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Administrative Sciences

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Suggested Citation: Calabrese, Mario; La Sala, Antonio; Fuller, Ryan Patrick; Laudando, Antonio (2021) : Digital platform ecosystems for sustainable innovation: Toward a new meta-organizational model?, Administrative Sciences, ISSN 2076-3387, MDPI, Basel, Vol. 11, Iss. 4, pp. 1-14, <https://doi.org/10.3390/admsci11040119>

This Version is available at:

<https://hdl.handle.net/10419/275237>

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Article

Digital Platform Ecosystems for Sustainable Innovation: Toward a New Meta-Organizational Model?

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Abstract: This work aims to develop a conceptual model to support countries, institutions, and firms toward the accomplishment of present Agenda 2030 sustainability goals. The last two decades have seen a growing interest in sustainability. Climate change, resource scarcity, multipolarity of interests, mistrust and delegitimization of institutions are just some of the critical issues that need to be addressed. There is broad consensus on the urgency of generating further social, environmental, and economic innovation to address these challenges, reshaping global markets, and offering new spaces of action to firms and institutions. Accordingly, there also is a wide search for new models of organizing firms. Digital platforms are among those. Moreover, since digital platforms require coordination among multiple actors and interests in order to succeed, they may also be conceptualized as meta-organizations, less hierarchical than firms yet more tightly coupled than markets. However, despite the wide literature on platforms, this organizational lens seems not to have been taken into the right consideration. This conceptual work aims to fill this gap, providing a framework that clarifies why and how a digital platform ecosystem could configure a sustainable meta-organizational model, and also providing the main steps to build it.

Keywords: digital platform ecosystem; organizational model; sustainable innovation



Citation: Calabrese, Mario, Antonio La Sala, Ryan Patrick Fuller, and Antonio Laudando. 2021. Digital Platform Ecosystems for Sustainable Innovation: Toward a New Meta-Organizational Model? *Administrative Sciences* 11: 119. <https://doi.org/10.3390/admsci11040119>

Received: 14 August 2021

Accepted: 11 October 2021

Published: 20 October 2021

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1. Introduction

The purpose of this paper is to develop a model focused on accomplishing the sustainability goals of countries, institutions and firms through digital platform ecosystems. In particular, the research aims to identify digital platform ecosystems as meta-organizational models that can enable all social actors to channel their efforts toward achieving the higher sustainability goals. Sustainability was defined as meeting the present needs without compromising future generations' abilities to meet their own (United Nations 1987). On the same line, sustainable development involves three dimensions: the environmental (responsible use of resources), the economic (ability to generate income and employment), and the social (security, health, justice, and wealth) (Elkington 1997; Dempsey et al. 2011). Furthermore, the European Union (EU), in the 2030 Agenda, underlines the challenges that nations, organizations, and individuals need to overcome to achieve the Sustainable Development Goals (United Nations 2015; Colglazier 2015; Köhler et al. 2019). Indeed, a broad consensus exists on the urgency of innovating to meet these challenges (EC 2009, 2010; OECD 2010, 2011a, 2011b, 2012). The social and managerial literature has shown that the joint action of the paired "innovation-business model" has often successfully effectively solved issues posed by sustainability (Porter and Kramer 2011; Schaltegger et al. 2016a, 2016b; Abdelkafi and Täuscher 2016; Schneider and Clauß 2020). In fact, competitiveness relies on the capability to create new, sustainable markets built around innovation (Wever et al. 2010; Montalvo et al. 2011; Boons et al. 2013).

In this line, digital platform ecosystems configure a new model that is able to combine different functionalities, technologies, actors, interests and aims, expanding already existing markets and creating new ones (Greenfield 2017; Busch et al. 2021).

The main design feature of a digital platform ecosystem is the coexistence of central and complementary components, which are modular and interdependent among each other, and are held together by a shared rules and a comprehensive value proposition. Accordingly, to succeed, digital platforms require coordination among multiple actors and interests that are not necessarily aligned. Thus, digital platforms may also be conceptualized as meta-organizations—less formal and less hierarchical than firms, yet more coupled than traditional markets (Kretschmer et al. 2020). However, given the relevance of this issue, the extant literature seems not to take this perspective into consideration, and also lacks a framework that clarifies why and how a (sustainable) digital platform ecosystem could be configured as a sustainable meta-organizational model. In this direction, the paper offers steps to build a sustainable digital platform ecosystem and stresses its meta-organizational nature (McIntyre et al. 2020), i.e., that of a “population of developers, complementors and others, as partners co-create value with the platform owner by developing applications and solutions to be used on the platform” (Adner 2017; Jacobides Michael and Gawer 2018; Ozalp et al. 2018; Ciulli et al. 2019; Kolk and Ciulli 2020; Hein et al. 2020).

