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"The evolution from products towards digital platforms: the Schneider Electric case."

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Abstract

Questa Prova Finale affronta il tema dell'Industry 4.0 e il fenomeno di evoluzione dell'offerta da prodotto tradizionale a piattaforma digitale che sta progressivamente investendo l'industria manifatturiera a livello globale.

L'avvento delle tecnologie digitali in ambito industriale modifica le potenzialità e i business model di molte aziende del settore, determinando la creazione di nuove opportunità di ricavi e di sinergie strategiche. In questo processo, le piattaforme digitali rivestono un ruolo di primaria importanza e contribuiscono ad incrementare la spinta verso una visione ecosistemica in cui la creazione di valore per l'impresa avviene in maniera congiunta ad altri business. Il caso Schneider Electric, in questo senso, è emblematico.

La trattazione dell'argomento in questione comincia dalla definizione di Quarta Rivoluzione Industriale e indaga la letteratura accademica esistente nell'ambito di Business Model. Inoltre, vengono presentati i temi della Digitalizzazione e Servitizzazione in chiave economica.

Parte fondamentale di questo studio è rappresentata dalla descrizione evolutiva e delle tipologie di piattaforme digitali esistenti, in cui trova spazio la tematica relativa agli ecosistemi di business.

Alla presentazione della metodologia impiegata nello studio, segue una descrizione della piattaforma digitale sviluppata da Schneider Electric, arricchita da un'ampia digressione sulle conseguenze positive derivanti dall'impiego della stessa per le imprese clienti.

I risultati della ricerca vengono dunque analizzati da una prospettiva strettamente aziendale, attraverso l'utilizzo di interessanti framework per comprendere come la trasformazione digitale modifichi il business model delle imprese manifatturiere attraverso tre fasi distinte: *product skimming, platform revenue generation* e *platform orchestration.*

Infine, le conseguenze della trasformazione digitale vengono analizzate in maniera critica. La discussione comincia dalla valutazione dei fattori politici, economici e sociali che determinano la propensione di un paese a cogliere le opportunità offerte dalla digitalizzazione; prosegue con l'interrogativo circa la possibilità di assistere ad un fenomeno di oligopolizzazione di mercato da parte dei fornitori di piattaforme digitali; e si conclude con considerazioni sul piano manageriale e sull'influenza della digitalizzazione sulla forza lavoro, nonché della necessità di un'attenta pianificazione strategica per la gestione degli ecosistemi di business.

Table of Contents

1. Executive Summary

This study examines the phenomenon of Industry 4.0 and the ongoing shift from traditional products towards digital platforms in the manufacturing industry, by adopting the perspective of business model innovation. As a consequence, the Fourth Industrial Revolution and some related concepts are defined, while a general framework to understand business models is proposed. Additionally, before introducing the idea of digital platforms and the emergence of the ecosystem approach, the digitalization and servitization are inspected, as well as the link between the two concepts. The Schneider Electric case is taken into account as a successful example of technological backbone in the context of business ecosystems. Finally, the topic is analysed from a business point of view and plausible future trends and managerial implications are discussed, offering suggestions on how to effectively manage this delicate transition.

2. Introduction

Technology has long shown its disruptive power upon society, changing profoundly our behaviours, the way we communicate and ultimately, our jobs.

In the business world, the beginning of the development of significant technological innovations, which can be traced back to the last decades of the 19th century, has altered life in the manufacturing industry.

The introduction and spread of the steam engine are usually regarded as the main indicators of the First Industrial Revolution. This phenomenon mainly involved the textile and metallurgic sectors.

Approximately a century later, the introduction of the first automated machines, made feasible by the deployment of electricity in the manufacturing industry, gave Henry Ford the opportunity to translate Taylor's theoretic work into a real-life assembly line. This shift marks the beginning of the Second Industrial Revolution. The main idea behind it was the need to substitute labourers with more efficient and precise machines, ultimately increasing the obtained total output. From that moment on, technology has shaped firms' evolutionary paths and its impact has rapidly become even greater, growing almost exponentially.

To reach the Third Industrial Revolution, we had to wait until the 1970s. In that case, the innovations introduced were more subtle. Flexible automation, which consists of machinery capable of performing a variety of complex operations, is considered to be a big upgrade of this period. Furthermore, the use of software to manage such machinery was introduced.

During this time, a new approach towards consumers and other businesses started spreading. Customers became central and the firm started caring about customer loyalty; a servicedominant logic started to characterise businesses. Moreover, firms started to acknowledge their role in the supply chains and the value networks.

Nowadays, the advent of Information and Communication Technologies (ICT) has further expanded technology's impact on the business world, not only calling our understanding of the relationship between people and work into question, but also creating new opportunities for companies. This shift was so clear that it brought the so-called *Industry 4.0* (or *Fourth Industrial Revolution*) into the manufacturing world.

Quick research through Google Trends shows that interest for I4.0 worldwide skyrocketed from 1 to 100 in the years between 2013 and 2016.

Industry 4.0 enables the transformation of factories into smart environments by connecting people, objects and information through the convergence of physical and virtual worlds in the form of Cyber-Physical Systems (CPS) (Ibarra et al., 2018). The degree of organisational complexity associated to this concept is high, since manufacturing firms are required to accommodate I4.0 into their existing setup (Sanders et al., 2016) while taking into account ongoing and potential changes in their business model (Porter & Happelmann, 2015), making the process even more difficult to handle.

An interesting area of development in this field is represented by the emergence of digital platforms and platform-centric companies. Examples are many but Netflix, Airbnb, and Spotify are worth mentioning for two reasons: firstly, their great success; secondly, because they share a common and often unnoticed base-platform, namely the Amazon Web Services platform (Pirvan et al., 2019).

Indeed, a large number of organisations are deploying the Internet of Things (IoT) in order to build similar solutions. In this sense, Schneider Electric's EcoStruxure constitutes another successful example.

Such platforms contribute to the evolution of the manufacturing industry, on an innovation ecosystem perspective. In this case, an essential technological system acts as a substrate for other firms to develop complementary products, services or technologies (Gawer, 2014).

In this fast-changing scenario the firm becomes increasingly reliant upon the cyber-physical world where smart objects deploy the Internet to communicate between them and with people inside and outside of the firm, blurring the traditional corporate boundaries.

The relevance of the IoT market is shown by its projected numbers.

McKinsey & Company (2021b) estimates that by 2030, the IoT could enable from \$5.5 trillion to \$12.6 trillion in value worldwide, including the value captured by customers and consumers of IoT-based products and services. The potential economic value behind the IoT is large and growing.

On the same level, the Industrial Internet of Things (IIoT) will be a $500 billion market by 2025, with the main reason for this growth being advances in its essential technologies driving up underlying demand (McKinsey & Company, 2021a). The expected growth rate for the IIoT market from 2020 to 2025 is 12 percent annually.

Furthermore, technology trends for this market look rather promising and three top-line IIoT-related tendencies can be identified (McKinsey & Company, 2021a). First, the deployment of use cases is becoming easier thanks to the network effect, a simplified development process, imprinted scalability and increased use case availability. Second, edge computing[1] is becoming more and more diffused. Last, 5G connectivity[2] offers manufacturers a solution where alternatives fail (McKinsey & Company, 2021a).

Hence, in response to the increasing relevance of the topic and the will to increase the understanding of the basis of the Fourth Industrial Revolution as well as the acknowledgement of potential future scenarios, this paper aims at analysing the meaning of the main terms used in the field, as well as the threats and opportunities generated by the adoption of I4.0 technologies in the manufacturing industry. Moreover, by analysing Schneider Electric's specific case, examples of the shift from traditional products towards digital platforms will be provided.

The remainder of the article is organised as follows: first, a literature review of the main topics discussed; second, an explanation of the methodology used during the study; third, the presentation of the empirical study for this thesis, namely the Schneider Electric case; last, the explanation and discussion of the results of the study, which anticipate the conclusion.

3. Literature Review

3.1 Industry 4.0 and Business Models

The term Industry 4.0 conventionally dates back to 2011 in Germany, where "Industrie 4.0" was first mentioned; from that moment on it was translated in the Anglo-Saxon world to be associated to an emerging phenomenon (Ibarra et al., 2018).

There is no uniquely accepted definition of *Industry 4.0* or *Fourth Industrial Revolution*, as it is often referred to. According to Frank et al. (2019), for example, Industry 4.0 concept comprises different business dimensions (e.g., manufacturing, product development, supply chain and working processes) sustained by emerging technologies.

[1] *Edge Computing* is an alternative to cloud computing. Indeed, it refers to decentralised data processing, at the edge of a network. The aim is to process data streams as close as possible to their origins, thus granting lower latency if compared to the case in which data is sent to a cloud server first (McKinsey & Company, 2021a).

[2] *5G* is the fifth-generation technology standard for cellular networks. It consists of new spectrum bands for cellular usage, new bandwidth allowing for high speeds and lower latency. This technology is also deployed in IIoT and enterprise networking (McKinsey & Company, 2021a).

