DOCTORAL THESIS

Knowledge Biases in Supplier-Based Innovation Ecosystems

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In an ever-changing and complex world, the sharing and dissemination of knowledge have become pillars of its evolution. While knowledge resides in organisations, fields of study, research, technological platforms, tools, tasks, and so on, it primarily lives in the minds of the people who are responsible for its appropriate use, transfer, and enjoyment. This is why knowledge reflects the culture and values of both a person and a society. These premises have guided me during this research and in the preparation of this thesis.

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ACRONYMS

B2B	business-to-business
B2C	business-to-consumer
B2G	business-to-government
BMI	business model innovation
CAGR	compound annual growth rate
EU	European Union
EV	electric vehicle
IATA	International Air Transport Association
ICE	internal combustion engine
IVD	in vitro diagnostics
KPI	key performance indicator
LCV	light commercial vehicle
OEM	original equipment manufacturer
R&D	research and development
RT PCR	reverse transcription polymerase chain reaction
SBMI	sustainable business model innovation
WHO	World Health Organization

ABSTRACT

While research into digital platform-based innovation ecosystems is generally accelerating, research into modular innovation ecosystems that are supplier-based/manufacturing-centred remains in its infancy. These modular innovation ecosystems have wide-ranging, practical applications and new frameworks to explore—alongside new challenges—and present a fascinating area of study. Deeper technological changes, emerging sociocultural trends, and crises such as the COVID-19 pandemic are disrupting the global, complex, linear, and contractually governed supply chains from which these ecosystems have emerged, causing unprecedented technological and business model transformations. These changes are driving new dynamics of competition, which is no longer limited to a zero-sum game in which all competitors compete for a market of a given size; rather, the focus is on how each of these competing ecosystems can meet the emerging, overlapping new customer base and social needs. Within the study of these ecosystems, knowledge gaps are rising due to their growing context-dependency and the shortcomings of conventional approaches to supply chains that remain spatially and virtually confined. The research gap regarding mechanisms for value creation is, thus, particularly salient in these supplier-based ecosystems.

This thesis seeks to determine the drivers and obstacles to the emergence and creation of opportunities for the cross-fertilisation of interdisciplinary knowledge insights within and across the boundaries of these multilayered ecosystems. To do so, it uses a detailed inductive and exploratory multiple-comparative case study of the global clinical diagnostics, luxury fashion, and EV ecosystems, identifying different types of knowledge bias that hinder knowledge flows. The thesis concludes that these ecosystems share different types of knowledge bias related to a low understanding of the complex new codes of consumption; this has led to unclear value proposition, emerging trade-offs within these ecosystems' different competitive contexts and sociocultural environments, and rising opportunities related to concurrent and potential new combinations of modules, complementarities, and technological disruptions, adoptions, and adaptations. At the same time, knowledge from distant actors in these ecosystems is increasingly omitted, influenced by the rising risks associated with the growing knowledge asymmetries. These asymmetries are due to increased demand for high-intensity generation in these ecosystems; the effects of growing power and role imbalances among ecosystem participants that are breaking founded and subtle equilibriums of cooperation and competition; the effects of knowledge familiarity, self-referential technologies, and product and service architecture that continue to influence these ecosystems' dominant designs and business models; and the growing effect of time dependence on both internal and external interdependencies of these innovation ecosystems.

This thesis also highlights causes of these knowledge biases, such as these ecosystems' strong organisation- and supply-centric approach, their greater dependence on specialised but longer supply chains, the growing diversity of organisational behaviours, low organisational ambidexterity, and a soft service-dominant logic or lack of new elastic co-alignment structures and digital platforms at different levels (or 'units') of analysis at both the spatial and non-spatial levels. It also discusses the absence of a complete new blueprint requiring a conductor to sustain the power of vision and maintain cohesion by coordinating 'the mélange of disparate sounds and timbre' from each community of specialised participants and supply chains that form these ecosystems. Finally, the thesis proposes a new framework for these ecosystems.

CHAPTER 1. INTRODUCTION

Both the term and emerging research field of 'business ecosystem' have firmly established themselves as innovation management buzzwords due to their attractiveness and ability to describe a fresh, new approach to the current complex, adaptive business environments (Peltoniemi & Vuori, 2004). Many innovation academics and managers alike, afraid of missing out on this trend, feel compelled to come up with their own contributions and ideas—or at least to be involved in one of these large emerging ecosystems and their theories. However, they sometimes struggle with the broad conceptual scope of 'business ecosystem', unclear definitions, and a lack of practical advice on how this concept can be deployed in the real world because it has been adopted by such a wide variety of scholarly perspectives, with varied phenomenological and conceptual emphases within an extensive and growing body of literature (Thomas & Autio, 2020). While several rigorous conceptual pieces of research exist—such as the studies of Adner (2017), Jacobides et al. (2018), Shipilov and Gawer (2019), and Thomas and Autio (2020)—there remains some distance to cover for the ecosystem literature to reach theoretical maturity (Thomas & Autio, 2020).

Until recently, the dynamics of technological, social, and sustainable progress were predominantly modelled and constrained using linear, rigid, and isolated models of innovation. However, thanks to economic globalisation, to truly disruptive technological, scientific, and communications innovations, to the rise of consumerism—and to the diverse social and economic transformations that these imply—more complex and multilayered frameworks have now begun to emerge. These new structures and schemes emphasise the interactive, dynamic, and open nature of innovation, a nature that gives prominence to networks of communities and specialised actors and their interactions, relationships, and coevolution. Technological and social revolutions create new premises for competitive advantage and, for this reason, firms increasingly compete on an ecosystem basis rather than as individual entities (Almirall et al., 2014). This interactive, iterative new model of innovation embodies the new innovation ecosystems and sheds light on how firms are increasingly interdependent in their businesses and innovation activities (Ritala et al., 2013). At the same time, the coevolution of these innovation ecosystems means more and more firms and communities of participants can rapidly achieve business success (Adner & Kapoor, 2010; Rubens et al., 2011). However, this business and innovation success might be temporary since these companies and networks may rapidly lose momentum and since other firms and competing ecosystems can take over their leading position due to the constant emergence of new challenges and opportunities in today's ever-changing, complex, and connected business environments. These transformations are driving a range of enormous changes—in audiences and their needs, business models, outputs and their complementarities, technological adoptions and adaptations, and the supply chain—that entail the emergence of new business visions and values, participants, interdependencies, co-alignment structures, organisational structures, and forms of governance and coordination.

In supplier-based innovation ecosystems, companies do not simply produce products but also provide services and (above all) solutions that can add value to stakeholders such as clients, owners, suppliers, sources, environments, and consumers or end users (Brem & Schuster, 2012). Within this new paradigm of innovation management, companies in supplier-based innovation ecosystems must change their focus not only at the strategic level regarding the allocation of new opportunities, objectives, resources, competencies, policies, and goals (Adner, 2017), but also regarding a growing service-dominant logic at the ecosystem level (Matthies et al., 2016). An ecosystem is a community of co-specialised actors who are often organised around physical and digital platforms, within which actors interact to co-create mutual benefits (i.e., value or knowledge). These actors co-opt advances in innovation platforms and infrastructure to boost the range, variety, intensity, and flexibility of their interactions and their collective ability to enhance co-creation (Autio & Thomas, 2019). Within this

type of ecosystem, innovation and learning in relationships with other actors is increasingly driving value creation (Leal-Rodriguez, 2019).

In this context, innovation ecosystems play an important role in the economy and society, and a crucial research gap has emerged in those supplier-based/manufacturing-centred ecosystems. The growing knowledge gaps are a result of the conventional approach to the complex, linear, and spatially and virtually confined supply chains from which this type of ecosystem has emerged being adapted to these new scenarios and paradigms. These ecosystems are now at a crucial point in their evolution, facing a new and compelling governance challenge: They are destined to shift from the contractually and centrally based governance of supplier relationships to a new governance and coordination model in which not all inputs and resources should be centrally and contractually governed to enhance serendipity and generativity (Autio & Thomas, 2019; Jacobides et al., 2018). In these ecosystems, suppliers, actors such as original equipment manufacturers (OEMs), manufacturing firms, distributors, and service providers need more autonomy, and new open relationships and collaborations should be allowed to emerge.

An additional challenge is that unlike reprogrammable digital assets (such as the digital technologies and infrastructure of digital platform-based ecosystems), the physical assets of the three ecosystems studied here tend to be asset-specific and cannot be easily reassigned to an alternative use without non-trivial modification or significant loss of value (Autio & Thomas, 2019). While research into digital platform-based innovation ecosystems in general is accelerating, research into modular innovation ecosystems that are supplier-centred remains in its infancy and presents a fascinating area of study with wide-ranging practical applications and new frameworks to explore within their new challenges. To deal with the aforementioned research gap, existing literature provides some conceptual and case-based understanding of how innovation ecosystems are built and managed/orchestrated (e.g., Ritala et al., 2012; Ding et al., 2019; Vlaisavljevic et al., 2020). However, the literature still lacks systematic evidence on how leading firms within these supplier-centred modular innovation ecosystems can facilitate both value and knowledge capture and creation within their ecosystems. Little research exists on the mechanisms that focal actors and innovation platforms employ to orchestrate the relatively self-contained, self-adjusting processes of value co-creation and innovation. It is crucial to understand these mechanisms since the majority of economic and social actors that are connected by shared institutional and value chain logic and by mutual value creation through service exchange are loosely coupled (Lusch & Nambisan, 2015; Lusch & Vargo, 2014).

The discussion of value creation and value capture must be expanded to the context of innovation ecosystems and the actor relationships therein (Holgersson et al., 2018). Hence, there is a research gap regarding the mechanisms for joint value creation in these innovation ecosystems (Bogers et al., 2019). In the ecosystems studied in this thesis, joint innovation with suppliers particularly affects firm results (Nylund et al., 2020). Integrating suppliers into the development of new products and business models benefits both innovation generation and subsequent financial performance (Ağan et al., 2018). Scholars increasingly argue for suppliers' importance in firm innovation but the specific mechanisms that foment or hinder such supplier participation have not yet been addressed (Liliani et al., 2020; Nylund et al., 2020). Thus, the research gap regarding mechanisms for value creation is particularly salient in supplier-based ecosystems.

To narrow this research gap, this study seeks to determine the drivers and obstacles to the emergence and creation of opportunities for the cross-fertilisation of interdisciplinary insights across these supplier-based innovation ecosystems. To do so, I analyse three cases of supplier-based/manufacturing-centred ecosystems from three industries in order to inductively identify drivers that accelerate innovation processes. In relation to these drivers, I identify biases that lead to

innovation hyperopia, which is related to the concept of marketing myopia (Levitt, 1960) and is defined here as the omission of knowledge from distant actors in an innovation ecosystem. This ecosystem disorder constrains the ability of actors to achieve a clear, deep, and immediate understanding of complex problems, challenges, or situations that are about to emerge in that ecosystem. I find that the drivers of ecosystem interaction are blurred by ecosystem participants' perceptions of their environment, hence amplifying the value gap and generating a blind spot in an ecosystem (Thaler, 2015). These blurred perceptions also inhibit the gathering of new insights, especially in terms of intuitively comprehending those crucial and emerging relationships within this type of innovation ecosystem. Finding and understanding the specific innovation hyperopia and knowledge biases in a supplier-based innovation ecosystem allows ecosystem participants to capture potential opportunities, resources, and competencies—and thus, improve their value co-creation and co-alignment processes (Edelman et al., 2005). In this thesis, I discuss the findings in relation to lead or focal users' perceptions and preferences of multiple innovation attributes (von Hippel, 1986).

This thesis is organised as follows: It begins with the theoretical background, leading to the formation of the conceptual framework. Next, it addresses research methods and data collection for the multiple case study of three ecosystems, which is followed by an in-depth presentation and analysis of each of the cases: the global clinical diagnostics ecosystem, the luxury fashion ecosystem, and the electric vehicle (EV) ecosystem. Then, the thesis discusses and compares the case study findings before providing main conclusions and implications in the final chapter.

CHAPTER 2. THEORETICAL BACKGROUND

In 1993, Moore introduced the notion of an 'ecosystem' within the strategic and innovation management literature. From this perspective, a firm is viewed not as a member of a single industry but as part of a business ecosystem that embraces a variety of firms, industries, and supply chains that work together 'cooperatively and competitively' (Moore, 1993). Within the new approach to strategic decision-making, all specific framing of a business ecosystem's value proposition is context-dependent since proper assessment and interpretation rely on changing situations, firm backgrounds, or business environments. To understand how firms should direct change in ever-evolving, complex, and connected business environments and contexts, Moore and subsequent scholars began to apply the notion of the biological ecosystem to its business counterpart in terms of self-organisation, coevolution, emergence, and adaptation within path-dependent, chaotic, and random processes (Iansiti & Levien, 2004; Peltoniemi & Vuori, 2004).

Currently, a wide proliferation of literature exists on this approach, and numerous perspectives have applied this new framework. It has been fundamental during my examination of this concept and framework using multiple research perspectives and units of analysis; because they are complementary, I have been able to see the broader picture, better determine the root causes of the stated problem within this exploratory study, and discover solutions that account for the needs of the diverse actors involved in this complex framework. This multilayered, multidisciplinary, and multidimensional approach is necessary due to the elasticity of the new ecosystem framework and its different units or levels of analysis (Thomas & Autio, 2020; Pickett & Cadenasso, 2002).

Several key approaches exist on how to view a business ecosystem. The first perspective of a business ecosystem focuses on firms as individual participants. Within this perspective, each firm sees the ecosystem as the environment that it must monitor and react to, as it affects their customers and supplies, their dynamic capabilities, and thus, their ability to build a sustainable competitive advantage (Teece, 2007; Adner, 2017). The second perspective sees the ecosystem as a dynamic community of co-specialised, independent but interdependent organisational collectives (e.g., firms, institutions, public administrations, agencies, and individuals) that are constantly rethinking and redesigning their interactions to enhance value creation, capture, and delivery (Iansiti & Levien, 2004; Thomas & Autio, 2020). Within this approach, individual members' performance is tied to the ecosystem's overall performance and its networks of participants and communities (Jacobides et al., 2018). Adner (2017) expanded this approach and introduced the notion of ecosystem-as-affiliation, which considers ecosystems to be affiliations of business networks that are characterised by many loosely interconnected participants that depend on each other for their mutual effectiveness and survival (Iansiti & Levien, 2004). This perspective emphasises the breakdown and dissolution of all traditional industry boundaries, such as spatial and virtual confinements, as well as the emergence of new participants and specialisations, the rise of different types of interdependencies (e.g., cognitive, technological, economic), and the potential for symbiotic relationships in productive ecosystems (Adner, 2017, Jacobides et al., 2018).

A variant of the ecosystems-as-affiliations perspective treats ecosystems as affordance platforms that enable (re)combinative innovations and enhance the generation of new innovative inputs by large and uncoordinated business networks (Autio & Thomas, 2019). For example, value creation in digital platform ecosystems is ultimately enabled by a digital platform, which acts as a shared connectivity interface that provides digital affordances opened up by specific digital infrastructures (Majchrzak & Markus, 2013; Nambisan et al., 2017). A second variant of ecosystems-as-affiliations states that in an ecosystem, organisations can also be affiliated with a focal firm that defines and controls the overarching ecosystem blueprint, persuades others to contribute accordingly, and leads all innovation blueprints (Adner & Kapoor, 2010; Hannah & Eisenhardt, 2018). Within

this perspective, value creation depends on this focal firm's ability to orchestrate ecosystem offerings and synchronise all participants (Autio & Thomas, 2019). For this approach to affiliation, each participant's position and competitiveness is derived from its links, leading to different characterisations, such as digital platforms, focal firms, brokers, or hub-and-spoke networks (Adner, 2017). This approach considers the crucial individual role that each participant has in both value co-creation and knowledge transfer. For this reason, it is a priority to understand that these actors may have different perspectives and perceptions on value-proposition framing and business model adaptation (Snihur et al., 2018).

Any analysis of ecosystems—and particularly, those with exploratory settings regarding knowledge transfer processes, such as this study—must account not only for divergence in participants' interests (e.g., traditional notions of competition and value capture). They must also consider divergence in their perspectives (e.g., fresh expectations on value creation and value distribution to third parties) and divergence in their perceptions of the other actors and of their relationships or environment changes and disruptions (e.g., the different flows of knowledge and information within and across the ecosystem boundaries) (Adner, 2017). Within this affiliation approach, ecosystems' strategic construct starts with the actors—usually defined by their ties to a focal actor—and then considers their links and divergences, and ends with all possible value propositions. By contrast, the structuralist strategic construct of ecosystems begins with the value proposition framing, then considers the activities required for its materialisation, and ends with the actors that must be selected and aligned (Adner, 2017). Regardless of the analytical construct used, a key consideration is that ecosystems cannot be entirely planned and designed since they are also emerging. This adaptability of ecosystems is actually one of their major strengths.

A diverging view of ecosystems focuses on the outputs, focal value propositions, or focal innovations that must materialise in each ecosystem, as well as the sets of components/modules and complementarities that conform and support them. Within this perspective, the nature of ecosystems—and of their structures and processes—facilitates the collective generation of ecosystem outputs (Thomas & Autio, 2020). This perspective features the supply-side emphasis on value co-production of ecosystems, and the outputs that ecosystems co-generate can be products, services, business models, or knowledge. Some authors have classified ecosystems based on the type of output they co-generate; for example, in 'knowledge ecosystems', participants interact so that there is 'collaborative exploration of new knowledge as central activity and output' (Järvi et al., 2018). In modular innovation ecosystems, delivered products, services, and complementarities are compatible with one another, adhering to a modular product architecture that allows the user to assemble a customised composition of modules and complementarities to suit individual preferences (Thomas & Autio, 2020).

A different approach to ecosystems focuses on a structuralist approach to conceptualising the ecosystems construct. From this perspective, some ecosystems evolve around a co-alignment structure, a set of shared product and service technological compatibility standards and procedures that feature architectural interfaces and allow for the customised composition of modules and complementarities to suit individual preferences (Thomas & Autio, 2020; Adner, 2017). These co-alignment structures, procedures, and protocols can be developed by employing different types of architecture and constructs depending on the main typology of interdependencies that they must support and emphasise (e.g., technological, cognitive, economic) and that characterise each type of ecosystem (Thomas & Autio, 2020). For example, innovation ecosystems that feature strong technological and technical interdependencies often employ technological architecture and platforms as their co-alignment structure (Wareham et al., 2014), while other types (e.g., entrepreneurial and knowledge ecosystems) may emphasise economic or cognitive co-alignment structures (Autio &

Thomas, 2018; Järvi et al., 2018) since they rely on strong cognitive and economic interdependencies. In this approach, participants' links are derived from the alignment requirements that lead to positions in the overall value blueprint (Adner, 2017). These co-alignment structures might reflect power relationships within the ecosystem and its stratification (Gulati et al., 2012), assign ecosystem participants specific roles that are not necessarily defined by formal contracts, or reflect different forms of governance, coordination, and communication protocols. These aspects clearly affect the knowledge transfer processes within ecosystems and they must be clearly understood (Gawer & Phillips, 2013).

Finally, another perspective is to view the ecosystem as 'the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution' (Adner, 2006; Thomas & Autio, 2020). This approach highlights ecosystems' commercial approach and emphasises users' roles within the co-creation of value propositions and outputs, as users acquire and use the end products and offerings rather than the firms that create them. Within this perspective, firms must identify what drives user value to ensure participants develop a coherent, user-customisable offering at the ecosystem level (Jacobides et al., 2018; Thomas & Autio, 2020). These roles include identifying and understanding all aspects related to end users' profiles, needs, education, knowledge, problems, expected benefits, perceptions, expectations, requirements, and so on that are crucial to evaluate within all innovation processes. For example, and within this view of ecosystems as systems of consumption, the market conditions of innovation ecosystems are determined by user choice and the instrumental utility of the offered value propositions (Autio & Thomas, 2019). The new service-dominant logic approach fully aligns with this user-centric view of ecosystems since it states that the customer should have the triggering role of a value creator rather than merely that of a resource integrator (Autio & Thomas, 2020; Vargo et al., 2008).

At the same time, the literature on innovation ecosystems relies on the knowledge-based view of the firm (Spender, 1996; Nonaka & Takeuchi, 1995; Penrose, 1959), which emphasises that the organisation's two predominant goals are generating and applying knowledge (Bratianu & Orzea, 2010). Interorganisational knowledge flows that are purposively used to accelerate innovation are known as open innovation (Chesbrough, 2003). While open innovation is often related to open-source software development (West & O'Mahony, 2008), it also includes many other types of collaboration, such as alliances for the purpose of learning or co-creation (Chesbrough, 2006). Scholars have introduced complementary views of such value co-creation and value capture, including in relation to open innovation (Chesbrough & Appleyard, 2007), strategic management (Adner, 2017; Jacobides et al., 2018; Thomas et al., 2014), and service-dominant logic (Barrett et al., 2015; Lusch & Nambisan, 2015). Chesbrough and Appleyard (2007) define the need to capture value in order to sustain continued participation in and support for the initiatives of value co-creation, writing that to pursue innovation, organisations must implement a strategy that balances value capture and value creation instead of losing sight of value capture during the pursuit of innovation. Hannah and Eisenhardt (2018) establish that to create value, interdependent firms must cooperate and then, to capture value, subsequently compete. Jacobides et al. (2006) note the importance of generating advantageous industry architecture to increase value capture or appropriation without requiring vertical and horizontal integration and diversification. For these reasons, scholars have developed the concepts of knowledge co-specialisation (Jacobides et al., 2006) and the coordination and governance of co-productive activities of value production (Adner, 2017; Dattée et al., 2018) that define an ecosystem as a co-alignment structure with an underlying platform device of a multilateral set of partners that must interact for a focal value proposition to materialise (Adner, 2017).

The value offering of my studied modular innovation ecosystems targets a defined audience to the extent that market choice is relevant to their survival (Thomas & Autio, 2020; Baldwin & Clark, 2000). This type of ecosystem involves a multilateral set of partners that must interact for a focal value proposition to materialise, with a set of shared technological compatibility standards as a co-alignment mechanism and structure (Adner, 2017; Thomas & Autio, 2020; Jacobides et al., 2018; Thomas et al., 2014; Yoo et al., 2012). These ecosystems represent an evolution of industries that were based on rigid, vertical supply chains and then grew and expanded due to globalisation. Compared to other types of ecosystems, they have a narrow purview since they consist of the focal firms and those immediately adjacent complementors and suppliers; the customer is represented in the abstract through their adoption and/or acceptance of the ecosystem output, which would not be viable if it did not meet their specific needs (Thomas & Autio, 2020).

At the same time, supplier-based ecosystems are defined as linear and sequential value chains that integrate consecutive activities of value creation (Adner & Kapoor, 2016; Jacobides et al., 2018). This implies a perspective on value creation that is centred on supply and production, with the end user's role generally relegated to that of a more or less passive recipient buying the system-level orchestrated offering (Autio & Thomas, 2019). In the 1980s and 1990s, research analysed suppliers, manufacturing firms, service providers, and distributors' relationships and interactions under the notion of supply chain management; supply chain management was defined as the coordination, integration, and planification of all business processes that span the spectrum of different flows of products, components, money, and information from the raw materials extractors to the end user to provide product (Mentzer et al., 2001; Cooper et al., 1997). In the intervening decades, and due to globalisation and global free trade, companies have been under constant pressure to optimise their supply chains to provide complex product and service solutions for customers around the globe even as they have struggled to achieve supply chain integration. This conventional approach is based on finding the best suppliers, wherever they are located, to cut costs and improve the efficiency of supply chain processes. To achieve this, firms developed and implemented strategies such as the lean production, just-in-time manufacturing, single-source suppliers, and global outsourcing from low-cost countries (Viswanadham & Kameshwaran, 2013; Ketchen et al., 2014).

By doing so, companies have significantly dispersed their supply sources from confined areas to long supply chains that often span the globe. At the same time, this new construct has resulted in emergence of a strong supply-and-production-centric perspective to value creation within these chains, with the end user increasingly becoming a passive recipient buying the system-level orchestrated offering (Autio & Thomas, 2019). The unanticipated consequence of this approach has been increased supply chain complexity, with rising interdependencies (e.g., economic, technological) among these firms that are characterised by a lack of visibility and an increased risk of disruption in a wider, diverse, and changing context. An emerging requirement is interorganisational coordination of risks within the management of these supply chains, although no appropriate governing structures are in place for monitoring and controlling the globally dispersed manufacturing and service networks during normal or abnormal times (Viswanadham & Samvedi, 2013; Ketchen et al., 2014).

This complexity has brought a compelling new challenge for supply chain participants to sustain the balance between their self-interest and the required interdependencies within these long supply chains (Wang & Ran, 2018), and it demands a redesign of the supply chains' governance (Richey et al., 2010). Modern supply chains are not simply linear chains or processes. They are complex networks: Products and information flows travel within and between nodes in a variety of elongated, interconnected, multilayered networks that link organisations, regulators, service providers, customers, industries, economies, and even competing ecosystems with profound

interdependencies—which can no longer be described adequately using the linear concept of a 'chain' (Millar, 2015). Within these new supply chains, firm boundaries become less important since they must be more porous and permeable and since coordination across the value chain needs to become much more fluid.

Within this evolving, competitive business environment, the current theory of supply chains cannot provide a fresh, up-to-date method for supply chain managers or academics to overcome the shortcomings of using this conventional approach to deal with those complex supply chains. Scholars have proposed models of governance and frameworks for these new supply chains. For example, Wang and Ran (2018) propose a sustainable collaborative governance framework that is based on adaptive decision-making and action mechanisms throughout the supply chain life cycle that would enable the entire supply chain to respond to uncertainties or perturbations proactively and resiliently without undergoing significant changes to firms' normal operations. According to Richey et al. (2010), firms within a supply chain can compensate using their internal focus, individualism, and competitive leadership while they are excelling and understanding their interdependencies with other participants. To do so in a supply chain context, the firms must reduce their barriers to integration and/or increase those facilitators of integration by being open to being aligned, communicative, jointly structured, quantified on supply chain metrics, and open to developing new and emerging interdependencies with new partners (Richey et al., 2010).

Another perspective is the ecosystem approach to supply chains, which focuses on tightening and integrating supply chains and highlights supplier autonomy while acknowledging the buying company's leadership. In this new framework, organisations must develop dynamic capabilities to effectively work not just with multiple partners in their own ecosystem (Teece, 2018) but also with the same partners playing multiple roles across other competing or collaborative ecosystems (Millar, 2015; Ketchen et al., 2014). Furthermore, other frameworks focus on different co-alignment structures and architecture, such as Dalmolen et al.'s (2015) finding that the enterprise connectivity interface would enable different types of interorganisational collaborations and more agile business networks to increase the efficiency/effectiveness of scarce resources in an emerging scenario in which IT and business collaboration are intertwined. It would also add a new functionality for an ecosystem of organisations that are willing to collaborate—namely, orchestration of the ecosystem—since it would allow ecosystem partners to share data, scale assets up or down as needed, collaborate internally and externally, speed decision-making, and so on (Dalmolen et al., 2015). This new digitised supply chain could also create opportunities for entirely new revenue models since it would allow these supply chains to shift from product-centric to service-centric business models. Within the growing complexity and volatility of supplier-based/manufacturing-centred ecosystems, all participants must simultaneously and synchronously address, direct, and balance value creation and value capture while emphasising the end user as one of the main co-creative participants in this value creation process (Autio & Thomas, 2019).

Value capture is a consequence of value creation and knowledge capture, a method to appropriate and protect value generated by the firms. Organisations in supplier-based ecosystems that wish to cope dynamically with the changing environment must be able to continuously create, transmit, and absorb new knowledge better and more quickly than their competitors (Gore & Gore, 1999; Tang et al., 2020). A firm becomes a focal firm in an ecosystem if it defines, orchestrates, and controls an overarching blueprint for that ecosystem, thus leading value co-creation and persuading the remaining actors to contribute accordingly and synchronously (Hannah & Eisenhardt, 2018; Autio & Thomas, 2019). Knowledge creation processes depend on the context of the ecosystem (e.g., social, cultural, technological) and on the stimulating conditions within that ecosystem's organisations (e.g., leadership, culture, learning). Thus, knowledge is also contextual—that is,

created and captured in a specific context, with meaning relevant to that specific context (Jakubik, 2008). According to the knowledge-based view, the 'tacitness' of system-specific knowledge determines the use of knowledge transfer mechanisms, and several generic knowledge attributes measure the latent construct of 'tacitness', such as codifiability, teachability, and complexity. These attributes are the extent to which knowledge can be transferred through specific attributes such as encoding, training, demonstration, and participation (Winter, 1987; Zander & Kogut, 1995).

Interfirm business networks in a variety of forms (such as strategic alliances, open innovation platforms, and industry clusters) have become increasingly important in helping firms improve their competitive positions through enhanced access to knowledge, innovation, and resources otherwise not directly available to them (Yin et al., 2020; Tang et al., 2020). I analyse the knowledge and value exchange and transfer processes as a combination of knowledge management systems that enhances functionality by combining a substantial proportion of information and communication tools (Maier, 2007) and open innovation platforms, each with its own inputs and outputs (Chesbrough, 2006). In the supply chains that cross the studied ecosystems, different open innovation platforms act as hubs connecting the supply chains. These platforms involve an interchange of inputs and outputs with other platforms, and they can be highly specialised because they can combine inputs from different specialised supply chains. However, the 'new normal' of supply chain complexity and volatility creates a new challenge for participants, which is to leverage their partners for economies of scale, economies of scope, and combined sustainable competitive advantage whilst protecting organisational assets such as human capital, tribal specialised knowledge, and proprietary customer intelligence (Millar, 2015; Ketchen et al., 2014).

An important ongoing debate concerns the optimal structure for knowledge diffusion in networked firms, as in supplier-centred ecosystems. Two approaches exist to enhancing knowledge creation: The first is based on clustering and localising innovation ecosystems due to the underlying assumption that knowledge transmission and recombination are easier among agents of a geographically localised area, where industrial research and development (R&D) and a knowledgeable workforce abound (Tang et al., 2020; Lai et al., 2014). However, recent research shows clustering may be too great or too dense in an innovation ecosystem (Capaldo, 2007; Lai et al., 2014; Zhang et al., 2017). The second perspective is based more on informal processes of knowledge transfer and anchored on random participant networks of knowledge diffusion within an innovation ecosystem, with a more realistic knowledge trade rule used to develop new partnerships across the borders of the spatially localised clusters in order to obtain more efficient knowledge diffusion in innovation ecosystems (Tang et al., 2020). This approach is based on methods such as technical cooperation forums, entrepreneur salons, firm associations, and industry forums of technological consulting (Tang et al., 2020; Zhang et al., 2017). However, the current debate focuses more on finding the appropriate knowledge transfer conditions by implementing the optimal combination of gift trade, barter trade, and the collective good that truly drives these participant interactions and collaborations (Tang et al., 2020).

CHAPTER 3. RESEARCH METHODOLOGY

Within this study, I seek to answer the research question through a detailed inductive multiple-comparative case study, which aims to identify all relevant factors and biases that hinder ecosystem knowledge flows (Eisenhardt et al., 2016). This method of inquiry is especially appropriate for the contemporary and exploratory nature of this study since theory development is emergent and emanant due to the changing nature of these evolving ecosystems (Yin, 2009). My studied cases serve as the basis from which to develop theory inductively by recognising patterns of relationships within and across constructs, including their underlying logic (Eisenhardt & Graebner, 2007). Additionally, this approach is highly suitable for my research objectives since it aims to address knowledge gaps in the existing theory of knowledge flows with the ultimate goal of advancing theoretical explanations within the modern theory of innovation ecosystems (Ridder, 2017). According to Yin (2009), multiple case studies provide a stronger base of varied empirical evidence for theory-building since the theory will be better and more deeply grounded and more accurate, testable, and generalisable. At the same time, this methodology has allowed me to emphasise the rich, real-world, and complex constructs and contexts that characterise the innovation ecosystems in which the studied phenomena occur (Eisenhardt & Graebner, 2007). Additionally, the case study methodology provides a better understanding of phenomena since knowledge processes are context-dependent (Andersen & Kragh, 2010; Flyvbjerg, 2006).

The use of multiple case studies is particularly suitable for identifying hidden and emerging factors and mechanisms within these ecosystems, facilitating an understanding of communities' complex networks and crucial relationships and a recognition of all complex social and environmental issues within the increasingly permeable and expanding boundaries of these innovation ecosystems. This qualitative research method is, therefore, adequate to analyse these innovation ecosystems since they are an emerging business field and phenomenon that requires multiple data sources and for which qualitative research is needed to quantitatively test identified factors, mechanisms, and cause-effect relationships (Yin, 2009). This approach is also appropriate to illustrate the broader theoretical and practical significance and the rich qualitative evidence within the studied ecosystems, as well as in their long-term organisational and strategic processes (Eisenhardt, 2012). At the same time, it has allowed me to identify emerging opportunities, threats, and challenges that cannot currently be identified by these rigid, confined supplier-based/manufacturing-centred ecosystems. Moreover, Acs and Varga (2002) argue case studies are the more suitable approach for examining clusters and cluster-based phenomena that are highly related to my studied ecosystems. I also follow the current tendency to use secondary data when studying innovation ecosystems (Vlaisavljevic et al., 2020; Beltagui et al., 2020; Ding et al., 2019; Gifford et al., 2020; Arribas-Ibar et al., 2020).

3.1. SAMPLING

To carry out the multiple case study approach, I have applied the sampling approach of intrinsic case study (Stake, 2005) and chosen three modular innovation ecosystems of high social, organisational, technological, and environmental relevance: the global clinical diagnostics, luxury fashion, and electric vehicle (EV) ecosystems. Within the cases, I have looked for specific, singular characteristics and for intrinsic and extrinsic factors of these ecosystems, aiming for accurate descriptions and the 'big picture' of these cases to maximise opportunities to learn. These modular innovation ecosystems have been selected for study because even if they have different types of audiences and outputs, they all have a high likelihood of revealing pivotal insights and crucial

knowledge barriers within the enormous coevolution and value processes of these types of innovation ecosystems (Ridder, 2017).