This paper has a conceptual nature and is articulated as follows. After Section 1, which introduces the main dimensions involved in the analysis, Section 2 provides a short methodological note to give better evidence of the steps we followed in this research. Section 3 presents a literature review oriented towards investigating digital platform ecosystems as business models and their link with the concept of sustainable innovation. Section 4 addresses the link between the business-oriented and the organizational-oriented nature of digital platform ecosystems, also providing a conceptual framework that illustrates the steps to build a sustainable digital platform ecosystem. Finally, Section 5 discusses theoretical and managerial implications and includes some concluding remarks.

2. Methodological Note

This work has a conceptual nature, and the proposed model is not derived from empirical data collection but from the integration of previously developed concepts and theories (Hirschheim 2008; Fulmer 2012; Gilson and Goldberg 2015). The research is based on a rigorous literature review that made it possible to develop insights to be tested in future empirical research studies (Jaakkola 2020). The literature review has a clear goal: starting from a consolidated base to create new knowledge by building on carefully selected sources and expanding, organizing, or offering a new or alternative explanation of digital platform ecosystems as a meta-organizational model (Fulmer 2012). In this direction and with this aim, scientific papers and books, dealing with the following topics, were collected and analyzed: (a) digital platforms; (b) sustainable innovation; (c) sustainable business models; and (d) sustainable organizational models. In particular, the research was conducted on Web of Science, Scopus, Google Scholar and EBSCO, recalling the following keywords: *sustainable innovation AND business models; sustainable innovation AND organizational models; digital platforms AND sustainability; digital platforms AND business model OR organizational model*. Nevertheless, it was decided not to carry out a systematic literature review to maintain freedom in terms of the selection of works and literature streams (Petticrew and Roberts 2008). Therefore, this work is strictly conceptual as it drew on ideas, streams of literature, theories and perspectives of analysis that were taken together to develop the final conceptual framework (Lukka and Vinnari 2014).

3. Literature Review

3.1. The Rise of a New Business Model: The Digital Platform Ecosystem

This section focuses on the framing of a new emerging business model, i.e., the digital platform ecosystem, on its building blocks and on the population of actors that co-create value through it.

A business model articulates the logic, the data, and other evidence that supports a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value (Teece 2010).

Digital technologies' hybridization has led to a new business model dominating the market: the digital platform ecosystem (Teece 2016; Parker et al. 2017; Parker and Van Alstyne 2018; McIntyre et al. 2020). Digital platforms are defined as the set of products, services, or digital technologies developed by one or more companies that form a technological base on which other companies can develop complementary products, services, and digital technologies, generating potential network effects (Evans 2003; Eisenmann et al. 2011; Gawer and Cusumano 2013; Tsujimoto et al. 2018; Barile Sergio and Simone 2019). The 'Big Five' (or FAMGA: Facebook, Apple, Microsoft, Google, and Amazon) represents the most eloquent example of digital platforms. They consist of a digital structure that allows individuals and organizations to innovate or interact in ways that are not otherwise possible (Van Dijck et al. 2018; Cusumano et al. 2019; Kapoor et al. 2021). The managerial literature links the term digital platform to the term ecosystem in reference to the population of actors that co-create value with the platform owner (Ozalp et al. 2018; Jacobides Michael and Gawer 2018). Digital platform ecosystems have been studied under systemic and structural dimensions. From a *systemic* dimension, it is possible to identify four categories of actors characterizing the digital platform ecosystem: *the platform sponsor*, *the platform provider*, *complementors (supply-side)* and *users (demand-side)* (Parker and Van Alstyne 2012; Cusumano et al. 2019; McIntyre et al. 2020; Calabrese et al. 2020) (Figure 1).