In order to provide a better understanding of this concept it is useful to consider the results it delivers first. Hence, Industry 4.0 enables the transformation of factories into smart environments by connecting people, objects and information (Ibarra et al., 2018). The above-mentioned Cyber-Physical Systems (CPS) “is defined as transformative technologies for managing interconnected systems between its physical assets and computational capabilities” (Lee et al., 2015, p.18). The integration of CPS with existing practices in the manufacturing industry such as production, logistics and services would generate an example of Industry 4.0, leveraging Big Data[3] and the interconnectivity of machines with the goal of creating smart, resilient and self-adaptable machines (Lee et al., 2015).

In 2016, the Italian Ministry of Economic Development linked nine technologies to Industry 4.0 (e.g., Internet of Things, cloud computing, cybersecurity, Big Data and Big Data analytics, simulation, horizontal and vertical integration, added manufacturing, advanced manufacturing solutions, augmented reality) (Agostini & Filippini, 2019) showing that I4.0 refers to a wide spectrum of transformative technologies in continuous evolution, whose application innovates firms, generating significant economic potential.

In particular, the Internet of Things deserves a specific explanation. IoT systems rely on digital devices connected to the Internet in order to create and transmit data on a real-time frame (Sorri et al., 2022). In plain words, IoT is a technological system that links together physical and virtual objects, creating a cyberspace in which things communicate automatically, transferring high-volume information to data clouds and making products and objects more intelligent (Markfort et al., 2022).

In literature, the new technology cluster associated with Industry 4.0 is often referred to as *digital technologies* (Warner & Wager, 2019). Their development is a true challenge for companies, which try to exploit the opportunities provided by digital technologies to foster competitiveness (Agostini & Nosella, 2021). In order to do so, it is important to understand that the simple implementation of such technologies by itself is not sufficient. Quite the opposite, organisational aspects and strategic management are crucial in order to guarantee the realisation of the economic potential assured by the implementation of digital technologies. To take advantage of these technologies to the fullest, firms need to transform their business models, either partially or completely.

In general, a business model is defined as a holistic concept to explain *how* firms *do business,* trying to explain the process of value creation for customers (Zott et al., 2011).

[3] The term *Big Data* makes reference to the output of a process of continuous high volume data collection, enabled by the use of interconnected machines and sensors (Lee et al., 2015).

Business models usually comprises three core elements: *value proposition*, *value creation* and/or *delivery* and *profit equation* (Markfort et al., 2022).
Value proposition refers to the company's offerings feature that create value for customers; *value creation* and/or *delivery* indicate the internal and external operations that allow for fulfilment of the value proposition; *profit equation* comprises the value creation costs structure and the financial manifestation of value capture for customers or partners.
Therefore, the implementation of digital technologies within a company may modify one of these components, leading to business model innovation.

3.2 Digitalization and Servitization

Although recently digitalization and servitization have been closely linked to each other (Markfort et al., 2022), they are two different concepts.
On one hand, *digital transformation* is defined "as organisational change that is triggered and shaped by the widespread diffusion of digital technologies" (Hanelt et al., 2020, p.1160). *Digitization* is defined as the process of translating analogue data into digital sets and it constitutes the framework for *digitalization* which, on the contrary, is intended as the exploitation of the opportunities offered by digital technologies (Rachinger et al., 2018).
Digital transformation addresses the process of implementation of the above-mentioned digital technologies, such as IoT, cyber-physical systems, cloud computing, big data, artificial intelligence, machine learning, cloud computing, and blockchain among the others (Markfort et al., 2022).
Nowadays those technologies generate major changes on a business model level, creating new revenues and opportunities for value-creation (Markfort et al., 2022). Therefore, digitalization can be safely regarded as a source of innovation for companies.
On the other hand, *servitization* refers to a strategy of product firms, which consists in an evolution towards product-service systems; it is a consequence of the shift of customers' expectations to receive additional services when buying a product and the perception of the use of a product as a service itself (Frank et al., 2019). In other words, servitization indicates the shift from products bundled with add-on services to integrated product-service-software systems (Kohtamäky et al., 2019).
One motive of servitization is that it fosters relationship creation between the firm and its customers, while increasing customer retention over time; another driver is related to the nature of services themselves, which can be seen as a stabler source of profits if compared to physical products, because of products' fluctuating business cycles (Simonsson et al., 2020)

By linking together these concepts, *digital servitization* is introduced. It can be defined as the transition toward product-service-software systems through the implementation of digital technologies (allowing for monitoring, control, optimization and autonomous functioning) that drive value creation and capture (Kohtamäky et al., 2019).

The conceptualization of digital servitization enables firms to move beyond the traditional view of standalone products, instead emphasising the interconnectivity among physical objects enabled by the IoT, as well as the cooperation between companies, facilitating communication and exchange between operators, customers and suppliers (Kohtamäky et al., 2019).

Two consequences of this phenomenon should be considered. Firstly, IoT platforms represent a key enabler of digital servitization, being able to potentially impact the business model of product companies (Markfort et al., 2022). Secondly, by deploying shared digital platforms, the firm gets to be considered as part of a business ecosystem, which requires the alignment of the business models of different companies within the ecosystem; hence, business models in digital servitization should be seen from an ecosystem perspective (Kohtamäky et al., 2019).

3.3 Digital Platforms and Business Ecosystems

Before introducing the concept of *digital platform,* it is useful to go back to the original idea of *product platform*. In particular, this concept became a popular topic of discussion among researchers during the 1990s. The term refers to the component reuse for different products or models, which was enabled by the introduction of modular product architectures (Cusumano, 2010). In this sense, the product platform represents a common foundation around which a company can design a series of different products sharing the same reusable component (Pirvan et al., 2019). Precisely, this idea guarantees benefits in terms of costs to the firm. Indeed, the firm can leverage both *economies of scale,* which allow for cost reduction as the total volume of output increases (i.e., the production of a unique product platform in high volumes is advantageous for the producing firm), and *economies of scope,* generated by the presence of a common product platform, deployed in the production of a range of different products.

An effective example to get the idea behind the introduction of product platforms is represented by the automotive industry, where several firms produce different models that share the same underbody platform.

According to Gawer and Cusumano (2014), *platforms* can be distinguished between *internal* or *company-specific* platforms and *external* or *industry-wide* platforms.

As its name suggests, an *internal platform*'s impact lies within a firm's boundaries, where it is used to design a series of derivative products; an *external (industry) platform,* on the contrary, is a product, service or technology that can act as a commonly shared asset for a business ecosystem, upon which external innovators can act in order to develop their own derivative products, service or technologies (Gawer & Cusumano, 2014).
To the extent of this research, industry platforms are an extremely interesting concept. They provide a usually technological common base whose features do not come from a specific firm only; quite the opposite, additional technological features derive from the action of different external agents called *complementors* (Pirvan et al., 2019).
Looking at their function, Cusumano et al. (2019, as cited in Butollo & Schneidemesser, 2022) propose an additional distinction between *innovation* and *transaction platforms.* The former aim at the extension of a platform's functions in the perspective of complementary value co-creation through the contribution of ecosystem partners, resulting in the creation of an open innovation system. The latter pursue a different goal by creating an online marketplace to facilitate transactions among suitable partners and reduce transaction costs.
As we will see later in detail, we can classify Schneider Electric's EcoStruxure as an *external*, *innovation* platform.
As Lyman et al. (2018, p.3) defined it, a digital ecosystem is a "network of cross-industry players who work together to define, build and execute market-creating customer and consumer solutions. An ecosystem is defined by the depth and breadth of potential collaboration among a set of players: each can deliver a piece of the consumer solution, or contribute a necessary capability." The power of ecosystems lies within two main features. The first aspect is that no single player needs to own or operate all the components of the solution; the second characteristic is that the value generated by the entire ecosystem is larger than the combined value that each player could reach individually (Lyman et al., 2018). Hence, we can recognize a network effect.
Nonetheless, a key feature of platform-based ecosystems is represented by the participants' changing roles and relationships, which can extend from collaboration to competition. In this sense, a great example is represented by Apple and Google, two firms that used to partner to include Google Maps service in Apple's iPhone platform, until Apple decided to replace Google's service with a self-developed Maps application (Gawer, 2014).
We can conclude then, that the implementation of digital technologies in the context of digital servitization overcomes the boundaries of a single firm, developing in a *business ecosystem*: a concept that emphasises the value creation and capture process between interrelated firms (Kohtamäky et al., 2019).

As a matter of fact, considering firms and their individual value chains in a context of digital servitization is rather limiting. On the contrary, embracing an ecosystem perspective allows us to acknowledge the existing interrelations among partner companies.

Kohtamäky et al. (2019) argue that within an ecosystem, firms should aim at creating a strategic connection by aligning their own business models; the innovative potential of the ecosystem depends upon the firms' activities and shared assets. Hence, focusing on ecosystems remains an important condition for digital servitization.

To recap, platforms evolved from a product-related dimension, to an industrial dimension. The first developed mainly within a firm's boundaries, while the latter goes beyond these boundaries, usually leveraging digital technologies.