These ecosystems have also been selected to explore and compare the stages of evolution and outputs of innovation ecosystems, gathering different levels of explanation and implications (Eisenhardt & Graebner, 2007). Both the specific nature and community dynamics of these sampled ecosystems have allowed me to extract maximum efficiency from my exploratory research. This is because they all have a powerful and diverse base of highly specialised providers that can exert significant influence on the relationships and interdependencies among the participants involved in these ecosystems. Within each of the sampled ecosystems, this solid base of specialised suppliers has a crucial role in value creation, knowledge transfer, and development of the final output. For this reason, these suppliers can all play a pivotal role in transforming these ecosystems since they can easily become focal firms leading different types of ecosystem transformation and regeneration. The reason for this is that the majority of these specialised suppliers emerged in spatially confined industrial districts and clusters that constantly attract specialised resources that derive economies of scope from spatial proximity (Thomas & Autio, 2020). These spatial affordances—together with their high degrees of specialisation, know-how, and flexibility—allow the specialised suppliers to discover and exploit all new opportunities. These opportunities are constantly emerging due to the profound changes and new demands in the macroeconomic and microeconomic contexts of these ecosystems, which are driving the emergence of—for example—new consumer behaviours and trends, materials, regulations, and technologies.

Due to these suppliers' extraordinary capacity for value capture, they can develop new and improved modules and complementarities and can lead important regenerations and changes within these ecosystems. However, these sampled ecosystems all remain embedded in rigid, vertical linear supply chains that constrain the development of new relationships and interdependencies within and across these ecosystems' boundaries and, hence, limit their inherent capacity to exploit these new opportunities and these ecosystems' generativity. On the other hand, both technology and manufacturing-and-service techniques play a crucial role in these ecosystems' value creation processes since those specialised suppliers share relevant technological interdependencies even though these interdependencies' scale and scope vary in each of the sampled ecosystems. These differences have allowed me to better assess the impacts of emerging technologies and their respective opportunities on the remaining interdependencies, as well as the specific dynamics and networks of these ecosystems within these ecosystems' different stages of evolution.

At the same time, these leading ecosystems have all undergone a dizzying expansion based on highly standardised business models as a result of the emergence of globalisation and the rise of international trade and economies of scale. Additionally, the attractiveness of their markets and the democratisation of consumption have fostered the growth of these sampled ecosystems. The EV and internal combustion engine (ICE) vehicle ecosystems have been strongly influenced by the democratisation of automotive technology, the luxury fashion ecosystem has been impacted by the 'luxury mass affluence' phenomenon (Nunes & Johnson, 2004), and the emergence of the global clinical diagnostics ecosystem has been driven by healthcare democratisation. Additionally, the role of communications and marketing in these ecosystems' growth has meant these business models have been easily replicated in different sociocultural contexts. Additionally, this rapid and apparently seamless—but unplanned and uncontrolled—expansion has meant ecosystem participants have overlooked the emerging fundamental dynamics that should drive all ecosystem evolution and that differentiate ecosystem dynamics from the dynamics of those rigid and more spatially and virtually confined supply chains. Consequently, it seems that all these ecosystems have reached a kind of saturation or paralysis in many aspects—such as the offered business models, the development of

new value propositions, the roles of each participant, and the development of new relationships and interdependencies—that are also limiting the coevolution of all the sampled ecosystems.

3.2. DATA COLLECTION AND ANALYSIS METHODOLOGY

Data collection and analysis were conducted via the search for both within-case patterns and cross-case patterns (Ridder, 2017) to obtain both analytical depth and comparability (Yin, 2009). This combined methodology allowed me to examine the data within each case analysis, examine the data between the case analyses, and finally create a cross-case analysis (Gustafsson, 2017). To achieve deeper and more solid insights, I also pursued data triangulation to develop a more comprehensive understanding of phenomena (Patton, 1999) and to test validity through the convergence of information from different academic and business secondary data sources. Additionally, this approach provided the ability and flexibility to identify and analyse all complex subsystems that are located within those larger cases comprising enormous ecosystems (Yin, 2009). Thus, this systematic method enabled me to study the different spatial and non-spatial levels, units of analysis, and contexts in which the concept and broad nature of this type of ecosystem can be applied (Thomas & Autio, 2020).

First, I carried out in-depth single case studies for the three selected modular innovation ecosystems (global clinical diagnostics, luxury fashion, and EV), using a similar methodological framework for each to ensure they were comparable. I also used various types of secondary data sources that include specialised academic papers and journals related to each ecosystem, reports from relevant consulting firms, books from relevant experts in each field, business publications, reports from related international agencies, blog posts by experts, newspaper articles, firm websites, and news releases. For each in-depth single case study, I conducted a structured narrative synthesis for assembling, synthesising, and describing my main findings. This narrative is interspersed with quotations, which have been drawn from the secondary sources and are intertwined with theory from the literature review, to demonstrate the close connection between the empirical evidence, the gathering of new insights, and emergent theory (Eisenhardt & Graebner, 2007). These three case studies—individual, intensive, qualitatively rich in detail, and carefully conducted—have allowed me to identify and describe the most important systems and actors within each ecosystem. Within these comprehensive narratives, I studied each ecosystem by reviewing and applying the distinct commonalities across ecosystem concepts within the modern ecosystems theory (Thomas & Autio, 2020). Within this modern theory, these studied commonalities encompass different ecosystems' characteristics and concepts, such as participants' degree of heterogeneity, nature of dominant interdependencies, rules of engagement, and type of co-alignment structure. At the same, I analysed these ecosystems from the perspective of the most relevant, up-to-date management mechanisms applied to these ecosystems since they are seen as crucial factors to help maintain, realise, and deploy opportunities for value creation and capture (Ritala et al., 2013).

Within this managerial construct of ecosystems, I analysed relevant topics that are fundamental to understanding this typology of supplier-based ecosystems that also target specific, growing audiences, such as business models, organisational ambidexterity, strategic management, knowledge management, value capture and creation, supply chain analysis, consumer behaviour, new product development and adoption, technology management, and market segmentation and targeting. This approach helped me to identify and describe the most important variables and factors that characterise each ecosystem and to determine their respective performance and internal knowledge and value flows. I also studied each ecosystem from the perspective of ecosystem-building and mechanisms of evolution since they are seen as facilitating and defining the premises

of value creation and value capture (Ritala et al., 2013). Within this life cycle construct of ecosystems, I assessed factors such as the ecosystems' life cycle stages, market growth, leading focal firms, emerging capabilities, gaps and/or risk-sharing initiatives, and ecosystem dynamics (e.g., emergence, competence), as well as the evolution of community dynamics in these ecosystems. This perspective allowed me to identify and describe the most relevant interactions, relationships, and interdependencies among ecosystem actors and firms from a contextual view with their business networks and changing contexts.

Additionally, within the individual analysis of these ecosystems, I dedicated attention to identifying and assessing additional factors associated with the COVID-19 pandemic that are directly affecting the current trends in these ecosystems and their evolution. These changes are leading to profound shifts in the macroeconomic and microeconomic environment of all the studied ecosystems and driving the emergence of, for example, new consumer behaviours and new technologies.

After the in-depth single case studies, I compared the three sampled innovation ecosystems following the multiple case study approach in order to understand the patterns, differences, and similarities among cases (Baxter & Jack, 2008; Stake, 1995) and to gather deeper insights into the studied topics. This approach allowed me to clarify whether an emergent finding in one of the in-depth single case studies was simply exclusive to that case or consistently replicated by the remaining two cases (Eisenhardt, 1991). This comparison of cases has reinforced my study, as it has enhanced multiple and diverse replications, contrasts, and extensions to the emerging theory constructs that I began to develop in the in-depth single case studies (Yin, 2009).

For a better grounding of the cross-case synthesis, I developed several comparative summary tables that complement the individual narratives of each case study, presenting the most relevant findings from the analysis of each individual case and further emphasising the rigor and depth of the empirical evidence of the theory (Eisenhardt & Graebner, 2007). These tables and the comparative examination of the cases are included in this study's concluding chapter. These tables indicate how the focal construct is 'measured' across the cases' evidence, thus increasing the 'testability' of the theory (Eisenhardt & Graebner, 2007). They facilitate comparison of the cases (and characteristics of agreement or disagreement across these cases) and the identification of common characteristics, patterns, and differences. Within these tables, data are displayed according to predefined frameworks that I have based on the modern theory of ecosystems and their managerial and building mechanisms of construction. In essence, these tables provide a synthesis of the main characteristics, constructs, and structures of these ecosystems; these ecosystems' situation regarding identified knowledge gaps; their omitted knowledge sources based on the literature review; the types of knowledge biases identified; and proposed strategies that ecosystem participants can develop and implement to mitigate each of these biases.

Following this, I carried out a final narrative synthesis of the comparative study using text to assemble and condense all the information for categorising and explaining results in terms of ecosystems' characteristics and knowledge biases across the studied cases, based on the relationships in the data and the findings from the previous cross-case synthesis. Within this final narrative, located in the conclusions, I identify and describe each of my findings that is linked to both the supporting empirical evidence for each construct and the proposed relationships between the different theoretical constructs that I have identified. The conclusions consider possible configurations and causal flows among the different themes of ecosystems theory, and I end my analysis with overall conclusions and recommendations.

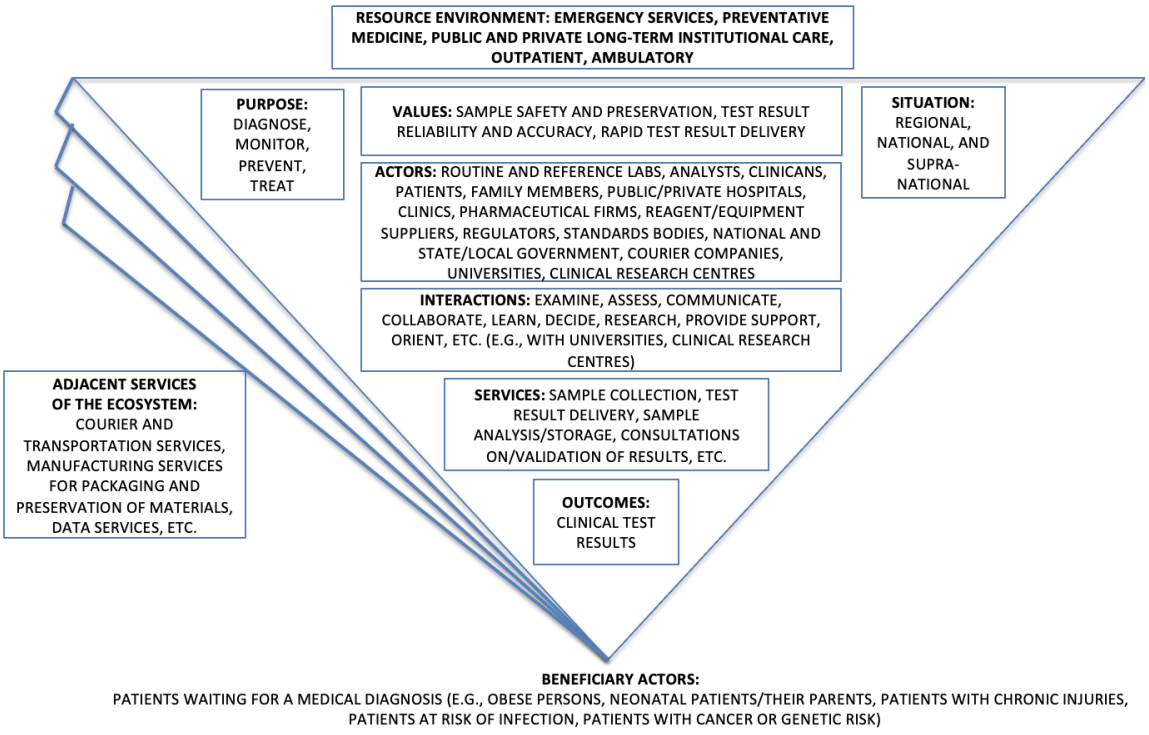
CHAPTER 4. GLOBAL CLINICAL DIAGNOSTICS ECOSYSTEM

4.1. INTRODUCTION TO THE ECOSYSTEM AND RECENT TRENDS

Within the first case study, I analyse the supplier-based ecosystem of the global clinical diagnostics—or global in vitro diagnostics (IVD)—market, which includes the markets and supply chains that cross the actors and organisations in this healthcare ecosystem. The data collection for this case study has also included participant observation of a specific case of innovation (Yakura, 2002; Vinten, 1994).

The global IVD market stood at US$69.2 billion in 2019, and it is projected to grow from US$84.5 billion in 2020 to US$96.0 billion in 2025 at a compound annual growth rate (CAGR) of 2.6 per cent (Markets and Markets, 2020). Figure 4.1 depicts this ecosystem, following Lawer's (2018) model for health ecosystem value design. The primary inputs of this ecosystem are the human samples from patients and clinical trials, as well as the new demand for screening tests of preventive medicine. IVD tests are considered medical devices, which require reagents, techniques, instruments, or a combination of these to be used in vitro in order to examine specimens such as blood, urine, or tissue with the goal of obtaining a diagnosis from assays in a controlled environment outside a living organism (Morel et al., 2016). The final outputs of this global ecosystem are the test result reports provided to healthcare professionals and clinicians, as well as the new knowledge that enhances medicine and healthcare. The global clinical diagnostics ecosystem suffers from poor outcomes, growing costs, and high patient burden. With increasingly scarce resources, the sustainability of the structures, institutions, and new practices created to prevent and treat illness is under mounting threat from multiple pressures and numerous complex, persistent system problems. The need for open innovation management is crucial to improve and increase performance in healthcare organisations (Biancone et al., 2019).

Figure 4.1. The global clinical diagnostics ecosystem



Source: Adapted from Lawer (2018)

The global clinical diagnostics ecosystem encompasses different healthcare systems and human-test-results supply chains, as well as other supply chains from various industries that also request testing, including pharmaceuticals, food processing and intolerances, and the veterinary industry, among others (this is considered industrial testing). The ecosystem comprises various actors and innovation platforms: patients; logistics firms; hospitals; clinicians; routine, reference, pharmaceutical, and emergency clinical labs; manufacturers and suppliers of reagents, autoanalyzers, and testing equipment; transportation companies; export and import agents; airlines; national and international health agencies; international transportation agencies (e.g., the International Air Transport Association [IATA]); national and international certification and accreditation agencies; and suppliers of materials for uses such as sample extraction, collection, preparation, packaging, and preservation. The environment also interacts with a wider range of socioeconomic actors (Rasiah, 2019), such as in terms of the health situation, quality of life, and life expectancy.

Based on the end user, the market is broadly classified into hospital laboratories, non-hospital laboratories, academics, point-of-care (POC) testing, patient self-testing, and others. Hospital laboratories hold the largest share in the market due to the tremendous amount of diagnostic testing required to support clinical decisions enhancing patient recovery (Markets and Markets, 2020). This ecosystem operates within the service-dominant logic approach, which defines a 'service' as the application of competencies (knowledge and skills) for the benefit of another party (Vargo & Lusch, 2004). In contrast to the traditional logic, service-dominant logic considers service creation and consumption to be a collaborative process, emphasising the user's role in value co-creation. In the global clinical diagnostics ecosystem, the services framework largely includes before- and after-sales or follow-up services; information processes regarding test results and procedures; global sample transportation; sample reception; preservation and storage; sample analysis and testing; data collection on test results; delivery of test results to clinicians, customers, and hospitals; quality and patient feedback processes; and clinical validation and interpretation of results.

Within this ecosystem, several current trends are affecting the strategies and competitive position of its participants, as well as the relationships, interdependencies, and knowledge flows between them. These trends are described in the following subsections.

4.1.1. High concentration and centralisation of testing labs and suppliers

In recent years, centralised health systems have tended to centralise and concentrate their clinical labs into several core labs to reach economies of scale or scope. These core labs are divided into three types of lab specialisation: laboratories that are highly specialised in the technology of a group of techniques and their specific investments (e.g., laboratories specialising in polymerase chain reaction, or PCR); laboratories that focus on the specific application of a testing panel or on a specific form of human disease (e.g., on infectious diseases); and a group of large laboratories that run routine tests and techniques (e.g., in haematology or biochemistry) on high volumes of samples. Also of note, the overall IVD market of reagents and equipment is dominated by six or seven key players that are large multinationals. Smaller suppliers tend to be highly specialised; as in the broader IVD market, a lack of product differentiation makes economies of scale and scope essential (Morel et al., 2016). Diagnostic manufacturers and suppliers need to seek a broad portfolio in order to achieve scale. As a result, they can sell the capital equipment at low margins and make the bulk of their revenues from the sales of reagents and consumables.

4.1.2. Testing globalisation and delocalisation

Free trade and more rapid development of logistics and communications have allowed testing labs to delocalise their installations and to collect and analyse samples anywhere in the world. For example, a Spanish lab can now process samples collected in Brazil the day before. However, these changes have induced a growing competitive pressure that has pushed many labs to different types of mergers and acquisitions that have enhanced the concentration of businesses. This competitiveness has forced many small labs of doctor's offices to shut down.

4.1.3. High sensitivity to macroeconomic and microeconomic factors

Diagnostics suppliers and laboratories are more sensitive to changes in the macroeconomic cycle than other parts of the healthcare system because around 20 to 25 per cent of the sector's revenue-generation capability comes from exposure to industrial (as opposed to clinical) end markets, such as food testing, which often carries greater macroeconomic sensitivity.

4.1.4. High sensitivity to government funding for scientific research, new regulations, and unfavourable reimbursement

Cuts to government funding for scientific research are likely to have a deeper impact on diagnostics companies. At the same time, regulatory and legal requirements applied to IVD in the US and European countries are becoming more stringent. In Europe, new regulations are expected to replace earlier European Union (EU) directives and add stringent requirements for the CE marking of new and existing devices (Markets and Markets, 2020). These barriers are constraining the development of new tests and innovations within the global clinical diagnostics ecosystem. Low reimbursement by insurance companies and the public healthcare systems is 'burning' testing labs because the reimbursement is sometimes less than the actual cost of the tests. As a result, testing labs limit the expansion of their testing capacity and increase testing times.

4.1.5. Growing automation, robotisation, and modularity of testing platforms

To group all testing, reduce manual tasks, and decrease transportation times for samples inside labs, suppliers in recent years have been developing connected-automation solutions using sensors, robotics, and different IT solutions to track the samples (Bio Molecular Systems, 2020). They have been designing authentic long testing chains involving different types of autoanalyzers, connecting them to allow for maximum predictability of the time until test results. Additionally, the majority of equipment manufacturers are focused on developing more modular equipment to allow labs to customise and configure their own platforms adapted to their own test panels. At the same time, pre- and post-analytical tasks have been automated, offering maximum efficiency through flexible standalone solutions and cutting down the cost of these low-added-value activities.

4.1.6. Growing product and service complementarities

Due to the high cost of many diagnostic platforms and their rapid obsolescence, it is common for suppliers to offer equipment rental or leasing services instead of selling the equipment and their technology. The rental/leasing fees are included in the cost of purchasing the associated reagents, and the agreements are tied to contracts that also include all equipment maintenance costs and

technology updates over the life of the contract (normally three or four years). These types of agreements allow testing labs to use innovative technology and be constantly updated with the newest testing technology and techniques. However, new technology uptake may be hampered if contracts are long term to cut monthly costs, as end users are locked into existing agreements that prevent upgrading or switching to technology that would be more cost-effective (Markets and Markets, 2020).

4.1.7. Rise of new business models involving public-private collaboration

Since the 2008 financial crisis, new types of public-private collaborations have been developed and implemented to control the rising costs of public testing systems, especially in Europe. The rapid design and launch of new tests due to the rise of preventive medicine has transformed the traditional, confined business models of outsourcing and sending tests to reference labs. New localised agreements involve pay-per-patient models instead of pay-per-test or pay-per-use-of-reagents. These models have fostered new types of agreements and collaborations and joint ventures between testing labs and suppliers.

4.2. STAGE OF ECOSYSTEM EVOLUTION

This global clinical diagnostics ecosystem is now in a life-cycle phase of constant growth and expansion due to the increasing importance of preventive medicine and continuous healthcare follow-up. Additionally, the increasing geriatric population in developed, as well as developing, countries will also influence the growth of this market. With the rapid growth in the geriatric population globally, the prevalence of age-associated diseases is expected to increase significantly (Markets and Markets, 2020). Demand is also rising for point-of-care IVD devices, which has positively impacted the growth of this market. Point-of-care testing occurs at the site of patient care, and it is sought after in the field of infectious bacterial diagnostics to allow the care team to receive results more quickly and to make immediate, informed management decisions (Morel et al., 2016). The recently launched IVD instruments/devices are convenient to use and highly efficient, which has increased their adoption among healthcare professionals. Additionally, several over-the-counter diagnostic products are available on the market (such as glucose monitoring kits) and have become increasingly important during the COVID-19 pandemic, as people are opting for convenient diagnostic tests that can be performed in multiple, diverse point-of-care settings. These factors—combined with the increasing prevalence of chronic diseases such as cancer and diabetes, increasing awareness of disease diagnosis, and growing disposable income levels—are expected to support the growth of this market.

4.3. THE IMPACT OF COVID-19 ON THE ECOSYSTEM

The COVID-19 pandemic has affected day-to-day life, led to one of the largest death tolls in history, and resulted in an unprecedented shutdown of economic activity worldwide. This pandemic has affected many millions of people, who have either become sick or died due to the spread of this disease. The most common symptoms of this viral infection include fever, cold, cough, bone pain, breathing problems, and pneumonia (Haleem et al., 2020). The substantial revenue growth between 2019 and 2020 in the global clinical diagnostics ecosystem essentially originated from molecular and antibody COVID-19 testing. I have identified a number of relevant new trends associated with the pandemic that have broadly influenced the coevolution of this crucial ecosystem, which are described in the following subsections.

4.3.1. Growth of testing demand, supply chain shortages, and the collateral effects

Even as testing labs' revenues have grown, their testing capacity has been shaken by the abrupt rise in demand for tests; thus, labs have needed to set up and reconfigure their operations and resources in an effort to help manage the pandemic and increase their testing capacities and efficiency. Well-known suppliers (e.g., of the devices and diagnostic kits required for different testing platforms) are manufacturing as much as their existing physical facilities allow, and thus are limiting the allocations they can sell to individual laboratories. Additionally, these limitations are having a secondary impact on diagnostic tests for other diseases due to the ever-changing picture for even the most basic testing materials (Marx, 2020). This enormous effort, however, remains insufficient compared to the scale of demand, meaning COVID-19 could seed deep structural shifts that will have long-term implications for diagnostic-test laboratories and manufacturers alike (Behnam et al., 2020).

This supply chain shortage is affecting many of the labs' tests and is certainly affecting patient care (Marx, 2020) since tests are carried out too slowly or have been rationed for patients with several suspected illnesses, including gastroenteritis, sepsis, gonorrhoea, and chlamydia. Many labs globally have been forced to limit how many samples they can process and what diseases they can test for. New testing labs have been built around the world and new types of public-private collaborations have rapidly emerged to cope with this pressing problem of testing capacity. This change has created room for the development of new types of business models and franchises that will shake and transform this industry's traditional models and competitive forces, such as suppliers' power and the industry's barriers to entry. It seems that in the foreseeable future, the most promising way to perform large numbers of tests will be to use a mix of diagnostic methods that rely on different instruments and platforms and different supply chains, ensuring a sudden spike in worldwide demand will not deplete any key materials. In a specific area, testing labs and all relevant stakeholders (e.g., health authorities, local government, reagent suppliers, and hospitals) should agree on a specific diagnostic model with a particular mix of diagnostics and a model of centralised and decentralised infrastructure for point-of-care and testing labs.

4.3.2. Emergence of new relationships and interdependencies across ecosystem boundaries

This pandemic has fostered new relationships and interdependencies involving new participants across the global clinical diagnostics ecosystem's boundaries—such as airports, schools and universities, retailers, doctor's offices, restaurants, and travel agencies—that will continue to purchase tests to prevent future pandemics and diseases as an added measure to provide value and safety for their stakeholders (Maddipatla & O'Donnell, 2020). Demand for molecular diagnostic tests may decline once a majority of people receive COVID-19 vaccines, although the demand for antibody tests, which detect past infections, could increase and remain high. These interactions and relationships have also reached participants from unrelated supply chains in different ecosystems, such as IT participants from the platform ecosystems that can develop and supply new modules and complementarities to testing labs (e.g., specific apps). These new interactions are fostering new technological interdependencies that are shaking the rigid, traditional boundaries of the global clinical diagnostics ecosystem.

4.3.3. Emergence of new behavioural factors affecting demand for clinical tests

In addition to the traditional factors of income, lifestyle, age, and ethnicity, new behavioural factors have emerged due to the disruption caused by COVID-19. The pandemic has accentuated that

the demand for a specific clinical test is strongly influenced by its potential value and benefits and by the experiences of its potential users (Malmendier & Nagel, 2016). At the same time, testing preferences may vary along many socioeconomic characteristics (Serra-Garcia & Szech, 2020). For example, the demand for COVID-19 antibody testing depends on the amount of time to receive test results back and the strength of protective immunity from antibodies. Additionally, older people and those who have experienced more death due to COVID-19 demand this test more frequently (Serra-Garcia & Szech, 2020). Another factor that influences testing demand is uncertainty. Even though most people tend to overestimate their likelihood of having been infected, test demand increases with the uncertainty over the real evolution of the pandemic and of being infected. At the same time, and despite the fear that people have of the virus, different studies have demonstrated that test price still plays an important role in consumer decision-making, with a US study finding the demand for the COVID-19 antigen test drops by half when the price is US$20 or more (Serra-Garcia & Szech, 2020). Political views have also become a factor affecting the demand for tests (Mandavilli, 2020). For example, Serra-Garcia and Szech (2020) found supporters of then-US President Donald Trump demonstrated lower test demand, while those approving of key US medical adviser Dr Anthony Fauci's performance displayed significantly higher interest.

4.3.4. Rising demand for new types of testing panels and the development of new tests

This pandemic has fostered innovation on faster testing and also on testing in much higher volumes (Behnam et al., 2020). COVID-19 and the shortage of different types of kits due to supply saturation have accelerated the development of dozens of new diagnostic methods and tests, all of which detect viral material but in different ways (e.g., next-generation sequencing, CRISPR, and new portable antigen tests that can deliver results in 15 minutes). Kit and autoanalyzer suppliers are accelerating their research and looking for affordable, easy-to-use new tests to speed up and simplify testing (Guglielmi, 2020), and new rapid tests and auto-tests have also been designed. These emerging testing technologies could come to challenge the dominant methods for diagnosing most viral infections, such as the leading position of the current reverse transcription PCR (RT-PCR) systems for viral COVID-19 tests; RT-PCR assay has been the dominant method for diagnosing most viral infections for 20 years. The unprecedented, accelerated R&D on these new tests and testing techniques will likely affect this ecosystem's dominant designs across the different test panels of diagnosis.

Suppliers are also developing new testing methods that will add individual 'molecular barcodes' to clinical samples before pooling them and using next-generation sequencing to decode them all at once. These new methods will be able to analyse up to 100,000 samples in one run instead of the hundreds that can be analysed at once with the traditional PCR autoanalyzers (Guglielmi, 2020). In parallel, different approaches for faster and cheaper diagnostic tests are also being developed. These new tests contain an antibody tailored to bind to a specific protein or antigen—similar to the technology that enables home pregnancy tests (Guglielmi, 2020). The accelerated development of new tests and techniques will certainly not be temporally built, as development will remain within this ecosystem since it has established appropriate and efficient co-alignment structures and procedures that will foster generativity and innovation.

4.3.5. Increasing laboratory automation and the application of disruptive new technologies

Increased demand has pushed testing labs and suppliers to conduct testing more quickly and deliver more lab-accurate, actionable, and timely results on the spot. Suppliers have reacted by

enhancing laboratory automation with more customisable, multidisciplinary automation solutions to fit the different sizes and types of labs and by applying advanced robotics and artificial intelligence solutions to help technicians analyse data samples (Roche, 2020). The new solutions focus on streamlining the conventional lab workflows with the new lab workflows related to the new and increasing tests, with the management of all test results intended to be driven by rules-based informatics that are customised for each specific lab.

4.3.6. Rising decentralisation of production

COVID-19 has disrupted the traditional discussion on the dilemma of rising decentralisation of production, and the pandemic has introduced additional elements of analysis that convey innovation into both centralisation and decentralisation. In years preceding the pandemic, there was a strong tendency to focus on centralising sample analysis to achieve economies of scale and scope. In this approach, samples are collected in different centres of blood extraction and then delivered to a central laboratory, where multiple patient samples and types of tests are run by multiple chains of autoanalyzers and automatic testing platforms and by specialised, trained technicians. The design of these centralised labs uses lean principles and focuses on high-throughput processing in a controlled environment since the labs can process a significant number of samples with great efficiency and a high level of automation, which requires less manual support (Roche, 2020). The overarching goal of moving to a centralised, core lab structure was to create opportunities for shared technologies, staff, and infrastructure, thereby driving logistical efficiencies of supplies (e.g., decreased turnaround times and economies of scale when ordering supplies) and positively impacting patient care and customer service.

However, the main problem with this system is that samples must be collected at the different points of care (e.g., in hospitals, doctor's offices, and pharmacies) and transported to a central lab to be processed; thus, these processes require additional time. New problems have arisen with COVID testing since the clinicians need an 'immediate' result because of the immediate impact on detecting infection and determining a course of treatment. These new testing needs are pushing labs to divide their workload into groups of test panels and distribute them into different units of production that share similar testing methodologies and testing times and are strategically localised. The development of new tests is catalysing the decentralisation of testing labs.

4.3.7. More point-of-care testing systems and testing services and solutions

This pandemic is transforming traditional care delivery, which historically has been spatially confined and restricted, and improved the patient experience. However, even though access to testing is crucial to globally recommended control strategies, key geographical barriers exist, such as the dispersion of small populations that constrains testing access (Hengel et al., 2020). The volume of testing conducted near the patient—point-of-care testing—has risen during the COVID-19 pandemic in response to the demand for more rapid on-site screening (Behnam et al., 2020). Point-of-care testing gives healthcare providers the information to quickly determine a course of action or treatment for a patient, and it also increases infection prevention and control. All this has obvious benefits at almost any of the points of care—the emergency room, an ambulance, a pharmacy, or even the home of the patient receiving at-home care (Roche, 2020). Point-of-care testing enhances access to testing, reduces the time waiting on results, provides appropriate isolation and privacy to patients, and eliminates the need for confirmatory testing (Hengel et al., 2020). Suppliers and clinical labs are more committed than ever to supporting front-line healthcare professionals and helping them

to deliver high-value critical care to patients at each stage of COVID-19 disease management: diagnosis, prognosis, therapy, and follow-up (Roche, 2020). Additionally, for safety reasons and to shorten testing times, testing labs are avoiding gathering potential patients and collecting samples at their sites; instead, researchers are trying to bring testing to the masses by devising new assays that could be used in temporary testing facilities, drive-through testing centres, and even people's homes (Guglielmi, 2020).

4.3.8. Accelerated development and adoption of new technologies and testing techniques

New innovations have been developed by combining the traditional diagnostic platforms and technologies with those emerging and disruptive new technologies, such as intelligent technologies to enhance testing productivity. These innovations are transforming platforms into more highly adaptable, multidisciplinary track configurations that also drive cost-efficient and patient-centric care. The current innovations focus on reduced sample loading, preparation, and handling to free lab staff from those time-consuming, low-value tasks.

4.3.9. Rise of digitalisation

Due to the pandemic, government health agencies have aimed to create centralised reporting systems for COVID-19 test results. They have sought information from testing labs, sectoral IT services firms, research centres/entities, and other organisations about their capability and past performance, as well as their capacity to use secure and scalable cloud-based platforms to accept and transmit all testing data to relevant state and large local health departments, with a focus on multistate, large regional, and state-wide reporting entities (Anderson, 2020). The idea is to create a centralised platform that will connect the diverse testing sites (e.g., schools, restaurants) and labs in a shared connectivity interface. In the future, this platform could act as an underpinning co-alignment structure. Implementing these digital platforms will allow testing labs to decentralise their points of care and units of production for communities of patients in need, especially those that are undertested and socially vulnerable (Hengel et al., 2020).

4.4. LEAD USER BIASES AND SEGMENTATION BIASES

This case study has selected a reference laboratory within the global clinical diagnostics ecosystem as a focal firm and focuses on the laboratory's service providing sample collection and transportation. Balague Center is a specialised clinical-testing reference laboratory in Spain that performs reference tests that its customers cannot perform due to their high cost and due to the technological capacity and scientific expertise required. For example, the laboratory provides molecular diagnostics, genetic testing, pathology testing, and chromosome analysis, which require considerable investments in new technology and in expertise. While the laboratory also ran routine tests (e.g., biochemistry, haematology), its core activities at the time of this case study were reference and specialised tests. Balague Center consistently performs clinical trials and research to remain at the forefront of European reference laboratories and to meet healthcare systems' demands and requirements in terms of new diagnostic and prevention trends. The human resources of this type of laboratory comprise a wide range of experts, specialised lab staff, clinicians, and medical specialists and researchers. Balague Center uses a complex transportation system and packaging to preserve the test samples in terms of physical integrity, humidity, and temperature.

At the time of this case study, Balague Center's customers were large public hospital laboratories, medium-sized laboratories of private clinics and hospitals, localised laboratories and pharmacies, pharmaceutical companies, food processing companies, and allergists. Seventy per cent of Balague's tests came from Spanish customers, and the remaining 30 per cent came from six non-European countries. Like other reference labs, Balague also outsourced some techniques or tests to European or US reference laboratories or institutions due to the low number of samples and high cost per test.