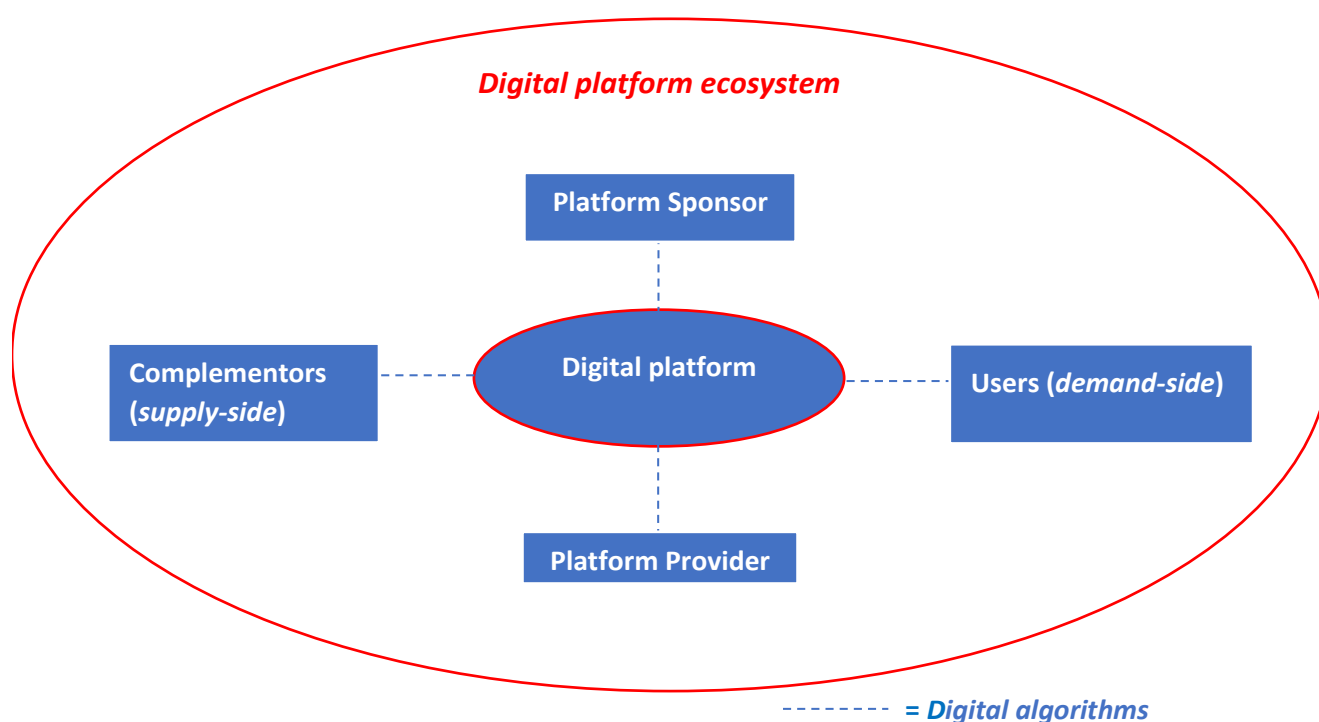


Figure 1. The digital platform ecosystem. Source: Authors' elaboration.

The *platform sponsor* (the role played by one or more companies, called platform leaders) is the general designer and the owner of the intellectual property rights of digital platform ecosystems. Sponsors establish digital platforms' components, rules, and architecture (Gawer and Cusumano 2002). For example, Apple is the platform sponsor of the well-known Apple platform. *Users (demand-side)* are the consumers (individuals or companies) of the services offered by the digital platform ecosystem. *Users (supply-side)* are content and application developers. They provide the specific items that attract consumers to the digital platform (e.g., music, games, information, etc.). WhatsApp Inc., Deliveroo,

Uber and Car2go are only a few cases of the items provided by Apple iOS Developers. Finally, the *platform provider* is the contact point for all the users of the digital platform ecosystem. In most cases, the role of the *platform provider* is played by the *platform sponsor*. For instance, Apple is the owner of the Apple platform and, at the same time, provides the iOS operating system. This strategic choice protects a specific platform's core technologies. As shown in Figure 1, digital platform ecosystems can create value through complementary innovations and/or their ability to quickly connect the market's sides (Yablonsky 2018; Gawer 2020; Panico and Cennamo 2020; Calabrese et al. 2020). In particular, the actors adhering to digital platform ecosystems interact and co-create value through several digital algorithms (Van Dijck et al. 2018; Jovanovic et al. 2021).