In particular, IoT platforms contain digital features and sensors that allow for high-volume data collection about product condition and usage. This allows firms to provide tailored services that can generate additional revenue. In this sense, IoT platforms can be considered innovation platforms (Markfort et al., 2022).

Once the foundation or core platform has been established, complementors operating in the ecosystem add subsequent digital features and functions such as advanced sensors, improved data analytics, self-learning and autonomous applications, data storage, etc. The complementors can be anyone from the company that originally developed the platform, to its suppliers and competitors. Therefore, this process requires two main aspects: a certain platform and an ecosystem approach (Markfort et al., 2022).

A successful example of the digital ecosystem approach is represented by Schneider Electric's own digital ecosystem: Schneider Electric Exchange. It brings together startups, software developers, system integrators, designers, plant managers, data scientists, service providers, and others to create, collaborate and scale solutions for the digital economy (Schneider Electric, 2020). In this sense, digital ecosystems guarantee to their players access to tools and resources via real-time collaboration in order to help them to overcome obstacles and complexities.

A critical role in the innovation ecosystem is played by customers. Companies try to get to know their customers and their needs (digital technologies and functions embedded in IoT platform can help the ecosystem, in this sense) and engage with them through relationship building. Due to customers' raising expectations, firms extend their products and services offers. To create complementary networks of offerings and services, companies' alliances are created (McKinsey & Company, 2018).

Industry 4.0 gives the opportunity to create more customer-driven value propositions, which is shown by the expansion of innovative service offering (Ibarra et al., 2018). Gawer (2014) shows a great example of this concept, mentioning the role played by consumers in digital platforms such as Facebook or Google. In particular, users take advantage of the specific service offered by these platforms, while feeding them with loads of personal data, which allow the platforms to provide their services, therefore contributing to the platforms' own innovation.

Nevertheless, the advantages of sharing a platform within an ecosystem do not come alone. In particular, in order to leverage the network benefits, firms must be able to face the challenges of managing complex inter-organizational relationships (Eloranta & Turunen, 2016).

As digital ecosystems take shape and evolve, the industry landscape is facing an upheaval. In order to take advantage of it, companies will need to embrace new relationships and ways of collaborating (McKinsey & Company, 2018).

4. Methodology

This research starts from a proposal made by Prof. Paiola, who suggested focusing on the ongoing process of shift from traditional products towards digital platforms happening among industrial supplier groups, mentioning the Schneider Electric case as a great example of this phenomenon.

The proposed paper to acquaint with the topic was written by Markfort et al. (2022).

Firstly, I started by reading this paper, trying to understand the main ideas behind the study and taking some notes on possible areas on which to focus during my analysis. The result was a list of potential aspects to examine in depth. In the end, only some of them were effectively debated in this study.

Secondly, since the suggested article did not take the Schneider Electric case into account, I went for preliminary research on Google, in order to have a general idea of the company and its offer. Contextually, I started looking for some articles related to the Internet of Things and Industry 4.0 on Harvard Business Review, The Economist and The Financial Times.

It is right and proper to specify that up to this point I still considered myself in a preliminary phase that anticipated the effective research for the study. The goal of this stage was to deepen my personal knowledge of the topic, before heading to the effective start of my thesis.

Thirdly, Prof. Paiola and I agreed to start searching on ScienceDirect and Google Scholar to find relevant academic writings on the topic. In particular, we established to use the following Boolean string for the research: TITLE-ABS-KEY (("serviti*ation" OR "service*") AND "business model" AND ("internet of things" OR "iot" OR "digitalization") AND "digital platform*") AND PUBYEAR > 2016. This was the final result of a series of adjustments and corrections made by Prof. Paiola on the initial string I proposed.

In particular, we filtered for results containing the key words servitization (and related) *or* service (and related), *and* business model, *and* Internet of Things *or* IoT *or* digitalization, *and* digital platform (and related). Moreover, given the innovative nature of the topic, we decided to consider papers published from 2017 onwards only.

This done, I created a shared Excel chart, where I arranged the 20 most relevant articles found during the research. The information included for each paper where the following: an ID code (created using a number for the order in terms of relevance and the acronym of the journal where the article was published), authors, title, publishing journal, year of publishing, volume and issue number, abstract, page reference and DOI link. By doing this I had almost every useful info about the article ready to be used and quick to be found.

After the research, Prof. Paiola helped me to select the most relevant ones for the purpose of my study. The list was therefore reduced to 5 articles. Consequently, I deployed the snowballing technique in order to expand the list by starting from the approved articles. Approximately 5 articles were selected among the references mentioned in each approved paper. The resulting papers were categorised in the shared Excel chart, using the ID code to link the derived articles to the starting paper. The updated chart was again checked by Prof. Paiola, who helped me to identify the most pertinent papers. The final result was a list of 16 approved sources.

Before starting the writing part of my study, I felt the need to acquire some specific information regarding Schneider Electrics' EcoStruxure platform. Given the industrial nature of the project, the only way to acquire this type of info was to scan through Schneider Electric's website, white papers of consulting or high-tech firms and online industry sites. Fortunately, this further research resulted in enough material to have a clear idea about the main case proposed in this study.

Once the writing was started, I deployed once again the snowballing technique in order to provide a detailed description of aspects that needed specific references.

The work's final version was shared with my supervisor in order to allow for his correction and to get useful pieces of advice on the aspects that had to be developed more in detail before the official submission.

5. Empirical Study

In the following section, the Schneider Electric case will be analysed. It constitutes an effective example of the development of digital platforms by industrial supplier groups.

Besides, it highlights the potential benefits enabled and reached through the use of digital technologies, on a business level.

5.1 Schneider Electric's EcoStruxure

Schneider Electric is a French multinational firm that was first founded as Schneider & Cie. in 1838 by the Schneider brothers, two years after the acquisition of mines and forges at Le Creusot, France (Schneider Electric, 2022a). The company soon specialised in armaments, before diversifying into the emerging electricity market, by the end of the 19th century. In 1999 the group was renamed, adopting its current name.

Through the years, the company grew through strategic business acquisitions to help build unique positioning and accessing critical technologies.

Schneider Electric's path towards digital transformation started decades ago, precisely during the 1990s, when Transparent Factory, an Ethernet-based architecture connecting factory shop floors to the internet, was launched (Schneider Electric, 2021). This solution could be defined as a prototype version of Schneider Electric's modern EcoStruxure solution.

Nowadays, the group develops innovative, connected technologies and solutions for safety, reliability, efficiency and sustainability (Schneider Electric, 2022b) in four key sectors: buildings, data centres, industry and infrastructure (Schneider Electric, 2021). To the extent of this study, two of these sectors are particularly interesting, namely industry and data centres.

EcoStruxure is an IoT-based digital platform, consisting of connected products; edge control solutions; applications, software for data analytics and services. EcoStruxure Platform is the foundational technological backbone upon which Schneider Electric solutions, applications and extensions are built and delivered (Schneider Electric, 2022b). It guarantees digital transformation of energy management and automation by affording visibility and control across the enterprise via real-time monitoring, mobile insights, digital twin capabilities, and proactive risk mitigation (Schneider Electric, 2021). **Figure 1** summarises EcoStruxure's Architecture.

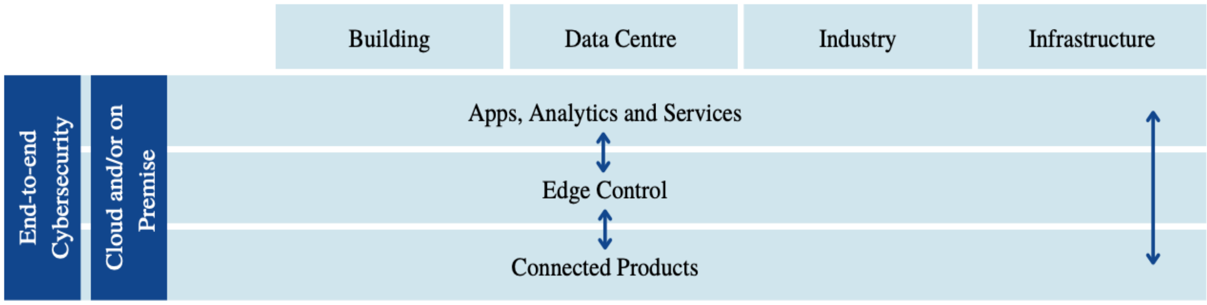

Figure 1: Schneider Electric's EcoStruxure Architecture (Schneider Electric, 2021).

According to Schneider Electric (2022b), EcoStruxure Platform enables three main consequences:

- *Core capabilities* for embedded connectivity and intelligence, through standards-based communication protocols and the ability of smart devices to perform analytics for control decisions;
- An *interoperable foundation* assisting developers, system integrators and engineering staffs in building application for smart operations such as monitoring, visualization and control;
- *Infrastructure* for cloud-connected digital devices, leveraging scalable Microsoft Azure IoT technology to deliver value-adding digital services to optimise customers' operations.

Schneider Electric (2021) affirms that nowadays EcoStruxure covers 500,000 sites globally, connecting around 45,000 between developers and system integrators, 3,000 utilities, and 650,000 service providers and partners as a community. This truly gives the idea of the extension that digital ecosystems can reach, arising from one single digital platform provided by a hub firm.