One of the most important knowledge gaps in the global clinical diagnostics ecosystem is due to the segmentation approach that testing labs and suppliers alike use to segment their shared target audiences. These actors normally segment and target their markets by grouping types of tests, testing techniques, or platform technologies instead of segmenting the market's users and end users; they focus on product/service segmentation of the market and set aside studying service users' changing needs and customs, generating important knowledge biases. Testing labs and suppliers need to switch to a new segmentation approach that focuses on the two audiences in this ecosystem that must be widely understood to enhance effective targeting and innovation strategies: First, there are the health institutions that request the clinical tests, which labs and suppliers can consider to be the service users and identify and characterise their profiles. Health institutions treat patients and demand IVD, and they can include entities such as hospitals, clinics, doctor's offices, insurance firms, and businesses in the pharmaceutical or food processing industries. These organisations comprise health professionals and other professionals who demand tests for their patients' treatment. Second, testing labs and suppliers should also consider who the end users of their services are—essentially, the business' patients or clients. Participants in this ecosystem should consider that service providers (users) are not the sole value creators; patients and consumers also create value. While the first type of relationship with global clinical diagnostics users focuses on business-to-business (B2B) or business-to-government (B2G) interactions, the second type with end users focuses on business-to-consumer (B2C) interdependencies. The participants in this ecosystem should address both audiences and markets simultaneously to enhance the cross-fertilisation of new insights.

Applying the lead-user approach as an important source of innovation (von Hippel, 1986), I determined this ecosystem's lead users were national and international, private and public; they included renowned and first-rate hospitals and clinics that were developing new therapies and treatments with leading teams of medical specialists. These new tests were constantly demanding new or improved technical solutions from Balague Center as a reference lab. (Table 4.1 provides each user segment's perceived current attributes and attributes that must be developed in the future in response to the trends.) These new methods and preventive treatments required new clinical tests, which were constantly expanding the test panel—providing new and renewed or improved tests and, thus, producing important trends of innovation throughout the ecosystem. From the lead-user hospitals, these new trends flowed forward to the patient or consumer and backward to the clinical test lab, to the freight companies and agents, to the suppliers of reagents and chemical components (to perform the new tests or improve the testing methods), to the manufacturers of autoanalyzers, to other researchers, to universities, and so on. Another important trend in the ecosystem was cost reduction due to the increased cost of all these new techniques in comparison to routine tests. Additionally, the efficient management of all ecosystem supply chains was required to compensate for the operations costs in public health systems. The lead users needed to pay full attention to knowledge creation and knowledge capture processes because of their participation in these processes and the processes' impact on knowledge creation.

Table 4.1. Current and future product attributes per Balague Center user segment

ATTRIBUTE	PUBLIC HOSPITALS	PRIVATE HOSPITALS	CLINICS	PHARMACIES	CLINICAL ANALYST OFFICES
SHARE OF SALES	65%	5%	15%	5%	10%
PHYSICAL INTEGRITY OF SAMPLES	Current	Current	Current	Current	Current
TEMPERATURE INSULATION: REFRIGERATE	Current	Current	Current	Current	Current
TEMPERATURE INSULATION: FROST	Current	Current	Current	Current	Current
TEMPERATURE INSULATION: FREEZE	Future	Future	-	-	-
TEMPERATURE TRACKING	Future	-	-	-	-
LARGE CONTAINER SIZE	Current	-	-	-	-
REDUCED CONTAINER SIZE	-	-	-	Current	Current
REDUCED CONTAINER WEIGHT	Future	Future	Future	Future	Future
ACCREDITATION OF CONTAINERS	Future	Future	-	-	-
HIGH SAMPLE QUALITY	Current	Current	-	-	-
EASE OF USE	Current	-	Current	-	-

Source: Author's creation

4.5. PRODUCT/SERVICE ATTRIBUTE BIASES

These emerging trends and the explosion in new-test development required constant and comprehensive reassessment, reformulation, and improvement of all service attributes, preferences, and perceptions affecting the processes and actors within this ecosystem. This included, for example, the technical attributes of test results, transportation attributes of sample transportation and preservation, attributes of delivering test results to the client, quality control attributes, financing attributes, and old-sample-searching attributes. Analysing these trends and their effects on the multiattribute mapping of this ecosystem and its supply chains, I found that I could expand the concept of lead users (von Hippel, 1986) to include other focal firms in the ecosystem that could provide different solutions to those new needs and could also provide important sources of innovation equal to or in advance of the ecosystem's lead users. Thus, I found the following focal firms in this ecosystem: the lead transporters that could provide new transportation services, the lead integrators and suppliers that could provide new testing methodologies with new or improved equipment and reagents, the lead distributors and importers of techniques, and—above all—the leading global laboratories that could efficiently and rapidly implement those new requested tests in large quantities.

I concentrated my analysis of value capture and value creation on transportation processes, which had a significant impact on emerging innovation trends in the case ecosystem. These trends involved the expansion in the number and types of new tests, which impacted cost reduction in the ecosystem and required a revision to transportation processes. Value capture and value creation innovations helped align transportation processes with these new trends. Additionally, the new tests made novel demands and facilitated solutions for sample transportation in terms of new or improved sample preservation and delivery requests, new forms of sample transportation to cut transportation costs, and other areas.

The global clinical diagnostics ecosystem requires an improvement to sample transportation operations. The sample value is high, and a specific sample could save more than one life, perhaps

even thousands. Safety and preservation are important attributes of the functionalities required for these transportation operations, and attributes related to sample cost and the specifications of transportation containers carrying samples (e.g., capacity, level of recycling, and ease of preparation and use) are also fundamental. The impact of these attributes on sample transportation and how the focal firms manage the attributes is also crucial. This means that to innovate on transportation attributes and processes, each actor could add value for each specific end user or market for these services, as well as for each of the companies and supply chains in this ecosystem.

From this analysis, I found that it is necessary to develop and craft a new focal value proposition for transporting samples. The aim of the sample-transportation innovation process is to find a more effective and efficient solution regarding the following attributes:

- **Transporting samples efficiently and sustainably.** It is a priority to address factors such as cutting transportation times, modifying pick-up times for samples, changing routes, varying scheduling and type of transportation, and integrating recycling.
- **Enhancing sample preservation (sample temperature, integrity, and thermal insulation).** Testing labs need to design new types of containers with new raw materials to increase containers' capacity, reduce their cost, enhance sample preservation, and increase their reuse and recycling.
- **Improving shipment tracking and sample identification.** Testing labs must introduce barcodes, temperature probes, and tracking to enhance sample monitoring. Balague Center focused the innovation process on finding a new container for sample transportation to match these requirements. The centre's innovation process was based on multiattribute mapping and positioning for product concept evaluation and generation (Roberts & Urban, 1985) and on the product development process phases described by Ulrich and Eppinger (2012). To innovate the sample container, they followed the steps below:
    - **Collecting data from lead users.** Testing labs need to gather raw data from the different container users in the ecosystem: segmenting the platforms and users of the containers; observing the container being used in the lead user facilities (e.g., hospitals, clinics), in the transporter installations and vehicles, and in the laboratory reception area; and finally, interviewing employees of the facilities and firms that operate or handle the container (e.g., preparing and storing the samples in the container to be shipped, opening the samples container in the reference lab).
    - **Proposing and developing new product and service attributes and improving the current ones.** Participants must interpret the raw data in terms of user needs and transform them into innovation attributes (product perceptions or preferences for requirements). They have to agree on organising these attributes into a hierarchy to establish their relative importance, as well as group the attributes according to the similarity of the needs they express to simplify the subsequent analysis, discussion, and development.
    - **Comparing those selected attributes.** Later, firms should discuss and compare the selected attributes or technical requirements among the available commercialised containers and transportation solutions for samples within this ecosystem. (Balague Center obtained a comparison of attributes; see Table 4.2.)
    - **Sharing a list of crucial desired attributes to innovate.** The involved firms need to prepare and agree on a list of crucial attributes to improve, including new ones to be introduced per user segment (see this list for Balague Center in Table 4.3).

Table 4.2. Comparison of existing transportation containers in the ecosystem (Balague Center)

TECHNICAL REQUIREMENTS	OUR CONTAINERS	LAB COMPETITOR A CONTAINER	LAB COMPETITOR B CONTAINER	PROVIDER A NATIONAL	PROVIDER B EUROPEAN	PROVIDER C ASIAN
CONTAINER WEIGHT (DEPENDS ON BOX AND NUMBER/WEIGHT OF THERMAL ACCUMULATORS)	HIGH	LOW	HIGH	LOW	MEDIUM	MEDIUM
CONTAINER RESISTANCE	HIGH (EXTERNAL RIGID MATERIAL)	MEDIUM (ONLY EXPANDED POLYSTYRENE OR POREXPAN)	MEDIUM	MEDIUM (POREXPAN INSIDE A FLEXIBLE PLASTIC CASE WITH HANDLES)	HIGH (RIGID)	ACCEPTABLE (RIGID)
GRADE AND DURATION OF THERMAL INSULATION (REFRIGERATED SAMPLES)	HIGH	LOW	HIGH	MEDIUM	MEDIUM	MEDIUM BUT DEPENDS ON RELIABILITY OF THE DIFFERENT LOTS SUPPLIED
GRADE AND DURATION OF THERMAL INSULATION (FROZEN SAMPLES)	LOW	MEDIUM	HIGH	LOW	HIGH	MEDIUM BUT DEPENDS ON RELIABILITY OF THE DIFFERENT LOTS SUPPLIED
TRANSPORTATION CERTIFICATION FOR SAMPLES	NO	NO	NO	NO	YES	NO
NUMBER OF CONTAINER SIZES	3	3	1	2	1 (BUT VERY LARGE)	4
VOLUME (SAMPLES/BOX)	1 (200) + 1 (70) + 1 (2 FROZEN) OUR LAB AVERAGE PER SHIPMENT WAS 50 SAMPLES	1(100) + 1(60) + 1(10)	1(80)	1(100) + 1(10)	1(200)	1(300) +1(200) + 1(100) + 1(50)
POROSITY/ABSORPTION OF WATER	VERY LOW	HIGH	LOW	MEDIUM NOT TESTED	LOW	MEDIUM BUT DEPENDS ON RELIABILITY OF THE DIFFERENT LOTS SUPPLIED; NOT SECURED
CATEGORY OF SAMPLES THAT CASES COULD CARRY	CATEGORY B, NO CATEGORY A (INFECTIOUS SAMPLES)	CATEGORY B, NO CATEGORY A (INFECTIOUS SAMPLES)	CATEGORY B, NO CATEGORY A (INFECTIOUS SAMPLES)	CATEGORY B, NO CATEGORY A (INFECTIOUS SAMPLES)	CATEGORY B, NO CATEGORY A (INFECTIOUS SAMPLES)	CATEGORY B, NO CATEGORY A (INFECTIOUS SAMPLES)
COST PER CONTAINER/ PER ROUTE	VERY HIGH/VERY HIGH	VERY LOW/LOW	HIGH/MEDIUM	MEDIUM/MEDIUM	VERY HIGH/HIGH	VERY LOW/VERY HIGH

Red: Negative characteristic | Green: Positive characteristic | Orange: Characteristic in between positive and negative

Source: Author's creation

Table 4.3. List of crucial transportation container attributes (Balague Center)

CUSTOMER SEGMENT	% OF CUSTOMERS	ATTRIBUTE 1	ATTRIBUTE 2	ATTRIBUTE 3	ATTRIBUTE 4	ACTUAL ATTRIBUTES TO IMPROVE	NEW ATTRIBUTES TO INNOVATE AND DIFFERENTIATE
PUBLIC HOSPITALS	65%	PHYSICAL INTEGRITY: PRESERVING PHYSICAL INTEGRITY OF SAMPLES	TEMPERATURE INSULATION REFRIGERATION (DURATION)	TEMPERATURE INSULATION FROST (DURATION)	- CAPACITY (HIGH) - EASE OF USE - CATEGORIES OF SAMPLES (SOMETIMES NEED CATEGORY A)	- **TEMPERATURE INSULATION (FROZEN + REFRIGERATED)** **- WEIGHT**	- **TEMPERATURE TRACKING FINAL VERIFICATION** - **CERTIFICATION AND ACCREDITATION OF CASES** - **NUMBER OF DIFFERENT CONTAINER SIZES (INCREASE CAPACITY FOR FROZEN SAMPLES)**
PRIVATE HOSPITALS	5%	PHYSICAL INTEGRITY: PRESERVING PHYSICAL INTEGRITY OF SAMPLES	TEMPERATURE INSULATION REFRIGERATION (DURATION)	TEMPERATURE INSULATION FROST (DURATION)	- EASE OF STORAGE - CATEGORIES OF SAMPLES (SOMETIMES NEED CATEGORY A)	- **TEMPERATURE INSULATION (FROZEN + REFRIGERATED)** **- WEIGHT**	**- CERTIFICATION AND ACCREDITATION OF CASES**
CLINICS	15%	PHYSICAL INTEGRITY: PRESERVING PHYSICAL INTEGRITY OF SAMPLES	TEMPERATURE INSULATION REFRIGERATION (DURATION)	TEMPERATURE INSULATION FROST (DURATION)		- **TEMPERATURE INSULATION (REFRIGERATED)** **- WEIGHT**	**- NUMBER OF DIFFERENT CONTAINER SIZES**
PHARMACIES	5%	PHYSICAL INTEGRITY: PRESERVING PHYSICAL INTEGRITY OF SAMPLES	TEMPERATURE INSULATION REFRIGERATION (DURATION)	TEMPERATURE INSULATION FROST (DURATION)	- CAPACITY (LOW) - VOLUME PER CASE (TO REDUCE STORAGE AREA)	- **TEMPERATURE INSULATION (REFRIGERATED)** - **WEIGHT**	
CLINICAL ANALYST OFFICES	10%	PHYSICAL INTEGRITY: PRESERVING PHYSICAL INTEGRITY OF SAMPLES	TEMPERATURE INSULATION REFRIGERATION (DURATION)	TEMPERATURE INSULATION FROST (DURATION)	- CAPACITY (LOW) - VOLUME PER CASE (TO REDUCE STORAGE AREA)	- **TEMPERATURE INSULATION (REFRIGERATED)** **- WEIGHT**	**- NUMBER OF DIFFERENT CONTAINER SIZES; SMALLER REFRIGERATED CASES NEEDED**

Source: Author's creation

- **Scanning environments' emerging opportunities and threats.** For each user segment, ecosystem participants should identify and recognise those hidden market and environmental biases and those promising opportunities and emerging trends within and across the boundaries of this ecosystem. Firms should check those crucial and prominent participants, such as the suppliers of container materials, accreditation agencies, hospitals, transportation agencies, company commercial and medical departments, and government agencies. The Balague Center found opportunities representing a mix of market pull and technology push (Brem & Voigt, 2009; see Table 4.4).

Table 4.4. Emerging opportunities in the ecosystem

Opportunities	Source of the opportunity
Privatisation of public labs into private concessions contracts; to win public tenders, reference labs need to improve transportation containers	Public administration, national health systems
Permission to sell Balague Center clinical test services to distant countries	Globalisation, international courier and logistics services
Modifications to the specific regulations for sample transportation in categories A and B launched by the global organisations IATA and the World Health Organization (WHO)	International regulatory agencies
Release of new materials (new gels) to manufacture frozen accumulators for the container to achieve better container performance	Suppliers
Release of new materials for transportation and packaging with less weight and very similar rigidity	Suppliers
Public tenders seeking verified environmental protection management to increase recycling	Sustainability
Shipping deferred Balague Center tests to reference labs in the US, reducing costs	Economies of scale, outsourcing

Source: Author's creation

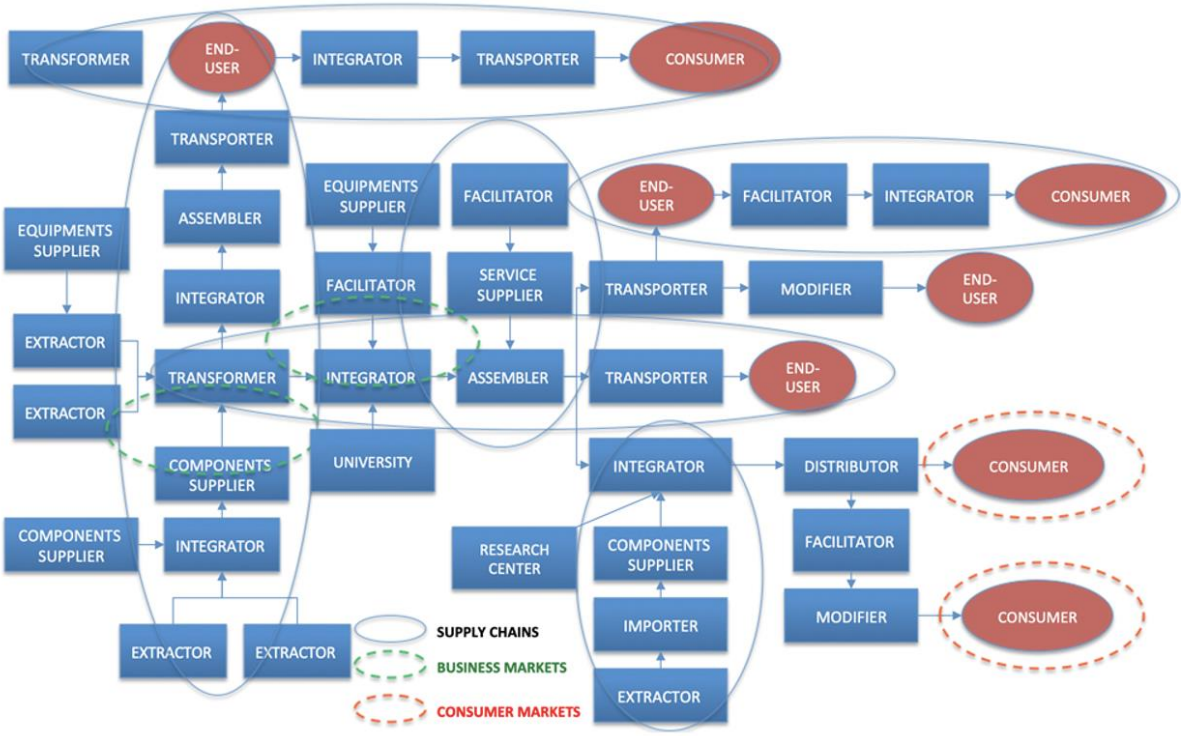
- **Comparing innovations' desired attributes with emerging opportunities and threats.** Furthermore, participants in the global clinical diagnostics ecosystem should position and map the comparison of these attributes with those opportunities, as well as identify how these emerging opportunities can improve the attributes. Then, firms should use a cross-functional team to combine the list of required attributes with the list of market biases or promising opportunities. This teamwork would allow participants to develop the best combinations of attributes and opportunities for the design of the new container. Within this consensus, participants should determine the target segments for innovation (e.g., public hospitals and clinical analyst offices) and design the processes to innovate (e.g., sample transportation processes—including the set-up process, shipping process, and reception and check-in process). They must form cross-functional teams that belong to the different ecosystem participants for following up the product development. Balague Center formed a team integrating staff from customer service, operations, logistics, and the samples reception and commercial departments.
- **Selecting the desired attributes to innovate.** Participants have to agree on the attributes to innovate and relevant modifications of the current innovation. Balague agreed to reduce weight (e.g., by changing the container materials and the type and materials of thermal accumulators) and add new sizes of containers, proposing larger size for frozen samples from public hospitals and smaller sizes for refrigerated samples from clinical analyst offices. Balague also agreed to prioritise the accreditation of containers by international agencies

(e.g., Applus+ and TÜV), proposed developing and implementing a new system to track sample temperature with sensors and verify values during transportation, and agreed to increase the duration of temperature insulation through methods such as using new container materials and changing accumulator materials.

- **Overcoming the development stage of the product and its complementarities.** Finally, participants should overcome the remaining product development phases for the new container, including idea generation and idea scanning; product concept development; system-level design (5P design); detail design; testing; refinement; and production ramp-up with different phases to launch the new container and its complementarities, such as new specific timetables and courier service.

An analysis of innovation in Balague Center's transportation processes yields a number of insights. In this specific supplier-based ecosystem, I have found different specialised supply chains of modular offerings, complementarities, components, and services that compose the transportation processes. These supply chains cross the studied ecosystem, providing different types of specialisations that, in combination, can accelerate value co-creation within these types of processes (see Figure 4.2). Within this ecosystem, I have identified different specialised supply chains, such as the supply chains of reagents and autoanalyzers, the supply chains of fungible lab material, and the supply chains of transportation and courier services.

Figure 4.2. Network of supply chains in specialised supplier-based ecosystems



Source: Author's creation

4.6. SOURCING BIASES: KNOWLEDGE INPUTS FROM SUPPLIERS

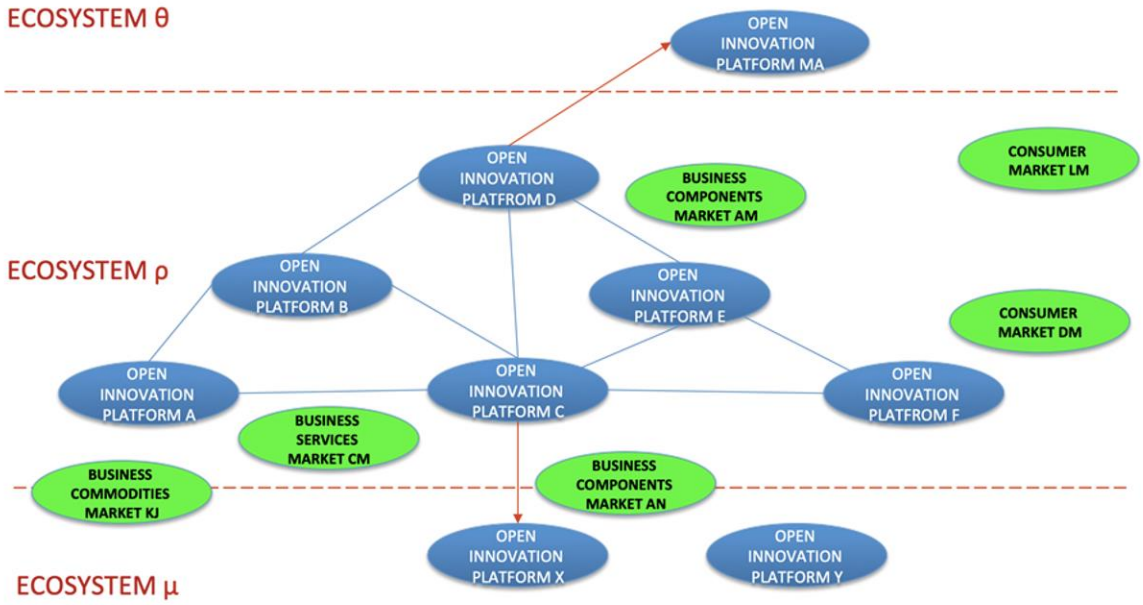
In this case study, I paid particular attention to the container supply chain and the sample transportation supply chain working throughout the ecosystem. Innovating within the container supply chain was crucial for Balague Center for several reasons: It would allow Balague Center to

offer its services to other distant countries, enhance the performance of sample transportation containers by improving sample preservation in terms of temperature and safety, reduce transportation costs (e.g., by decreasing container weight through the use of new materials), and ensure compliance with new transportation and health regulations on human sample transportation. To innovate, Balague Center acted as an innovation platform and had to combine the following attributes, complementarities, or modular offerings from different supply chains in order to provide a new and better solution for ecosystem users:

- Materials and products produced in the supply chain of cooling materials and devices (e.g., gels, accumulators, thermometers, and temperature sensors);
- Materials and products produced in the supply chains of packaging materials (e.g., cardboard, plastic bags, and Styrofoam boxes);
- Services provided by accreditation agencies; and
- Services provided by the transportation supply chain (e.g., shipping frequency, timetables, and delivery tracking).

I consider knowledge that is transformed or processed in an open innovation platform to be an input of this hub because this platform's resources (e.g., technical, personnel, and data) have had the capacity and vision to seize this knowledge from a specific supply chain in order to apply it. The personnel of this hub have identified this knowledge as potentially necessary to join innovation with other forms of knowledge or complementarities from other supply chains to produce more knowledge (knowledge creation and capture)—thus generating unique complementarities both in consumption and in production (Jacobides et al., 2018). The knowledge that each innovation platform generates comes from combining and transforming different types of knowledge previously seized from the platform. The value created becomes an input for the next platform, moving forward or backward—i.e., towards the sources or the end users of the ecosystem—and thus creates supermodular complementarities of both consumption and production by increasing the quality of sample services and reducing transportation costs (Autio & Thomas, 2019). These supply chains can also cross other types of ecosystems and provide knowledge interchange between them (see Figure 4.3).

Figure 4.3. The network of open innovation platforms in a supplier-based ecosystem



Source: Author's creation

For Balague Center, a number of situations arose that hindered the innovation process. In each situation, Balague Center omitted required knowledge from the ecosystem or outside it. The firm centred attention on its relationships with immediate stakeholders from the different supply chains, leading to a type of cognitive bias. The focus on close connections made Balague Center unaware of recent ecosystem developments. After struggling to create a viable solution, Balague Center finally directed attention towards a solution that a fishery ecosystem had innovated to transport fish from remote places in order to find a means of preserving and safeguarding human samples during transportation. Balague Center developed a new system of transportation, a supermodular complementarity formed by new containers made with new materials and of different sizes, a new information system for monitoring sample temperature during transportation (e.g., with data loggers and sensors), a new logistics system of nodal transportation that enhances multiple services and scheduling, and an international accreditation of the system provided by third-party certification bodies.

Within the analysis of this case study, I identified nine typologies of cognitive biases (see Table 4.5). First, there is a group of market biases that encompasses all knowledge gaps related to end users and consumer markets, which are the real drivers of the different supply chains in this type of innovation ecosystem. Then, there are the sourcing biases related to knowledge from the different tiers of suppliers and their specialisations. Due to the strong technological interdependencies of the global clinical diagnostics ecosystem, I have also identified technological biases related to the emerging technologies and techniques within and across the boundaries of this ecosystem. Service biases are also important due to the ecosystem's strong focus on service-dominant logic. In my case study of containers, the fishing companies' solutions for transportation were used to innovate in sample transportation. Additionally, I found complementary product offering biases (Kim & Mauborgne, 2005) since they define the total solution that clinicians may seek when they request a specific testing service for a patient. Legal and regulatory biases are also fundamental since they can accelerate and support some innovation projects; in the case study, the world regulatory organisations IATA and WHO have launched modifications of the specific regulations on sample transportation that affect their shipping and preservation processes. Financial biases are also crucial since they can hinder those financial opportunities from new financing conditions, innovative fundraising ideas, and new business models that can support different initiatives. Additionally, strategic biases constrain strategic vision and strategic decision-making in the global clinical diagnostics ecosystem, and environmental biases (e.g., political, economic, sociocultural) can limit and influence participants' perceptions of the ecosystem.

Table 4.5. Ecosystem biases of Balague Center

SITUATION OF BALAGUE	OMITTED KNOWLEDGE SOURCE	BIAS
INCREASE IN THE PREVENTIVE MEDICINE AND TREATMENT PRACTICE MAPS, OVERLAID WITH NEW HEALTH PRACTITIONER TYPES AND NEW TECHNOLOGY USER PROFILES	End users and consumers (von Hippel, 1986)	Market bias
EXISTENCE OF ORBITAL TRANSPORTATION ROUTES AND SOLUTIONS TO AVOID DIFFERENT TIERS OF TRANSPORTATION FRANCHISES AND LOCAL INTERMEDIARIES	Different tiers of suppliers	Sourcing bias
TRANSPORTATION CONSIDERED AUXILIARY	Service suppliers	Service bias
FISHING INDUSTRY USED SUPERIOR TRANSPORTATION SOLUTION	Cross-industry solution (Kim & Mauborgne, 2005)	Industry bias
EXISTENCE OF CLIMATE MONITORING AND DATA DOCUMENTATION SYSTEMS WHEN TRANSPORTING SAMPLES	Complementary product producers (Kim & Mauborgne, 2005)	Complementary product bias
MODIFICATIONS TO SPECIFIC REGULATIONS FOR SAMPLE TRANSPORTATION IMPLEMENTED BY IATA AND WHO	New legislation	Legal and political biases
ATTEMPTED EXTENSIONS OF CURRENT TECHNOLOGY	Technological innovation	Technological bias
EXISTENCE OF DIRECT GOVERNMENT FUNDING AVAILABLE FOR THE DEVELOPMENT OF LARGE INVESTMENT PROJECTS	Credit institutions	Financial bias
UNEXPLORED ADJACENT SOCIAL ECOSYSTEMS WHERE FACTORS ARISE THAT PREVENT OR REDUCE THEIR ABILITY TO COPE WITH NEW DISEASES AND NEW MEDICAL TREATMENTS	Social environment	Environmental bias

Source: Author's creation

4.7. FOCAL FIRM BIASES

I deduce that each focal firm or innovation platform requires different types of resources to be integrated, managed, directed, and made operative. These resources seize, create, and capture knowledge. At the heart of the open-innovation model is the recognition that today, competitive advantage often comes from inbound open innovation, which is the practice of leveraging and seizing the discoveries of others: Companies need not—and indeed, should not—rely exclusively on their own R&D (Chesbrough & Crowther, 2006). In addition, outbound open innovation suggests that rather than relying entirely on internal paths to market, firms can look for external organisations with business models that are better suited to the commercialisation of a given technology. Companies thus share the knowledge captured to make profits and reinvest. To direct and accelerate these processes of knowledge creation and capture in innovation platforms, the open innovation platforms have to research market bias or lead trends within that ecosystem.

Balague Center enhanced relationships with the diverse actors, specialists, and other stakeholders of the entire ecosystem from top to bottom, including end users and patients. Balague Center chose not to focus only on its immediate clients but also focused on its clients' clients, suppliers, and other ecosystems. The process thus followed the criteria that innovation should be oriented towards the people who use the container and consume the final results (e.g., patients and doctors) rather than oriented towards the product and its characteristics (Levitt, 1960). This case study affirms that an ecosystem differs from conventional supply chains in that not all supplier

relationships are contractually and vertically governed, yet the value of the focal firm's offerings for the customer may depend on the availability of complementary products and services (Adner, 2017; Adner & Kapoor, 2010).

4.8. INNOVATION PROCESS BIASES

Analysing the case study results, I have concluded that these supplier-based ecosystems confront a dilemma while innovating: On the one hand, ecosystem specialisation is attained by combining specialisations. Each actor—for example, a specific autoanalyzer manufacturer, reference lab, or courier service—invests in and operates physical assets that tend to be asset-specific. Within this lens, actors' relationships and roles are highly fixed in the studied ecosystem, and these actors lead the focal firms that connect the ecosystem's loose networks (Gawer & Cusumano, 2013). On the other hand, those specialised actors must develop a coherent shared vision of the ecosystem because they are codependent (Autio & Thomas, 2019).

I conclude that other crucial factors direct and drive the global clinical diagnostics ecosystem's participants to enhance their processes of knowledge and value capture. I consider these factors to be ecosystem biases or inputs of open innovation platforms, and they are related to external opportunities and ideas originating from the ecosystem's markets, environments, and actors (e.g., suppliers, manufacturers, accreditation agencies, governments, distributors, consumers, universities, and researchers). Additionally, new opportunities can arise from other ecosystems' markets, participants, and stakeholders, such as opportunities due to disruptive technological trends.

Furthermore, when these biases are identified and eliminated, the processes of value creation and value capture accelerate. These opportunities and 'connection of dots' are indispensable to guide open innovation platforms. Correctly identifying, associating, forecasting, highlighting, and recognising these biases within the ecosystem represents another capacity—not only of the specific resources of open innovation platforms but also of the stakeholders or partner organisations that belong to these platforms. There is a resilience gap in organisations included in the innovation platforms, with the world becoming turbulent faster than organisations are becoming resilient. According to Hamel and Välikangas (2003), 'Strategic resilience is not about responding to a onetime crisis. It's not about rebounding from a setback. It's about continuously anticipating and adjusting to deep, secular trends that can permanently impair the earning power of a core business. It's about having the capacity to change before the case for change becomes desperately obvious'. Based on the case study and analysis of the literature on this topic, I find that many firms focus their research on only their immediate customers' needs and expectations, ignoring the importance of learning about the requirements and needs of the most strategic customer of all: the end user (Saavedra, 2016), who is also a co-creative participant. Firms also ignore the opportunities and needs of their suppliers, their suppliers' suppliers, and so on. In addition, they ignore the actors integrated into the different supply chains that cross them and that provide different types of services to these companies (e.g., transportation actors in the transportation supply chain that crossed the Balague Center lab).

