategic decisions exploiting the big data explosion and opening the API led to sustaining the technology's development and commercialization. IBM was able to propose Watson as a GPT due not only to its potentiality but also because of the strategic decisions taken. Indeed, the decision to open the API is counterintuitive for a core business due to complexity and data protection issues. All the different solutions use the same technology and the same machine-learning algorithm, even if owned by different players. Notwithstanding this, IBM considered this as the only way to create a pervasive digital solution.

4.2. Second, do not be shy: Co-develop with others

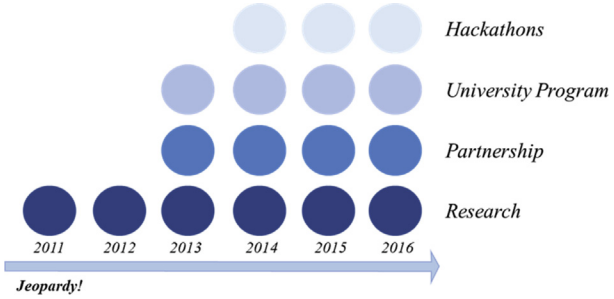
In addition to internal development that allowed Watson to become pervasive and spread its innovativeness, IBM made other strategic decisions to support its commercialization. In particular, our database analysis and interviews showed that external collaboration played an essential role in fostering the development and commercialization of AI technology.

Four external collaboration initiatives emerged from our analysis: (1) research activities with third parties; (2) partnerships; (3) university programs; and (4) hackathons. In particular, research activities refer to all the initiatives IBM put in place to find new application fields for the technology based on researching and experimenting the opportunities technology offers through strong interactions with key players in the field. In the early stage of AI development, due to the complexity and cost, research was undertaken with a few select players, such as hospitals or premium banking institutions, willing to support the research as they could already envision an opportunity. Driving this initiative was the IBM's uncertainty regarding the effectiveness of the final solution. Thus, joint research with other players seemed the best option. Partnerships refer to commercial collaborations with companies to develop Watson-based applications. In this case, the initiative was driven mainly by the exchange of money instead of knowledge. Indeed, the partners were involved as beneficiaries of the final solutions but, given the nature of the technology and the need to explore its opportunities, higher involvement was required. A partnership was formed, for example, with an insurance company to better manage road accidents.

Partnerships guarantee mutual involvement in exploring opportunities and higher involvement of adopters. This was fundamental in fostering the discovery of more opportunities and thus envisioning future applications. University programs are initiatives to find new uses and deepen the system capabilities by collaborating with expert academic researchers in the AI field. This initiative brought IBM to connect with top universities around the world with the intention of bringing different and more theoretical knowledge to the development. Indeed, it was evident to the managers that the practitioners' perspective alone was not enough to spread AI around the world. Finally, hackathons refer to external calls aimed at start-ups, students, and citizens to unveil potential new users of the Watson technology. These external collaboration initiatives led to the explosion of the adoption of IBM AI solutions in literally every industry. There were two reasons behind the decision to organize hackathons: (1) to envision new opportunities and solutions (2) to communicate the technology's existence and power to the world.

Figure 2 shows that the first 2 years of experimentation were dedicated mainly to research activities. The IBM research team, together with the research centers, developed AI applications for the health and banking industries. Between 2013 and 2014, other initiatives and activities were adopted to expand the technology's potential. Thus, IBM launched partnerships, university programs, and hackathons mainly targeting external players to inspire the technology's future development.

Figure 2. Different initiatives that supported the evolution of IBM Watson over time



5. AI creates value in the digital world

This longitudinal qualitative analysis sheds light on the way a company can adopt AI to create value in today's digital world. In particular, it shows the relationship between the intrinsic characteristics of AI technology and how these influence the strategic decisions made to sustain innovativeness and pervasive commercialization. Specifically, our qualitative study identifies new and thus far unexplored effects a company's commercialization of a digital technology with the aim of crafting it as a GPT. In particular, Figure 3 shows the two perspectives companies can adopt to create value with AI. First, companies look inside the technology to unveil hidden opportunities and its core essence, which is usually an internal activity. Second, they develop a strategy to create new value by putting in place interactions with external collaborators in order to increase the technology's pervasiveness of adoption and value generated.

Our study enables better understanding from an ex-ante perspective on how companies can experiment and explore AI technology to sustain its pervasiveness as a GPT. Indeed, through digital technology, commercialization in the market is overturned. It is not only a matter of developing the technology internally and then licensing it (Gambardella & McGahan, 2010) but also developing the technology with users through internal cultivation and external collaborations.