According to the company, businesses and organisations struggle to manage the complexity associated with digital transformation or digitalization, showing the need for a reliable authority to drive them to unlock their full digital potential (Schneider Electric, 2021).

If the role of the platform developer as a key enabler for empowering digitization across firms seems obvious, it is tough to systematically propose evidence of the power of digitalization across the spectrum of global commerce.

Schneider Electric (2021) managed to propose a study comprising 330 data points developed from the analysis of 230 customer projects. The result was the creation of a list of 12 key business benefits of digital transformation, (see **Figure 2**) providing readers with a realistic benchmark on digital transformation's potential. These benefits are divided in 3 different categories, each of which is essential to reach effective marketplace competition: capital expenditure (CapEx), operational expenditure (OpEx), as well as sustainability, speed and performance (Schneider Electric, 2021).

BENEFIT	UP TO	AVERAGE
CapEx		
Engineering costs and time optimization	80%	35%
Commissioning costs and time optimization	60%	29%
Investment costs optimization	50%	23%
OpEx		
Energy consumption savings	85%	24%
Energy costs savings	80%	28%
Productivity	50%	24%
Equipment availability and uptime	50%	22%
Maintenance costs optimization	75%	28%
Sustainability, Speed and Performance		
CO2 footprint optimization	50%	20%
Time to market optimisation	20%	11%
Decrease in occupant comfort-related incidents	33%	24%
Return on investment	0.75 year	5.3 years

Figure 2: The 12 key business benefits of digital transformation (Schneider Electric, 2021).

a. Capital Expenditure – CapEx

In some cases, businesses perceive digital transformation as an expensive upfront prospect, due to the need to buy new high-tech equipment and the need to integrate it with their complex legacy systems. Most of the time, this evaluation proves to be wrong.

Indeed, not only are newer high-tech solutions easier and faster to integrate than outdated systems, but they also allow for intelligent maintenance and monitoring which generate gains in terms of equipment longevity (Schneider Electric, 2021). Potential outcomes for businesses are the possibility of deferring capital expenditures and the ability to better establish future investment plans.

Digital transformation offers companies a means to overcome fragmentation among participants in the business ecosystem in the planning, design, installation, and commissioning phases, subsequently creating upfront value (Schneider Electric, 2021).

- *Engineering costs and time optimization*

  In complex projects where many subcontractors often work in non-communicating divisions, digitalization helps to streamline the work by guaranteeing centralised integration among projects and systems. This can generate significant savings in engineering costs and time optimization (Schneider Electric, 2021). Among the benefits mentioned from customers deploying EcoStruxure in their businesses are cost and energy reductions, prevention of costly slowdowns and time savings in the engineering phase, resulting in extra days of profit (Schneider Electric, 2021).

- *Commissioning costs and time optimization*

  One of the main features of digital platforms is flexibility, which enables business ecosystems to continuously add and develop new systems and features. The commissioning process, as a matter of fact, is not a one-time process. An appreciated feature of IoT-connected devices is the ability to "communicate well" with other systems during the commissioning stage (Schneider Electric, 2021).

  Schneider Electric's Digital Transformation Benefits Report (2021) provides an effective example of how decreased commissioning times can speed the overall progress of digitization while guaranteeing faster startup. *Petróleos Mexicanos,* Mexico's state-owned company operating in the petroleum industry, started an ambitious process of digital transformation in order to update its natural gas measurement sites. To reach this result, Schneider Electric partnered up with SCADA International, which helped the customer to move from older flow computers and replace them with SCADAPacks, a solution consisting of smart terminal units. The new system perfectly integrates with the existing one, reducing installation time by 60 percent and labour hours for site startups by 50 percent. Furthermore, the new solution provides *Petróleos Mexicanos* with the ability to monitor the volume of gas flowing through pipes in real-time, guaranteeing a greater visibility into the system's performance.

- *Investment costs optimization*

  Digitization can prolong the life of existing equipment and create investment cost savings by ensuring that the assets are optimally maintained during their life cycles through the use of cloud analytics tools that make timely recommendations suggested by historic and real-time data (Schneider Electric, 2021). This aspect proves to be crucial within the manufacturing industry and beyond, for example by allowing delivery contracting methods based on lean principles.

b. Operational Expenditure – OpEx

Digitization guarantees improvements in terms of efficiency, reliability, safety and sustainability through interoperable software and cloud analytics, which enable intelligent decision making. Digital transformation offers a smart alternative to guesswork and reactive maintenance; automation and digitised management generate savings during the OpEx phase (Schneider Electric, 2021).

- *Energy consumption savings*

  Through digitalization of energy management and automation businesses can reach two apparently contradictory goals: consuming less energy while assuring productivity or comfort. Automated tools guarantee that energy is used only when needed (Schneider Electric, 2021).

  A successful example of this benefit is shown by the application of the EcoStruxure Plant platform at the wastewater plant in Lakeland, Florida. Using Schneider Electric's platform as a digital backbone, a series of process enhancements and technical upgrades were carried out guaranteeing increased control over energy consumption as well as increased performance (Schneider Electric, 2021).

- *Energy costs savings*

  The greater the amount of energy consumed, the greater energy costs. Increased energy costs drive operational costs up. To face increasing energy prices worldwide, businesses look at renewables and digitally driven approaches with faith (Schneider Electric, 2021). The data collected and analysed through the platform give businesses a clear perspective of how they are shifting towards a green energy future.

  A stunning example of this benefit is represented by *Hilton Garden Inn Dubai Mall of the Emirates* (UAE), which is renowned as one of the most sustainable hotels in the world. In this case EcoStruxure Building platform was used to gather under a comprehensive and integrated platform the building, guest room and property management (Schneider Electric, 2021). The combination of energy management and automation generates a great savings potential, for example by allowing customers full environmental control of their rooms while automatically turning off lights or adjusting temperature when sensors detect unoccupied rooms. In this way the *Hilton Garden Inn Dubai Mall of the Emirates* was able to gain competitive advantage by optimising energy savings and customer's comfort, as testified by the LEED Gold Certification[4] it was awarded (Schneider Electric, 2021).

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[4] The *LEED* (Leadership in Energy and Environmental Design), developed by the U.S. Green Building Council, is a globally recognized symbol of sustainability achievement and leadership. It provides a framework to classify

- *Productivity*

  World Economic Forum and Accenture (2018) sampled over 16,000 companies from 14 industries to conclude that digital transformation produced benefits in terms of productivity gains, growth acceleration and revenue. Digitalization also played a major role in generating new efficiencies, enhanced customer experiences and new business models. Early adopters of digital technologies generated huge benefits. Furthermore, research showed that businesses investing in a set of digital technologies (AI, cloud computing, IoT-connected devices, …) tripled productivity compared to those investing in a single element.

  A successful example of improved productivity through the adoption of Schneider Electric's EcoStruxure Plant as central architecture is represented by *Baosteel*, China's biggest steel-producing enterprise. The company adopted this solution to counter huge problems such as rising labour costs, tighter regulatory standards and energy efficiency issues (Schneider Electric, 2021). By implementing the digital platform, the firm managed to automate almost every phase of the crane operations, enhancing safety and labour efficiency. To ensure that systems throughout the plant operated at peak performance, real-time monitoring of important equipment was used.

- *Equipment availability and uptime*

  Uptime and equipment availability are key OpEx metrics, especially considering that the smallest downtime can have high financial and reputational costs on businesses in the digital age. Central digital platforms are able to detect problems and fix them quickly, providing comprehensive visibility against equipment failures through real-time notifications of anomalies (Schneider Electric, 2021). For example, *New Belgium Brewing Company* leveraged digital transformation to gain further insights into their production efficiency, enabling them to gather real-time info on unscheduled downtime, better supply chain visibility and predictive capabilities to enhance performance (Schneider Electric, 2021).

- *Maintenance costs optimization*

  The operation and maintenance stage represent the longest phase of an asset's life cycle, so it is easy to imagine that this stage hides some of the largest cost reduction opportunities. Digitally transforming this process generates a change in the predominant approach towards the problem: from a prescriptive or reactive approach, which usually results in premature or late intervention; to a predictive approach,

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healthy, efficient, carbon and cost-saving green buildings. The certification is awarded according to four different levels: Platinum, Gold, Silver, Certified (U.S. Green Building Council, 2022).

enabled by the presence of IoT-connected sensors collecting real-time data on the cloud which guarantees timely and efficient maintenance (Schneider Electric, 2021). On average, Schneider Electric's customers claim a 28 percent reduction on maintenance costs.

c. Sustainability, Speed and Performance

Nowadays, companies' success or failure not only depends on Capital and Operational Expenditure, but also on trends that are increasingly pushing corporate responsibility beyond simple financial and other quantitative metrics.

An example of this trend is represented by the Triple Bottom Line, according to which companies should think and act by considering consequences on a three-layer perspective: people, planet and profit (Elkington, 2000). In accordance with this idea, a broader economic view argues that firms are accountable towards a huge variety of stakeholders, beyond mere financial or economic interests.