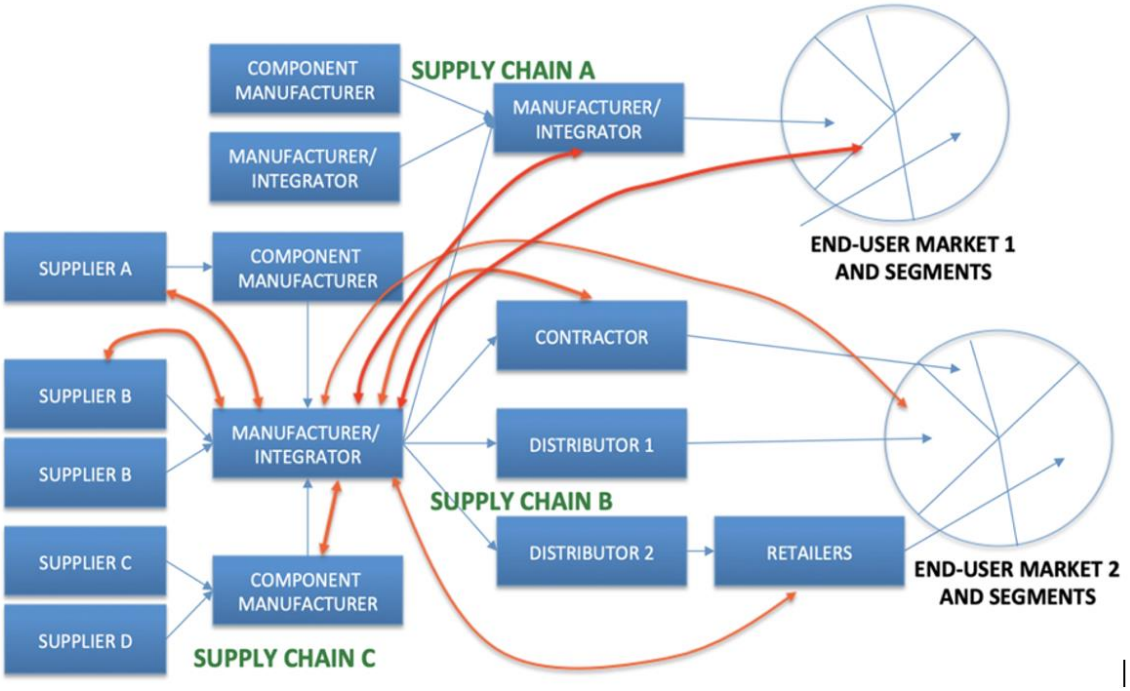
This analysis can also be expanded to all the components and actors of the global clinical diagnostics ecosystem and the supply chains that cross it. In his review of the concept of structural stream, Adner (2017) defines an ecosystem as 'the alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize'. An integrated vigilance on ecosystem biases in such multilateral relationships should drive the focal value proposition by adapting and meeting the emerging and changing stakeholder requirements. An organisation or innovation platform could then enhance its innovation performance by controlling

and managing ecosystem relationships, thereby being able to better predict all the flows and fluctuations of information and ideas that cross those supply chains.

4.9. BIASES FROM OPEN INNOVATION PLATFORMS

To increase knowledge creation, firms must establish relationships not only with the end user or consumer but also with all of the integrators of the supply chain that are adding value to the different segments of end users or consumers. Inside the innovation platforms and their resources, a good approach to—and development of—these external relationships enhances the effectiveness and efficiency in capturing these opportunities: for example, in terms of innovation speed, dependability, cost, and flexibility, as well as in terms of the resilience of the open innovation platform. Therefore, the innovation platform that first captures one or more of the ecosystem biases that cause innovation hyperopia secures an important potential competitive advantage. As a result, open innovation platforms need to take into account two components: first, a strategic component in the sense that these opportunities are the basis of defining the mission and objectives, specific planning, and organisation of each open innovation platform, and second, an operational component because capturing ecosystem knowledge is a prerequisite for knowledge creation that entails an increase in innovative value and can be traded towards the end of the supply chains, and thus, address the end users and consumers (see Figure 4.4).

Figure 4.4. The capture of ecosystem knowledge by an organisation



Source: Author's creation

4.10. CONCLUSIONS

In the coming years, the global clinical diagnostics market (also referred to as the global IVD market) will experience significant growth due to rising demand for early and accurate disease diagnosis in preventive medicine, the increasing prevalence of infectious diseases, the rising adoption

of fully automated instruments and automation in laboratories, the increasing adoption of point-of-care testing, and the growing awareness of increasingly personalised medicine. This growth is driving new discoveries and innovative technologies that will create new opportunities and interdependencies in this market and attract new participants from different ecosystems—transcending the boundaries of healthcare. This phenomenon will enhance the value-sensing, exploration, and co-creation framework of all healthcare ecosystems (Lawer, 2018), and the global clinical diagnostics ecosystem's role has become pivotal to the development and evolution of other healthcare ecosystems.

This supplier-based ecosystem is crossed by different specialised supply chains that connect the organisations inside and outside of this type of ecosystem. Within this supplier-based ecosystem, ecosystem specialisation is attained by combining different types of specialities; each of these areas constitutes a subsystem formed by combining the different supply chains and communities of participants that affect the focal actor. Every supply chain that crosses the ecosystem could be a potential source of innovation for the ecosystem's organisations because they specialise in specific topics or functionalities they provide to that ecosystem. Each main topic or functionality of a supply chain that crosses the studied ecosystem confers a specific characteristic or identity to that ecosystem. For this reason, an ecosystem's identity is the sum of these identities and supply chains crossing that ecosystem.

This study has demonstrated that supplier-based ecosystems are complex due to the limited problem understanding; lack of system-wide vision; absence of a common language; entrenched organisational behaviour and technological assumptions; spatially confined business models; and misaligned innovation, strategy, and change management plans and action. Additionally, the global clinical diagnostics ecosystem has experienced slow technology adoption, although the eruption of COVID-19 has brought these deficiencies to light and accelerated adoption. Overall, these problems all constrain knowledge flows among participants and limit innovation since they hinder the capacity of ecosystem participants to identify, understand, engage, and satisfy the needs of the remaining stakeholders. If the global clinical diagnostics ecosystem's participants need to create new value, they must understand how complex their own ecosystem is and how it would adapt and evolve in response to increasing direct and indirect interactions from diverse stakeholders and to changing contexts within and across the boundaries of the ecosystem.

Another conclusion from this case study is that perceived risks increase when participants in an ecosystem try to learn about an emerging problem or challenge from only one or two stakeholders or communities of participants (e.g., immediate client or supplier), leaving important gaps in understanding and leading to the design of partial interventions and piecemeal solutions based on incomplete evidence (Lawer, 2018). This decoupling is driving knowledge gaps and knowledge asymmetries among participants, which are constraining the effective adoption and adaptation of those emerging technologies that are impacting the studied ecosystems. The result is limiting the hoped-for scale of their implementation and, thus, casting aside many emerging opportunities.

The Balague Center case study has led to different types of biases being identified and to the finding that these biases reduce companies' capacity to understand the problems and challenges that cohabit these complex systems. I argue that temporarily built open innovation platforms would have to capture and create knowledge for future value development. For this reason, participants and open innovation platforms would have to minimise the effects of these biases to accelerate innovation. Open innovation platforms help prevent this issue because they encompass different types of resources and abilities that can provide the platform with diverse perspectives on and visions of the ecosystem, increasing the field of vision (Frey et al., 2011). These open innovation platforms need to develop powerful intelligence systems that can continuously address and manage an interactive process for exploring, collecting, synthesising, and analysing structured, domain-specific information (often stored in a data warehouse) to discern trends or patterns in that ecosystem, thereby

deriving insights and drawing conclusions to boost innovation (Markarian et al., 2007). In addition, open innovation platforms have to establish multiple relationships alongside the different supply chains that cross them to accelerate research and to rapidly detect and assess market biases in the ecosystem. These extensive investigations should also provide potential knowledge and ideas for capture by the innovation platform that could then be transformed and reused to create more knowledge or new ideas.

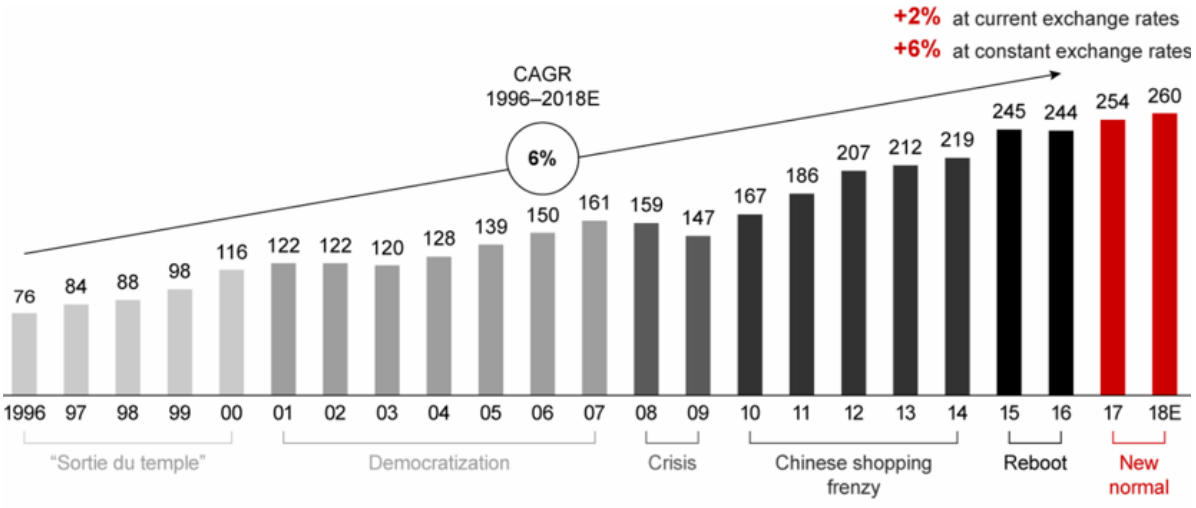
For the above reasons, I also conclude that the real drivers of innovation in this type of ecosystem are the different ecosystem biases. Thus, intelligence systems, bias research, and an appropriate systems perspective would accelerate knowledge flows and innovation. This should be the main task of open innovation platforms within this type of ecosystem, and the results of that continuous research into distant opportunities in the ecosystem should also determine the vision and strategy of each participant and open innovation platform. These ideas or captured opportunities from the distant actors in the ecosystem should also guide the innovation platform's operations. My conclusions are aligned with the service-dominant logic perspective's myopic focus on within-dyad resource integration, which has attracted insufficient attention at the ecosystem level, and cross-dyad influences on within-dyad value co-creation and service ecosystem boundaries (Autio & Thomas, 2019).

CHAPTER 5. LUXURY FASHION ECOSYSTEM

5.1. INTRODUCTION TO THE ECOSYSTEM AND RECENT TRENDS

Over the last 25 years, factors such as the rise of globalisation and free trade, the world's economic growth, the galloping internationalisation of markets and companies, the rise of consumerism within developing and emerging economies, the increase in tourist flows, and the massive influence of social media have led traditional European luxury fashion companies to a new era of constant growth in new customer markets and niches, driven by the democratisation of luxury. As a consequence, the market for luxury goods rapidly expanded from the mid-1990s to the late 2000s, a period in which the majority of companies were able to post double-digit growth because of those favourable market conditions and few luxury firms worried about operating costs or productivity (D'Arpizio et al., 2019a). Although the manufacturing of luxury fashion products continues to be concentrated mainly in Europe and the US, the distribution and commercialisation of these products have become completely delocalised in emerging markets. Despite the 2008 financial crisis, extremely strong growth in sales to Chinese and other Asian consumers has allowed many of those luxury goods companies to post rapid growth and attractive profit margins (Rozario, 2019). This expansion has translated into a continuous CAGR of 6 per cent since 1996 (Bain & Co., 2018; see Figure 5.1).

Figure 5.1. Global personal luxury goods market (EUR, billions)



Source: D'Arpizio et al. (2019a)

Despite this continuous growth, even before the COVID-19 pandemic, the sector reached a 'new normal' of flat growth in the luxury goods industry, with gradually decelerating growth—below 3 per cent at best in constant exchange rates—from 2017 to 2019 (D'Arpizio et al., 2019b). According to Claudia D'Arpizio from the consultancy firm Bain & Company, which specialises in the luxury sector, the personal luxury goods market in 2019 had a moderate growth rate associated with this 'new normal' era, which is mainly driven by Chinese buyers and other Asia-Pacific nationals (Bain & Company, 2019). As a result, Bain & Company expected a CAGR of 3 to 4 per cent for the luxury goods market through 2020, to approximately EUR280 billion.

This slowdown in sales growth augured a new competitive market situation, but the emergence of the pandemic has introduced additional uncertainties and trends that are also driving and shaping all the ongoing transformations of this ecosystem. In this case study, I assess the intrinsic

and extrinsic factors that are driving these changes, as well as the knowledge barriers and what the new quests for innovation should be within this complex ecosystem. Through this process, I have found that many of these factors hide various new dynamics and behaviours that are emerging and distorting perceptions of this ecosystem. All ecosystem stakeholders and participants must clean or change their lens to correctly anticipate, predict, and interpret all these new signs within this ecosystem, which demand new strategies of innovation.

5.1.1. The democratisation of luxury fashion

Although luxury has often been conceptualised in terms of the dimensions of uniqueness, rarity, and inaccessibility (Dubois & Paternault, 1995), empirical evidence indicates luxury brands' sales began to constantly increase beginning in the 1980s (Catry, 2003; Remaury, 2004). During this period, society has embraced a process of 'luxurifying', as middle-market consumers have been able to trade up to luxury products due to the rise in disposable income, lower unemployment rates, and growing numbers of wealthy consumers in emerging countries (e.g., BRIC countries) (Truong et al., 2009; Twitchel, 2001). Concurrently, traditional luxury firms have introduced new brand extensions and product categories, such as cosmetics, that are more affordable and thus appeal to a wider group of consumers (van Schalkwyk, 2014). This emerging phenomenon has been described as the 'democratization of luxury' (Kapferer, 2006; Remaury, 2002) or 'luxury mass affluence' (Nunes & Johnson, 2004), in which luxury firms leverage competing objectives of exclusivity whilst increasing brand awareness, market share, and profit (Silverstein & Fiske, 2003).

Kastanakis and Balabanis (2011) affirmed a new conceptual business model—the bandwagon consumption of luxury products—that is now more visible in public and strongly depends on the consumption behaviour of others. Underlying this model is a consumer's interdependent self-concept of product consumption, a behaviour that seduces the masses and increases individuals' demand for a product because others are also consuming it (Leibenstein, 1950). This rising model of consumption has also triggered further demand (Chaudhuri & Majumdar, 2006; Vigneron & Johnson, 1999). The bandwagon effect represents people's desire to purchase a product in order to get 'into the swim of things' (Kastanakis & Balabanis, 2011), to conform with the people they wish to be associated with, to be fashionable or stylish, or to appear to be 'one of the boys' (Leibenstein, 1950)—all of which affect individual behaviour. 'Snobs' value goods that few own (Kastanakis & Balabanis, 2012) and, therefore, find scarce luxury brands to be appealing, to confer status through dissociation, and to be 'appreciated by similar like-minded significant others' (Kastanakis & Balabanis, 2014). Luxury firms have exploited these phenomena by achieving dominant positions or by producing compatible goods (Kastanakis & Balabanis, 2011). Simultaneously during this period of long economic growth, the success of the luxury sector has relied on narcissistic consumer behaviours like self-branding and exhibiting success on social networks (Kapferer, 2020).

The exponential growth of sales in the luxury fashion industry, the rise of this market's attractiveness due the new 'democratisation of luxury', and the bandwagon effects that can offer many new opportunities and value propositions to their stakeholders have pushed many firms to renovate, enhance their collaborations, innovate, extend their offerings, and also enter the stock exchanges to enlarge their capital and support their transformations and expansion into global markets (Eveno, 1999; Bonin, 2012; Donzé & Wubs, 2019; Donzé & Fujioka, 2018). Additionally, the high barriers to entry—guarded for centuries by the traditional luxury sector and their family-owned firms—have been lowered due advancements in business and management practices, driven by globalisation and the internet (Okonkwo, 2007). All these factors and transformations have

increased competitiveness in this sector and generated new strategic movements in terms of new strategic alliances, diversification, and mergers and acquisitions; this has led to the creation of large luxury conglomerates that operate a range of luxury brands, luxury product categories, and luxury businesses. According to Donzé and Fujioka (2018), the dominance of large businesses in the luxury industry is a recent phenomenon. For example, LVMH Moët Hennessy Louis Vuitton (widely known as LVMH) is a French multinational corporation and diversified conglomerate specialising in luxury goods, and it controls around 60 subsidiaries that each manage a small number of prestigious brands (75 in total). The subsidiaries are often managed independently under the umbrellas of six business units: fashion group, wines and spirits, perfumes and cosmetics, watches and jewellery, selective distribution, and other activities.

5.1.2. Exhaustion of the democratisation model of growth and consumers' and firms' new cognitive impairments

As a consequence of these changes, new market dynamics, and events over the last two decades, both current growth and business models within this ecosystem have experienced exhaustion and 'wear and tear'. According to Kapferer (2020), there is fatigue in the most mature markets—Europe, Japan, and the US. I conclude this is because the firms have been focusing too heavily on maximising profits by pursuing oversaturation of their markets, offerings, and points of sale and e-commerce. Boston Consulting Group and Global Fashion Agenda (2017) conclude that luxury brands need to act quickly on their saturation of stores and omnichannel retailing in Asian cities and should consider opening more in the US and elsewhere. These companies have been overwhelming their markets with repetitive and predictable collections, creations, and collaborations that also closely resemble those of competitors. According to Cheryl Chan from *A Magazine Singapore*, unlimited creativity and originality of ideas may have reached their limit due to globalisation, the speed with which consumers devour information, and their insatiable need for novelty, as well as because designs need to remain commercially viable and due to the pressure and creativity standards that designers or brands feel they must adhere to (Chan, 2020).

Luxury fashion product categories have been always the same—for example, blouses, shirts, t-shirts, jackets, or handbags—and designers and brands launch collections that include products within those categories every season. Simultaneously, creativity, originality, and authenticity have lost their meaning in view of the reinvention, repetition, and reinterpretation of older styles and trends of fashion and brands (The Finery Report, 2018). Observing how luxury fashion brands design handbags, for example, one can observe a sort of domino effect. For example, when the Celine luggage tote took the lead in 2011, other luxury brands immediately adopted the bag's silhouette, stealing the original brand's idea to reach a wider audience (The Finery Report, 2018).

Luxury fashion firms have fostered an uncontrolled mass consumption approach, essentially driven by the effects of bandwagon luxury consumption behaviour, volatile trends, and 'logomania'—all of which have driven these firms closer to the fast-fashion retailing industry's practices. Luxury fashion labels have been abusing logomania not only in clothing, but especially in accessories that elevate the status of any product simply because they are expensive and make that fact clear; this has been a one of the main entryways of traditional luxury brands into the life of younger audiences (Branding News, 2018). Today, goods from luxury houses are ubiquitous and recognised not by their distinctive designs but by their prominent logos (Rabkin, 2019). Marketers give the masses the illusion that they are consuming luxury when, in reality, they are doing nothing of the sort: Luxury and exclusivity are, by and large, no longer synonymous (Rabkin, 2018). I believe that this monotony has triggered consumer fatigue and a kind of 'cognitive impairment' that creates

significant confusion when consumers select and buy this type of product and that constrains their ability to achieve an immediate, clear understanding of what luxury should be and what the true essence, symbolism, and distinction of luxury should be for them. This evolution has introduced a new challenge for luxury firms and their consumer-perceptions positioning since polarisation is occurring between prestige for the masses—'masstige'—luxury and silent, classy, and more intimate luxury. According to research from the global media agency network Mindshare (2018), millennials have emerged as a demographic with over $200 billion in purchasing power; however, over 55 per cent of millennials that are luxury consumers are sceptical of large luxury brands because they believe they have 'lost their personal feel', indicating that luxury brands may be missing out on significant spending.

At the same time, the excessive diversification by large luxury conglomerates may have negatively impacted the effectiveness of corporate management, such as the overextensions of businesses, brands, products, and resources; paradoxical tensions and additional costs among standardisation (variation, collective), individual, and exploration (Wareham et al., 2014); and additional costs due to inefficient investment of the firm's resources in areas unrelated to the main business (Lee et al., 2016). This has also generated confusion among luxury fashion consumers since they expect a brand's domain, specialisation, and expertise in the fashion product or area for which it has always been known; for example, Hermès is known for its expertise and for the savoir faire and craftmanship of its silk 'carrés'. Simultaneously, these dynamics, oversaturation, and a routine, excessive, and unbridled rhythm have overexposed all ecosystem participants. They have also affected participants' ability to achieve a clear, deep, and immediate understanding of the complex problems, challenges, situations, and new visions that are about to emerge in that ecosystem due to their evolution—thus, blurring actors' perceptions of their environments and relationships, as well as limiting their room to manoeuvre.

5.2. STAGE OF ECOSYSTEM EVOLUTION

The luxury fashion ecosystem emerged and expanded due to the phenomena of the democratisation of luxury and globalisation. In recent years, this growth has been fostered by the rise in consumption in Asia, increased expenditure by young generations, and the rise of online channels (Boston Consulting Group & Altagamma, 2020). In the last decade, luxury fashion has definitively led the growth of luxury goods and the competition with other ecosystems targeting the same increasing audience.

The emergence of these markets protected the luxury sector from the 2008 global economic crisis, but we do not yet know the precise impact of the COVID-19 crisis for industry growth or how long the pandemic will last (Cabigiosu, 2020). However, as discussed in Section 5.1, I assert that this ecosystem's evolution is now deeply influenced by the exhaustion of the democratisation model, pushing firms to redefine luxury. At the same time, this pandemic has forced participants to improve their ability to adjust to changes in demand and enhance their resilience dynamics. These important changes are driving all ecosystem participants into a new era of coevolution that is characterised by self-renewal, in which participants must undertake profound structural and cultural changes and incorporate new innovations (Moore, 1993).

5.3. THE IMPACT OF COVID-19 ON THE ECOSYSTEM

Within the exhaustion of this growth model, I have identified several cognitive biases that hinder knowledge flows within the luxury fashion ecosystem. Understanding and more deeply

analysing these biases will allow firms to determine the real drivers of and obstacles to the emergence and creation of new opportunities for cross-fertilisation of interdisciplinary insights across this ecosystem, as well as allow them to accelerate all innovation processes. Nevertheless, this ecosystem's process of exorbitant growth, transformation, and rethinking has been shaken by the eruption of the COVID-19 pandemic, which has heavily impacted all ecosystem stakeholders and forced each to rethink its current vision, strategic objectives, value propositions, and innovation framework. COVID-19 has envisaged and made more prominent these knowledge biases and disorders, as well as the real erosion, fragility, and saturation of the current luxury fashion model that was becoming obsolete and uniform. The rise of the pandemic has accelerated these changes and deeply affected cognitive biases.

Boston Consulting Group revised its initial estimates and forecasted a decline in sales of between US$85 and US$120 billion from 2019 to 2020, or around 29.2 per cent of the US$350 billion luxury market. The fashion and luxury category as a whole will lose between US$450 and US$600 billion in sales (Biondi, 2020). The leading advisor to the global luxury goods industry, Bain & Company (2020), reports that after falling by an estimated 25 per cent in the first quarter of 2020, the downturn should accelerate in the second quarter and could lead to an estimated overall contraction of 20 to 35 per cent for 2020. According to the seventh edition of the 'True-Luxury Global Consumer Insight' study, the luxury industry will gradually recover its losses but will not return to 2019 levels until 2022 or 2023 (Boston Consulting Group & Altagamma, 2020). The pandemic has also affected supply because the two primary manufacturing countries for personal luxury fashion—Italy and France—were locked down and heavily struck by the outbreak of COVID-19 (Kapferer, 2020).

Comparing COVID-19 with the 2008 financial crisis, the pandemic has affected all luxury fashion consumers from its onset because COVID-19 has impacted consumers equally and without distinction as a health emergency. By contrast, the financial crisis affected consumers indirectly and in a gradual and differentiated way depending on their demographic, socioeconomic, and geographical characteristics. The pandemic has also had an unprecedented impact on people's personal lives via their mental health (Singh et al., 2020; Tubadji et al., 2020) and has imposed many environmental constraints (Hamilton et al., 2019). At the same time, the virus' cultural and economic impact has created a 'new normal' that has necessitated a radical transformation in how people interact and operate within the workplace that could potentially influence many facets of consumers' daily lives for the foreseeable future (Dwivedi et al., 2020; Griffin & Denholm, 2020). The current crisis is, therefore, much deeper than 2008's and will affect not only consumers' behaviour and their purchasing and consumption habits but also their perceptions of luxury and how they externalise, express, and share their own experiences as users with others.

During this era of the pandemic, the consumers of luxury fashion—like all people—have been subjected to unprecedented psychological and survival pressures and environmental constraints that have pushed them to:

- **Learn to improvise, quickly learn new buying and consumption habits, and rethink their return to old habits** (Sheth, 2020). For example, luxury fashion consumers cannot go to the store because their mobility is constrained, but the store and sales associates can deliver items to consumers' homes so they can privately try them on. Sheth (2020) explains the following immediate effects of COVID-19 on consumption behaviour: Hoarding is a common reaction to managing uncertainty over the future supply of basic necessities, and improvisation is a new habit in which existing habits are discarded and new ways to consume are invented. Another tendency is pent-up demand due to postponing the purchase and consumption of discretionary products or services. At the same time, and due to the

lockdowns, consumers are unable to go to stores or shopping centres, and instead, the stores 'come home'. Additionally, with more flexible time at home, consumers have experimented and practised their talent, performing creative new ways and forms of consumption, sharing learning, and shopping online more creatively (Sheth, 2020).

- **Learn to use and adopt new technologies.** Consumers have had to quickly embrace emerging technologies, affecting these technologies' development and adoption by luxury fashion firms in this traditional industry. This learning has introduced new digital trends related to purchase, consumption, and sharing experiences among consumers, and luxury fashion houses have needed to speed up their digitalisation processes.
- **Learn innovative ways to cope with consumers' new, blurred, and uncertain boundaries**. This new situation has pushed consumers to learn innovative forms of coping with the vague new boundaries of work, leisure, and education that have been transformed and drawn by the pandemic.
- **Learn new forms of socialisation for life events and social contexts.** Consumers have had to learn and experience new forms of socialisation for key life events and social contexts, including the workplace, community, neighbours, and friends (Sheth, 2020). All people have adopted habits such as wearing masks, using sanitizer, regularly washing hands, practising social distancing, using new mobility patterns, not going out unnecessarily, partying or going out less (or not at all), having minimal participation in social gatherings like weddings, and working from home. Processes of socialisation had never taught us to behave like this, but all human beings—including luxury consumers—have needed to learn these practices, and this has affected their shopping preferences as well as the way they use fashion to express and communicate themselves and their image. According to Vardhan (2020), COVID is bringing change to human socialisation and communication in a process called 'covidalisation' (i.e., COVID socialisation).
- **Reflect on COVID's health and pain effects.** Consumers have reflected on how COVID's health and pain effects, restrictions, access to basic needs, and so on have affected their own consciences, well-being, values, beliefs, solidarity, and life priorities.
- **Reflect on luxury's new role and its meaning within their lives.** This pandemic has also made consumers reflect on luxury's new role and what it means in their lives, such as in terms of the importance of the individual, the image that luxury fashion consumption aims to project to the world and society, the relevance of the product itself, and the importance of supporting artists and craftmanship initiatives to create sustainable ecosystems more aligned with their changing conditions. In a post-virus world, more intimate consumer values on luxury may prove more relevant than ever and replace the previous narcissistic consumer behaviour (Kapferer, 2020).

All these factors will drive the emergence of new and unpredicted forms of buying and consumption, as well as new and unprecedented combinations of consumer priorities, expectations, sought-after benefits, and perceptions of luxury fashion. Taking the approach of environmentally imposed constraints, Kirk and Rifkin (2020) examined consumer behaviours during the pandemic and found three phases of consumer behaviours and reactions: reacting (i.e., focused on hoarding and rejecting); coping (i.e., focused on maintaining social connectedness, do-it-yourself behaviours, changing views of brands); and longer-term adapting (i.e., driven by potentially transformative changes in consumption and individual and social identity). Luxury fashion research must progress beyond simple recognition of the bandwagon effect in luxury fashion consumption. Firms need to undertake a deeper analysis of the new, more complex characteristics and behaviours of the luxury consumer and the new forms of luxury consumption to create a new taxonomy of luxury fashion consumption (Braun & Wicklund, 1989; Dubois et al., 2005; Mason, 1984; Wilcox et al., 2009).

Luxury's supply chains and its stakeholders have experienced unprecedented disruption due to COVID-19, showing the need for new relationships, models, and value propositions. The pandemic is forcing many organisations to undergo a significant transformation, rethink the key elements of their business processes, and increase the use of technology to maintain operations whilst adhering to a changing landscape of new guidelines and new procedures (Dwedi et al., 2020). The traditional supply chains and processes of luxury fashion also need to be revised and rethought, as they should align with the upcoming post-pandemic recovery, the subsequent wave of globalisation, and their consequences and resulting new taxonomy of luxury fashion consumption.

Within the case study for the luxury fashion ecosystem, I have identified and analysed current knowledge biases that are fully affecting the observed ecosystem's cognitive impairments, described in the following sections.

5.4. BIASES RELATED TO NOTIONS OF LUXURY AND CONSUMER BEHAVIOURS: THE NEW CODES OF THE LUXURY ECOSYSTEM

The enormous and complex changes that are now taking place within the societies, cultures, and environments in which we live are influencing the changing needs, priorities, behaviours, and values of luxury fashion consumers. The fast-moving, constant transformation that is taking place in this market is affecting our perceptions of luxury fashion consumers and also their behaviour, thus producing a gap between our perceptions and reality. This section describes factors causing the gap in knowledge about luxury consumers.

5.4.1. Different notions of luxury

The definition of luxury is no longer as standard and simplistic as it appears, as 'luxury' has many connotations and approaches. Reviewing the existing literature, one realises the definition of luxury is not monolithic but is now more diverse than ever. This is a dynamic concept with different approaches (e.g., from the consumer or product perspective) and a multidimensional construct of cognitive, emotional, and motivational human psychographic and behavioural variables (Wiedmann et al., 2007) that rely on deeper and ever more distinct individual and cultural dynamics. These dimensions are influenced by sociocultural variables related to localised ecosystems with new lifestyles and realities—which combine, for example, global with local trends, variables of individual behaviours and personalities, and variables of interpersonal influences—that cause differences in consumer behaviour within and across national borders (Dawar & Parker, 1994; Miller, 1995; Shaw & Clarke, 1998). At the same time, luxury takes on many different forms for different people and depends on the consumer's mood and experience.

5.4.2. New general perceptions of luxury

When it stood for lavishness and opulence, luxury was all about ostentatious displays to signal social exclusivity and high class; it was perceived as the opposite of ordinary. However, the aspirational race that led consumers to use luxury as a vehicle for social mobility to gain peer approval has only led us to conformity and luxury fatigue (Tak et al., 2017). Thus, if excess has now become ordinary, then luxury by definition must become the opposite of excess. Instead, though, luxury has become more affordable (Kapferer & Bastien, 2009; Mundel et al., 2017), and the strategy of 'exclusion' is losing its personal relevance. As a result, luxury fashion now lives in an era of

excess determined by mass production and the Information Age. Within the democratisation of luxury, the word 'exclusivity' no longer resonates on its own. We appear to be moving towards the New Age of Meaning, in which authenticity, sustainability, sense, and shared experiences are becoming the most valuable social currencies (Olbertova, 2019). 'Luxury' appears to be gaining the opposite meaning of what it held in the past.

5.4.3. Art and culture's role within the luxury fashion market

While art has always been important in the luxury fashion sector, there are different perspectives and approaches on art's relevance and significance within the fashion industry and on related consumer perceptions. While some companies and experts claim a strong relationship exists between art and luxury fashion products and brands, others argue that companies might be using art as a mere communication strategy to maintain their relevance and desirability among their target audience. From the first perspective, the collaboration between luxury brands and artists enhances the perceived value of a product by evoking positive emotions in consumers (Estes et al., 2018). Historically, luxury fashion companies have used art to create unique consumer experiences (Naletelicha & Paswan, 2018). Koronaki et al. (2018) state that integrating art into brands results in emotional value for luxury-brand connoisseurs and suggest this emotional value positively affects brand attachment and brand loyalty. On the other side, some important figures in the industry have rejected this form of collaboration. Kapferer (2014) introduced the term 'artification' to criticise this phenomenon, writing that the artification process 'is timely for a sector that is becoming increasing less artisanal' and more democratic. The researcher uses the artist Andy Warhol as an example, indicating that luxury brands have learned a lesson from Warhol, who considered technical reproduction to be art (Kapferer, 2014).

Since the democratisation of luxury, the sector has become more global, integrated, and accessible, shifting away from small, local family businesses based on features such as feelings of privilege, rarity, exclusiveness, craftsmanship, uniqueness, and personalisation; luxury fashion has moved toward a highly profitable, international industry more focused on branding and growth. This industry is actually driven by the rationale that luxury 'is not because it is art anymore, but rather because it needs to be viewed as art' (Kapferer, 2014). Another perspective claims brands should be patrons of contemporary local artists in concordance with luxury brands' genuine values. This may be seen as a more sustainable practice that will determine sustainable new associations with the brand. This perspective should be led by the 'geolocalisation' of the artists with whom the brand collaborates, which would enhance awareness of the local cultures and habits, as well as attract new local customer segments by fostering specific local promotions and events.

Applying the cultural iceberg model (Hall, 1976), all of the perceived relationships among art, fashion, clothing, and lifestyle are determined by the cultural notions, values, and beliefs (e.g., on life, age, time, beauty, gender roles, work) of each cultural group, society, country, and so on. These relationships create important biases that, alongside segmentation, must be considered when determining the roles of art and fashion within luxury fashion companies' international marketing strategies.