Our investigation also shows that the digital innovation process follows a different path compared to the traditional technology development view (Cooper, 2008). It is no longer a funnel process in which the technology is developed for a single use (e.g., railway technology), but rather an opportunity to expand the boundaries to several different applications. This shift in perspective from market to technology influences the way the technology is designed and commercialized. For example, in order to create value through the adoption of AI, the Watson case shows us that understanding the core essence of the technology is crucial (Danneels & Frattini, 2018). Indeed, the strategic decision to leverage big data and the API to allow AI to become pervasive was key for the success of the technology itself. This was only possible because the company started to look inside the technology in search of its capabilities and did not focus solely on understanding user needs. This is a perspective shared in designing meaningful innovations (Verganti, 2017) but it is still underexplored on the technological side (Magistretti & Dell'Era, 2018). IBM's intuition to look inside the technology first before leveraging external collaborations to commercialize it is one of the most important findings of our research.

Our qualitative research aims to shed light on technology development, especially in the design process of a GPT. In this sense, experimentation in different application fields—more than 32 in a 6-year period—allowed IBM to create a very powerful technology and spread it to so many countries and markets, thereby matching all the characteristics of a GPT. This is very important for more research in this field. Current GPT studies help practitioners and academics recognize and label a technology as a GPT (Gambardella & Giarratana, 2013). This article shares insights on how companies in the digital era can exploit different aspects to increase the probability of creating a GPT by analyzing GPT literature in a completely different way. Indeed, by adopting different research, university programs, partnerships, and hackathon initiatives, IBM was able to address 32 different markets and reach a very high level of

Figure 3. Different strategies that can support companies in creating value through AI

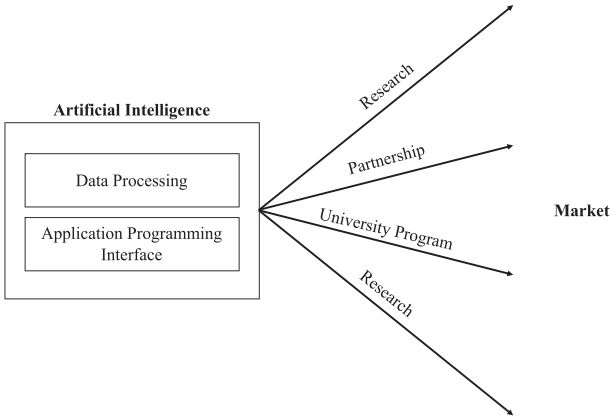
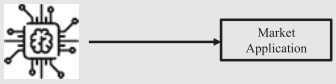
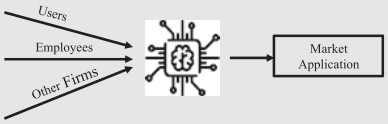
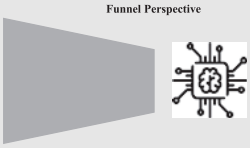
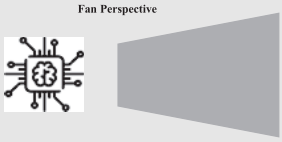
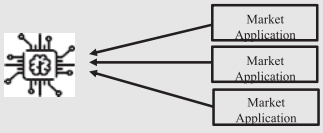
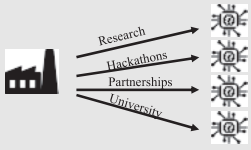


Table 2. Managerial contributions to steer the development of globally impactful digital technology

Contributions in a nutshell	FROM Traditional view	TO Evidence from IBM Watson
The article proposes an ex-ante perspective on **how companies can experiment and explore AI** technology to sustain its pervasiveness as a GPT	**Licensing**  Tech developers patent the technology without proposing their own product but licensing its use	**Co-Developing**  Developers together with other players in the market co-develop the solution to unveil more technology opportunities
The investigation shows that the **digital innovation process follows a different path** to traditional technology development when it comes to technologies such as AI	**Funnel Perspective**  Stage-gate approach to reach one promising market application. Development is driven by the market	**Fan Perspective**  Understanding the essence of AI to develop several different market applications. Development is driven by the unveiling of tech opportunities
The qualitative study enriches knowledge on **technology development, and especially the ex-ante creation and crafting** of an AI solution	**Recognizing General-Purpose Technology**  Tech developer proposes the technology in several different application fields to pursue its pervasiveness and foster improvements by adapting it to a different context	**Designing General-Purpose Technology**  Tech developer leverages diverse knowledge to identify different market application fields to pursue its pervasiveness and foster improvements by adapting it to a different context

pervasiveness, which is the first crucial element of a GPT. Out of the 270 applications created based on IBM AI, some were downstream (e.g., image recognition for a fashion player) while others were more upstream and strategic (e.g., helping a company better frame the machine learning algorithm). The use and exploitation of API also performed extremely well on the improvement dimension, the second crucial factor of a GPT. Indeed, IBM's strategic decision to open the technology's development to external players by letting them use the API was counterintuitive for a GPT for which firms usually target technology patenting and licensing in an attempt to preserve their knowledge from being exploited externally (Youtie et al., 2008). Finally, through the Bluemix solution, the cloud platform where different applications for the Watson technology are made available to users, IBM also pursued the innovation-spawning dimension of GPT.