In this perspective, businesses are pursuing efforts in order to increase sustainability, comfort, safety and speed of their operations and services (Schneider Electric, 2021)

- *CO_2 footprint optimization*

  For years, economic growth went together with emissions. Nowadays, businesses are still far away from reaching carbon neutrality towards the environment, but digital transformation can certainly help them to reach this goal and to respect new regulatory standards, which are becoming more and more stringent.

  Through the power of digital transformation, net zero waste, net zero energy and net zero carbon are realistic goals to which aspire (Schneider Electric, 2021).

  Moreover, digitalization gives companies the means to vastly improve the accuracy of monitoring and reporting on sustainability measures taken across the supply chain (Schneider Electric, 2021).

  Given the increasing importance of sustainability-related reporting and the interest of financial markets towards these topics, especially for listed firms, it is easy to imagine that increased accuracy on sustainable practices measures can have a huge impact on companies, for example by facilitating access to credit and reaping benefits from financial incentives.

- *Time to market optimisation*

  Digital transformation enables companies to design faster, produce faster and sell faster. Through digitization, businesses can speed up every aspect of their supply chains, ultimately reducing their time to market[5] and enhancing efficiency (Schneider Electric, 2021).

A successful example of a company reaching this goal is represented by the *Raylo Chemical* of Edmonton (Alberta, Canada), a manufacturer of products applied in the healthcare sector. Given the extreme need of quality and regulation compliance for such products, the firm relied on Schneider Electric's ad-hoc IoT-integrated sensors for pH detection (Schneider Electric, 2021). The result was a 20 percent reduction in manufacturing cycles thanks to the real-time readings from sensors; a reduction in the time spent to calibrate pH levels and the production of a higher number of batches in the same timeframe (Schneider Electric, 2021).

- *Decrease in occupant comfort-related incidents*

  Connected devices and centralised building management systems are transforming buildings and production plants into responsive environments capable of adapting to specific lighting and heating preferences (Schneider Electric, 2021). Given the impact that the organisational environment can have on people's feelings and comfort perception, changes like these can ultimately influence labourers' productivity.

  Furthermore, the business space is a crucial aspect in communicating to employees the firm's *organisational culture* in its spatial conception. Making the business environment more user-friendly and adaptable can give people the idea of a company that cares about the people.

  However, as the capability increases, expectations become greater, driving the development of future innovation to meet the increasingly sophisticated requirements of companies and their talents (Schneider Electric, 2021).

- *Return on investment*

  This aspect has a decisive role when deciding whether or not to invest in digital transformation.

  Many businesses do not invest in digitalization because they do not believe in its economic potential, or because they think that it will take too long to realise (Schneider Electric, 2021).

  According to Schneider Electric's (2021) Digital Transformation Benefits Report, on the contrary, the company's customers faced an average payback period of 5.3 years, with some projects producing return on investment after less than one year.

[5] The *time to market* is defined as the time that goes from the first conceptualization of a product to its commercialization (conventionally the first unit being sold). Given the importance of the first mover advantage for businesses, time to market is often considered an important KPI or metric for the evaluation of the effectiveness of the product development phase.

6. Results

The main results of this research comprise strictly economic considerations only. As a matter of fact, the focal point of this section is the business model evolution of firms embracing digital transformation. This topic is interesting and complex to handle, because the influence of digitalization on business models is rather blurry and the exploitation of digital technologies for companies is still challenging (Rachinger et al., 2019).

Before diving into the concept of business model innovation, it is useful to offer a conceptualization of digital servitization business models by highlighting the core characteristics upon which they are built, using a study by Kohtamäki et al. (2019) as reference. In order to do so, three dimensions are deployed: (1*) solution customisation* (ranging from standardization to offering customisation), (2) *solution pricing* (ranging from customer-oriented to customer oriented), (3) *solution digitalization* (ranging from monitoring to autonomous solutions).

First, *solution customisation* refers to the value created by tailoring the proposed solutions to customers' needs, influencing the effectiveness (value creation) and efficiency (value capture) of the firm's business model (Kohtamäki et al., 2019).

Second, in Kohtamäki et al. (2019)'s study, *solution pricing* starts from the firm's offerings by considering its pricing logic, which may be product oriented, agreement oriented, availability oriented or outcome oriented.

The third dimension is *solution digitalization.* It comprises the core digital features of smart solutions today (Kohtamäki et al., 2019).

Figure 3 summarises the typical business models using these three dimensions as a framework to define the features of solution offerings. It is relevant to point out that manufacturing firms' business models are comprehensive concepts that may comprise a variety of strategic configurations, relative to different business units (Kohtamäki et al., 2019). This aspect seems to legitimise Schneider Electric's choice to split up its solution offering into four key sectors, each having its own requirements to better match customers' needs.

The introduction of digital platforms and their gradual development, forces manufacturing companies to continuously rethink and redesign their business models (Markfort et al., 2022). Thus, in this context, digital platforms and the IIoT will drive business model innovations not only on a technical production level, but also by generating organizational consequences and opportunities for businesses and global value chains (Markfort et al., 2022; Kiel et al., 2017; Butollo & Schneidemesser, 2022).

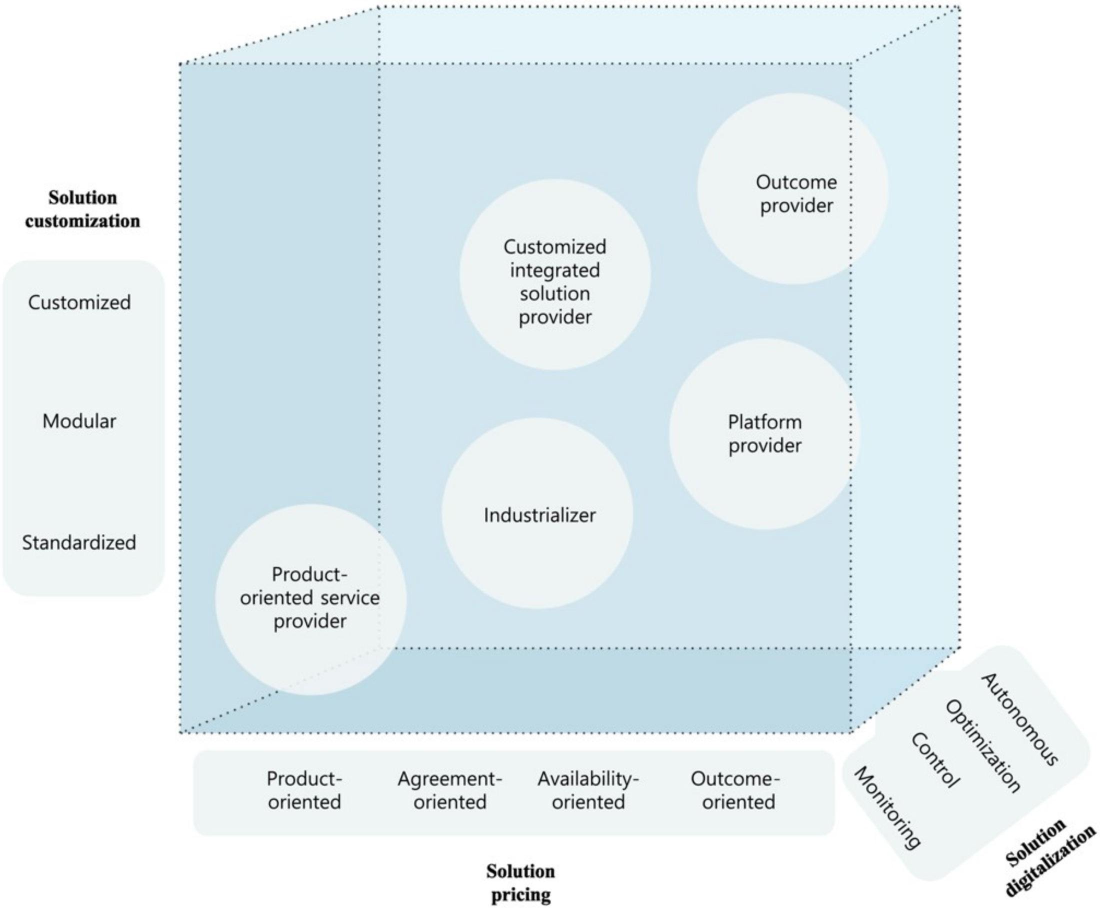

Figure 3: Solution offerings' features in digital servitization business models (Kohtamäki et al., 2019).

As a result of the already established interrelation between digital platforms and business ecosystems, companies are able to address broader value propositions and offer new ways to create and capture value by leveraging digital technologies (Markfort et al., 2022). Still, further research is needed in order to understand what patterns of business model innovation support firms in advancing their IoT platforms.

A study from Markfort et al. (2022) identified three patterns of business model innovations, since each of these include consistent modification to value proposition, value creation and profit equation; in addition, platform investment, age and advancement discriminate about the categories. These patterns are: (1) *platform skimming,* (2) *platform revenue generation* and (3) *platform orchestration.*

Pattern 1 (*platform skimming)* represents the early stage of platform development, dominated by relatively low platform investments and limited revenue generating capacity for the value proposition, while value creation arises from basic digital services and applications (Markfort et al., 2022). More specifically, platform skimming is concerned with cost savings generation reached through the implementation of complex digital technologies.