5.4.4. New roles of self-expression when projecting one's identity and self-worth to others through luxury fashion

In a culture that values individuality, personality, and belonging—and in which personal appearance and body image are crucial—the clothing and accessories that we choose to wear provide

a potential opportunity to fulfil our need for self-expression and for communicating and projecting our identity to others (Belk, 1988). We use dress to manage our appearance, which reflects, shapes, and even changes our identity. Self-expression is an important driver of consumer preference and choice (Aaker, 1999; Belk, 1988; Richins, 1994). Contemporary society introduces complexity that requires further understanding the social-psychological mechanisms that shape people's behaviour. Social media constantly exposes people to their own and others' dress and appearance, and such societal changes call for updating our knowledge in this area of study. Dress- and luxury-related behaviours and self-expression are currently under review using the lens of social psychology due to their new complexity and ambiguity. This complexity is underpinned by the following personal and social tendencies that can hide or project a blurred image of real, complex consumer behaviour towards luxury fashion products:

- **Changes to perceptions and understandings of some traditional identities (e.g., gender, race, beliefs, roles, social group memberships).** More people now accept gender-fluid identities, and the multiracial proportion of the population is growing quickly. At the same time, new behaviours are increasing; for example, pro-environmental behaviour involves personal changes to decrease the harmful effect on the environment (Ates, 2020; Mostafa, 2006; Shrum et al., 1995; de Leeuw et al., 2015). The rise of these new personal identities is affecting traditional behaviours related to luxury fashion.
- **'Logomania' obsession.** Nowadays, we cannot deny the leading role that logomania and brands play in the marketplace, and especially in luxury fashion, for fulfilling our persistent need to express individuality, personality, and belonging. The abuse of logomania is because known luxury brands tend to strongly influence consumers' decision-making on purchases because they provide a valid and rapid means of identification (Cătălin & Andreea, 2014). By choosing a particular brand, a person may reaffirm both their own and others' perception of their desired identity (Cătălin & Andreea, 2014).
- **The complex and ambiguous relationships between the new social patterns of consumer's self-construal theory about individualism/independence and collectivism/interdependence with luxury fashion consumption.** This describes how people see themselves in relation to others and how this influences their cognition, emotions, motivations, and relationships with others regarding their luxury product consumption (e.g., social approval, buying decision-making, consumption, and brand evaluations and attitudes)—thus, determining very different self-construals and behaviours (Triandis, 1995). Consumers who purchase luxury products are concerned with how others view them and are more susceptible to interpersonal influence (Yim et al., 2014). This can explain why motivations for the consumption of luxury brands are primarily based on others' evaluations (Bushman, 1993). However, according to Bakir et al. (2020), it is not currently clear how, and to what extent, both individualism/independence and collectivism/interdependence self-construal affect attitudes toward luxury brands. Consumers with interdependent self-construal place importance on prestigious and luxury brands (Aghaei et al., 2014), which enables them to impress others, receive social approval (Clark, 2006), and enhance their ideal interdependent self-concept through group affiliation (Sirgy et al., 1997; Gentina & Chandon, 2014)
- **Prior research has shown mixed results concerning the relationship between independent self-construal and the way individuals consume luxury items** (Bakir et al., 2020). Consumers with the individualism/independence self-construal can express their value of being unique by consuming expensive and/or scarce luxury goods that many others may not be able to afford (Tepper & Hoyle, 1996). Also of note, Kastanakis and Balabanis (2012) depict a negative correlation between independent construal and status symbol

consumption since the signalling value of a luxury good disappears (for the person with higher need for uniqueness) when many people own it—that is, when this luxury eventually becomes a 'mass symbol'. These inconclusive findings highlight the need for more research that explores the relationship between independent self-construal and luxury consumption. During adolescence, individuals assert independence while seeking approval from their peers, and they value luxury brands that appeal to mass-market consumers (Gentina et al., 2016).

- **The complex, ambiguous relationships between luxury fashion consumption and new social patterns among consumers related to the self-worth theory of motivation.** This theory states that an individual's main priority in life is to find self-acceptance, which is often found through achievement (Covington & Beery, 1976). Prior studies have shown a significant relationship between self-esteem and the consumption of luxury products for self-directed pleasure, suggesting that individuals can maintain or boost their contingencies of self-worth by purchasing luxury goods (Truong & McColl, 2011). Through the value-expressive function, luxury brands help consumers communicate facets of their self-identity (e.g., success, sophistication) to others (Hudders & Pandelaere, 2012). Material accomplishments enable individuals with contingent self-worth in the competition domain to achieve a sense of superiority in terms of owning better gadgets and more luxurious products (Nagpaul & Pang, 2017). Research has shown the desire to demonstrate social superiority to others—status-seeking—motivates individuals to possess luxury goods (Tsai, 2005). On the other hand, as Bakir et al. (2020) write, a high level of the virtue or moral dimension of someone's self-worth may mitigate the development of positive attitudes toward luxury.
- **Increasing divergence between consumers' personal appearance as part of their self-worth and their desired body image.** Many people focus on appearance-contingent self-worth—that is, individuals stake their global self-evaluation on whether they meet social standards for physical attractiveness and body image—and they expend a great deal of time, money, and effort enhancing their attractiveness (e.g., more time grooming and shopping, from Crocker et al., 2003). The domain of appearance is one of the strongest predictors of global self-esteem, especially among adolescents (Harter, 1986), who are the growing audiences of luxury fashion. However, the luxury fashion market also has consumers with lower levels of appearance-contingent self-worth and who are less focused on their appearance, body shame, body surveillance, and body comparison (Modica, 2019).
- **The gap between luxury fashion consumers' personal appearance and the fashion choices and body image they want to project** for several reasons: First, basing self-worth on one's physical appearance is associated with specific negative consequences not only for people's view of and satisfaction with their physical appearance but also for their overall self-evaluation (Adams et al., 2017). Recent research has framed positive body image as a complex, multifaceted construct distinct from low levels of negative body image and extending beyond body satisfaction or appearance evaluation (Tylka & Wood-Barcalow, 2015); thus, adequate understanding and measurement of positive body image's multiple facets is needed. Second, traditionally psychological research on dress and clothing practices has focused on women, but the fusion of consumption and identity apparent in market segmentation has placed a greater emphasis on narcissistic aspects of self previously unavailable to men and evokes a greater emphasis on appearance and display (Frith & Gleeson, 2004). Finally, according to Frith and Gleeson (2004), appearance through clothing and fashion has been marginalised within the narrowly focused field of personal perceptions, which mainly addresses how clothing is perceived by others rather than how the wearer uses clothing to construct a particular image (Damhorst, 1990), as well as ignores people's

everyday clothing practices, and overlooks the context-specific sociocultural meaning of clothing (Tsëlon, 2001).

- **Previous research treating clothing as the expression of pre-existing essentialised identities** (Frith & Gleeson, 2004). Fashion does not promote the ideal body (as opposed to natural body) but an imagined body (Venkatesh et al., 2010), thus entailing a universe of personal possibilities when selecting clothes for a specific use and moment. Currently, consumers' attitudes and preferences related to appearance are more linked to their perceptions of the aesthetics of fashion (Venkatesh et al., 2010). Consumption is no longer viewed merely as material sustenance, but also as a heightened aesthetic experience (Holbrook & Hirschman, 1982; Joy & Sherry, 2003; Sjöstrand, 1997), which shapes the relationships between personal appearance and body image.

5.4.5. Summary

All these factors have surfaced the notions of individuation, aesthetics, and self-expression, which makes perfect sense as the new codes of luxury emerge due to the democratisation of luxury fashion. These notions alter the traditional rationale and logic of consumer decision-making within luxury fashion, thus introducing a wide variety of individual variables, dimensions, and notions more related to the consumers' DNA and self-construal of their identity. Unlike the period before the democratisation of luxury, there are currently no clear, predefined patterns of consumer behaviour at the international level. For that reason, the standard models of luxury fashion brands have been challenged, as they are increasingly striving to address individual consumers' needs by complementing their identities and personal lifestyles (Olbertova, 2019). The nature of associations among consumption values and brand relationships might vary significantly in different segments, and luxury fashion brand managers should find a specific set of customer values appropriate to their luxury fashion products to strengthen the relationship with their customers (Choo et al., 2012). Wiedmann et al. (2009) explored a multidimensional luxury value framework to identify and segment luxury consumers, suggesting that a confirmatory study of luxury consumption value structure was required.

These notions are driving new and different sought-after benefits among consumers that underpin different combinations of material, functional, symbolic, social, and aspirational values that are blurring the consumer's decision-making when buying a luxury fashion product. These emerging and more complex notions and sought-after benefits of luxury fashion should be widely interpreted and understood to:

- **Align new notions and sought-after benefits of luxury fashion with new product and collection development and the aesthetic aspects of design.** Product design provides a medium for expressing the consumer's identity—personal or social—while the need for uniqueness mediates the relationships between identity expression and design dominance (Byun et al., 2018).
- **Focus more on the creativity of design's aesthetic aspects rather than the luxury-fashion setting (the context, environment, and background in which the luxury fashion currently exists) or its monotonous, ubiquitous global branding imagery.** Luxury fashion firms should also offer vivid imagery and aesthetic experiences through their clothing design and collections to enhance consumers' self-expression (Hirschman & Holbrook, 1982; Dahl et al., 1999; Postrel, 2003). Luxury fashion design must turn to a new, compelling marketing and innovation element (Schmitt & Simonson, 1997; Postrel, 2003) and recover its essence. The personal value associated with design aesthetics can wield a

powerful, independent influence on consumers' identity expression, and possessing a nice-looking product makes consumers feel more attractive to others and similarly boosts their sense of self (Townsend & Sood, 2012). Although consumers use both design and brand to express their social identity, the positive relationship between the need for uniqueness and design dominance reflects consumers' desire to differentiate themselves in both inter- and intra-group situations in order to mitigate possible conflicts among social identities. Design dominance allows consumers to fulfil their need for uniqueness beyond the boundaries of brands, diminishing brand power and loyalty—thus, enhancing firms' differentiation within the competitive arena (Byun et al., 2018). All this would foster consumer narratives and experiences.

- **Generate more personalised interactions with consumers to understand the key insights and motivators behind their actions, thoughts, behaviours, and expectations.** This dialogue could foster a collaborative process of value co-creation and value-in-use because both the service provider and the service beneficiary would integrate resources (Barrett et al., 2015; Lusch & Nambisan, 2015) and because it would give the consumer an ideator role (Lusch & Nambisan, 2015). Firms should emphasise user engagement, with resources made available in user-provider dyadic exchanges—thus, offering a more inclusive approach (Autio & Thomas, 2019). This would ensure a sustained focus on creating offerings and creations that appreciate diversity, boding well for selective targeting and innovation in this sector (Kumar et al., 2018). For example, Hermès is known for its specialisation in silk scarves commonly marketed to and worn by women. But the consumer mindset is constantly evolving, and it is becoming popular for some men to wear these scarves even though the Hermès scarf is an iconic piece associated with women. But how would a sales associate know to offer a scarf to a man? For this reason, Hermès must train associates to better understand the changing, diverse needs and insights of their customers (e.g., in terms of style, tastes, mechanisms of dress, preferences, needs, and occasions of use). Hermès' sales associates should be trained to exude confidence in order to promote fluid dialogue with consumers and consequently understand consumers' sought-after benefit and values. In the case of the scarf, for example, the sales associate would consider whether it is appropriate to offer a scarf to that male client.
- **Implement service-dominant logic within the luxury fashion sector**. A new and differentiated customisation is required in luxury fashion customer service because of the cannibalisation of new customisation practices implemented within the fast-fashion industry and the new sought-after benefits of the changing target audiences. In a letter to *WWD*, designer and entrepreneur Giorgio Armani stated that the decline of the fashion system as we know it began when the luxury market adopted fast-fashion methods of operation to minimise the delivery cycle in hopes of selling more—yet forgetting that luxury is the opposite, something that takes time to be achieved and to be appreciated. Luxury cannot and must not be fast (Zargani, 2020). Currently, the luxury fashion industry is much more focused on the service-dominant perspective of its market rather than the traditional goods-dominant logic focused on the exchange of goods. In this goods-dominant logic, the firm's purpose is the production and distribution of units of output (such as physical goods), which accrue value during the manufacturing process and are then consumed by the customer (Normann, 2001). In contrast, service-dominant logic defines a 'service' as the application of competencies (knowledge and skills) for the benefit of another party (Vargo & Lusch, 2004). In contrast to goods-dominant logic, service-dominant logic considers service creation and consumption to be a collaborative process, emphasising the user's role in value co-creation (Autio & Thomas, 2019). Then, customer value is produced in a co-creation process between the seller and the customer. Within the process of service-dominant logic

> within innovation, the customer becomes a co-producer and main protagonist of the service, which is also being consumed; thus, customers play a central role within this process and innovation, and they function as active participants in value creation (Vargo & Lusch, 2008). The customer becomes primarily an operant resource (co-producer) rather than an operand resource (target) and can be involved in the entire value chain (Hollensen, 2020).

Luxury fashion firms should also provide a collection of diverse resources, competencies, and assets to the customer, who could then add and blend them. In combination, these would provide a benefit or service to both the customer and the seller (Bharadwaj, 2000; Karaosman et al., 2018). This collection of resources and competencies—brought together by the seller and the customer—includes an entire network of resources that work together to produce value, and it includes a wide diversity of new and changing technological resources and assets, employee competencies and skills, managerial competencies, material resources, and so on. Simultaneously, firms should create high-quality, unique consumer experiences by focusing on all five of the senses through which humans engage with the world around them: sight, sound, smell, touch, and taste. Consumers' entire understanding of the world is experienced through these senses, which are their link to memory and can tap right into emotion (Hollensen, 2020). Firms should assess the importance of senses' role in designing customer experiences and their impact on purchasing decisions, especially in this sector. Companies should be aware of consumers' reactions and behaviours through communication channels and touchpoints rather than the product itself in order to enhance the customer experience. Additionally, companies should be aware of and track consumers' increasing expectations for adaptive services and experiences to feed their changing needs and innovate (Bain & Company, 2019).

In parallel, firms should take into account that they can offer different forms of services, such as self-service, e-services, and personalised services. They must analyse customer preferences and perceptions in depth within different sociocultural contexts in order to satisfy their specific wants with these specific forms of services. Vargo and Lusch (2008) argue that in service-dominant logic, the firm (seller) cannot create value, but only offer different value propositions; then, it is up to the customer as an operant resource to select those value propositions that are necessary to 'solve his/her specific problem' and ultimately create new and differentiated customer value. To implement service-dominant logic, luxury fashion firms must organise their service activities and processes, resources, competencies, and international marketing activities in a manner that supports the development and selection of those appropriate value propositions. This strategic decision—adequate selection of resources and competencies, appropriate development and design of these services' value propositions, and their delivery to specific consumer journeys—should account for consumers' desires, perceptions, and behaviours as much as possible, as well as factors like the specific sociocultural influences, the economic situation, and competitors' service offerings. These are particular difficulties in achieving uniformity among marketing parameters in remote locations, where exerting control can be especially problematic.

Pricing, too, can be extremely difficult because fixed costs can be a significant portion of the total service costs. Consumers' ability to buy and their perceptions of the service received may vary considerably between markets, resulting in significantly different prices and profits. Moreover, preserving customer loyalty to obtain repeat business may prove difficult because of the need to provide personalised services (Hollensen, 2020). As an example, Louis Vuitton recently opened Le Café V, the first ever Louis Vuitton Café, in cooperation with renowned chef Kosuke Suga. The space is located inside the firm's new flagship store in Osaka. The store's design offers different intimate atmospheres that shape different consumer experiences and stimulate all five senses, and the store combines Osaka's maritime aesthetics, Japanese culture, and the brand's own identity.

Within this type of innovation, these combinations and value propositions scale up unique customer experiences and consumer journeys.

5.5. MARKET SEGMENTATION BIASES

Several factors have led to a transformation of the luxury fashion market's audience: the market's maturity, the development of the new codes of luxury, the alteration of traditional patterns of consumer behaviour in this market, and the enormous individualisation and sophistication of consumer behaviour. This transformation is generating a fundamental shift in the audience profile; while traditionally the market was viewed as simple and compact segments, it now has more complex segments and also emerging segments and audiences with a wider range of needs to assess and satisfy. This market transformation is being driven by several current consumer biases within this ecosystem, described in the subsequent subsections. These biases entail new consumer behaviours and cognitive impairments that are emerging due to global and local economic, social, and cultural changes that affect all audiences in different ways. These new behaviours and the growing diversity of consumer profiles distort all previous patterns of segmentation and targeting strategies because time dependence remains an important concern in international segmentation (Lemmens et al., 2012). As discussed by Steenkamp and Ter Hofstede (2002), 'Over time, the number of segments, segment sizes and structural properties of international segments may change'. From a managerial viewpoint, ignoring dynamics in international segments is likely to lead to suboptimal marketing strategies (Lemmens et al., 2012), and as a consequence, the segmentation and targeting strategies of this market need to be reviewed and updated constantly and conveniently.

5.5.1. Market segmentation within developed countries

Consumers in developed countries represent 45 per cent of global personal luxury goods market value (Bain & Company, 2019), and a wide-scale transformation in luxury consumer patterns is taking place in developed nations because their evolving cultures and subcultures (e.g., religious, ethnic) are gaining increasing influence. These consumers prioritise such characteristics of luxury brands as product quality, self-concept, and self-pleasantness, and they have more complex behaviours (Yim et al., 2014). Luxury brands will need to acknowledge and address these groups to remain relevant (D'Arpizio et al., 2019a). In these countries, middle-class people worry about the future and are less optimistic, so progress is no longer associated with happiness (Kapferer & Bastien, 2012); they fear their children will have a less pleasant life than their own. This uncertainty has shaped consumer behaviours and reactions to new patterns of responsible consumption that brands should identify and track to develop and deliver more adjusted products and services. In these countries, luxury firms must handle a growing diversity of consumer profiles and local habits that are driven by an increasing diversity of expectations. Thus, brands should develop and adjust a wide range of strategies. Also of note, the shopping habits of Western consumers differ notably across the major European markets, reflecting the need for luxury brands to position accordingly in different geographies (The Luxury Opportunity, 2015).

5.5.2. Market segmentation within developing countries

The outbreak of new economies in developing countries has driven the emergence of newcomer market niches and consumer segments to satisfy their needs. These new segments are shaped by new combinations of sociodemographic and sociocultural variables that differ from those

of audiences in developed countries. The rise of middle-class consumers in those rapidly transforming emerging markets has attracted the attention of luxury business executives (Belbağ et al., 2019). Imbued with the confidence to spend, underpinned by a lifetime watching new skyscrapers rise in tandem with their family incomes, these consumers are eager to tap luxury as a means of social advancement and self-differentiation (Luan et al., 2019). Within these countries, luxury consumption is characterised by significant focus on the social values and status/elite belonging consumption (Naumova et al., 2019). Thus, managers of luxury fashion companies must understand and qualify the new middle class in emerging markets not simply by their access to disposable income, but according to deeper attitudinal and behavioural characteristics (Belbağ et al., 2019). In these countries, as basic needs are met, there is an additional challenge to innovation: determining the subtler factors that nevertheless affect customers' choices—the so-called 'hidden needs' (Goffin & Mitchell, 2016; Goffin et al., 2010)

5.5.3. New younger and conscious audiences

The influence of younger consumers and conscious buyers is growing, and new generations will be the primary engine of growth for the luxury market in the coming years. Generations Y and Z will represent approximately 55 per cent of the 2025 luxury market and will contribute to 130 per cent market growth between now and then, offsetting the decline in sales among older generations (D'Arpizio et al., 2019a). Their expectation for luxury brands to be aligned with their values is becoming increasingly important. The younger affluent generations are indeed more conscious of the environmental and social impact of their purchasing decisions (Nielsen, 2015). Growth in luxury has been primarily driven by brand heat and newness, although millennials and members of Gen Z are increasingly demanding higher quality and greater sustainability (DiPasquantonio, 2020).

5.5.4. Macro-segmentation versus micro-segmentation

A current strategic dilemma exists between global fashion trends, as supported and adopted by large luxury corporations, and the local market tastes and preferences in fashion and styling that are attached to the culture and behaviour of a country's inhabitants. Macro-level segmentation includes geographic, political, economic, social, and cultural data that have been collected across countries, and luxury firms have widely used this approach to identify global market segments—ignoring within-country heterogeneity. Luxury firms have used micro-level segmentation bases in international segmentation research to understand and classify local audience profiles and behaviours. Micro-segmentation can use product-specific bases for market segmentation that include perceived product characteristics or consumer-specific bases such as lifestyles and values (Mooij & Hofstede, 2011). Whereas consumer-specific bases are closer to the consumer, product-specific bases are more actionable (Urban & Hauser, 1993). Macro-level segmentation leads to a conceptual framework for offering products and/or global marketing strategies that are standardised across countries by targeting the same consumer segment(s) in different countries (Verhage et al., 1989) and with the aim of maximising economies of scale, homogenisation, and the integration of marketing activities across markets globally (Kotler & Keller, 2013). Simultaneously, micro- or domestic segmentation can lead to a multi-domestic segmentation and strategy, wherein each country represents a separate segment (Jeannet & Hennessey, 1998), or to an individual-level segmentation basis that is more heterogeneous and can have a range of domain-specific characteristics such as consumer attribute evaluations, attitudes and risk, brand loyalty ratings, and values. Micro-segmentation aims to enhance market responsiveness by responding to each market's needs and wants (Hollensen, 2020), as well as by recognising the countries' unique cultural and social heritage

and the different local meanings of luxury. Time dependence remains an important concern in international segmentation.

5.5.5. Poor and simple segmentation strategies and biased targeting

According to Jodie Huang from Mindshare North America, luxury consumers are not just one demographic: 'Something critical for brands to know about these consumers is that you can't pigeon-hole all luxury consumers into one or several groups' (Mindshare, 2018). When segmenting markets, many marketers rely on demographic information, such as age, gender, race, employment, education, and income, while ignoring the deep drivers of consumer decision-making processes that could be used to obtain personally meaningful segments and consumer behaviours. These drivers include customers' behavioural and psychographic variables related to the offered product/services, such as lifestyles, purchasing and consumption habits, frequencies and occasions of product use, attitudes, beliefs, sought-after benefits and emotions, expectations, personality, aspirations, and feelings. For this reason, if luxury firms focus more on demographic segmentation, they can have biased assumptions of their audiences and fail to acknowledge or attract those important segments when targeting them. When firms use only product and demographic criteria of segmentation, all customers could fall into a specific product or market segment (e.g., moms, millennials, Parisians) and products would be marketed identically, providing luxury firms with a blurred image of those customers' expectations, sought-after benefits, and so on. Those brands that deeply know their customers, segments, and behaviours can target their customers more conveniently, efficiently, and respectfully, and they have the potential to attract more loyal and richer market segments.

5.5.6. Addressing market segmentation biases

To remove these biases, firms should develop and implement the following strategies:

- **Increasing behavioural and psychographic segmentation and multivariate segmentation.** Rather than relying on biased assumptions that focus more on demographics when segmenting markets, marketers might attempt more creative methods to break into affluent luxury audiences by implementing different and more solid segmentation approaches based on psychographic and behavioural/attitudinal approaches, which they can also combine with demographic and geographic approaches. Lin (2002) writes that simultaneously combining segmentation variables like demographics and psychographics can create precise information on relevant, apparently hidden submarkets and subsegments. Psychographic aspects of the consumer (e.g., feelings, thoughts, reflections, lifestyles, personality) can provide researchers and managers with more descriptive insights into consumers and their lifestyles (Lesser & Hughes, 1986), and can even be used to help predict future behaviour regarding luxury fashion (Sandy et al., 2013). According to Kotler and Keller (2013), behavioural segmentation divides consumer into groups on the basis of (1) knowledge of; (2) an attitude toward; and (3) a use of or consumer response to a product and its meaning, and this segmentation method has the advantage of using variables that are closely related to the luxury products/services and their attributes. Some of the more common behavioural segmentation variables are consumers' benefits sought, rate and occasions of use of the luxury products, brand loyalty, readiness to buy, purchase occasion, major influencers, and price sensitivity.
- **Enhancing the fusion of macro- and micro-segmentation approaches**. Steenkamp and Ter Hofstede (2002) recognise a key conceptual problem in international segmentation:

General or macro- (domain-specific) segmentation bases tend to be more (less) construct-equivalent and yield more (less) accessible and stable segments, but also tend to be less (more) actionable and responsive. The authors suggest a two-step model that combines the macro- and micro- approaches to segmentation. Firms must create new relevance, cultural connections, products, and stories (Olbertova, 2019) for engaging both global and local audiences. Respecting and honouring the cultural heritage of key target audiences and supporting local cultural events as well as craftsmanship initiatives remain powerful strategies to explore for creating momentum and consumer bonds. Additionally, luxury brands have to mine local cultural symbolism in order to localise brand meaning. In this way, luxury fashion houses must try to optimise the balance between standardisation and adaptation of the firm's international marketing activities if they want to remain competitive (Svensson, 2002). These firms have to focus on determining and understanding both the underlying forces for global integration and market responsiveness.

- **Enhancing value proposition framing within value-in-cultural-context innovation.** As discussed earlier, changes in customers also mean that traditional market segments can disappear, change, or fragment and that companies will need to adjust their product ranges accordingly, thus boosting all innovation processes within this ecosystem. To cope with this diversity and complexity, luxury firms should develop new models of innovation based on generating the value-in-cultural-context that uses value proposition framing and business models' adaptations to different contexts to meet emerging consumer requirements, reducing uncertainty and promoting a nascent ecosystem over that of incumbents and focal firms (Snihur et al., 2018). These models should regulate perceived value among these different contexts. They can also facilitate productive innovation and idea exchange in their own right, as shared institutional logic across the supply chain can homogenise business and cultural assumptions, evaluation methods, and mental frameworks, as well as rules of exchange within luxury brand-consumer dyads (Autio & Thomas, 2019).

By applying these new approaches to segmentation and targeting bases, firms will gain a better understanding of their consumers and their cognitive impairments and, hence, improve all their marketing and innovation strategies and programmes.

5.6. LUXURY FASHION PRODUCT ATTRIBUTE BIASES AND STRATEGIC BIASES

A product's attributes are what makes it distinct from other products. Based on previous research, Eckman et al. (1990) determined the importance of fashion products' attributes relies on elements such as product composition, style, colour/pattern fit, fabric, textures, fibre content, care, durability, coordination with wardrobe, quality, construction, and fabric. Product development and planning objectives are often set based on improving consumers' perception of a product in terms of the specific product attributes deemed to be most important. From a consumer perspective, these attributes determine the set of considered attributes and influence the ultimate purchase decision (Wallace & Sherret, 1973). By identifying the product attributes and measuring their relative importance in the target market, marketers can determine the most suitable offering for a given market (Hawes & Baker, 1994). Currently, consumer perceptions of a fashion product are strongly influenced by the brand perceptions and the consumer's image of the product rather than the product's physical attributes. Consumers compare products to their perceptions, which are highly influenced by their perceptions of the product's brand. As marketing and branding expert Stephen King (1973) noted, 'A product is something that is made in a factory; a brand is something that is bought by a customer. A product can be copied by a competitor; a brand is unique. A product can be

quickly outdated; a successful brand is timeless'. People perceive brands differently than mere products and are both more inclined to trust brand quality and prepared to pay more for the reliability this quality and trust imply (Rubinstein, 1996) because a product's reputation is more about what the brand represents—symbolic value—than its technical qualities (Wiedmann et al., 2009).

At the same time luxury brand perceptions are difficult to change because a consumer's brand loyalty and attachment have a strong emotional component (Keller, 2010) and create strong personal involvement through various emotional benefits (Garbarino & Johnson, 1999). According to Tsai (2014), brand attachment has four indicators: (1) The right physical chemistry exists between the brand and the consumer; (2) the brand and the consumer seem to be meant for each other; (3) the brand fits the ideal standard of the consumer's self-image; and (4) the consumer feels miserable if the brand is not available. By their very nature, luxury brands drive brand attachment and have a systematic positive effect on intentions to purchase (Kaufmann et al., 2016). Due to the rapid growth and democratisation of the luxury fashion sector and markets in recent years, as well as due to greater accessibility to the market through digital communication platforms, branding and logomania have become a strategic trend used by firms to reach more market niches and expand their audience. Therefore, branding and logomania are also recognised as current strategic topics in marketing and managerial studies (Emond, 2009; Ko & Megehee, 2012).

All these elements have overshadowed the role of the product's core attributes, which are the essence of their differentiation from other products. As a result, and within this spiral of logomania, brands are creating a false perception of luxury and are confusing their customers with an illusion of exclusivity and status (Brocca, 2018). Currently, the aspirational value and status value of luxury products appear to be more important factors in conspicuous consumption than the quality, craftsmanship, and exclusivity of the product (Brocca, 2018). In the 21st century, 'loud luxury' features predominate: products with highly visible brand markings that enable people to easily distinguish the brand. Luxury brands use instantly recognisable monogram print, which can be found emblazoned across an extensive array of their bags, clothing, and accessories (Romagnoli, 2020). Atwal and Williams (2009) argue that luxury clientele use these high-end products to make statements about themselves, to create identities, and to develop a sense of belonging, whether they are consciously aware of it or not.

On the other hand, companies should be aware of the differences between the 'loud luxury' and 'quiet luxury' consumers since they represent two important communities of consumers, and firms should assess their relationships with the different types of product attributes. A study by Han et al. (2010) showed that wealthy consumers with little need to demonstrate their status pay an elevated price for quiet brands and pay more attention to the physical attributes of clothes, whereas the affluent with a high need for status buy loud luxury items to distance themselves from less affluent people and pay less attention to products' physical attributes. On the other side, less well-off consumers with a high need for status use loud counterfeit goods to associate with more affluent groups (Bagheri, 2013). Wanting to reach a wider audience with branding, these firms have made silent fashion buyers and the main target groups lose interest in the firms from which they used to buy. The silent luxury consumer has seen the brand image damaged and not in accordance with its principles.

Additionally, in recent years, the rise of logomania has surpassed all other fashion trends, with large logos plastered across all clothing items and accessories. The emphasis on growth based on branding and communication rather than products' quality, originality, and physical attributes has driven firms to enhance standardisation within their portfolio of products, collections, and services. All these strategies have begun to relegate luxury fashion apparel to pure merchandising products and set aside several aspects: Firms have ignored products' design, aesthetics, and craftmanship, and

several firms have left behind the original essence and values shaping the luxury fashion houses' legacies. Many companies have neglected to implement a differentiation strategy focused on the process of adding meaningful and valued differences to distinguish a company's offering from the competition.

When setting aside these genuine, authentic, and iconic aspects, luxury fashion houses appear to be experiencing several cognitive biases that are associated with their strategic decision-making process. Since strategic decisions are characterised by ambiguities (e.g., global and local trends), uncertainty (e.g., COVID-19), and a lack of structure (e.g., multiple segmentation variables and customer profiles), one could expect that strategists would not be exempt from various cognitive biases (Schwenk, 1984). These firms appear to be suffering from a kind of partial strategic bias related to their vision of their businesses because luxury fashion firms are not taking the full picture into account. This is likely due to their inability to enhance their adaptative capacity, reduce their resistance to change, and disrupt their autopoietic processes because their decisions are self-referential and a product of how they see and think about themselves (Goldstein, 1988; Mitleton-Kelly, 2003). It seems their norms and configurations tend to hold organisation-environment relations in a particular configuration because they are guided by their preconceptions (Huff, 1982; Hamel & Prahalad, 1994; Smircich & Stubbart, 1985). One can apply Karl Weick's (1988) idea that organisations enact their environments as part of the self-referential process through which an organisation attempts to hang on and grow, but these actions simultaneously constrain them (Varela, 1996).

To overcome these biases, firms should develop and implement several strategies. These firms must encourage managers to challenge and rethink their firms' identities and missions. I believe these firms currently face a strategic decision-making dilemma blurring their strategic perspective, which they have to overcome. This dilemma has been exacerbated by the COVID-19 crisis and embeds two possible strategic decisions: In parallel, firms could make and implement risky decisions coupled with new strategies and programmes, using some dangerous and unexpected actions; in exchange, this would allow them to have a greater understanding of the current situation. In this situation, their new actions would facilitate their understanding of the environment but could affect future events and make things worse (Weick, 1988). Alternatively, if action is a means to receive feedback, learn, and build an understanding of unknown environments, then a reluctance to act could be associated with less understanding and more errors (Weick, 1988). Firms could remain conformist and safe by taking no actions and waiting for events to occur, but this stagnation could produce more confusion in the ecosystem among stakeholders (Weick, 1995) and greater irrelevance to consumers. Within this approach, brands would become more irrelevant for an increasingly conscious luxury fashion consumer (Todaro, 2019).

At the same time, firms should pay more attention to the physical attributes of the products and services they design and deliver because these are the essence of luxury fashion. The product should be a worthy investment that offers longevity and timelessness. Investing in durable, high-quality pieces is a more effective cost strategy over time than participating in a waste culture driven by fast production models (Olbertova, 2019) that become obsolete and outdated. This approach will enhance luxury fashion firms' ability to differentiate themselves from fast-fashion retailing models and processes. Firms should also attempt to adapt some product attributes to their international audiences, which will facilitate global localisation—'glocalisation' (Robertson, 1995). Firms should focus design not only on products' functional features and characteristics but also on product styling and aesthetics. It is also relevant to enhance the design of the pieces' complementarities, such as their packaging, the stores, and additional services like laundering. Additionally, to enhance customisation, firms should simultaneously have modular offerings from horizontally related

suppliers, and the final choice of which components to integrate—and integration work—could be left to the customer (Jacobides et al., 2018; Reynolds et al., 2005). For this reason, firms should give more importance and relevance to suppliers and collaborators like garment suppliers, complement suppliers, raw materials suppliers, and clothing ateliers. By offering these new 'spaces of creativity' and innovation, firms would deliver multiple value propositions to their customers, give more room to the co-creation of value, and differentiate themselves from fast-fashion companies' practices.

Luxury fashion houses should also focus on developing products' social and intangible attributes—such as ethical-, sustainability-, and labour rights-related attributes and country-of-origin attributes—that are strongly tied to consumers' emotions and feelings. In this sector, as products become more similar and difficult to compare, intangible attributes are expected to play a more important role in consumers' purchasing decisions (Lefkoff-Hagius & Mason, 1990). Previous research has shown that intangible attributes impact purchase intentions and that individuals from different countries tend to value these intangible attributes differently (e.g., Auger et al., 2003; Auger et al., 2008; Erdem et al., 2006; Gürhan-Canli & Maheswaran, 2000). For their product and services, luxury firms should review and update based on social attributes like sustainability, respect, and inclusivity, adapting them by the sociocultural purchasing context and by target audience based on their degree of product involvement. This will determine new forms of differentiation, prestige, and uniqueness among luxury fashion offerings. Understanding the relevance of these attributes will help companies to sustain their competitive advantage. Meanwhile, if luxury fashion brands want to remain relevant and as a reference in the silent market, they should once again focus on this type of consumer, not set them aside, and propose alternatives in terms of product and service design and also personalisation and attention. They should find new strategies to enhance their savoir faire and product quality, once again placing importance on the product itself. Luxury brands should tap both markets (loud and silent) by expanding their portfolio of marketing mixes and brand extensions to appeal to both types of customers and understand the subtle complexities of different target groups.