In fact, from a structural perspective, the platform sponsor designs digital platforms' algorithms with consideration of four crucial aspects: *shared standards*, *rules of participation*, the *degree of openness*, and *direct and indirect network effects*. The first crucial element is *shared standards* that provide clarity for how digital platforms' components interact. The second crucial element is *rules of participation* that make digital platform ecosystems work. The third crucial element is the *degree of openness* that implies several decisions: how much core technology to share with the complementors, which actors (both complementors and users) can participate in the digital platform (and how), and the degree of compatibility of the innovation platform with the technology of other complementary and substitutive digital platforms. Finally, the *network effect* dynamics implies that every additional user makes the platform more valuable to every other user on the same side (same-side network effects) or the other side (cross-side network effects) (Tiwana 2013; Castells 2011).

Concerning digital platform's aim, it is possible to identify three different digital platforms: *transaction platforms*, *innovation platforms*, and *hybrid platforms* (Cusumano et al. 2019; Gawer 2020). *Transaction platforms* facilitate interactions and transactions within the market side. Typical examples of transaction platforms are Twitter, Uber, Airbnb, Amazon Marketplace, Alibaba and LinkedIn that facilitate the buying and selling of existing goods and services or facilitate other interactions, enabling users to create and share information and content. Conversely, *innovation platforms* facilitate innovations by acting as technological foundations upon which complementors can develop new complementary innovations. For example, Xiaomi Miui, Apple iOS, Google Android, Nintendo, Sony PlayStation and Amazon Web Services consist of technological building blocks upon which it is possible to create new complementary innovations (Gawer 2020; Cusumano and Frishammar 2021). Instead, *hybrid platforms* combine transaction and innovation functions (Gawer 2020). A consistent example of a hybrid platform is Amazon, which incorporates the transaction function with the marketplace and innovation function and with the web services.

3.2. Sustainable Innovation

Underlying sustainable innovation is an ecosystem in which the relationships between the economy, society, and the environment are continuous, and collaboration assumes a strategic role. This section provides a theoretical background on sustainable innovation, particularly focusing on the relevance of collaboration and sharing processes in "sustainable" value creation.

Although, in the last decade, the term sustainable innovation has been widely used, the number of definitions in the literature is limited. Carrillo-Hermosilla et al. (2010)—in the systematic review they conducted and subsequently referred to by Cillo et al. (2019)—listed definitions of innovation that focus on ecological sustainability, eco-innovation, and environmental innovation, introducing their eco-innovation's definition as "innovation that improves environmental performance" (Carrillo-Hermosilla et al. 2010, p. 1075).

The European Commission (EC) also moved in this direction, defining eco-innovation as "the production, assimilation or exploitation of an innovation in products, production processes, services or management and business methods that aims to prevent or substantially reduce environmental risk, pollution and other potential negative impacts from the use of resources (including energy)" (EC 2008, p. 10) (EC 2008). Interestingly, the EC related

eco-innovation to sustainability the year before, stating that eco-innovation is any kind of innovation that contributes to significant and demonstrable progress toward sustainable development, through the reduction in impacts on the environment or the achievement of more efficient and responsible use of natural resources, including energy (EC 2007).

Thus, based on what has emerged from the European debate and the definition provided by Carrillo-Hermosilla et al. (2010), sustainable innovation can be described as an innovation that increases sustainability performance in its ecological, social, and economic dimensions. However, as these dimensions—that are constructivist and cultural in nature—are changeable over time and space, sustainable innovation has distinctive meanings in different contexts (e.g., the distinction among developed, emerging and Base-of-the-Pyramid economies discussed in Hart and Milstein 1999; Prahalad and Hart 2002; Prahalad 2005; Seelos and Mair 2005, 2007; Tukker et al. 2008; Yunus et al. 2010). However, sustainable development innovations must go beyond incremental adjustments and require the transformation of much larger parts of production or consumption systems (Boons 2009; Boons and Wagner 2009). Incremental innovations—be they product or process innovations (Arrow 1962; Henderson and Clark 1990; Rogers 1998)—can, in fact, only lead to subsequent improvements in sustainability performance, but not to a true system reconfiguration (Afuah 1998; Larson 2000; Truffer 2003; Kirschten 2005; Tukker and Tischner 2006; Frenken et al. 2007; Schaltegger and Wagner 2011; Wagner 2012). Indeed, the concept of sustainable innovation takes on different meanings depending on the level of analysis: organizational, inter-organizational, or societal (Boons et al. 2013; Boons and Lüdeke-Freund 2013; Mahajan 2010).