Platform revenue generation implies a superior level of platform development, offering customer value through significant performance improvements and stimulating customers' propensity to pay fees for more complex services (Markfort et al., 2022). The key focus of this stage is to monetise digital technologies through outcome-based models within the firm's boundaries.

The third pattern (*platform orchestration)* is characterised by higher investment levels and longer initiative age; in this phase companies typically embrace the ecosystem perspective by leveraging collaboration with external partners to foster value creation through digital services (Markfort et al., 2022). In a nutshell, Markfort et al. claim that platform orchestration is about letting platform-based, business ecosystems emerge beyond the firm's boundaries and develop as an organisational form for value creation.

Therefore, the framework proposed by Markfort et al. (2022) suggests that the business-model components change over time not following a gradual evolution scheme but rather following specific triggers such as technological advancements for platform skimming, financial requirements for platform revenue generation and competence and/or skills requirements for platform orchestration.

Kiel et al. (2017) offer a complementary analysis through a multiple case study approach based on IIoT-related experiences of 76 German manufacturing firms. According to this article, the business model component most frequently affected by IIoT is *value proposition*, at the level of customer value in terms of product and process optimization and new solution offers. *Customer relationships* also play a major role, driven by the need to communicate, integrate and engage with final end users (Kiel et al., 2017), who often become integrated in digital ecosystems. Subordinate importance manifests for *distribution channels* and *target customers,* since IIoT does not immediately influence the means by which companies their established customer base, while *revenue model* is not usually adjusted in the short term. Despite not stating at what stage the *partner network* evolves into an ecosystem perspective as Markfort et al. (2022) do, Kiel et al. (2017) agree that IIoT impacts firms' core competencies, activities and resources.

Still, it is crucial to highlight that the extent to which digital transformation impacts corporate activities and drive business model innovation differs from industry to industry and takes time, due to the fact that business models are extremely context-dependent if compared to the technology (Rachinger et al. 2019). Case study from Rachinger et al. (2019), for example, discovered some similarities as well as substantial differences when exploring the situation in the media industry compared to the automotive industry, concluding that the influence of digitalization on business models and its innovative potential for process optimization heavily depends on the company's industry. In other words, if it is easy to imagine companies operating in different industries while deploying the same digital technologies in their respective field, it is logical to suppose that the impact of a technology in one industry, may be far greater than in another one. As a consequence, we may suppose that business model innovation may be easier to be triggered by digital technologies in some industries if compared to others, given the context dependency of business models (e.g., the subscription system prevalent in the streaming industry).

We should also consider that the impact of digital transformation on business models depends on company-specific aspects such as existing organisation, infrastructure, interfaces, capabilities and managerial readiness to digitization (Rachinger et al. 2019; Accenture, 2015) as well as on country-specific enabling factors (Accenture 2015).

On one hand, several successful examples of platform-based innovations can be mentioned. Balodi et al. (2021) analysed Rivigo's journey from being a humble Indian logistics vendor to a unicorn in a 5-years timespan. In particular, Rivigo revolutionised the trucking business through the use of technology: Internet-connected trucks (tracked by customers via app) and sensors providing data to coders who map out optimised routes and drivers' pit stops allocation (Balodi et al., 2021).

On the other hand, most firms are still not able to take the most out of digital technologies from an ecosystem perspective. Research from Accenture (2015) shows that most companies are not fully ready to take advantage of the IIoT, mainly due to the lack of the complete spectrum of enabling conditions required to spur the application of digital technologies in the economies of many countries and a diffused sentiment of overconfidence by companies in their readiness for the IIoT. Indeed, 84 percent of the surveyed C-suite decision makers claim that their organizations have the capabilities needed to create new, service-based revenue streams from the IIoT, while 73 percent confess that their companies have not made any concrete progress yet. Only 7 percent have reached a comprehensive strategic understanding, establishing matching investments (Accenture, 2015).

As a matter of fact, we can argue that in many cases companies are far from having a clear understanding of the full potential of the adoption of the IIoT, while most lack the necessary requirements to generate secure revenue streams. The result is the generation of uncertainty over digital transformation.

The primary difficulty towards IIoT adoption being regarded as a technical implementation challenge, in combination with the obstacles of an unclear business plan and insufficient organisational capabilities contribute to the "pilot trap" (McKinsey & Company, 2021a). In particular, in order to derive real business gains from the adoption of digital technologies, the top management team must work in order to create the necessary conditions to enable changes in the processes; this requires the commitment of leadership to ensure that the IIoT shifts from an IT initiative to an organisation-wide effort.

In order for companies to move from acknowledging IIoT's potential to effectively take actions, they need to improve their understanding through early experimentation and collaboration with a wide range of partners (Accenture, 2015).

Due to the numerous complexities, even firms that show a great understanding of the long-term implications of Industry 4.0 struggle to face the emerging challenges alone, which is why business ecosystems are constantly growing and improving (McKinsey & Company, 2021a). In most cases, collaboration with partners having high levels of expertise in specific aspects such as cloud computing, data analytics and others, can be regarded as a competitive advantage. Still, despite constituting an answer to the obvious need for collaboration, ecosystems carry an additional level of complexity to be handled by companies, concerning the integration of business operations, organisation and technology (McKinsey & Company, 2021a).

In the following section, managerial implications and other considerations will be discussed more in depth.

7. Discussion and Implications

Firstly, the technological diffusion of an innovative solution is different from its economic diffusion (Accenture, 2015). Only when the IIoT-related technology combines with several broader social, economic and political enabling factors can a country reach its innovative and productive potential. Accenture (2015) ranks countries according to their "National Absorptive Capacity" (NAC), taking 55 enabling factors into account. Those can be divided into four main categories: the *business commons*, including reliable banking, education and health supplier-networks; *take-off factors* such as R&D levels, presence of high-tech firms and degree of technological skills; *transfer factors* including end-user acceptance, propensity towards organisational change; *self-sustaining innovation dynamo,* when existing levels of entrepreneurialism and the ability to commercialize new ideas get multiplied by the ubiquity of IIoT technologies (Accenture, 2015).

As **Figure 4** shows, Italy had a weak enabling environment as for 2015. Still, it is safe to imagine that after the Covid-19 pandemic things have evolved. For example, we may suppose that the social use of digital technologies as well as the propensity to embrace organisational change may have increased in many countries as a result of the pandemic, which generated major changes in businesses and society at large.

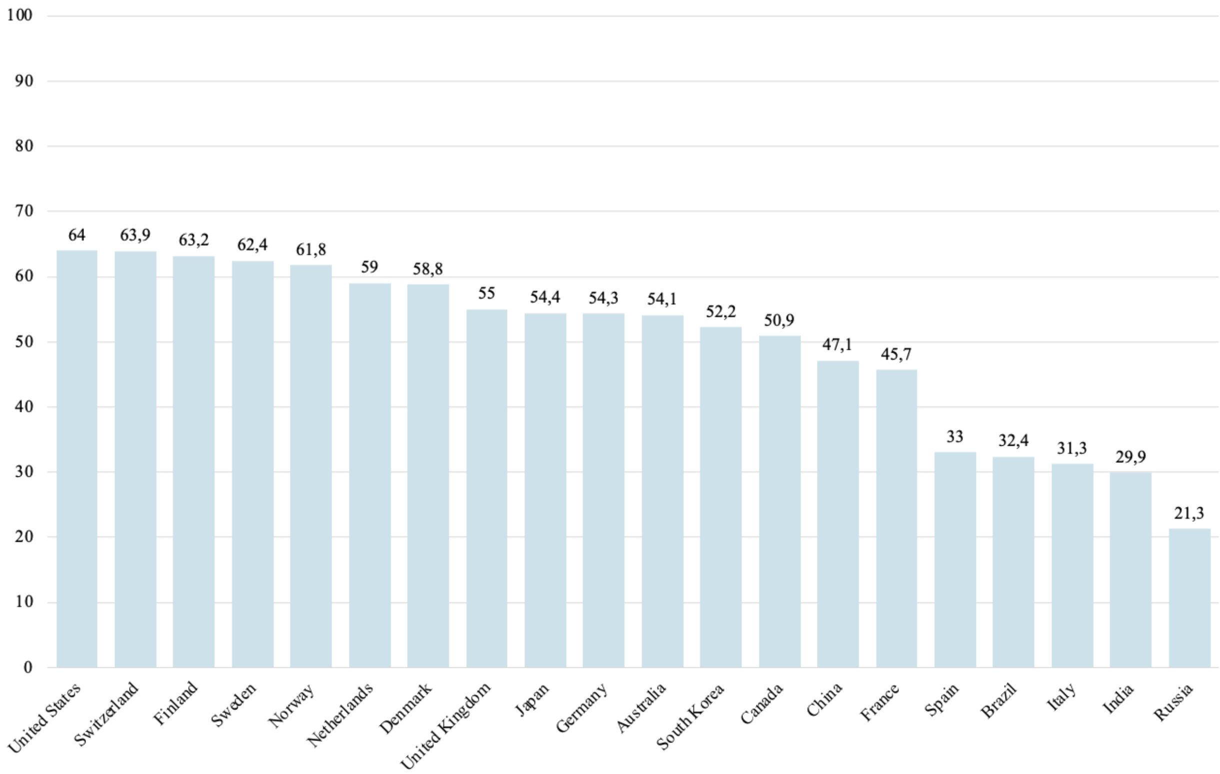

Figure 4: Rankings of countries' Industrial Internet of Things enabling factors (Accenture, 2015).