Additionally, luxury fashion firms should renovate their cobranding and collaboration strategies. A brand's identity has limits, and in the growth process, a brand can overcome these limits through a partnership and hence fill any gaps where the brand is not legitimate or adequate (Kapferer, 2015). Co-branding has become increasingly popular as a strategy within the luxury industry and is not only growth-related (Oeppen & Jamal, 2014). Kapferer (2012) provides various reasons for co-branding, such as achieving success in a different market, increasing the ability to communicate with another target group that might have been inaccessible due to the brand image, and creating buzz around the collaborating brands. Luxury brands can use a co-branding extension strategy because it allows them to offer different combinations of product attributes and limited editions of their products (Shin et al., 2017). The objective could be to increase profitability temporarily by attracting or targeting customers they otherwise would not reach because consumers do not identify with the original brand values.

Firms should carefully analyse and select associated brands to determine new types of brand associations and new transfers of tangible and intangible product attributes and motifs that will enhance the company's brand image and perceptions. Businesses should take into account both related brands and unrelated brands to inspire new connections within their firm's brand association map of perceptions. Correctly identifying this network of strong favourable and unique brand associations in consumer memory (Keller, 1993) will enhance brand equity and the network memory of the consumer. Companies should be able to expand this network of brand and product attribute associations to reach new market niches, as well as to increase their penetration in their current target markets. Companies should identify new ways the brand's equity can be leveraged in the marketplace (Aaker, 1996), and they must convey how these associations can be connected to new consumer

insights and expectations, brand values, and one another (John et al., 2006). For example, launching a limited-edition collection in collaboration with another brand can signal high quality and value to the relevant consumers. From the scarcity and rarity of a limited-edition product, consumers can signal their uniqueness and status by possessing it (Shin et al., 2017). These types of temporary brand associations can generate an improved brand evaluation and intent to purchase by creating a sense of urgency amongst consumers (Shin et al., 2017).

5.7. SOURCING AND SUPPLY CHAIN BIASES

5.7.1. Biases related to a shared performance measurement of the luxury fashion ecosystem supply chain

Internalisation, collaborative networks, and an impressive focus on customers are changing fashion supply chains. In this scenario, performance measurement (PM)—which is considered the best way to monitor and control processes and resources (Neely et al., 2000)—cannot simply be reduced to static and quantitative financial key performance indicators (KPIs) (D'Avolio et al., 2017). To improve supply chain management, firms must introduce and develop a process-oriented approach to performance measurement and a holistic measurement method that includes KPIs related to the main business processes. This process-based performance measurement will enhance firms' ability to recognise problems in operations, monitor process-related progress, support resource allocation, and enhance communication on process goals (Kueng, 2000). Process-oriented KPIs should not be seen as static measures; instead, one goal for a complex industry such as fashion should be to compare KPIs at different stages of the supply chain in order to identify elements such as value-added and non-value-added tasks and bottlenecks.

Currently, the performance measurement approach's selection and design appear to depend on some internal company characteristics (drivers and constraints) and external influences (e.g., stakeholders, markets, suppliers, subcontractors), as well as appear to be associated with different consequences and effects (D'Avolio et al., 2017). In this ecosystem, each firm seems to configure and design information and control systems like the performance measurement approach according to internal factors and needs, meaning there are different isolated systems within the ecosystem. This configuration negatively affects the ecosystem's connectivity and information generativity, which is the overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences (Zittrain, 2006)—thus, providing a blurred image of firms' real performance and reducing their value co-creation capabilities. Firms should continually detect and assess the nature and importance of these drivers and constraints and evaluate their impacts on the most important processes along the entire supply chain within the different participants. Based on this analysis, companies should determine the most crucial, suitable shared and efficient performance indicators to monitor and control. Additionally, for financially focused KPIs, Mattila et al. (2002) propose the following classification system based on the core fashion processes that focus on marketing and retail needs: sourcing, production, distribution, retail, and services. Additionally, D'Avolio et al. (2017) recognise a set of measures and KPIs related to the product development process that is crucial within this type of business model (e.g., sampling indicators, prototyping indicators, ramp-up indicators). At the same time, firms should determine a balance among quantitative and qualitative metrics; resources, output, flexibility, and innovativeness; and general purpose and industry-specific metrics to holistically assess fashion supply chains (D'Avolio et al., 2017).

To fulfil these approaches, I assert that it is fundamental for firms to track all organisational cultural attitudes, behaviours, values, and commitments to this performance measurement approach along the entire supply chain and among its participants. Elements such as the firm's different

business units, resource suppliers, distributors, and logistics subcontractors often represent obstacles to meeting a shared unique objective of performance measurement (D'Avolio et al., 2017). Detecting these internal biases would allow firms to fully exploit this process-oriented approach within the luxury fashion industry. Thus, these firms and their collaborators and stakeholders in the supply chain should agree on and develop a unique process-oriented proposition of shared KPIs in order to enhance the entire supply chain's and stakeholders' alignment and performance. For participants, this agreement would facilitate resource allocation, the exchange and co-creation of knowledge and value, the standardisation of processes, the performance of open innovation, operational efficiency, and a more solid, neat value proposition for the ecosystem (Adner, 2017).

5.7.2. Sourcing biases related to raw materials for luxury fashion: Transparency, traceability, and sustainability biases

As the luxury fashion industry has grown, so has the demand for raw materials in recent years. The quality of the raw materials is inherent to luxury, and thus, there is a need to ensure the highest standards in terms of savoir faire and environmental and social criteria. Luxury fashion houses use the most beautiful leather, the finest cashmere, the softest silk, and so on; products are primarily made with natural materials versus synthetic ones that are manmade, are mostly derived from oil, and have undergone extensive chemical processing. Those natural raw materials come from plants and animals, and they undergo natural processes to turn them into useful materials. What ensures luxury products' quality is the health of the natural sources used to produce these raw materials. High-quality raw materials are notoriously rare and come from countries that have tapped natural ecosystems to create beautiful materials, using the right people with the appropriate skills to ensure the quality of these raw materials along the manufacturing process. Raw materials are the foundation of the luxury fashion supply chain, which transforms them into distinctive, valuable, and workable materials for designers to craft into luxury garments for customers to wear or related items (e.g., handbags). All these manufacturing steps require the greatest care, savoir faire, and know-how related to the materials' intrinsic quality and also sophisticated manufacturing and craftsmanship processes using the right amount of labour force, water, energy, and chemicals to create the highest-quality products (Vallejo, 2018). Whilst the majority of luxury products are manufactured in Europe, the raw materials they use come from all over the world.

To cope with existing requirements and current challenges, firms should develop an adequate sourcing strategy by implementing the following strategies:

- **Securing the supply and consistent quality of the raw materials**. Firms must ensure the supply and consistent quality of these special raw materials that meet their brand values and customers' aspirations and exigencies. Luxury houses must continuously monitor the quality of the raw materials and customers' perceptions on product/service quality with respect to their intended purpose, customer expectations, and their alternatives. Firms should streamline stakeholders' perceptions of quality by developing and implementing a new form of a structured quality management system in their organisations (Bilek & Torun, 2017) and an integrated quality system within the supply chain that will monitor, ensure, and align all quality requirements from sourcing to distribution. To implement these changes and structures, firms should track corporate cultures and employee involvement (Valmohammadi & Roshanzamir, 2015), training, education and customer focus (Kaynak & Hartley, 2008), and top management's commitment and leadership (Kaynak, 2003). While some authors highlight the importance of quality management inside organisations within the luxury fashion industry, the literature still requires new contributions to explore the implementation

of quality management in luxury industries (Bilek & Torun, 2017).

- **Supporting suppliers of raw materials.** Firms should preserve, support, and develop the sources of these supplies and know-how related to them. For example, the luxury shoe industry's success is directly related to the success of fashionable design, craftsmanship, technical skills, creativity, and premium quality (Nguyen, 2004; Doran, 2011). Companies should explore new ways to support their suppliers within their localised ecosystems and suitable to their specific sociocultural and economic contexts by granting them the access to—for example—new technologies, adequate tools, new training and education programmes, and best practices on farming. Additionally, companies should promote the importance of sources and the craftsmanship surrounding the raw materials by developing adequate intellectual properties tied to geographical indications. The growing interest in values such as sustainability, the environment, and one's well-being has pushed consumers to demand more information about what they buy. The user of a luxury good wants to know for certain that the item bought conforms to the highest ethical values. Now more than ever, customers want to know: Where does the product come from? Which materials were used? Where was it manufactured? Who made it? With what guarantees was it produced?

It is also crucial to connect all participants within the supply chain to ensure fluid communication and knowledge exchange, as well as consistent traceability through blockchain and artificial intelligence. This will allow firms to design and achieve a shared focal value proposition for each local ecosystem and its local stakeholders, as well as a focal global value proposition for the company's entire supply chain. To remain authentic and relevant to the high-end market, brands are increasingly looking to technology in order to reassure consumers about the provenance of their products. Greater product traceability may help mitigate the risks of opaque and inefficient supply chains. Through implementing blockchain, brands can create a unique digital identity for every garment, helping give luxury brands the confidence to stand behind the goods that bear their name (Kemp, 2020). By applying these technological means, fashion firms can combat counterfeiting while being seen as more transparent by the consumer. Customers will be able to trace the product life cycle, from the origins of its raw materials to the times in each production process. At the same time, it will allow firms to, for example, find new sustainable raw material sources and substitutes for these supplies from different origins.

I assert that implementing this new technology will enable firms to adopt and adapt the circular model of sustainability within this industry, reducing the use of natural resources and waste (Arrigo, 2015). Of course, companies should explore and promote the development of alternative locations for sourcing and manufacturing worldwide because of the overexploitation of traditional locations of sourcing in Europe. All these developments will also allow companies to find new sourcing value propositions attached to new geographic indications, adding value and intellectual property assets to luxury houses. These changes will help to mitigate the environmental and social impacts of sourcing and supply chain activities, from raw material extraction right up to the sale of products in its houses' stores. Also, this strategy will enhance corporate social responsibility policies by exploring, developing, and implementing sustainable practices like using new environmentally friendly materials or eco-manufacturing production processes (Bilek & Torun, 2017) while expanding the traditional essence of luxury. Consumer awareness on the environment has increased, and sustainability practices have become an important aspect to gain a competitive advantage (Hersom, 2010; Franco et al., 2019; Bigwood, 2013). For example, the luxury shoe industry has a negative impact on the environment since the production process and delivering goods require significant energy consumption and the shoemaking business model relies on using leather and rare skins, which contributes to climate change, land destruction, pollution, and water supply contamination (People for the Ethical Treatment of Animals, 2020).

Luxury fashion brands should turn from the past and look to a new, sustainable future, expanding the notion of luxury in concordance with consumers' demand for ecological tracing and ethical practices. Currently, affluent buyers care about the environment and name sustainability as an important brand factor that motivates them to purchase from it (Olbertova, 2019)—meaning these are now becoming crucial predominant attributes for luxury brand positioning. These new attributes should be related to becoming eco-friendly, organic, green, ethical, sustainable, and socially responsible. Thus, brands should analyse and explore which of these new sustainable positioning attributes, properties, and utilities to expand and develop within their products and services in order to remain distinctive and relevant to their clients and new potential buyers. When exploring these new attributes among customers, companies should be aware that the meaning and notions of sustainability are not static and depend on the needs of each target group and the specific influences of the broader sociocultural contexts. Luxury houses should lead a new culture to educate customers on the ethical and sustainable values of longevity, craftsmanship and savoir faire, and high-quality sources—acting as the antidote to the disposable nature of fast fashion and conspicuous consumption (Olbertova, 2019).

All these proposed strategies will catalyse and lead to positive social change along the supply chain by allowing luxury fashion firms to become cultural platforms to bring stakeholders' attention to these important sustainability and social issues. This will help to develop a common corporate social responsibility strategy and objectives across the supply chain that will enhance all stakeholders' sustainable alignment and competitive advantage.

5.8. MARKETING INTELLIGENCE BIASES

According to Tan and Ahmed (1999), marketing intelligence is viewed in its totality as a continuous, interacting structure of people, equipment, and procedures to gather, sort, analyse, and distribute pertinent, timely, and accurate information; this information is used by marketing decision-makers to improve their marketing research, planning, implementation, and control. The main goal of marketing intelligence within a firm is to cultivate the ability to fully understand, analyse, and assess all the internal and external environmental variables (Huster, 2005) and their relationships associated with actors such as customers, competitors, suppliers, designers, the media, and industry. Market intelligence systems must generate profitable, long-term relationships with all stakeholders across the supply chain through the use of information and communication technologies in researching, selecting, entering, and competing, as well in new market niches and global markets (Kumar et al., 2019). At the same time, solid and reliable market intelligence systems must find, anticipate, and share new knowledge on customer attitudes, preferences, and tastes, as well as suppliers' capabilities, potential innovations, and designers' new ideas, that will allow all stakeholders to identify successful new offerings and value propositions that, according to Kumar et al. (2019), will ensure growth and revenue maximisation.

Simultaneously, this system must help to improve the quality of customer segmentation decisions by providing more opportunities for companies to fully understand the real variables of segmentation within ever-changing luxury markets by differentiating hard and soft segmentation variables. Soft segmentation variables encompass all geographical and demographic variables, such as sex, age, income, and country, while hard segmentation variables include psychographic and behavioural variables such as lifestyle, values, attitudes, beliefs, sought-after benefits, expectations, personality, aspirations, and feelings. By using only soft segmentation variables, all offerings that target all customers who fall into a specific segment (e.g., mothers, millennials, Parisians) would be marketed identically, giving the firm a blurred image of those customers. This information is

necessary, but taken alone, will lead the company to a vague image of its customers; these customers will then have erroneous perceptions of the brand that do not match their real expectations. In addition, by only using soft segmentation variables, luxury brands will receive few indications as to whether customers would be interested in firms' products and value propositions. A fuller understanding helps firms to identify and understand those value segments and contextualise those hard-segmentation variables on a finer level, thus identifying more precise growth opportunities.

Furthermore, marketing intelligence systems will enable luxury fashion firms to identify and forecast future demand by anticipating the adoption of new trends and new customer preferences by using data-driven trend forecasting within these systems. This will help companies to facilitate and improve their production and sourcing planning in order to improve their operational efficiency and reduce waste. At the same time, these marketing intelligent systems will allow luxury firms to reduce their burning of unsold products. Also of note, brands will be able to ask consumers about their product preferences (in terms of factors such as materials, colours, and style) before producing and officially launching new collections. These practices will allow these firms to establish an efficient pre-order system. As an example, the brand Jacquemus is committed to progressive, sensitive, and sustainable production, and pre-orders help the brand to ensure that production corresponds more directly to demand, ultimately establishing a positive commercial model for all (see https://www.jacquemus.com/shop/women/pre-order).

By implementing these practices, luxury fashion firms can understand who their customers truly are and why they make certain choices, enabling manufacturers and suppliers to know what they can provide to firms and afford, as well as how designers can better fit brands and can better generate and apply new ideas. Consequently, all luxury stakeholders and firms will benefit from nurturing this feedback and future behaviour. To gather all this information, companies should develop an integrated and intelligent market research system to make all hard and soft data readily available to all stakeholders, reinforcing all virtual and physical touchpoints with their stakeholders across the entire supply chain.

5.9. SECONDHAND MARKET BIASES

The 'True-Luxury Global Consumer Insight' study (Boston Consulting Group & Altagamma, 2020) estimates the secondhand personal luxury market at over EUR20 billion, with an annual growth of 12 per cent; this growth is especially prominent in Europe, driven by the young generation of consumers and new segments. Modern luxury consumption is no longer restricted to the sale of brand-new luxury goods (Antola, 2017). A secondhand good is perceived as a good of 'occasion', any good or object that is not new and thus been used or owned before (Cervellon et al., 2012; Cervellon, 2013). Roux and Guiot (2008) define secondhand consumption as 'the acquisition of used objects through often specific modes and places of exchange'. Research demonstrates how, as in the firsthand market, secondhand luxury purchasers are driven by functional, psychological, emotional, and symbolic determinants. It has been demonstrated that secondhand luxury goods, in equal measure to brand-new luxury, might be used as a basis for personal self-extension, self-worth and self-representation (Belk, 1988).

The rise of the secondhand luxury market has altered the personal value and motivations of luxury consumption for sellers and buyers. The process of disposing through selling entails erasing personal meaning, memories, and hedonic experiences related to purchasing and using the good, toning down the emotional value to the seller but increasing consumers' rational methods and behaviours to deal with a luxury product's value, such as its economic value (Turunen et al., 2020). For some sellers, the act of selling secondhand luxury items bestows them with the perception of

belonging to a higher social echelon, as they would never indulge in the purchase for themselves. By contrast, other sellers' self-perceived status shift relates to contributing to the circular economy and confers prestige that enhance their self-worth (Griskevicius et al., 2010). In this case, the brand and product are less important than the act of passing the goods on, extending their life. These sellers would only purchase luxury-branded items firsthand, and they are merely supplying the market and lower-status consumers with the opportunity to access these goods (Turunen et al., 2020).

I argue that several factors are leading to a further increase in the resale of luxury goods:

- **Economic factors.** Secondhand purchases allow customers to acquire luxurious and branded clothing without paying the full price—the real deal—which may be a source of pride and accomplishment. (Roux & Guiot, 2008) Bargain-hunting is an alternative that allows individuals to stretch their resources in order to spend money on multiple desires and their entire range of needs (Herjanto et al., 2016, 2019).
- **Perception factors.** In the past, secondhand luxury fashion was linked with poverty and the working class, with new garments only worn by the upper class (Huerlimann, 2020). This perception has completely changed. Due to the globalisation and the democratisation of luxury fashion, brands have opened stores worldwide and perpetually used aggressive marketing to increase global sales. This changed the image of luxury fashion, as it became normal to combine luxury garments with high-street outfits (Brocca, 2018). As a result, firms attracted new consumer niches involving diverse social and economic status. These consumers have lower incomes and luxury expenditures, and they are searching for more aspirational and social recognition benefits.
- **Entertainment factors.** Secondhand consumers are stimulated, excited, and entertained (Ferraro et al., 2016) by the idea of exploration and discovery while entering a secondhand store or visiting websites. Those feelings come from unexpected stock and unusual pieces found in the store or website (Ferraro et al., 2016). Consumers are also driven by treasure-hunting and amusement, as their main goal is to find the most unusual item at the lowest price (Cervellon et al., 2012; Cervellon, 2013).
- **Self-extension factors.** Secondhand stores and online platforms enable consumers to reach a certain level of singularity and are an alternative to express their social and desired self-image among other individuals or inside a group (Gullstrand Edbring et al., 2016). Acquiring and possessing distinctive and unusual displays conveying signals and differences among a group enhances one's social and personal image (Cervellon et al., 2012; Tian et al., 2001).
- **Sustainability factors.** Sustainability reflects a desire to escape the mass production and distribution systems that generate significant waste, especially chemical, which results in the deterioration of the environment (Guiot & Roux, 2010; Herjanto et al., 2016). These globalised economic practices constantly affect consumer perceptions and consciences, thus influencing their preferences when acquiring a luxury good. Current consumers are becoming environmentally 'eco-fashioned' and increasingly support reducing the mass consumption of clothes by considerably increasing their lifetime (Cervellon et al., 2012; Cervellon, 2013).
- **Collectors of iconic garments and limited-edition factors.** Nowadays, secondhand vintage is glorified and treasured as collector items. According to Gerval (2018), vintage goods are defined as 'rare and authentic pieces that represent the style of a particular couturier or era'. Collectors are looking for iconic pieces from past collections: rare and exclusive pieces that are hard to find. Acquiring these exceptional goods enables consumers to have a sense of distinction among mass-produced items and fleeting trends.
- **Fashionability factors.** True fashion connoisseurs and experts are more concerned with the true essence of styling factors, such as the colours, materials, and fit of the garments. They

know what clothes will flatter a variety of body types and see the possibilities in clothing. According to Palmer and Clark (2005) and DeLong et al. (2005), vintage clothing allows shoppers to combine past eras of fashion with contemporary pieces and, therefore, develop an individual identity. As connoisseurs are innovators and pioneers, they can easily mix conventional, past, and brand-new pieces to create unique, stylish looks. The secondhand market offers them more possibilities to combine pieces from different collections and seasons, allowing them to create more personalised and timeless styles that are more adapted to their tastes. They are not tied to the frugal tendencies dictated by fashion brands that are followed by brand and trend lovers. The secondhand retail store has allowed the consumer to create an authentic and original style while avoiding mainstream fashion (Da Silva Almeida, 2019).

- **Community-belonging factors.** The interaction between buyers and sellers creates a unique ludic space of passionate people seeking to be surprised by their mutual findings (Guiot & Roux, 2010; Cervellon et al., 2012; Ferraro et al., 2016) and wishing to interact with people who share their passion and love for a specific designer, collection, or brand.

These new perspectives and processes within the secondhand market for luxury products are transforming the traditional secondhand-market consumer and resellers' notions of luxury, as well as distorting firms' perceptions of potential new audience behaviours compared to the traditional behaviours of ecosystem participants. Additionally, the rise of the secondhand market is pinpointing the consumer's active role in the value creation process and the emerging dimension of resale value, which is underestimated by luxury firms (Turunen & Pöyry, 2019). The secondhand market is challenging the traditional understanding in which brand and company play key roles in building and curating the perception of luxury (Dion & Borraz, 2017). Luxury brand value (Hermès is a particular example) is now largely determined by resale value in the secondhand market (Turunen et al., 2020).

In sum, fashion houses should consider all the diverse underlying motivational factors and behaviours that are emerging within luxury fashion consumers' demand and supply for secondhand items. By understanding and assessing those factors, firms can develop more precise and suitable marketing and selling strategies, as well as programmes to match the specific needs and motivations of the different audiences of resellers and secondhand buyers. It is important to correctly identify the differences in perceptions and expectations among audiences to avoid distorting and misinterpreting the true motives and drivers of the different secondhand markets present in each country and region. While implementing these strategies, firms will be able to reach new target audiences that are reluctant to acquire secondhand pieces because of concerns over their authenticity. This will also enable these firms to design appropriate new integrated digital platforms (with supporting physical channels and systems) that will enable these companies to control, collect, refurbish, and distribute their own secondhand pieces while preserving and ensuring their authenticity and origin. These processes will facilitate firms selling their unsold products in good condition with the aim of reducing or ending burning practices and mitigating the effects of the counterfeiting market. Furthermore, these programmes will allow secondhand sellers to more easily reach their potential buyers and facilitate all commercial transactions and operations. Additionally, buyers of secondhand items will be able to access authentic, original pieces that are certified and compare secondhand offerings. All these actions will enhance a more collective and wider coordination of suppliers and stakeholders and also unconstrained individual-level action, striking a balance between variety and standardisation (Huber et al., 2017; Wareham et al., 2014).

These digital platforms will also enhance the digitalisation of luxury products and services, generating more flexible combinations of functions than the traditional luxury fashion chain does (Yoo et al., 2010). This will help generate new socio-material affordances, like data homogeneity,

that will enhance productive change and the flexible creation of new combinations of provider-beneficiary dyads across consumers segments, modules, and layers, thus supporting spontaneous, unpredictable change (Autio & Thomas, 2019). Firms face a crucial decision between subcontracting these services to an external operator/partner or developing and managing adequate structures and systems on their own.

Another possibility for luxury fashion firms is to develop rental services for luxury fashion products within these digital platforms. This method of luxury consumption would address another type of audience with specific needs and motivations. Moeller and Wittkowski (2010) identify renting as one form of access-based consumption, market-mediated transactions in which no transfer of ownership takes place and thus providing the consumer with an opportunity to access new and diverse products without the burden of ownership (Bardhi & Eckhardt, 2012). The form of renting is a growing societal trend, with the global online clothing rental market estimated to reach $1.856 million by 2023 (Iqbal, 2017). Modern consumers' renting behaviour and companies' brand image in this industry are affected by several motivations and perceived risks that firms willing to implement these rental systems must assess:

- **Performance risks.** Consumers may have concerns over the quality of rental items. These risks involve uncertainty over whether the product's performance and condition will meet expectations because rental clothes are shared—and thus worn—by multiple users (Schaefers et al., 2016).
- **Hygiene and sanitary risks.** Consumers have many concerns about contagion when they know they are renting an item has been physically touched by a stranger (Argo et al., 2006).
- **Psychological risks and drivers.** A dilemma exists between consumers' and society's perceived risks and drivers in terms of renting luxury goods. Traditionally, renting was associated with low social status and low financial power (Bardhi & Eckhardt, 2012). Additionally, Kang and Kim (2013) referred to the psychological risk and potential negative influence of rental clothes for one's self-image. Within the traditional perspective, consumers may consider renting to damage or reduce their image in the eyes of others. However, renting is now perceived as a more economical way to keep up with latest fashion trends and consume high-end fashion items. At the same time, consumers' mindset has evolved towards a more sustainable approach. Renting helps to reduce the negative environmental impacts by increasing use intensity and cutting waste (Botsman & Rogers, 2010; Moeller & Wittkowski, 2010). That approach will enhance the consumer's perceived image of rental services.
- **Enjoyment risks and drivers.** Perceived enjoyment refers to the extent to which performing a certain activity is perceived to be enjoyable in itself, regardless of the expected performance consequences (Davis et al., 1992). Perceived enjoyment reflects added pleasure, fun, and satisfaction while performing a certain activity (Teo et al., 1999), and it relates to the entire rental or ownership experience. Consumers' feelings, expectations, and experiences during the shopping process will affect their final purchase intention on fashion ownership or renting.

Luxury fashion houses should research and evaluate in depth all of these real drivers and barriers related to consumers' renting behaviour. This analysis should lead to the design and development of an appropriate rental business model, laying an adequate foundation to develop appropriate marketing, retailing, and operational strategies. These practices will encourage their fashion rental businesses while preserving and enhancing the brand image as well as empowering their creativity and innovation. These firms should select and target the appropriate audiences for the rental services without corrupting consumers' perceived benefits of luxury fashion and overcoming

consumers' perceived risk. By choosing and conforming to adequate new value propositions and business formats for rental services, considering different potential collaborations, firms will enhance value co-creation in this ecosystem.

Additionally, firms can integrate rental services into secondhand-focused digital platforms and add all their benefits and complementarities. Fashion houses should decide if they will directly manage these services or subcontract them to an external operator that can add specific know-how of rental processes. Within this 'make-or-buy' decision, firms should explore further collaborations with the traditional participants in the luxury fashion supply chain, as well as involve new specialised partners from related ecosystems (such as dry-cleaning companies, personal shoppers, leading delivery and packaging companies, technological and IT companies, and software and app development firms). These stakeholders can help fashion houses to create new value and develop differentiated value propositions based on integrating new complementarities in consumption (Jacobides et al., 2018). This will allow these firms to improve their new product and service development and the introduction of new collections. Renting will enhance testing among the brand's core consumers and provide real-time feedback to the firm's artistic director.

These digitalised platforms will enable firms to explore new meanings, approaches, and models of luxury fashion that are less attached to the old patterns of luxury—such as frivolity, opulence, exclusion, and ostentation—and offer fresh perspectives in concordance with consumers' new sought-after benefits, such as authenticity, sustainability, and durability. These new rental models will facilitate the exchange of information and knowledge and will drive powerful processes of value co-creation and value-in-use. These models can become important regulators of service beneficiaries' 'phenomenological experience' of value-in-use (Autio & Thomas, 2019).

5.10. BIASES DUE THE QUEST FOR AMBIDEXTERITY IN LUXURY FASHION COMPANIES: THE EFFECTS OF FAST-FASHION BRANDS ON LUXURY FIRMS

Ambidexterity is a firm's ability to exploit its current capabilities, resources, and knowledge while simultaneously exploring new competencies, resources, and knowledge (Levinthal & March, 1993; March, 1991). According to Raisch et al. (2009), organisational ambidexterity is a fundamental capability for firms to achieve long-term success within a changing market and environment. The exploration of resources approach focuses on researching new knowledge and resources, and it encompasses the meanings of search, variation, risk taking, experimentation, trial and error, play, testing, experimentation, discovery, flexibility, innovation, variation, and revolution (March, 1991). By contrast, the exploitation approach is more conservative and tries to leverage the known knowledge, capabilities, and resources and includes refinement, efficiency, choice, alignment, and fine-tuning (March, 1991). Scholars have defined ambidexterity as the ability to pursue and simultaneously balance the contrasting objectives of exploration and exploitation for survival and prosperity (Raisch et al., 2009; Volery et al., 2013). The search for this strategic equilibrium leads to internal tensions and conflicts, which each firm must reconcile and accommodate (Raisch et al., 2009). To achieve this balance, mitigate these tensions, and sustain a competitive advantage, firms should develop and design adequate strategies, structures, and processes and a suitable culture according to the company's competitive environment, essence and identity, and strategic objectives. For example, companies can organise themselves in dual and independent structures (Duncan, 1976) to separate and simultaneously pursue exploration and exploitation (Birkinshaw & Gibson, 2004). Through contextual ambidexterity, firms can encourage managers to make their own choices about time and resource allocation between exploration and exploitation, while the firms develop a supportive organisational context and culture (Birkinshaw & Gibson, 2004; Ghoshal & Barlett,

1994). Additionally, this separation of functions can be temporally built within the formation of focused task forces that can be project-oriented.

Within the 'quest for ambidexterity', it is crucial for firms to explore and research their external opportunities and threats within different markets, environments, and stakeholders while exploring, discovering, and determining what resources and competencies are crucial to adopt and adapt internally in order to seize those opportunities and overcome threats. They must also search for these opportunities and threats within different ecosystems, contexts, and environments. However, at the same time, it is also fundamental to identify and develop new and further applications, utilities, and uses for the current capabilities, resources, and know-how in order to address new target markets and niches. Within this quest, firms should enhance multiple interactions among stakeholders in parallel to generate, exchange, and contribute new resources and competencies. This will help these firms to lead value co-creation and to develop and materialise new focal value propositions within that ecosystem (Adner, 2017), as well as drive complement development and complementary input development (Autio & Thomas, 2019). To apply this approach, firms must find and develop an adequate organisational design and cultural balance to match and facilitate the implementation of both exploration and exploitation without losing the firm's essence and identity within the different international contexts in which it operates.

A contrast now exists between connoisseur luxury and mass luxury. Connoisseur luxury focuses on exploration practices and features many hours of toiling to produce the product, a commitment to quality and craftmanship at whatever cost, and unparalleled aesthetics. On the other side, mass luxury follows exploitation practices and is more driven by sales, profits, efficiency, and branding strategies in order to make luxury more accessible to a broader audience following the bandwagon and snob effects. At the same time, mass market competitors in fast-fashion luxury have made a concerted effort to use the same tactics employed by luxury companies, such as celebrity endorsements, trendy logos, and relationships with well-known designers (Bellaiche et al., 2010). Luxury companies have also adopted fast-fashion retail and marketing strategies, such as the implementation of e-commerce, sales promotions, the proliferation of new technologies and communication channels, inventory management, the opening of flagship stores located in iconic places, the development of social media platforms, and mass advertising campaigns. Furthermore, previous high-end consumers are currently rejecting more accessible luxury brands. Additionally, companies have devoted too much time and effort to penetrating emerging markets while de-emphasising and risking their presence in their traditional centres of demand, thus sacrificing their essence and core traits of luxury (e.g., selectiveness, refinement, local craftmanship) that are tied to the exploration practices of connoisseur luxury (Bellaiche et al., 2010). All these developments and practices, combined with COVID-19, are positioning luxury firms closer to the exploitation practices of mass luxury and are breaking the balance between connoisseur luxury and mass luxury. Current marketing strategies of luxury brands are being drawn to the fast-fashion model (Amatulli et al., 2016).

All these issues and factors are confusing consumers and all luxury fashion stakeholders because they cannot correctly identify and differentiate a luxury product and brand; consumers perceive a blurred boundary between what is luxury and what is ordinary because luxury firms are now abusing mass-luxury exploitation practices that drive them closer to the fast-fashion practices. Luxury fashion is showing its latest creations using refined, quality materials and unique craftsmanship, but consumers can see what are functionally the same designs in the trendy showcases of fast-fashion brands, although at significantly lower prices and quality (Amatulli et al., 2016). Consumers appear to have a distorted perception of the real value of a luxury item, which should evoke rarity, heritage of craftsmanship, exclusivity, premium pricing, and superior quality (Amatulli

& Guido, 2011; Chevalier & Mazzalovo, 2008). On the other hand, the new fast-fashion brands have become competitors of luxury brands through the introduction of limited-edition products, celebrity endorsements, high advertisement expenditure, and store openings in prestige retail locations (Amatulli et al., 2016).

Due to these factors, clear boundaries no longer exist between luxury and fast-fashion brands. Fast-fashion brands are threatening the luxury fashion houses: Their updated looks, greater variety and choice, well-designed and limited editions, and speed of availability have made the fast-fashion industry attractive to many consumers, both young and mature (Joy et al., 2012). Additionally, co-branding collaborations between a luxury and fast-fashion firm (e.g., Prada for Adidas or Versace for H&M) can also offer excellent opportunities for success, as well as risk of failure. According to Uggla (2004), this association can help both brands to access the other's customer base and may conquer new segments, but it could harm a luxury brand's image by merging their unique characteristics with a familiar product or fast-fashion brand, creating negative brand perceptions and diluting brand equity (Amatulli et al., 2016). Due to this association, luxury firms have become a mere dollar-value in the race of fast-fashion—in most cases, contributing just as much harm to the environment and labour rights as mass-produced bargain brands (e.g., luxury bag production relies heavily on leather; cattle ranching consumes massive amounts of natural resources, while leather tanning uses heavy metals and toxins that run off into the environment) (Lauren, 2019). These social attributes are affecting consumer perceptions of luxury and also distorting their image of luxury fashion houses.