At the organizational level, the focus is on the individual enterprise and its innovative capabilities. In this case, the literature focuses on the capacity of an individual structure to develop green technologies and how this capacity is linked to the other business functions (e.g., marketing or production) for the development of an effective value proposition. Although there are many contributions that provide tools for this (Jaffe and Palmer 1997; Brunnermeier and Cohen 2003; Montalvo 2008), understanding of the actual process remains limited (Visser et al. 2008). Much more often, organizations are treated as black boxes (Arimura et al. 2007; Taleb 2010, 2012, 2018).

At the inter-organizational level, however, the factors that condition a firm's innovativeness and their interactions are better understood (Weber and Hemmelskamp 2005; Kemp and Volpi 2008; Saint-Jean 2008; Seuring and Müller 2008). A relevant strand in this direction aims to identify inter-organizational network nodes involved in the generation of innovation (Hekkert et al. 2007; Lupova-Henry and Dotti 2019). Inter-organizational studies, therefore, focus on the relevance of relationships with other actors in the governance of the sustainable innovation process (Doganova and Eyquem-Renault 2009; Bolton and Hannon 2016).

Studies at the societal level draw an even wider boundary, aiming to understand transitions (Smith et al. 2010) or paradigm jumps (Kuhn 1962). There is a growing number of studies that trace social change back to technological change (Geels 2005; West 2017). Such studies focus on framing the value that brings actors together around a technology, existing or new (Genus and Coles 2008; Bartumeus et al. 2019). In this direction, Hall and Clark (2003) highlight a crucial aspect: without a real creation and diffusion of the value produced in the social fabric, the same process of sustainable innovation cannot succeed.

A further condition for the realization and dissemination of sustainable innovations, therefore, is the possibility that their effects unfold within the wider socio-economic context (Latour 2020). In other words, a systemic, architectural, and radical nature of sustainable innovation emerges, referring, above all, to the ways in which the groups of components that realize innovation are interconnected (Davies and Brady 2000; Hall and Vredenburg 2003; Elzen et al. 2004; Grin et al. 2010). Thus, the concept of sustainable innovation moves beyond the one of eco-innovation because it integrates social aims and is more clearly associated with sustainable development. The following definition captures its essence (Charter et al. 2008; Charter and Clark 2007): sustainable innovation is a process in which

sustainability (environmental, social, and economic) is integrated into social and business systems, from idea generation to implementation. This applies to products, services, and technologies, as well as to new organizational and business models. Thus, it is not a linear or mechanical process, but an ecosystem formed by continuous interactions between the economy, society, and the environment (Malerba 2002; Hsieh et al. 2017), an ecosystem of actors and relationships in which collaboration assumes an indispensable strategic role (Foxon and Pearson 2008; Smorodinskaya et al. 2017; Godin and Gaglio 2019).

Radicality, systematicity, and the architectural dimension, on the other hand, constitute important barriers for companies wishing to implement a business model centered on sustainable innovation. Such firms, therefore, will have to aim at aligning their motivational drives with the relevant actors and supra-systems (Barnard 1968; Barile 2009). Looking at sustainable innovation through the lens of the business model, in this sense, could shed light on how to address this challenge.

3.3. *Merging Business Model and Sustainable Innovation*

This section focuses on the crucial link between business models and sustainable innovation, showing how platforms bind together on multiple levels, not solely technological and organizational leverages, but also—in addressing sustainability—the needs of the socio-economic actors and communities involved.