Watson embraces the three elements of pervasiveness, improvement, and innovation spawning to sustain the growth and experimentation of this technology. As evident from the data, the initiatives IBM adopted—including different activities to experiment the opportunities offered by the technology during commercialization in different applications—allowed the company to enhance the improvement and innovation spawning effects (Bresnahan & Trajtenberg, 1995). Moreover, the inclusion of different APIs in the final solution increased the pervasiveness of the technology in society (Youtie et al., 2008). (See Table 2)

5.1. IBM Watson teaches academics

From a theoretical standpoint, this investigation enriches academic knowledge in various perspectives. First, the study contributes theoretical knowledge of AI by expanding upon related literature (Kaplan & Haenlein, 2019). Indeed, it shows that aside from changes in business models (Nenonen & Storbacka, 2018) and the possibility to adopt it to address different markets, better and deeper knowledge of AI can create value for academics. Indeed, by introducing the two dimensions of internal and external exploration, companies that aim to adopt AI can create value in the market. This is an interesting theoretical contribution, pointing out is even more difficult due to the different stakeholders involved. Second, this study enhances the GPT literature by shedding light on the designing perspective of the creation of a GPT (Gambardella & Giarratana, 2013). This is a rather neglected aspect in the literature. Third, it shows that companies can commercialize technology differently and particularly that the digital environment sustains such a

development. The analysis shows that companies should approach technology development from a different perspective compared to the funnel approach and the open innovation paradigm (Chesbrough, 2006). Technology is not channeled into markets thanks to an inbound or outbound perspective (West & Bogers, 2017), but resides within the company, while external stakeholders only develop the features. This enriches the open innovation and big data literature by showing that technology can be crafted to support multi-stakeholder interactions. Indeed, the big data literature argues that the dynamic involvement of different stakeholders can foster higher innovativeness (Bharadwaj & Noble, 2017). This study also shows the importance of stakeholders, academics, partners, and citizens through hackathons. Experimentation and development can steer the technology toward different application fields, opening up commercial opportunities for the company as well as potentially interesting modifications that can be introduced to better exploit the technology over different applications (Dell'Era et al., 2017).

5.2. IBM Watson teaches managers

Our investigation also has some interesting practical implications for companies facing technological innovation. The first and most important is that companies seeking to address a wider market should leverage the hidden key elements of the AI technology and explore them by integrating the technology in different application fields. Without exploration and integration, it is difficult to unveil all the potential of AI and, as reported in the IBM Watson case, it is difficult to predict ex-ante where the technology can be applied. Commercializing it in one field allows managers to explore and understand the opportunities and particularities of the technology to create value and learn where the same key traits are present, and even increase the value created through economies of scale (e.g., big data and relevance of speed in creating connections between them). Second, the overturned traditional funnel approach is relevant for practitioners. Indeed, it suggests that the approach toward AI development as a GPT should follow a different path, not focusing on a single use but on broadening the application scope to a larger set of application fields (see Figure 3). Third, the involvement of different external stakeholders, universities, hackathons, and partners is fundamental to speeding up the integration of AI in different markets.

6. Unlocking the opportunities hidden in AI

This study sheds light on how companies can create value through AI technologies. The unique and extreme case of IBM Watson offers novel insights on how to unveil opportunities hidden in AI. First, based on the digital transformation (Nambisan et al., 2017) and GPT (Youtie et al., 2008) literature streams, the investigation proposes a different perspective on AI. Indeed, it indicates some theoretical and managerial implications on how to design AI solutions to become a GPT. This will help companies aiming to commercialize these technologies to achieve high pervasiveness in the market. In addition, to the best of our knowledge, this investigation is one of the few that considers the ex-ante creation rather than the ex-post study of a GPT. Moreover, it enhances current knowledge on technology innovation in the complex digital ecosystem. Adopting a longitudinal perspective in the analysis, we show that technology must not only be understood in detail (Danneels & Frattini, 2018) but also crafted and designed to support its continuing evolution. Indeed, this allows opening opportunities while commercializing the technology without focusing on just one application and one product as is evident in the two main strategies IBM adopted for internal development and external collaboration initiatives.

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