To address these biases within organisational ambidexterity and co-branding, luxury firms can collaborate with fast-fashion firms but should carefully evaluate the collaboration's real strategic objectives. For example, for luxury fashion brands, co-branding with fast-fashion brands mainly aims to increase their interaction with consumers—in particular, younger ones (e.g., for appealing to sport consumers' motivations). Additionally, these firms should assess all prospective added value and value propositions for these potential collaborations. They should examine if the combination of elements—such as values, visions, and will to generate real synergies—between the brands presents an interesting path towards creating strong value co-creation, brand reputation, and differentiation among their potential audiences (Rollet et al., 2013). Furthermore, luxury brands should analyse the external and internal factors of these potential collaborations, such as the consumer's potential emotional connections with the luxury and fast-fashion brands and how this collaboration would affect consumers' overall perceptions of the luxury brand. Firms can accept a co-branding collaboration when they can remain relevant to their target audience.

Particularly after the COVID-19 pandemic, companies should find the right balance between exploration and exploitation, and they should be more able to 'explore' and innovate for the future to ensure future viability while they 'exploit' current lines of business (Alänge & Steiber, 2018). O'Reilly and Tushman (2013) argue a promising domain for ambidexterity research is to move from the firm's 'traditional' views of innovation to its external larger community, where it follows an open-innovation logic (Chesbrough, 2003; von Hippel, 2005). But to lead innovation across their traditional boundaries, luxury houses must develop new abilities to manage resources and competencies that they do not fully control, such as the technological ones that are constantly changing and influencing their customers (Alänge & Steiber, 2018). To enhance this value co-creation, luxury firms should develop a coherent, shared new vision and value proposition for the luxury fashion ecosystem among its participants. At the same time, firms should implement and accelerate digital transformation within the luxury fashion sector: introducing end-to-end digitalisation will help bring suppliers, firms, designers, and consumers closer. It is also crucial for the ecosystem's participants to understand the importance of cultivating all emotional connections

among stakeholders within this specific ecosystem (e.g., clients with their products, brands or artisans with the final users), as well as cultivate and orchestrate these interactions in order to integrate and generate new ideas.

I assert that luxury fashion firms could develop incubation units or corporate venture units, wherein internal ideas may lead to spinout companies (Alänge & Steiber, 2018) that can collaborate with, for example, different designers, workshops, artists or local artisans, target audiences, and raw material suppliers. These units could enable firms to turn value propositions that are actually firm-centric into new focal value propositions and business models (Adner, 2017) that should be more user-centric.

5.11. CONCLUSIONS

The analysis of these biases has revealed that this sector is facing a process of profound change: The current model is losing steam because it is losing its identity and originality in the face of other business models attracting the same audiences (e.g., fast-fashion retailing model) and the effects of COVID-19 on consumer behaviours. Thus, I see the sector as being in a phase prior to stagnation, in which a series of measures urgently needs to be configured in order to relaunch the sector and all luxury brands within its life cycle and to regain lost momentum. These firms appear to not recognise the stage they now occupy in their brand's life cycle: a time series of sales volumes of a brand, based on the relationship between consumers and the respective brand (Simon, 1979). However, as Levitt (1965) states, hindsight will always be more accurate than current sight, and perhaps the best way for these firms to see their current stage and biases is to attempt to foresee the next stage and work backwards. This approach will allow luxury fashion houses to detect and reduce the blind spots and gaps within their governance and core and functional strategies, which limit their ability to comprehensively address the complexity of this ecosystem's transformation (Autio & Thomas, 2019).

Additionally, and in order to relaunch their brands within the ecosystem's new contexts, I conclude that luxury houses should address a type of blind spot related to an unnoticed corporate heritage brand paradox, as stated by Cooper et al. (2020), for managing and reconciling the tension between their continuity and change. This is a significant challenge for brand management (Pecot et al., 2019) because it must balance the competing imperatives of exclusivity and attainability (Chandon et al., 2016; Riley et al., 2004), and this paradox has been largely unexamined in the context of luxury (Cooper et al., 2015b) and requires a specialised approach (Cooper et al., 2015a; Urde et al., 2007). At the same time, this paradox is not stagnant since the context is always changing (Cooper et al., 2015a; Merrilees & Miller, 2008; Urde et al., 2007); thus, it must be constantly reviewed and projected in the future to ensure consistent and durable brand positioning. According to Cooper et al. (2020), luxury houses should resolve this luxury brand paradox through a three-part approach to managing corporate brand change: (1) remaining true to the authentic core; (2) innovating; and (3) embracing change to maintain relevance.

To restart this ecosystem's life cycle, it is necessary to rethink and analyse how luxury corporations can renovate this sector based on different strategic approaches for coping with all of these biases and in order to overcome the COVID-19 crisis. To summarise my analysis of proposed strategies, I conclude that luxury fashion houses should conduct marketing and consumer research to understand new consumer insights associated with the post-pandemic period. This will allow firms to predict these behaviours and associated outcomes in order to inform future innovation and marketing practices. Luxury researchers and marketers need to understand why consumers would buy luxury, what they would believe luxury is, and how their perception of luxury value would

impact their buying behaviour (Wiedmann et al., 2007) and construction of self-identity. This process would allow firms to develop multiple, more personalised customer value propositions that could range from the extreme of 'masstige' luxury to the silent and more individual luxury extreme. Substantial opportunities now exist for luxury brands to use digital means to build better value propositions and relationships with their customers based on their unique preferences—and to bring new customers into their stores (Chamberlain, 2018). All this will help firms draw the new luxury fashion taxonomy.

At the same time, participants have to develop more adaptative and flexible marketing and innovation strategies. The aim of these strategies should be to identify emerging opportunities within all existing new needs and wants against the background of established luxury prejudices, norms, perceptions, and value estimations (Wiedmann et al., 2007). To overcome these prejudices, luxury fashion participants should introduce new segmentation approaches and models based on the hard-segmentation approach since in the new reality of luxury, there are a multitude of consumer profiles drawn by a huge range of individual, cultural, global, and local variables and segmentation modalities that are necessary to understand today's complex mosaic of consumers. Luxury fashion firms should apply a new unconventional marketing, which is any transformational approach to segmenting and targeting consumers and to questioning entrenched assumptions of mass-consumption luxury marketing (Cova & Saucet, 2014).

At the same time, these firms should incorporate a multidimensional approach involving consumers' sought-after benefits in the new mosaic of the luxury fashion taxonomy. This will lead firms to configure a strategic marketing strategy that is proactive rather than reactive in order to influence customers' expectations in accordance with the company's goals (Wiedmann et al., 2007). These adaptative and malleable strategies should enhance more personalised and socially oriented targeting, positioning, product development, and innovation strategies for firms and their portfolio of products and experiences. Luxury fashion firms should further explore and exploit service-dominant logic, thus moving from stand-alone products and collections to 'the customers' value-creating processes where value emerges for customers' (Knox & Gruar, 2007) and bolstering consumers' personal narratives and aesthetic experiences.

Firms should consolidate the personalisation and global localisation ('glocalisation') of their offerings and services to meet the emergence of new consumer mindsets, behaviours, and consumption models of luxury. Firms should be prepared to design and develop multiple, adaptative value propositions that combine multiple products and services and are highly localised. Chamberlain (2018) argues the traditional 'one-size-fits-all' approach employed by luxury houses no longer resonates with contemporary consumers, who increasingly desire personalised luxury products and services. Rosenbaum et al. (2021) argue that hyper-personalisation—or personalisation of consumer goods based on a person's unique DNA—with its emphasis on high aesthetics of design, quality, uniqueness, and price premiums, represents the new, unconventional luxury.

Finally, ecosystem participants should design new innovation strategies based on open innovation frameworks to enhance their experimentation and cross-fertilisation of new insights from all stakeholders and framed focal value propositions; this will help manage knowledge flows across all organisational boundaries of the firms (Chesbrough & Bogers, 2014) and boost firms' external cooperation with stakeholders (e.g., suppliers of raw materials, designers, workshops, modeling agencies) in a complex post-pandemic world. As a result, new stakeholders could become focal firms within this ecosystem to lead the value co-creation, complement development, and complementary input development that are crucial in this industry. These focal firms would define and control the ecosystem blueprint, as well as persuade others to contribute accordingly (Adner & Kapoor, 2010; Hannah & Eisenhardt, 2018). These firm could orchestrate an iterative and adaptative business model

of constant experimentation and gradual refinement that would reduce uncertainty and enhance the co-discovering and legitimatisation of new blueprints and end-user solutions within the uncertainty of this ecosystem (Ansari et al., 2016). Firms should turn the traditional, supply chain-centred ecosystem of luxury fashion into a service ecosystem of relatively self-contained and self-adjusting systems involving coupled social and economic (resource-integrating) actors that are connected by emerging and shared consumer and institutional logic and mutual value creation through service exchange (Lusch & Nambisan, 2015; Lusch & Vargo, 2014). This service ecosystem would boost value co-creation based on factors such as co-innovation and the discovery of and search for unknown value, unknown sources, and unknown competencies.

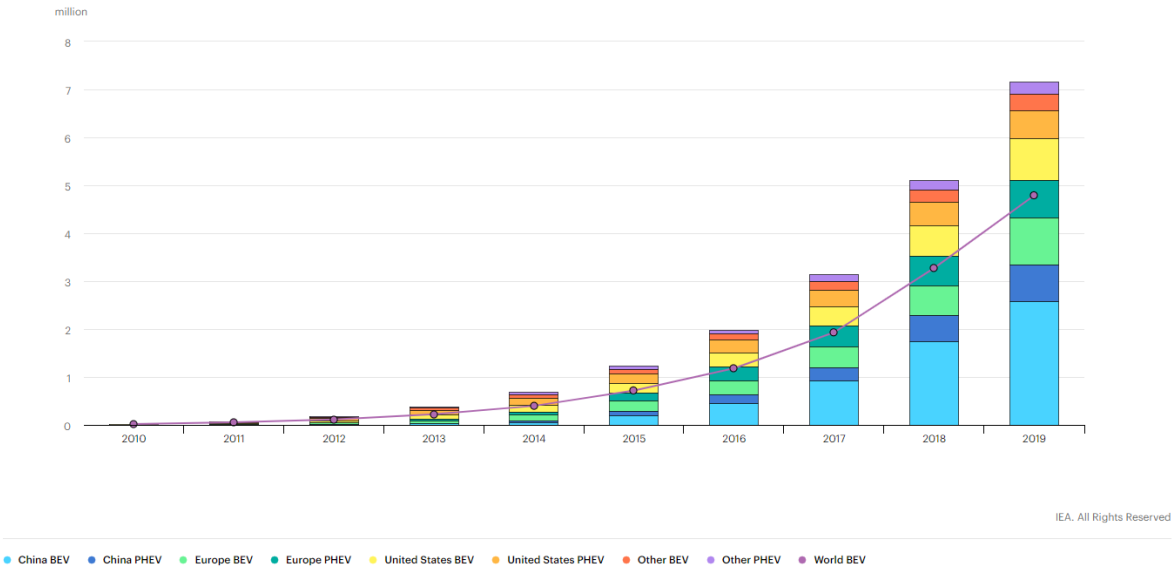
In the current context of COVID-19, with uncertain recovery and post-pandemic periods, I argue the luxury fashion industry must undertake two consecutive phases of revival, managing the objectives and settings of each. The first phase should focus on the period of 'descent' covering the crisis to recession, and the second phase should focus on the period of 'ascent' that covers the return to growth to the next normal stage (Silviero & Roberti, 2020). Firms, should asses the factors in both stages that stimulate ecosystem growth in spite of dire circumstances, conducting an in-depth analysis of those factors that influence ecosystem growth in general and during the pandemic in particular; they should then develop and implement strategies and programmes using different combinations of resources and competencies.

CHAPTER 6. ELECTRIC VEHICLE (EV) ECOSYSTEM

6.1. INTRODUCTION TO THE ECOSYSTEM AND RECENT TRENDS

Electric cars, which are solely powered by a battery, entered commercial markets in the first half of the 2010s and have recorded soaring sales, registering a 40 per cent year-over-year increase (International Energy Agency [IEA], 2020; see Figure 6.1). Only about 17,000 electric cars were on the world's roads in 2010, but sales of electric cars topped 2.1 million globally in 2019, surpassing 2018—already a record year. Of the 7.2 million in global electric car stock in 2019, 47 per cent was in the People's Republic of China. This growth has been possible thanks to EVs' significant improvements in technical performance and the increased variety of electric car models on offer. In fact, the automotive industry is an excellent example of a highly innovative industry driven by strong competitive pressure and constant technological progress (Holweg, 2008). For example, the industry has recently seen the rise of novel complementary technologies beyond the traditional core competencies of the automotive ecosystem (e.g., artificial intelligence for autonomous driving), major architectural innovations (e.g., fully electric drivetrains), new business models (e.g., internet-based ride-sharing platforms), and dissolving industry boundaries (e.g., between automotive and IT) (Sodenkamp et al., 2019).

Figure 6.1. Global electric car stock, 2010-2019



Notes: PHEV=plug-in hybrid electric vehicle; BEV=battery electric vehicle
Source: IEA, 2020

In parallel, EV costs have been decreasing—for example, battery costs decreased more than 85 per cent from 2010 to 2018 (Goldie-Scot, 2019)—and technological progress in the electrification of two-/three-wheelers, buses, and trucks is accelerating. Additionally, ambitious policy announcements have been critical in stimulating EV rollout in major vehicle markets in recent years, sending clear, long-term signals to the auto industry and consumers supporting the EV transition in an economically sustainable manner for governments. The application of direct subsidies and regulatory and other structural measures, including zero-emission vehicle mandates and fuel

economy standards, is strongly influencing EV uptake. There is also significant political and social pressure surrounding environmental and sustainability objectives and resource depletion, as the transport sector is responsible for 24 per cent of global CO_2 emissions (IEA, 2018) and the rapidly growing energy demand for mobility is creating a need for immediate energy-saving actions on all possible levels (Creutzig et al., 2015).

Despite all these enablers and drivers, EVs only accounted for 2.6 per cent of global car sales and about 1 per cent of global car stock in 2019. Only nine countries had more than 100,000 electric cars on the road, and at least 20 countries reached market shares above 1 per cent (IEA, 2020). Additionally, although a global consensus exists on EV development, the global car market started to contract in 2019 because total passenger-car sale volumes were depressed in 2019 in many key countries; for example, fast-growing markets such as China and India had lower sales of all types of vehicles in 2019 than in 2018 (IEA, 2020). Electric mobility is developing at a rapid pace, but market penetration is not uniform (IEA, 2020). As with most other new products with a new technology, the EV sales life cycle follows an S-curve (Adner & Kapoor, 2016; Utterback, 1994), and EVs are now in the stage of slow start with oversupply (Harrop, 2019). It is unclear when the EV market will enter the next life cycle stage, with the fastest growth and supply sometimes unable to keep up with demand due to the factors discussed in the following subsections.

6.1.1. Early adopters and technophile consumers

Today's consumer profile in the EV market is still evolving from early adopters and technophile purchasers to mass adoption (IEA, 2020).

6.1.2. No truly disruptive changes

The automotive industry has never had to deal with truly disruptive changes regarding its products, processes, or value network structure (Wollschlaeger et al., 2015). The automotive industry has traditionally been considered an innovative industry driven by strong competitive pressure and constant technological progress (Holweg, 2008). Nevertheless, this innovation has been incremental rather than breakthrough or radical because it has focused on optimising existing products for existing customers and processes (Nagji & Tuff, 2012). It has been in the last 15 years that this situation has started to change due to the rise of alternatives to the internal combustion engine (ICE), which has reigned for more than 90 years in this market, and new complementary technologies (Sodenkam et al., 2019).

6.1.3. Emerging technological megatrends

The automotive industry is also being disrupted by three megatrends—connected, autonomous, and shared driving—causing an unprecedented technological and business model transformation. Amid this transformation, COVID-19 is placing additional stress on the industry (Vatier et al., 2020). The ICE-powered vehicle was one of the greatest achievements in human history, and its design has been perfected over 90 years and become the most popular power source for vehicles.

6.1.4. No total substitution of the old technology

Despite the considerable progress made in EVs, a total substitution of the old technology has not yet occurred because EV technology's performance and its complementarities in consumption and production have not surpassed those of the old technology and its complementarities (Adner & Kapoor, 2017). EV firms must look not just at the EV technology itself but also at the broader supporting ecosystem. In this case, EV technology's success depends on the emergence of a new ecosystem and, thus, this new technology will become dominant more slowly (Adner & Kapoor, 2017). For this reason, the new EV technology curve has not yet crossed the old technology curve (Foster, 1986). When comparing technologies' performance, one should account for the performance of all related ratios and attributes that compose the product's value proposition and complementarities that have adopted this technology (e.g., manufacturing cost; raw materials cost and availability; engine efficiency; driving range; fuel/charging requirements, such as time and location; safety; engine dimensions; emissions; life cycle, maintenance, and infrastructure costs; variety of models in terms of factors such as capacity, seize, and power; and suitability) (DeLuchi et al., 1989). All these factors constrain consumers' choice of powertrain technology and its complementarities (Reitz et al., 2019). Also, as EVs' technical performance and cost continue to improve, consumers are attracted to EVs but wonder if it would be wise to wait for the 'latest and greatest model' (IEA, 2020). These conservative consumer behaviours are delaying this transition.

6.1.5. Improving performance of the old technology

The old technology's performance evolution after a new technology is introduced affects the pace of transition (Adner & Kapoor, 2016). It is important to consider the performance trajectory of not only the new technology but also the old technology, as well as the old technology's established and solid know-how (Adner & Kapoor, 2016). The pace of transition to EVs has effectively decreased because ICE technology's performance and its innovation infrastructure have improved significantly in recent years, and the ICE vehicle is still expanding its value propositions because the use of alternative fuels and advanced additives and oils have improved these vehicles' environmental performance (Pearson & Turner, 2014; Howard, 2014; Bennett, 2014; Mintz et al., 2014). At the same time, the ICE vehicle is constantly being improved due to factors such as the development of novel combustion systems, including the use of ultra-high fuel-injection pressures (Reitz et al., 2019); the implementation of advanced transmission technologies to reduce fuel consumption and gas emissions and improve vehicle performance; the application of sustainable designs; the manufacture of lightweight vehicle structures (e.g., using carbon fibre); the use of new materials in the engine; and the improvement of heavy-duty vehicle engines' environmental performance (Juhala, 2014; Xin & Pinzon, 2014).

Over the last four decades, in response to air-quality concerns, research on engine combustion, exhaust aftertreatment, and exhaustive controls has led to a demonstrably cleaner environment thanks to a thousandfold reduction in hazardous exhaust emissions (Reitz et al., 2019). Improved efficiency and methods to reduce fossil fuel dependence remain exciting, solid directions for future ICE research (Reitz et al., 2019). Additionally, the development of new generations of hybrid vehicles that still use the ICE—and also technology like fuel/electric vehicles and fuel-cell (hydrogen) electric hybrid vehicles (Hofman, 2014; Ehsani, 2014)—are influencing this transition. Reitz et al. (2019) write that highly efficient 'fully flexible' engines with hybridised solutions will be a major part of sought-after efficiency improvements, as well as emission/greenhouse gas reductions.

6.1.6. Inflated expectations or shortcomings

The emergence of new EV technology not only incorporates technological progress but also setbacks—technological challenges that are revealed a posteriori due to, for example, inflated expectations or shortcomings and failures being common features of the innovation process that can check, alter, or reverse initial progress made by the emerging technology (Kapoor & Klueter, 2020; Rosenberg, 1996).

6.1.7. Potential EV consumers have not yet perceived EVs' added value

Even with all the progress and changes made in the EV sector—and the new economic, social, and environmental challenges and threats that both the consumer and the automotive sector now confront—consumers appear to have not yet perceived the current value propositions of the EV and its complementarities to be equal to or higher than those of the traditional ICE vehicle. This is because the successful commercialisation of EVs and ICE vehicles no longer depends only on their technical breakthroughs (DeLuchi et al., 1989). It is also due to converted automotive ecosystem elements' role in determining the performance-in-use (as opposed to performance-as-developed) gap between old and new technologies (Adner & Kapoor, 2016). It could also be that the consumer has still not been offered affordable value propositions that are attractive enough to engage the mass market and overtake the current value propositions offered by the ICE vehicle and its infrastructure and complementarities. Thus, the question becomes: Are EV firms aware of both knowledge gaps related to the conversion of elements' roles and knowledge gaps related to the lack of affordable value propositions?

6.1.8. Unclear global or macro-environmental benefit of EVs

Compared to conventional fossil-fuel vehicle technologies, EVs are the most robust option to move to a zero-emission road transport system. However, in the short term, it appears that EVs' global or macro-environmental benefit remains unclear: Because of how electricity is generated and distributed, EVs' global environmental impact may be worse than that of modern, fuel-efficient conventional ICE vehicles (Hawkins et al., 2013). Additionally, energy interdependence constrains the implementation of new renewable energies and EVs. Electricity is now essentially produced locally, so EVs' benefits and total introduction in a country depend on the amount of green electricity generated in that country to power the EVs.

EVs can mitigate CO_2 emissions from car travel, especially when their production, use, and disposal are powered by renewable energies (McCollum et al., 2014; Tagliaferri et al., 2016). For these reasons, CO_2 emissions savings are significantly higher for EVs used in countries where low-carbon sources dominate the power generation mix and the average fuel consumption of ICE vehicles is high. This is an important bias within this industry. Hence, all hidden facts, impacts, and trade-offs about electricity and about the embodied fossil fuels contained in every kilowatt produced and consumed by EVs must be understood and assessed holistically. This assessment must occur in context and globally, taking into account all stages of the EV life cycle and its supply chain, including raw materials extraction and EV production, distribution, use, and disposal (Del Pero et al., 2018).

6.1.9. The EV as a sociotechnical transition

Humanity appears to be facing more than a mere technological transition related to EVs. Rather, this shift appears to be a more complex sociotechnical transition or revolution, which is a major shift or step change in which an existing sociotechnical system is replaced by a new one (Schwanen et al., 2011). This Great Transformation (Schellnhuber et al., 2011) is a transition from the current fossil fuel-based economy towards a sustainable society within planetary boundaries (Rockström et al., 2009).

A sociotechnical system is a cluster of aligned elements—including technology, regulations, consumer practices, cultural meanings, markets, infrastructure, scientific knowledge, supply, and maintenance networks—that is durably reconfigured (Kemp et al., 1998; Geels, 2011). More specifically, the ICE motor of the early-20th-century economy brought far-reaching changes to society that enabled convenient and affordable individual transportation (Cleveland & Morris, 2015). The question, thus, is: What changes will the EV bring to individuals and their economies and societies? This sociotechnical transition should imply that a micro-level niche (an emergent radical technological innovation led by a small group of actors) under the influence of macro-level or landscape developments (e.g., broader economic, demographic, and cultural developments) is changing the prevailing meso-level regime—the practices, knowledge, and resources that constitute the dominant transport system in a society at a given moment in time (Geels, 2002). According to Schwanen et al. (2011), this transition should be imagined as a coevolutionary process involving many actors and social groups that usually spans several decades.

6.2. STAGE OF ECOSYSTEM EVOLUTION

Based on my analysis of the current ecosystem trends, I conclude that the EV ecosystem emerged from the traditional ICE vehicle ecosystem. The participants and resources in the ICE ecosystem began to create this new EV ecosystem due to new social and consumer needs and concerns. As the previous section describes, and unlike the other two ecosystems examined in the case studies, the EV ecosystem is in a stage of slow growth and expansion that is characterised by strong competition with the ICE ecosystem, which has been leading the satisfaction of transportation needs for the past century. This legacy and influence remain a key impediment for the new EV ecosystem to take off and constrain its coevolution.

At this point in the current research and due to this ecosystem's current stagnation, I can assess the current status of this ecosystem by answering the following questions:

- **Why has the EV not yet entered the mass market?** Prior research predicted that EVs would enter the mass market in the near future, between 2012 and 2015 (Schade et al., 2012). Why has the EV not yet entered the mass market, and what factors and obstacles are blocking this market change? What factors are influencing the pace of this market transition to the EV? What should EV stakeholders improve, and how should they react to the different technological setbacks? Has the non-parity of EV prices with ICE vehicle prices been the main impediment? Are consumer perceptions of the EV and its value propositions?
- **Should global institutions, governments, and public opinion force this transition?** Should we instead let consumers freely decide and let companies focus on new and renewed value propositions for the EV and its complementarities? Consumer preference should not be decided by politicians, automakers, or academia (Reitz et al., 2019). Bans on ICE vehicles may be effective, but may not be publicly acceptable if they limit consumer choice, preferences, and decision-making freedom (Sen, 2020). It also seems that ICE vehicles'

impact on climate change has become politically charged, even though it needs to be assessed impartially. These limitations, bans, restrictions, and disincentives can erode consumers' perceived decision-making freedom and affects their reactance (Walton & Berkowitz, 1985). Within the formation of this new EV ecosystem and its boundaries, not all participant inputs and strategies should be centrally and contractually governed since the realisation and delivery of overarching value co-creation should depend on different and new focal firms and actors, who could orchestrate different, renewed, and affordable ecosystem value propositions that could be synchronously available for all users and participants to select from (Autio & Thomas, 2019). EV ecosystem leaders should enhance a collaborative value proposition framing and also business model experimentation and adaptation to engage all stakeholders, reducing uncertainty and thus promoting a new blueprint for the EV ecosystem that is accepted by other stakeholders (Snihur et al., 2018; Ansari et al., 2016).

- **Are EV ecosystem participants ready to make reliable and pioneering decisions and to establish the new quests for change for this ecosystem?** Are the factors listed above industry biases that the ecosystem's participants and stakeholders, government, and public opinion have included that impede and delay this transition? In the automotive sector, automotive managers and policymakers are now confronted with a broader variety of fundamental strategic decisions in leading this transition (Wollschlaeger et al., 2015; McKinsey & Company, 2016). However, the question is: Are they ready to make reliable and pioneering decisions and establish the new quests for change in this ecosystem? I feel not, as they are not yet aware of the biases that distort their perceptions of the real obstacles within this transition and of the different knowledge flows, relationships, interactions, and value-creation processes within this ecosystem. Understanding these biases will bring into focus the critical roles of—and interactions among—lobbying organisations, the media, financial agents like venture capital suppliers and insurance companies, designers, material and machine suppliers, and others alongside public authorities, transport companies, vehicle producers, and consumers (Schwanen et al., 2011). This will allow firms to investigate which institutional arrangements could foster durable reconfigurations of the current regimes to enhance this transition (Kemp & Loorbach, 2006; Kemp et al., 2011).

6.3. THE IMPACT OF COVID-19 ON THE ECOSYSTEM

Quarantined workforces, widespread shutdowns, disrupted global supply chains, and decreasing demand have ultimately undermined the automotive industry (Kaitwade, 2020). Araz et al. (2020) assert that COVID-19 is likely the most severe disruption to the global supply chain in the last decade; the most important firms in the automotive industry relying on those global supply chains (such as Tesla, Toyota, Hyundai, and Volkswagen AG) had to cease operations in several production plants, leading to a further downturn in the automotive industry. The pandemic has brought major automobile companies' aspirations and main projects to a grinding halt (Belhadi et al., 2020). The COVID-19 pandemic is affecting global EV markets, albeit to a lesser extent than the overall passenger vehicle market. While the overall automotive market was predicted to contract by 15 per cent in 2020 relative to 2019, the International Energy Agency (2020) expects that passenger and commercial EVs will remain broadly at 2019 sales levels and will represent 3 per cent of global car sales in 2020.

However, these predictions could change due to the effects of COVID's second and third waves, which have been slowing and weakening the expected economic recovery (Arnold, 2020). According to Eurometal (2020), the second wave of COVID-19 could push the automotive sector recovery into 2022 instead of the mild recovery currently forecast for 2021. These predictions and

the evolution of the second wave are expanding uncertainty among vehicle manufacturers, and it is difficult for this ecosystem's participants and stakeholders to know how long the recovery will take and to predict what the next normal will look like. The pandemic has introduced additional biases to this ecosystem and has expanded the gaps of existing biases and knowledge flows, as it is extremely difficult to foresee the post-pandemic EV ecosystem since it is now perceived very differently and as very distant by the different actors. According to Strauss (2020), COVID-19 is accelerating and reconfiguring existing trends in the economy. Before reaching new normal, firms and all related EV ecosystem stakeholders must first navigate the 'Valley of Death', named because even while preparing for the new normal, stakeholders do not know what condition they will be in when they arrive (Strauss, 2020).

Nonetheless, one should not forget that COVID-19 has not only caused the emergence of new threats looming in the sector but also new opportunities that the sector must carefully analyse as it crosses this valley. Both types of influences are introducing deeper changes in the macroeconomic and microeconomic environment of the EV ecosystem that are driving the emergence of, for example, new consumer behaviours, new regulatory trends, and new technologies that can certainly embed new challenges and opportunities for these firms. For this reason, it is also vital for firms to identify these additional factors that directly influence the current biases and blind spots of this ecosystem, which are described in the following subsections.

6.3.1. The emergence of new personal mobility behaviours

During the pandemic, automotive consumers and users—like all people—have experienced unprecedented psychological and survival pressures and environmentally imposed constraints (Sofi et al., 2020) that have led them to learn and improvise innovative methods to cope with the new, blurred boundaries of work, leisure, and education. Along these lines, consumers have had to learn to improvise and adapt quickly to new mobility and driving needs, constraints, and patterns (Hertzke et al., 2020; Sheth, 2020). For example, government measures to combat the pandemic—like regulations restricting movement (Drake et al., 2020)—and side effects such as panic-buying and its time interventions and pressures have affected consumer behaviours (Prentice et al., 2020). The population has learned a new skill, staying at home, that has interfered with their individual need for autonomy, connection, and competence (Drake et al., 2020). Faced with this new equilibrium, the consumer has adapted by developing and adapting new mobility and driving routines: for example, new routes, schedules, mobility purposes, or destinations. For example, in the UK, 'click to car' has become the latest pandemic-friendly way to shop (Eccles, 2020). During this time, the consumer has been experiencing and evaluating these new routines and has been adapting them to their needs and convenience. But we do not know for certain which of these new routines and spatial and temporal changes in mobility (Drake et al., 2020) will remain in the new normal if new ones arise as a result of changes emerging during the pandemic.

Consumers have switched to different modes of transport that reduce the risk of infection, but the exact shifts largely depend on their pre-COVID-19 habits (Hertzke et al., 2020). COVID-19 has meant a significant shift from public transport to private transport and non-motorised modes (Abdullah et al., 2020). For example, people who own a private vehicle use it more, while those who previously relied on public transport might have switched to another method, such as biking or walking. Some governments have encouraged people returning to work to travel by active means or private vehicles versus public transport. According to a survey by the consultancy firm McKinsey & Company on current consumer sentiment and anticipated mobility-related future behaviour as economies find a next normal, one-third of consumers value constant access to a private vehicle more

than before COVID-19; this opinion was held especially by younger consumers (Hertzke et al., 2020). Due to the lockdown, internet searches for secondhand cars for sale in the UK have increased (Kirwan, 2020), and their prices have hit record growth (Campbell, 2020). COVID-19 has led to an increase in used vehicle sales as people avoid mass transportation and are more sensitive to auto costs in the recession (Rosembaum, 2020). Even if there is no clear guarantee that such search results will translate into actual purchases, at the very least they suggest a shift in opinion (Oxford Business Group, 2020). People are more interested in using private vehicles for their commute, contradicting pre-COVID policy encouraging a shift to more sustainable active and public modes of transport (Budd & Ison, 2020). At the same time, micro-mobility and shared mobility are potentially becoming more popular because they are easy to use and ideal in congested city environments. There is also a shift from airplane and train to private vehicle for intercity travelling that is clearly visible across all regions.

Consumers are spending less on their car than before COVID, except in China, due to the economic effects of COVID-19 (Furcher et al., 2020). This could delay consumers' switch to EVs since they want to take less risk. At the same time, planned spending on vehicles has increased across all geographies compared to pre-COVID-19, and this indicates that in some cases, the pandemic has meant EVs might be financially preferable where there are subsidies and tax exemptions in place (Furcher et al., 2020). Furthermore, consumers are switching to new forms of active travel like walking and cycling (alone or with members of a single household). Active travel encompasses all healthy journeys that demand some form of physical exertion on behalf of the individual (Sport England, 2019). As well as offering a healthy break during lockdown, active travel also presents a feasible alternative to private vehicles or public transport for short journeys (Budd & Ison, 2020). Public authorities have seized this opportunity to rapidly reconfigure and redesign all transport infrastructure in towns and cities at relatively low cost 'to accommodate them to the active travel in order to improve public health and delivering clean air' (Greenpeace UK, 2020). This represents a threat to EVs, although cycling is not accessible to all and inclement weather and cultural and social barriers continue to limit the number of women and ethnic minority cyclists (Corcoran et al., 2014; Goodman & Aldred, 2018).

6.3.2. New technologies' emerging role as vital complementarities to EVs

This pandemic has strengthened new technologies' role as vital complementarities within the EV ecosystem. Due to the pandemic, consumers have needed to learn to rapidly adopt and use new technologies, positively affecting their perceptions and acceptance of new technologies and of their added value within the EV as modular offerings that encompass inputs of different natures (Jacobides et al., 2018; Reynolds et al., 2005). Such pandemic-driven acceptance of improved technology means that EVs are becoming more relevant and competitive. For example, the autonomous and connected EV, if approved for on-road use, could see higher-than-expected demand since it enables physical distancing (Hausler et al., 2020). Some consultancy firms, such as Accenture, say the adoption of megatrends in the automotive sector (connected, autonomous, shared, and electric driving) will remain unchanged, as trends will continue to drive industry evolution, although the speed of adoption might slow down due to the emergency (Vatier et al., 2020).