The concept of business model emphasizes that, to be successful, a firm must align its resources, competencies, and capabilities with its contexts and goals (Zott and Amit 2010; Teece 2010, 2016). These elements include the value proposition, the configuration of resources for value creation (e.g., including how a firm builds links with suppliers and customers), and a distribution model for the created value that highlights how value and incurred effort are distributed among actors in the socio-economic system (Boons and Lüdeke-Freund 2013). The concept of the business model became popular in the 1990s, largely due to the rise of enterprises-in-network that seemed to challenge existing business logic by providing ‘free’ services to customers through platforms for market exchanges between users and providers (Ludbrook et al. 2019). Such business models were linked to sustainable innovation and sustainable development in two different ways. First, as Boons and Lüdeke-Freund (2013) point out, the need to change existing business models was linked to the concept of natural capitalism (Hawken et al. 1999) and the mechanism of creative destruction of existing businesses for the purpose of sustainability (Schumpeter 1934; Hart and Milstein 1999). Second, the emergence of new business models has been instrumental in sustaining the so-called product-to-service switch (Tukker and Tischner 2006; Okkonen and Suhonen 2010; Kley et al. 2011). Therefore, business models have the potential to explain the relationship between sustainable innovation and business strategies while emphasizing two relevant issues: the technological issue and the organizational issue.

Regarding technology, according to Wells (2008), a business model can be analyzed to explore and understand the socio-economic logics that revolve around the satisfaction of specific needs through specific technological artefacts that connect suppliers and customers through economic exchange relationships. In other words, the business model mediates the ways in which technological artefacts are made, the artefacts themselves and their end use, and also influences the perception of these technologies by other primary stakeholders such as customers, regulators, and competitors (Cillo et al. 2019).

Regarding organization, Birkin et al. (2009a, 2009b) and Stubbs and Cocklin (2008) frame the emergence and the development of new business models as the expression of organizational and cultural changes that integrate sustainable development needs and aspirations by employing them as a vector for ecological modernization (United Nations 1987; United Nations 2015). Therefore, such change is about implementing alternative paradigms that differ from the neoclassical worldview, shape culture, structure and routines of organizations, and reorient business toward sustainable development (Foxon and Pearson 2008; Van Geenhuizen and Ye 2014).

Thus, a sustainable business model is the result of technological and organizational synergies oriented toward new ways of creating and distributing value. In this direction, the concept of the business model emphasizes three vital aspects for sustainable innovation (Foxon and Pearson 2008; Smorodinskaya et al. 2017; Wu et al. 2017):

- (a) The value proposition makes it clear that the company–customer relationship is not created around a given product/service, but rather via exchange of the value created. For the purpose of sustainability, this has the benefit of striving toward a balance of economic, social, and ecological value.
- (b) The value creation configuration points directly to the wider system within which the company technically and socially participate. It makes it clear that the company's activities are integrated, basic parts of a larger system;
- (c) The distribution of costs incurred and benefits obtained indicates the need for real synergies and an even balancing of the interests of all actors and communities involved (Bartumeus et al. 2019).

This implies that platforms are able to bind together (on several levels of analysis) not only technological and organizational leverages but also the aims and needs of the different socio-economic actors and communities involved, with a view towards sustainability.

4. Discussion

Digital Platform Ecosystems: Meta-Organizational Models Spreading Sustainable Innovation

Digital platform ecosystems are revolutionizing market logic, affecting international competitive dynamics and the evolution of several technological trajectories. They exploit technology to connect people, organizations, and resources within an interactive ecosystem that can constantly reproduce itself. These reproductive capacities allow digital platform ecosystems to reproduce themselves, entering and creating new markets (Simone et al. 2020). In essence, digital platform ecosystems can combine very different functionalities and technologies, expanding and hegemonizing new markets (Greenfield 2017; Calabrese et al. 2020). Digital platform ecosystems are reshaping industrial and organizational boundaries (Busch et al. 2021).

In this direction, as seen, the main design feature of a digital platform ecosystem is the coexistence of central and complementary components, both modular and interdependent, held together by a shared set of rules and by a comprehensive value proposition. Accordingly, platforms may be conceptualized as meta-organizations, which are less formal and less hierarchical than firms, and yet more coupled than markets. To succeed, platforms require coordination among multiple actors and interests that are not necessarily aligned. In this line, sustainability can act as driver of convergence and a digital platform may be built around it.