Secondly, it is interesting to reflect on the role of platform providers in nowadays' business ecosystems. As a consequence, an analysis of potential future trends for Industry 4.0 in markets is worth attention; in this sense, the evolution of the relationships between platform providers and manufacturers will drive future changes in global value chains. Industry platform providers' goal is to help manufacturing companies to reap benefits from data whether through the optimisation of the production or through efficient matchmaking in transactions (Butollo & Schneidemesser, 2022). The capacity of customers to generate increased revenues through platform-based services will determine the success of platform provider companies. Still, by considering the scenario of increased bargaining power based on network effects for industrial platforms, Butollo & Schneidemesser (2022) affirm that oligopolisation eventually might occur, following different trajectories for *production-centred* platforms and *distribution-centred* platforms. According to this study, the former consists of an open ecosystem based on a diverse network of complementors to create cross-side network effects, due to the obstacles to industrial data sharing in the case of same-side network effects; this scenario will generate oligopolisation only in a more mature phase of the platform, with the alternative of a fragmented landscape of specialised platforms. The latter carries higher risks for oligopolisation, due to the abundance of transactions data available for industry platforms, which may foster their match making capacity and constitute a source of information asymmetry towards complementors potentially resulting in the charge of higher transaction fees.

Thirdly, it is important for business leaders to understand what the managerial implications of digital transformation are. Managers should be aware of the three existing patterns (*platform skimming, platform revenue generation* and *platform orchestration*) acknowledged by Markfort et al. (2022). According to their view, companies might start their IoT platform journey by cutting service delivery costs (i.e., *platform skimming* stage), before moving their focus on the elaboration and extension of their offering to develop new revenue streams (i.e., *platform revenue generation*) and finally embrace an ecosystem view, working together with platform partners to propose innovative solution in a value co-creation perspective (i.e., *platform orchestration*). In order for this sequence to generate advancements to companies and their IoT platform-based business models, managers must also be able to recognize triggers and goals (see **Figure 5**) of each pattern while assessing the firm's own strengths and weaknesses by modifying business-model components accordingly (Markfort et al., 2022).

Fourthly, ecosystems represent a major source of industry disruptions and their role's importance will keep on growing (Lyman et al., 2018). Despite this, only a few firms are actually achieving their growth targets within an ecosystem perspective. Hence, what is holding companies back from gaining results as part of an ecosystem? If Markfort et al. (2022) limit ecosystems to the third stage of their proposed sequence (i.e., *platform orchestration*), suggesting the importance of *timing* when deciding to join an ecosystem,

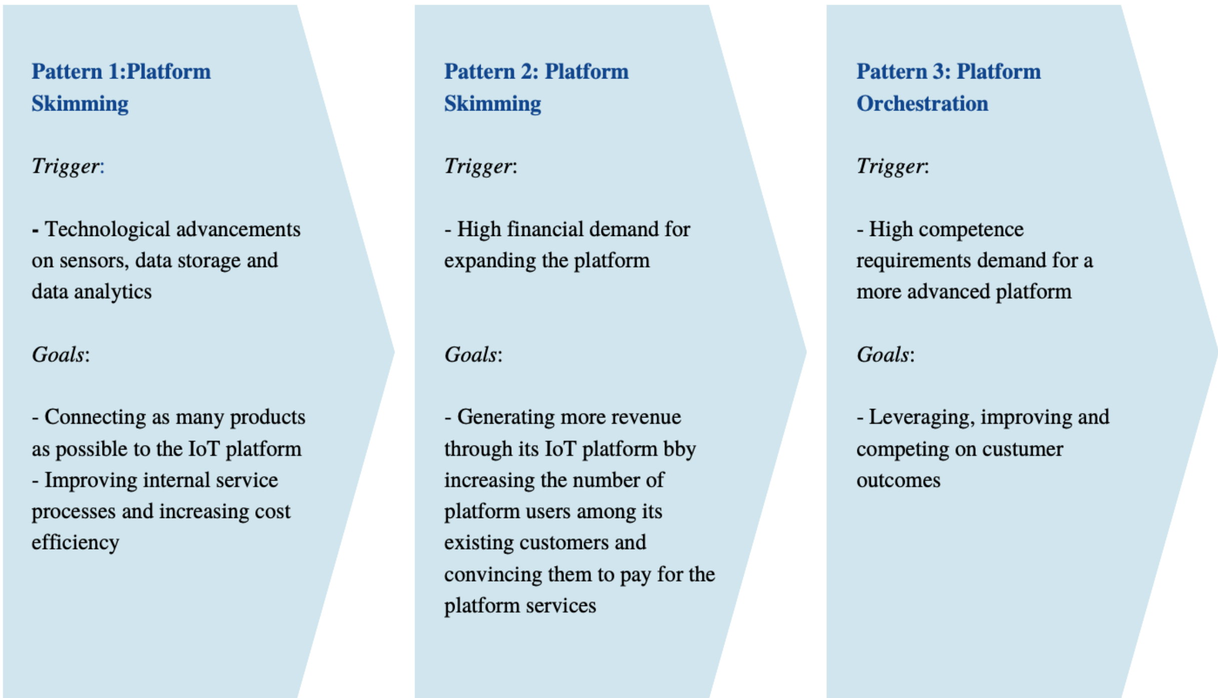

Figure 5: Guideline for advancing IoT platforms (Markfort et al., 2022).

report by Lyman et al. (2018) for Accenture Strategy highlights the fact that executives usually lack *experience* and *capabilities* to design and execute market-leading ecosystems. For this reason, they propose three pillars to help top managers guide the transition towards business ecosystems: *ecosystem strategy*, which requires the adoption of new corporate mindsets and a new allocation of resources, has the potential to foster innovation and revenue growth; *ecosystem business model*, asks firms to measure the effectiveness of relationship management and the business model components; *ecosystem operating model*, based on data and information sharing in order to reduce frictions among ecosystem participants (Lyman et al., 2018).

Lastly, digital transformation generates questions regarding the changing role of the workforce. Given the great amount of complexity introduced by digitalization, one may think that intelligent machines and smart business environments may constitute a threat for labourers. On the contrary, Accenture (2015) claims that the IIoT will make work more engaging and productive by automating mundane tasks and letting workers explore their creativity and collaboration networks. In other words, we will witness a gradual transformation of workers from operators to problem solvers, which has to be paralleled by adequate human resource development activities and training, in order to teach labourers skills tailored to the firm's IIoT-specific needs (Kiel et al. 2017). In this sense, Kiel et al. (2017) also highlight the increasing importance of a corporate culture that emphasises the comprehensive understanding of customers' requirements. This process will eventually blur organizational boundaries and create more flexible business environments focused on the creation of customer-oriented services; more frequent delegation will be required by leadership as well as more decentralised decision making (Accenture, 2015). If it is obviously true that in first place organisational inertia will pose great challenges on organisations, it is also plausible that the presence of executives truly engaged to digital transformation and their people will enable companies to take the most out of this process.

8. Conclusion

Through this study, Industry 4.0 and related phenomena were discussed through a substantial synthesis of the academic literature in the field. In particular, the impact of digital transformation on manufacturing firms was analysed from a business model perspective.

The main promise of digitization applied to the industrial sector is to do more with less (Schneider Electric, 2021). To be more precise, the industrial internet guarantees new possibilities for process rationalization and business model innovation related to the analysis of data in a manufacturing context (Butollo & Schneidemesser, 2022). Potential outcomes include process optimization (e.g., production scheduling, maintenance and quality control), using life-cycle data for product improvement and facilitated match making in business-to-business (B2B) transactions. Moreover, data from the empirical case study proposed in the previous sections, testify substantial savings in capital and operational expenditure as well as gains in terms of speed, sustainability and performance for Schneider Electric's clients deploying ExoStruxure-based solutions.

The adoption of the IIoT is being promoted by the growing affordability and availability of sensors, processors and digital technologies at large, which help facilitate access to and capture of real-time data (Accenture, 2015). Such technologies, applied throughout supply chains make it easier for companies to bring goods to the markets while improving the process's efficiency, ultimately lowering production costs on waste in the long run. On top of that, IIoT driven plants ease regulatory compliance and potentially reduce environmental impacts (Schneider Electric, 2021).

Despite this potential, the adoption of digital technologies in the IIoT perspective is pretty heterogeneous among manufacturing firms. While some companies are already reaping rewards from their early investments, widespread adoption is hampered by major challenges (Accenture, 2015), with many companies ending up trapped in an ongoing "pilot purgatory" (McKinsey & Company, 2021a). As a consequence, it is not safe to generalise conclusions for the whole sector.