Thus, a digital platform ecosystem oriented toward sustainability may be conceived as a sustainable meta-organizational model (Mattila et al. 2020; Kretschmer et al. 2020) that integrates innovative, hybrid technologies to market issues and sustainable development motives. A clear example of this dynamic could be found in the integration between green and blue technologies. Green technologies are defined as “techniques and technologies capable of reducing environmental damage through processes and materials that generate fewer potentially damaging substances, recover such substances from emissions prior to discharge, or utilize and recycle production residues” (United Nations 1997, p. 30). Green technologies make possible the joint management of environmental challenges with the aim of value creation (OECD 2009, 2011). On the other hand, blue technologies may be defined as the bundle of emerging digital technologies that have disruptive (but still virtuous) effects on the social, environmental, and economic fabric, opening new spaces of possibilities and opportunities (Schumpeter 1934; Floridi 2020). Therefore, the green/blue binomial enables the coordination and care of the social fabric, combining the green economy of environmental capitalism with the blue economy of digital capitalism, and thus, giving rise to new models of coordination and new mechanisms of governance (Floridi 2020). The hybridization of these technologies enables the achievement of the

ambitious goal of developing sustainable and innovative solutions. The combination of green and blue can radically improve how firms and societies innovate, produce, and consume products and services. Blue technologies can become the best ally of green technologies and nature. In everyday reality, we find several examples where blue and green technologies converge in the design of sustainable solutions. Modern cities are moving toward sustainable management models thanks to this combination. A striking case is electric mobility. An electric scooter clearly constitutes a green technology. In cities, these technologies are connected to blue technologies, i.e., a scooter sharing app to access the service. Thus, digital platforms could clearly be a model through which green and blue technologies can integrate, converging towards sustainability.

After demonstrating why a digital platform ecosystem could be conceived as a meta-organizational model oriented towards sustainability, the rest of this section aims to shed light on the design of a *sustainable digital platform ecosystem*, also stressing the importance of two key factors: the *platform sponsor* and *digital algorithms*. In particular, *digital algorithms* characterize different moments of *digital platform ecosystems*: (a) data collection and filtering, carried out through algorithms that record, process, and filter—in real-time—the activities of each user and the information coming from external markets; (b) the sharing of information, knowledge, and technologies: the members of the *digital platform ecosystem* adopt the algorithmic language to communicate and share information, knowledge, and technologies with each other; (c) the hybridization of technologies: *digital platform ecosystem* exploit the algorithmic language to make distant technologies merge and engage in dialogue. In fact, because the different technologies “communicate” with each other through the algorithmic language (Greenfield 2017), the *digital platform ecosystem* can make its technology communicate and merge with other technologies.

The establishment of a *sustainable digital platform ecosystem* revolves around four essential steps (Cusumano et al. 2019):

- **Step 1—Identification of market sides:** In this step, the *platform sponsor* must identify how to connect the opposite market sides (*supply* and *demand-side*) using the platform’s digital algorithms (Van Dijck et al. 2018). Digital algorithms solve problems and make decisions based on three types of instructions provided by the same *platform sponsor*. The first instruction that the platform sponsor must provide to the algorithms relates to the search for green technology developers and users. For example, Apple pays special attention in the selection of different developers of green solutions such as *Too Good to go*, *Ecosia*, and *Recycle Coach*. Secondly, the sponsor must indicate, to digital algorithms, the imperative to search for green users (*demand-side*), i.e., customers who consistently buy environmentally friendly products and are actively interested in environmental problems and their solutions (Banytė et al. 2010). Finally, the platform sponsor must indicate how to connect the two market sides to the digital algorithms.
- **Step 2—Solve cause–effect problems** by determining how to attract an increasing number of *users (demand-side)* and *complementors* to the digital platform and generate network effects. In fact, a *digital platform* cannot attract *complementors* if there are *no users (demand-side)* on it, and at the same time, *users (demand-side)* will not use it if there is not a sufficient variety of services offered. The *platform sponsor* must incentivize access to the digital platform to *users (demand-side)*, *complementors*, or both simultaneously. The general principle is to attract users (*supply* and *demand-side*) through innovative technologies that are complementary to new green technologies. In the case of Apple iOS, Apple developed a platform that can be combined with green complementary innovation. These attract both green developers and green users to the platform. Basically, the platform sponsor must shape the digital algorithms of the platform to fit with the green technologies.
- **Step 3—Design the organizational model** based on a collaborative governance model in which all actors communicate through the platform’s digital algorithms (Van Dijck et al. 2018) and the decision-making moment is shared among all actors. In essence, *sustainable digital platform ecosystems* must be designed so that all actors participate

in decision-making and sustainable innovation processes (Ansell and Gash 2008; Esposito De Falco et al. 2017). For example, *We Don't Have Time Climate Change* is an iOS app that shows which actions may be taken to protect the environment and helps in the sharing of those actions with other climate activists.