Furthermore, interesting managerial implications emerged, highlighting the role that companies' executives will play in guiding the path towards digitalization, as well as the consequences that the workforce will probably have to face.

Additionally, existing academic literature is rather fragmented, while the analysis of real-world business cases is limited, due to the highly innovative nature of the topic. Therefore, further research is needed before reaching a more organic systemisation of the phenomena related to Industry 4.0 and digital technologies.

In conclusion, digital transformation and the emergence of platform-based business models are undeniable trends, destined to shape the future of the business world and to create great opportunities and challenges for companies.

9. References

Accenture. (2015). *Winning with the Industrial Internet of Things: How to accelerate the journey to productivity and growth*. https://www.accenture.com/t20160909T042713Z__w__/us-en/_acnmedia/Accenture/Conversion-

Assets/DotCom/Documents/Global/PDF/Dualpub_11/Accenture-Industrial-Internet-of-Things-Positioning-Paper-Report-2015.pdfla=en

Agostini, L. & Filippini, R. (2019). Organizational and managerial challenges in the path toward Industry 4.0. *European Journal of Innovation Management*, *22*(3), 406-421. https://doi.org/10.1108/EJIM-02-2018-0030

Agostini, L. & Nosella A. (2021). Industry 4.0 and business models: a bibliometric literature review. *Business Process Management Journal,* *27*(5), 1633-1655. https://doi.org/10.1108/BPMJ-03-2021-0133

Balodi, K. C., Jain, R. & Das, R. (2021). Strategy, business model, and innovation at Rivigo: Is Relay-as-a-Service the way forward? *Journal of Information Technology Teaching Cases, 12* (1), 55-64. *https://doi.org/10.1177/2043886920986163*

Butollo, F. & Schneidemesser, L. (2022). Who runs the show in digitalized manufacturing? Data, digital platforms and the restructuring of global value chains. *Global Networks,* 1-20. *https://doi.org/10.1111/glob.12366*

Cusumano, M. (2010). Technology strategy and management: The evolution of platform thinking. *Communications of the ACM,* *53*(1), 32. https://doi.org/10.1145/1629175.1629189

Elkington, J. (2000). Cannibals With Forks: The Triple Bottom Line of 21st Century Business. *Journal of Business Ethics,* *23*(2), 229–231. https://doi.org/10.1023/A:1006129603978

Eloranta, V. & Turunen, T. (2016). Platforms in service-driven manufacturing: Leveraging complexity by connecting, sharing, and integrating. *Industrial marketing Management, 55*(4), 178-186. https://doi.org/10.1016/j.indmarman.2015.10.003

Frank, A.G., Dalenogare, L.S & Ayala, N.F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics, 210*(4), 15-26. https://doi.org/10.1016/j.ijpe.2019.01.004

Frank, A.G., Mendes, G.H.S., Ayala, N.F. & Ghezzi, A. (2019). Servitization and Industry 4.0 convergence in the digital transformation of product firms: A business model innovation perspective. *Technological Forecasting and Social Change, 141(*4), 341-351. https://doi.org/10.1016/j.techfore.2019.01.014

Gawer, A. (2014). Bridging differing perspectives on technological platforms: Toward an integrative framework. *Research Policy,* *43*(7), 1239-1249. https://doi.org/10.1016/j.respol.2014.03.006

Gawer, A., & Cusumano, M.A. (2014). Industry platforms and ecosystem innovation. *Journal of Product Innovation Management, 31*(3), 417-433. https://doi.org/10.1111/jpim.12105

Hanelt, A., Bohnsack, R., Marz, D. & Antunes Marante, C. (2020). A Systematic Review of the Literature on Digital Transformation: Insights and Implications for Strategy and Organizational Change. *Journal of Management Studies, 58*(5), 1159-1197. https://doi.org/10.1111/joms.12639

Ibarra, D., Ganzarain, J. & Igartua, J.I. (2018). Business model innovation through Industry 4.0: A review. *Procedia Manufacturing, 22*(8), 4-10. https://doi.org/10.1016/j.promfg.2018.03.002

Kiel, D., Arnold, C. & Voigt, K. (2017). The influence of the Industrial Internet of Things on business models of established manufacturing companies – A business level perspective. *Technovation, 68,* 4-19. https://doi.org/10.1016/j.technovation.2017.09.003

Kohtamäki, M., Parida, V., Oghazi, P., Gebauer, H., & Baines, T. (2019). Digital servitization business models in ecosystems: A theory of the firm. *Journal of Business Research, 104*, 380-392. https://doi.org/10.1016/j.jbusres.2019.06.027

Lee, J., Bagheri, B. & Kao, H.A. (2015). A cyber-physical systems architecture for Industry 4.0-based manufacturing systems, *Manufacturing Letters*, *3*(1), 18-23. https://doi.org/10.1016/j.mfglet.2014.12.001

Lyman, M., Ref, R. & Wright, O. (2018). *Cornerstone of future growth: Ecosystems.* Accenture Strategy. https://www.accenture.com/_acnmedia/pdf-77/accenture-strategy-ecosystems-exec-summary-may2018-pov.pdf

Markfort, L., Arzt, A., Kögler, P., Jung, S., Gebauer, H., Haugk, S., Leyh, C. and Wortmann, F. (2022). Patterns of business model innovation for advancing IoT platforms. *Journal of Service Management, 33*(1), 70-96. https://doi.org/10.1108/JOSM-11-2020-0429

McKinsey & Company. (2018). *Winning in digital ecosystems.* *https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/mckinsey-digital-insights/digital-mckinsey-insights-number-3*

McKinsey & Company. (2021a). *Leveraging Industrial IoT and advanced technologies for digital transformation: How to align business, organization, and technology to capture value at scale.* https://www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/a%20manufacturers%20guide%20to%20generating%20value%2

0at%20scale%20with%20iiot/leveraging-industrial-iot-and-advanced-technologies-for-digital-transformation.pdf

McKinsey & Company. (2021b). *The Internet of Things: Catching up to an accelerating opportunity.* *https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/iot-value-set-to-accelerate-through-2030-where-and-how-to-capture-it#*

Pirvan, C., Dedehayir, O. & Lefever, H. (2019). Industry Platforms as Facilitators of Disruptive IoT Innovations. *Journal of Technology Management & Innovation, 14*(3), 18-28. http://dx.doi.org/10.4067/S0718-27242019000300018

Porter, M.E. & Heppelmann, J.E. (2015). How smart, connected products are transforming companies. *Harvard Business Review*, 93(10), 96-114.

Rachinger, M., Rauter, R., Müller, C., Vorraber, W. & Schirgi, E. (2019). Digitalization and its influence on business model innovation, *Journal of Manufacturing Technology Management, 30*(8), 1143-1160. https://doi.org/10.1108/JMTM-01-2018-0020

Sanders, A., Elangeswaran, C. & Wulfsberg, J. (2016). Industry 4.0 implies lean manufacturing: research activities in Industry 4.0 function as enablers for lean manufacturing. *Journal of Industrial Engineering and Management, 9*(3), 811-833. http://dx.doi.org/10.3926/jiem.1940

Schneider Electric. (2020). *5 ways to grow your startup in a digital ecosystem. https://www.se.com/ww/en/download/document/Ecosystem_eguide09-10-19AR0_EN/*

Schneider Electric. (2021). *Global Digital Transformation Benefits Report. https://www.se.com/ww/en/download/document/998-20387771_DTBR/*

Schneider Electric. (2022a). Company Profile – History. Retrieved May 16, 2022, from https://www.se.com/ww/en/about-us/company-profile/history/schneider-electric-history.jsp

Schneider Electric. (2022b). EcoStruxure Platform. Retrieved May 20, 2022, from https://www.se.com/ww/en/work/campaign/innovation/platform.jsp

Simonsson, J., Magnusson, M. & Johanson, A. (2020). Organizing the Development of Digital Product- Service Platforms. *Technology Innovation Management Review, 10*(3), 36-47. http://doi.org/10.22215/timreview/1335

Sorri, K., Mustafee, N. & Seppänen, M. (2022). Revisiting IoT definitions: A framework towards comprehensive use. *Technological Forecasting and Social Change, 179*(6), Article 121623. https://doi.org/10.1016/j.techfore.2022.121623

U.S. Green Building Council. (2022). *LEED rating system.* Retrieved May 19, 2022, from https://www.usgbc.org/leed

Warner, K.S.R. & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, *52*(3), 326-349. https://doi.org/10.1016/j.lrp.2018.12.001

World Economic Forum & Accenture. (2018, May). *Digital Transformation Initiative: Maximizing the Return on Digital Investments* (120418). http://reports.weforum.org/digital-transformation/files/2018/05/201805-DTI-Maximizing-the-Return-on-Digital-Investments.pdf

Zott, C., Amit, R. & Massa, L. (2011). The business model: recent developments and future research. *Journal of Management*, *37*(4), 1019-1042. https://doi.org/10.1177/0149206311406265