- **Step 4—Establish and enforce rules of conduct:** the *platform sponsor* must establish and communicate the rules attached to joining the digital platform to ecosystem actors. In terms of sustainability, the respecting of the 2030 Agenda is one of the most important pillars. For example, Apple's rules revolve around three pillars: climate change, resources, and smarter chemistry (Apple 2020). In this direction, the platform sponsor must define how digital algorithms must carry out the controls regarding the respect of rules and impose sanctions for non-compliant behaviour. Thus, digital algorithms exercise control based on elementary and clear instructions provided by the *platform sponsor*. The more stringent the instructions provided to digital algorithms by the *platform sponsor*, the less freedom of decision and discretion is given to the individual actors of the ecosystem. In essence, the *platform sponsor* establishes the degree of decision-making decentralization and assumes a function of direction and control of the digital platform ecosystem (Gawer and Cusumano 2002; Gawer 2011, 2014; Eisenmann et al. 2011; Cusumano et al. 2019).

Following these four steps, the platform sponsor could create a sustainable ecosystem characterized by peer-to-peer procedures through which actors sustainably co-create value (Simone et al. 2017; Barile et al. 2017).

As separate as they may seem, green and blue technologies can merge because the systems involved all speak the same algorithmic language. In this way, these technologies can merge into powerful, hybrid ideas (Greenfield 2017), creating a *sustainable digital platform ecosystem*.

5. Implications and Conclusions

Even if the digital platform ecosystem phenomenon is under the spotlight of managerial studies, no frameworks clarify why and how a sustainable digital platform ecosystem could be understood as a sustainable meta-organizational model. This conceptual work takes an initial step in this direction. Firstly, it sheds light on the link between the business-oriented and organizational-oriented nature of digital platform ecosystems. The research shows that platforms may be conceptualized as meta-organizations, less hierarchical than firms and more coupled than markets. Secondly, the paper provides a conceptual framework that illustrates the steps required to build a sustainable digital platform ecosystem. It is shown that designing a collaborative platform governance model contributes to the emergence of the sustainable digital platform ecosystem. Although it provides a theoretical model, the paper also indicates the path a platform sponsor needs to follow to implement it. In particular, encouraging green complementors and green users to join the digital platform ecosystem is a crucial strategy. The incentive mechanism can involve only one side of the market (the green complementor or the green users) or both sides (both the green complementors and the green users). The above discussion leads to theoretical and managerial implications.

Regarding the theoretical point, digital platform ecosystems are reshaping industrial and organizational boundaries. Consolidated models (strategic, organizational, regulatory, and cognitive) no longer have the previous descriptive depth; thus, it is necessary to identify new units of analysis. Moreover, concepts taken from industrial organization and strategic management (e.g., the market) are becoming less effective in terms of obtaining holistic comprehension of platform dynamics (Busch et al. 2021). Ecosystems seem to be a better unit of analysis. These conceptualizations also shed light on the necessity of observing digital platform ecosystems as a meta-organizational model.

Concerning managerial implications, the strategic steps to build a sustainable digital platform ecosystem represent valid support in the platform sponsor decision making processes.

Following these four steps, the platform sponsor could create a sustainable ecosystem characterized by peer-to-peer procedures through which actors sustainably co-create value. As specified, the limitation of this study is due to its conceptual nature. However, the platform sponsor can easily adopt the proposed model by establishing an incentive mechanism to encourage green users and complementors to join the digital platform ecosystem. Future research will be oriented toward the investigation of this motivational mechanism.

Author Contributions: Conceptualization, M.C., A.L.S., R.P.F. and A.L.; Writing—original draft, A.L.S. and A.L.; Writing—review & editing, M.C., A.L.S., R.P.F. and A.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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