6.3.3. The rise of uncertainty and contradictions within mobility policies and EV-related regulations and incentives: The reconfiguration of policies and regulatory approaches

The consultancy firm McKinsey & Company believes that policymakers can react differently to EVs across regions: Some might view COVID-19's effects on EVs as an opportunity to reconfigure future transport policy and practice to benefit the global environment and individual citizens alike, while others could loosen regulatory mandates to prop up their sick automotive industry (Hausler et al., 2020). For example, if physical distancing continues, governments should relax regulations for private mobility, at least over the short term, because people feel less vulnerable to infection in individually owned vehicles (Hausler et al., 2020)—thus contradicting pre-COVID policies on sustainable public modes of transport. Due to the new human behaviours around mobility, policymakers could also revise local mobility regulations to give more space to pedestrians and cyclists. Governments should analyse and develop localised movement policies and regulations (Drake et al., 2020), and the design of incentives (e.g., green-mobility incentives in Europe) should align with these regulations and policies. It is clear that all previous approaches and policies to mitigate factors such as transport noise, emissions, and congestion (e.g., smart mobility, active travel initiatives, tax reduction) alone will be inadequate in a post-COVID world because they would omit relevant knowledge about the new needs and customs of individual and corporate travel behaviour (Budd & Ison, 2020).

6.3.4. COVID-19 as a strategic opportunity

The COVID-19 shutdown is an opportunity to reconfigure future transport policy and practice for the benefit of the global environment and individual citizens alike (Budd & Ison, 2020). EV firms should now focus on resource optimisation and standardisation, new growth segments, and cost rationalisation to overcome slowdown (Research and Markets, 2020). This will facilitate their transition to the mass market. As an additional strategic opportunity, the pandemic presents a testing ground for EV firms and governments alike since both can measure their decisions' effects on consumer perceptions: for example, the introduction and further development of new technologies within the EV and the design of new regulations and incentives for the EV. This will help frame more reliable strategic visions and appealing value propositions for EV consumers that can accelerate this transition. As an example, the technological and strategic application of mobility data analysis to monitor spatial and temporal changes in the mobility of connected vehicles—across residential areas; supermarkets, grocery shops, and pharmacies; workplaces; retail and recreational areas; transit stations (subway, bus, and train stations); and parks—would prevent unintended consequences, such as victimising disadvantaged groups that are less able to practice physical distancing, discrimination, or even targeted law enforcement against these populations (Drake et al., 2020).

6.3.5. Automotive supply chain resilience amid the COVID-19 outbreak

The countermeasures taken in this pandemic have caused stricter border restrictions and complete nationwide lockdowns, causing important disruptions to international trade and global supply chains (Kumar & Managi, 2020), especially in the automotive industry. For example, the number of EV models might be reduced to cut costs. All previous strategies related to global supply chain efficiency—such as just-in-time production, global networks, and lean inventory (Vatier et al., 2020)—have made the supply chain vulnerable to this disruption. These negative consequences have pushed these firms to rethink their strategies on supply chain resilience, which refers to the supply chains' ability to prevent and absorb changes and regain or improve their initial performance level

after an unexpected disturbance (Hendry et al., 2019). This pandemic has revealed that many of these companies focused only on quantifying their resilience level and its consequences rather than developing both response and recovery strategies (Hosseini & Ivanov, 2019; Graveline & Grémont, 2017; Ivanov et al., 2017), thereby limiting their capacity to recover from disruptions (Ivanov et al., 2017). The global analytics firms CRISIL (2020) has identified the automobile industry as being significantly affected by COVID-19 due to its low resilience. These firms now have an opportunity to reconfigure their supply chain resilience strategies in order to predict, be prepared for, and understand the extent of a future disruption's impact, as well as devise adequate strategies to respond to and cope quickly with a disruption's consequences and reconfigure their resources to strengthen competencies and adapt to the consequent effects (Belhadi et al., 2020; Elleuch et al., 2016). While the resilience of the automobile supply chain has attracted significant recent attention, extant literature lacks empirical investigation into building predictive, receptive, and preventing supply chain resilience strategies and has not addressed global supply chain impact (Scavarda et al., 2015; Bevilacqua et al., 2019).

According to Belhadi et al. (2020), the automotive industry feels the best strategy to mitigate risks related to COVID-19 and other potential disruptions is to develop localised supply sources along with decision-making proximity (Zsidisin et al., 2005) using advanced Industry 4.0 technologies to reduce supply chain integration. Firms should create a mix of geographically distributed suppliers, with an emphasis on suppliers that are closer to the various end markets and that will mitigate future risks (Mann, 2020). Firms should replace their traditional lead users with other focal firms in the ecosystem that can provide different solutions to those new needs and be important sources of innovation.

Additionally, I believe these participants should implement and accelerate the use of digital technologies and big data analytics across the supply chain; this would provide real-time, connected information and data-driven decision-making (Kamble & Gunasekaran, 2020; Belhadi et al., 2020) on various supply chain activities that could overcome the challenges posed by disruptions. This shared new digital infrastructure would enhance the opening of different types of non-firm-centric digital affordances (Autio & Thomas, 2019; Nambisan et al., 2017) that would anticipate future disruptions and biases and boost the open and recombinant generativity and innovation to cope with them. During this period, it is also crucial to enhance cooperation and collaboration globally with all supply chain participants and stakeholders as needed to overcome pandemic-related challenges and to build sustainable, agile, and resilient manufacturing and supply chain operations. For example, the automotive sector in Europe calls for coordinated vehicle renewal schemes for all vehicle types and categories across the EU (CLEPA, 2020). Accenture recommends firms synchronise with suppliers from tiers 2 and 3 to ensure rapid and accurate ramp-up (Vatier et al., 2020).

6.3.6. The pandemic as an opportunity to develop and reconfigure EV attributes

COVID-19 has highlighted the importance of further developing current and new EV attributes in response to pandemic-related trends and to protect people (Vatier et al., 2020). For example, EV firms must shift towards health and wellness solutions in vehicles as part of the new value propositions (Research and Markets, 2020). Vehicle manufacturers are reconfiguring the internal layout of seats and circulation spaces (e.g., on buses and taxis) and installing contactless door sensors, hand sanitiser dispensers, and clear screens between seats to provide a physical barrier to airborne aerosols (Paton, 2020); however, the efficacy and level of public acceptance for these new configurations are unknown (Budd & Ison, 2020).

Additionally, firms should enhance EV connectivity and the digitalisation of transport to increase consumer convenience and safety in order to enable new digitalised complementary services. This could include, for example, methods to stay in touch with family and friends in the car and to plan the following day with coworkers. It is also fundamental for EV ecosystem firms to analyse geospatial social mobility data based on transport modality. With this, researchers can evaluate in real time if changing social mobility in outdoor settings influences the spread of COVID-19. This powerful data can help inform prediction models and public policy decisions (Kurian et al., 2020).

6.3.7. The pandemic's effect on oil demand, supply, and cost

COVID-19 is affecting the supply of and demand for oil, helping to trigger a dramatic fall in oil prices due to coordinated massive production cuts to offset the collapse in oil demand (Jefferson, 2020). As a consequence, significant planned oil exploration and production is likely to be abandoned on cost grounds and the perceived weakness or uncertainty of demand. The forces of the pandemic will permit slow recovery for oil demand, thereby curbing major oil price increases for at least three or four years (Jefferson, 2020). In any case, analysts hope the price will rise again, so this effect should not interfere with the transition to EVs. For this reason, in some markets (like the United States), cheap oil has encouraged some buyers to purchase ICE vehicles and shift to less fuel-efficient vehicles (The National, 2020). Some experts suggest this could hinder drivers' perceptions of EVs as they look to capitalise on the cost savings associated with lower fuel costs (Oxford Business Group, 2020). These factors could help slow down the transition to EVs.

6.3.8. COVID-19's effects on light commercial vehicles (LCVs)

The pandemic has reconfigured the role, demand, and mobility of light commercial vehicles (LCVs) due to their role during the pandemic. Panic-buying in supermarkets was quickly replaced with overwhelming—and in many cases, unrealised—demand for online food delivery and shopping and home grocery deliveries as consumers tried to avoid going outside (Hanbury, 2020). For some logistics providers, this meant increasing the number of LCVs in their fleet to cope with a larger number of deliveries. COVID-19 has become a sudden catalyst for change within strategic fleet management (vehicle renewal, management, and new operations) because logistics operators have needed to reconfigure and renovate their value propositions. This is an excellent opportunity for EV manufacturers to extend their product portfolios to include new models of electric LCVs. It is fundamental that EV companies collaborate with logistics and rental companies of commercial fleets.

6.4. THE POST-COVID STRATEGIC BLUEPRINT: A SHARED NEW VISON OF THE EV ECOSYSTEM

All the previously described COVID biases have highlighted ecosystem biases. An important overall strategic bias that EV firms, stakeholders, and governments alike face within this transition relates to the apparent contradiction between the post-COVID priority of economic growth needed for rapid economic recovery and the environmental safeguarding and protection priorities through top-down interventions (Budd & Ison, 2020). Restarting the global economy will inevitably require the increased mobility of people and movement of goods, but this contradiction generates a knowledge gap since all ecosystem actors must align to achieve a delicate new equilibrium and a shared new vision for the EV ecosystem. Between the strategic demands and the period of transition

to a wider and mass technological acceptance, this balance is not easy to achieve. A coherent shared vision among participants will, thus, reduce this gap and uncertainty, as well as lower the threshold of complements to invest in this emerging EV ecosystem (Autio & Thomas, 2019; Dattée et al., 2018). The most important question is: Who should define and frame this shared vision?

Budd and Ison (2020) propose a new approach that uses the perspective of consumer behaviour to integrate both priorities, relying on the concept of responsible transport to shape transport policy and practice responses. This theory highlights the importance of the rational and ethical decision of the consumer as an individual citizen, who should independently assess the available transport choices and mobility behaviours in terms of the effects to themselves, others (fellow users and third parties), and the local and global environment, and then act accordingly (Budd & Ison, 2020). Before COVID-19, much of the emphasis was on transport interventionist policy based on demand management, 'smart' technological interventions, and sustainable mobility (Budd & Ison, 2020). However, within this new perspective, EV stakeholders should empower free and independent consumer decision-making in recognition of the importance of individual behaviour and collective responsibility to rapidly achieve positive social and environmental outcomes during global public health and climate crises. It seems that firms and institutions alike were ignoring consumer empowerment at their peril (Wright et al., 2006), and EV stakeholders must understand the different contexts, influences, and pressures in which consumers exercise their choices and make their views felt. Firms have to fine-tune and re-evaluate consumer expectations and their own marketing orientation in order to improve the quality of their value propositions to consumers and enhance their satisfaction with the change. Society at large and organisations must leverage what they have learned during COVID-19, with the pandemic highlighting the relevance and results of collective responsibility and actions by individual citizens rather than the policy responses of international agencies and national governments (Budd & Ison, 2020).

This new approach would further strengthen the perceived decision-making freedom of potential EV consumers, leading to dissonance-reducing behaviour among consumers (Reibstein et al., 1975) that accompanies an unfamiliar purchase such as of a new EV. This cognitive dissonance occurs since EV consumers are highly involved in what is an expensive, infrequent, and risky purchase and also because they perceive little difference among brands—likely due to their lack of information and education. Additionally, this approach would enhance consumers' involvement as an additional motivational variable within consumer behaviour, based on an increase in the EV's perceived relevance based on inherent needs, values, and interests (Zaichkowsky, 1986). According to Zaichkowsky (2010), high involvement implies a great deal of activation and influences consumer decision-making and interactive communications.

From this new perspective, it is consumers who should drive this change by becoming the new focal actor within the EV ecosystem—not a firm, institution, or government—because they need to feel they define and control all value propositions and this revolutionary new blueprint affecting all humanity, as well as persuade others to contribute accordingly (Adner & Kapoor, 2010; Hannah & Eisenhardt, 2018). EV stakeholders should ask themselves: How can we carry out such a revolutionary sociotechnical transition if we don't allow the consumer to lead it? The consumer should be the pivotal protagonist in this great step for humanity.

6.5. BIASES RELATED TO CONSUMER PERCEPTIONS OF EVS AND THEIR ADOPTION

In most countries, EV adoption rates are still low compared to ICE vehicles (IEA, 2019). For a multitude of reasons—including limited mileage before needing a recharge, an underdeveloped charging network, and lengthy charging times—consumers have not yet widely accepted EVs. The speed of diffusion, acceptance, and adoption of new EV technology and consumers' perceptions of this new technology depend on the energy-related investment perspective (Kastner & Stern, 2015) and the pro-environmental perspective (Bamberg & Möser, 2007) that are driving related consumer behaviours and decisions in the EV's transition to mass consumption.

EV firms must modulate and orchestrate both the energy-related investment and pro-environmental perspectives within their strategies. However, I have observed that consumers' EV-related choices, actions, and behaviours often deviate systematically from the assumptions that these should be highly rational, planned, and congruent with the consumer's values and intentions (Bobeth & Kastner, 2020; Kastner & Stern, 2015). Additionally, certain fundamental, persistent biases in human decision-making regularly produce a different behaviour that these assumptions cannot account for (Frederiks et al., 2015). For EV-related decision-making—characterised by high levels of novelty, complexity, choice, risk, and uncertainty (Kahneman et al., 1982)—an important knowledge gap remains between people and companies' expectations of how consumers perceive they behave individually and in groups and how they really behave in their daily routines and decisions. For example, some EV shoppers perceive the features and benefits of certain EVs to be on par with those of gas-powered luxury vehicles, and these shoppers' incomes allow them to be early adopters of this new technology. However, other consumers of more modest means feel EVs are not within their budgets or not practical enough for their everyday driving (IEA, 2020). This knowledge gap offers a blurry image of the real customers to EV firms and stakeholders, which hinders their strategic and marketing efforts and hence delays EV adoption. This misinterpretation of actual EV consumer behaviour is due to several factors, described in the remainder of this section.

First, when comparing EVs and ICE vehicles, consumers try to rationally assess the perceived pros and cons for each alternative: contrasting their perceived product/service performance and their economic/technical attributes (e.g., EV speed or boot size), and then weighing them to identify which is the most suitable investment from a rational or planned behaviour perspective (Ajzen, 1991). According to the technology acceptance model, which focuses on the relevance of the rational choice (Davis et al., 1989), this comparison is highly influenced by consumers' perceptions of the usefulness of new EV technology; it reflects their perceived advantages and disadvantages of a new technological system and hence refers to the anticipated outcome of the new technology's use and performance. Klöckner (2014) and Peters and Dütschke (2014) tested and affirmed the relationship between a global perceived usefulness measure and the EV's intention as a new technology. For example, EV performance and reliability are known to affect user perceptions of EVs (Franke et al., 2012).

Additionally, EV firms cannot easily deduce this comparison since it is altered by and conforms to consumers' individual concerns, values, and priorities; the specific sociocultural and economic contexts of the consumer decision; and the relative external influences of the consumer (e.g., media, friends)—all of which are time-specific. For example, some consumers prioritise their 'green' knowledge and values or their openness to shift (e.g., to renewable resources, sustainable products, or low emission technology) over other attributes and translate this into more directed pro-environmental choices when buying goods or using services that impact the environment (Frederiks et al., 2015). However, other consumers may have a strong desire for comfort or have desires that conflict with these 'green' motives (Wolske & Stern, 2018). In this sense, managers and strategists

alike underestimate that, for example, many people still rely heavily on nonrenewable resources or fail to recycle, actions they may themselves acknowledge as 'wasteful' (Frederiks et al., 2015). These are important barriers and biases that stall EV market penetration.

Consumers' behaviour related to the EV adoption is heavily influenced by their perceptions of financial and technological user-friendliness and usability constraints, drivers, and new demands (Schwedes et al., 2013). EV and battery-replacement prices are still perceived to be higher than those of conventional vehicles, but consumers are not fully aware that EVs are gradually becoming competitive in some countries based on the total cost of ownership or investment. Thus, the consumer must account not only for the purchase costs but also for projected ownership costs (for example, fuel/electricity expenses and savings). This knowledge gap is also influenced by the fact that EV consumers act by inertia and unconsciously apply the same economic valuation and criteria based on a kind of renewal approach that they used for many years when buying a new ICE vehicle. This inertia hinders an efficient economic valuation and an active and exhaustive search by the consumer for novel, appealing alternatives for EV purchase, financing, and use with better value propositions.

At the same time, although EVs have been designed to be easy to use and master, the potential EV consumer perceives they will have to adapt to new and unknown characteristics of an innovative technological system (e.g., lower driving range, unfamiliarity with the charging system, new maintenance programmes) (Bobeth & Kastner, 2020) and assume greater personal risk and cost in terms of effort, additional time for learning, and training time. These behaviours also align with the technology acceptance model theory because the intent to use and adopt a new technology relies not only on consumers' positive perceptions of the technology's usefulness but also on the perceived ease of use, which summarises an individual's perception of whether a technological system is designed in a user-friendly way (Davis et al., 1989). It is important to highlight that Fazel (2014) and Dudenhöffer (2015) tested and reported different types of significant associations between EVs' perceived usefulness, perceived ease of use, intention, and behaviour (the technology acceptance model's core constructs). As in Section 6.4, these perceptions—which are subjective representations of objective contextual factors and individual evaluations—hinder EV adoption since they lead to dissonance-increasing consumer behaviour (Reibstein et al., 1975). To overcome these cognitive biases, EV firms could develop appropriate driver training programmes as complementarities to the EV.

There are also several cognitive biases in human decision-making with high perceived risk that shift consumer choices and actions systematically away from rationality towards irrationality, generating an unexpected behaviour that rational assumptions cannot account for (Wilson & Dowlatabadi, 2007; Pollitt & Shaorshadtze, 2013). This is because consumers have an innate bounded rationality that limits their ability to acquire, memorise, and process all relevant information, which makes them rely on simplified mental models, approximate strategies, and heuristics (Acquisti & Grossklags, 2005). These behavioural anomalies influence consumers' patterns of EV adoption and behaviours and include the status quo or inertia bias, loss and risk aversion, sunk-cost effects, temporal and spatial discounting, and the availability bias (Frederiks et al., 2015). EV adoption behaviours hinder these irrational behaviours, which are driven by heuristics or mental shortcuts and which help consumers quickly make complex, risky decisions and judgements within the fuzzy EV boundaries by scrutinising a limited number of signals and/or alternatives and without having to spend significant time researching and analysing information (Dale, 2015). These irrational factors alleviate consumers' tension in the face of these complex decisions and social norms and accelerate their decision-making by leading them to dissonance-reducing behaviour (Reibstein et al., 1975).

It is highly complex for EV companies to truly understand which type of heuristics novel EV consumers use since these individuals do not have any previous experience of satisfaction or dissatisfaction, similar circumstances, or associated decisions because their precedents are mainly associated with ICE vehicles. Firms must consider that consumers are shaping their heuristics mainly by simplifying product information searches and alternative evaluation (Taylor & Fujita, 2018). The consumer enhances dissonance-reducing shortcuts, leading to 'irrational' behaviours related to energy investments. These irrational behaviours confuse EV firms and drive the emergence of several cognitive biases formed by EV firms' prejudices and preconceived, simplified opinions on their potential consumers. EV firms should understand how the specific heuristics of EV behaviour form within different consumer segments to gain better insight into potential consumers' personal biases and influences related to EVs (Dale, 2015); to develop appropriate and appealing messages with pre-cooked 'mental shortcuts' or 'rules of thumb' within EV marketing campaigns that can eliminate consumer biases; to simplify perceived problems surrounding EV adoption; and to help solve consumers' current EV dilemmas.

All the biases and behaviours discussed thus far in this section rely on an apparent consumer misunderstanding and misinterpretation of the real boundaries and dimensions of EV attributes and benefits (Krause et al., 2013). A sizable gap remains between consumer knowledge of how traditional ICE vehicles work and EV features and benefits (IEA, 2020). Firms should realise that in the absence of previous user experience, consumer evaluations and attitudes rely on their preconceived notions of subjective norms and behavioural control, which generate positive and negative expectations about EVs' utility among diverse portrayals and combinations of people, behaviours, and mobility related to EVs. These preconceived notions must be explored to provide consumers with the adequate, precise knowledge they need. At the same time, as EV penetration progresses, increased EV knowledge will alter consumer preferences, likely reducing the misunderstandings or misperceptions (Giansoldati et al., 2020).

Additionally, EV firms should explore and research these perceptions since they can provide firms with diverse, unexpected knowledge on consumers' EV mobility vision, needs, use, and desires, assessing how people imagine themselves as EV consumers. Those preconceived perceptions relate to EV attributes such as performance indicators, indicators' accuracy (e.g., autonomy accuracy), noise, and safety (e.g., risk of accident). Potential users' awareness of an EV's benefits, environmental considerations and impacts, financial incentives, infrastructure availability, and potential fuel-related savings are likely to be essential factors affecting EV uptake (Broadbent et al., 2018). For example, consumers are often uncertain about possible EV-related emission reductions and, at times, they are unaware of the harm caused by greenhouse gas emissions due to the use of ICE vehicles (Haddadian et al., 2015). According to Giansoldati et al. (2020), 'Incorporating EV knowledge will greatly enhance EV suppliers' ability to explain car choice to consumers and offsets but does not radically alter the negative attitude towards EVs'. Current actors in the EV ecosystem are not yet providing adequate business cases and compelling customer value propositions for most customers and, consequently, cannot capitalise on EVs' market potential and change the status quo of the automotive sector (Zulkarnain et al., 2014; Petrie, 2012).

The key challenge in the EV ecosystem in this competition with ICE vehicles is to change this status quo, facilitating the emergence and growth of a thriving global business ecosystem. To raise public awareness, EV firms and other ecosystem stakeholders alike must launch continuous communication campaigns and messages to provide potential consumers with adequate information to engage not only on EVs' technical attributes but also on their tactile and emotional appeal—portraying them, for example, as fun and exciting. Within these campaigns, EV firms should call for certain consumer actions on- and offline to collect and assess responses and, thus, apply data mining

to market research strategies in order to gather insights into consumers' resistance to change, specific changes drivers, and EV preferences by segment and niche. Later, these information campaigns could turn into specific relational-marketing promotional campaigns that could enhance one-to-one marketing strategies.

Additionally, consumers currently have a limited number of choices of EV brands, models, and variants compared to ICE vehicles. This is narrowing the number of affordable alternatives for users (Linzenich et al., 2019) and the number of attractive value propositions. Thus, it is hindering perceived decision-making freedom among consumers and slowing the increase of potential new sales and pace of transition. For this reason, potential EV consumers may perceive lower psychological freedom when choosing from smaller versus larger vehicle assortments (Aydinli et al., 2017; Reibstein et al., 1975) because it constraints the desire for variety (Botti et al., 2008) and the likelihood of finding an ideal match (Chernev, 2003). This perception also alters consumers' perceived safety and increases their dissonant behaviour.

Within these types of energy-related investments, certain norm-directed motives (Black et al., 1985) also address EV-related behaviours (Bobeth & Kastner, 2020). These motives include accepted social norms that involve (perceived) moral group rules or expectations regarding EV adoption and its effects (Klöckner, 2013b; Schwartz & Howard, 1981; Thøgersen, 2006): for example, regarding the moral obligation to help mitigate climate change in order to reduce the negative consequences for future generations. Additionally, personal norms, morals, and attitudes related to EVs reflect the individual's own rules or expectations, which can contrast or harmonise with those accepted social norms regarding this new technology. These social norms are subjective and should be examined within the context of how consumers perceive their peers' ideas on EVs and whether they perceive EV adoption to be a social norm (Rezvani et al., 2015). Both accepted social norms and personal norms shape the consumer's rationale and planned approach, as well as generate the cognitive bias that emerges under different circumstances (because, for example, some moral social motives might contradict some rational motives or the consumer's personal perceptions and attitudes). At the same time, firms must consider that what people say and what they do are sometimes very different. Thought-action gaps are especially common on the environment, an area in which people often fail to take actions that reflect their values. These gaps encompass knowledge-action gaps, value-action gaps, attitude-action gaps, and/or intention-action gaps. For example, people may know about EVs, intrinsically value them, view them positively, and/or genuinely intend to act in a socially desirable way regarding their environmental social benefits; yet, these thoughts often do not translate into actual behaviour. Attitudinal studies reflect consumer ideals for socially desirable values (e.g., environmental benefits) versus real purchase intentions (Mairesse et al., 2012). Consequently, it is fundamental that firms interpret and assess those norms and biases in consumers' specific sociocultural and economic context and take into account that these are evolving as the EV's pace of adoption increases. However, firms should also be aware that these socially accepted norms, an overwhelming amount of information on EVs, or excessive regulatory pressure can place additional pressure on consumers and affect their decision-making freedom related to switching to an EV or the best perceived alternative. Consequently, this could lower consumers' psychological freedom, affect the perceived risk in their decision-making, enhance their consumer dissonant behaviour, and thus slow the transition to EVs.

Based on this analysis, I hold that consumers' perceptions and attitudes towards new EVs are overly confined and tangled in—for example—socially accepted norms and behaviours, a lack of information and communication, infrastructure constraints, resistance to changing behaviours and patterns, risks, imposed regulations, financial incentives, unclear technology improvements, and personal prejudices. These perceptions are certainly blocking consumers' positive actions on EVs

because they are inducing a certain EV decision or analysis paralysis. This syndrome is due to consumers' overanalysing or overthinking an important decision, treating it as overcomplicated (Kurien et al., 2014) and generating a certain fatigue and anxiety. This paralysis makes EVs' potential consumers feel their buying process is totally self-contained while too many unclear pieces of information, options, pressures, perceived risks, and constraints actually lead most of them to fear—and feel they can make—a bad choice, paralysing them. According to Kurien et al. (2014), the potential EV consumer might be seeking the optimal or 'perfect' EV value proposition; for fear of making any decision that could lead to erroneous results or potentially larger problems, they might continuously seek a better solution. In this case, the opportunity cost of decision analysis exceeds the consumer's perceived potential benefits of enacting or postponing this crucial decision (Kurien et al., 2014) or leads to a non-deterministic situation due to the consumer's inability to objectively predict an outcome and in which the sheer quantity of analysis overwhelms the decision-making process, thus delaying and diverting the EV decision.

These perceptions also induce some EV consumers to feel they are losing their autonomy and freedom of choice, the individual's subjective sense of being able to make and enact decisions of their own volition (Wertenbroch et al., 2020). The 'paradox of choice' suggests that actual and perceived autonomy may not always correspond (Markus & Schwartz, 2010; Schwartz, 2005). Even when all prior consumer behaviour and individual judgements related to the EV ecosystem violate certain norms of planned rationality, they do not necessarily undermine consumer autonomy since they are part of everyday decision-making that EV firms should understand in context; however, individual autonomy is also limited by external influences (Wertenbroch et al., 2020). In the EV ecosystem, the external influences that limit this autonomy are integrated into extrinsic and intrinsic constraints (e.g., charging infrastructure constraints or unavailability of a viable choice option); prejudices (e.g., there is not an ideal solution); and imposed barriers (e.g., imposed laws or policies by global institutions), coercion (e.g., imposed gas tax), or manipulation (e.g., manipulated EV-related information). According to Wertenbroch et al. (2020), knowledge on perceived autonomy and the ways it is threatened, maintained, or enhanced is fundamental for firms to assess consumer behaviour.

Firms should also consider that new technologies cannot be viewed objectively given they have to be socially interpreted ('constructed'). What matters is the technology's performance as used by the society rather than as developed (Adner & Kapoor, 2016). Thus, the social interpretations and integrations of a new technology affect its life cycle and diffusion processes (Schwanen et al., 2011). A new technology must gain social and cultural legitimacy (Geels & Verhees, 2011) by becoming integrated into the context with all relevant industries and markets (business environment); by matching regulations, rules, and standards (regulation environment); and by fitting existing social norms and beliefs (wider society). In this way, all actors and users in the context can combine all complementarities to enhance value co-creation. Recent research suggests EVs' cultural legitimacy in Europe and North America has not been large enough to trigger a transition to electric road transport. This is because once launched, the ecosystem actors should also focus on the EV's as-used performance perspective, which depends heavily on the development of complementary elements such as charging station infrastructure (e.g., how convenient it is for a driver to recharge the battery). Firms and governments alike should take a systems perspective rather than a product perspective, assessing the context of the entire technology ecosystem on which product performance depends. There is an urgent need for a coordinated effort by automotive brands, governments, world organisations, marketers, and dealers to prioritise consumer education over short-term profits (IEA, 2020).

6.6. THE B2B MARKET AND SERVICE BIAS RELATED TO COMMERCIAL FLEETS

Also noteworthy within this historical transition is the importance of electric LCVs' capabilities within commercial fleets (B2B market), which now represents an excellent strategic opportunity for different types of firms. On the eve of the post-COVID-19 recovery, commercial transport—and especially last-mile delivery—are expected to grow because of the rise of e-commerce (Tsakalidis et al., 2020), particularly in urban and suburban areas (Wolff & Madlener, 2019). For these firms, which mainly belong to different specialised-supplier-based ecosystems, transportation was believed to be an auxiliary service. However, it has turned into a strategic pillar complementarity and a relevant value factor within their new and updated value propositions. These firms must address this service bias as soon as possible to embrace new value propositions for the new normal.

Overarchingly, this new normal means new social trends related to accelerations in e-commerce and home delivery that will lead to much higher demand for light commercial transport, as more frequent deliveries will require more tonne-kilometres (Tsakalidis et al., 2020), especially for same-day delivery (Lin et al., 2018). These scenarios will generate more demand for transportation and, hence, lead to greater fuel consumption and emissions in transport if ICE vehicles are still used to cope with these growing needs. Thus, the achievement of greenhouse gas emission and air quality targets will be compromised, representing a key threat to the environment. These factors illuminate an important market bias for EV manufacturers, since they appear to lack knowledge on the needs of B2B end users (von Hippel, 1986) and on the environmental needs that can be considered another 'end user'. This bias represents a challenge for EV firms since electric LCVs have been receiving much less public attention compared to passenger vehicles and since firms have similarly diverted their attention from LCVs and are too focused on passenger vehicles (Tsakalidis et al., 2020).

With their distinctive attributes and technological supermodular complementarities in both production and consumption, electric LCVs can offer B2B firms new and different patterns of use based on improved standards for economies of scale, with more efficient and flexible routing that has additional types of aggregated services. Commercial fleets could take advantage of big data to customise commercial EVs' battery size based on the user's travel, size, and weight needs and avoid batteries that are too large, which is especially relevant for heavy-duty vehicles (IEA, 2019). At the same time, market deployment of electric LCVs remains very low since, for example, they are not competitive enough in several EU countries due to the lack of adequate policies and fiscal incentives (Tsakalidis et al., 2020). Those governments and institutions are also experiencing relevant service and market biases since they are co-creative participants within all of these supplier-based ecosystems that accommodate and underlie value creation process (Autio & Thomas, 2019). Additionally, LCVs hold great potential to leverage the transition to EVs; unlike private users, fleet managers base their decisions on rational arguments, which makes them more likely to take into account electric LCVs' total cost of ownership, lower operating costs, and standardised patterns of mobility that allow firms to efficiently manage routes and charging needs compared to conventional vehicles, in particular for vehicles with high annual mileage (Tsakalidis et al., 2020). Additionally, fleet recharging infrastructure can be installed centrally in a fleet depot (Quak et al., 2016; Frenzel, 2016).

There are many similarities between LCVs and passenger vehicles because many of the available models are based on vehicle architecture that enables passenger and light commercial versions (Tsakalidis et al., 2020). Thus, EV automakers could take advantage of their current passenger models and rapidly convert them into the corresponding LCV versions to cope with the growing market for B2B mobility needs. Since governments and EV firms and stakeholders are

mutually codependent actors within this ecosystem (Autio & Thomas, 2018), all of these efforts should be accompanied by new harmonised and industry-tailored fiscal incentives, regulatory frameworks, and support measures stimulating EV demand in context. This cooperation will help all actors to build a shared vision of the EV ecosystem that will facilitate the co-alignment of all complementary inputs.

6.7. BIASES RELATED TO CONSUMER SEGMENTATION AND TARGETING

Despite the fact that innumerable rapid changes and innovations are taking place in the automotive sector in a very short time span, ICE vehicles' and EVs' market segmentation still focuses too heavily on static, macroaggregated, and isolated perspectives and results rather than the resulting individual-level dynamic reactions and behavioural changes among consumers (Taylor-West et al., 2018; Brand et al., 2017). Marketing strategies for new automotive product launches continue to be formulated for mass markets, with one-size-fits-all messages that leave decisions to a consumer's summary judgement rather than tailored messages for more defined, segmented markets (Delgado-Ballester et al., 2012; Taylor-West et al., 2018).

The automotive sector still uses an intuition-based market segmentation structure that has remained unchanged for some time (Dibb, 1998; Maheshwari et al., 2016) rather than a segmentation approach based on systematic analysis (Dibb, 1998; Wu et al., 2015). This intuition-based segmentation continues to use an aggregated approach to EV uptake based on single demand curves with single price elasticities and discount rates, ignoring heterogeneity in the private vehicle market (Creutzig, 2015). The electrification of the automotive market has also ignored this market's dynamic nature—i.e., that some market segments are unlikely to adopt new technology until critical mass is achieved in the market, at which point their demand characteristics will change (Brand et al., 2017). Currently in the automotive market, no classifications accommodate consumers' view or categorise the degree of innovativeness (newness) and complexity they perceive in a new product (Taylor-West et al., 2018). According to Anable et al. (2011), consumer preferences cannot be assumed to be static, particularly over the longer term and especially because EVs are 'disruptive' since they require a significant shift in consumer behaviour. Additionally, Taylor-West et al. (2018) argue that the consumer profile for new products is established by product development teams and that just one message is sent out to mass market segments based only on demographics, simply because these teams do not have data relating to the customer profile. Within the transition in this sector, it is a priority for automotive firms to not only redefine vehicles' product architecture but also identify and widely understand the key market segments for EVs that can lead this transition into the mass market. This would help to configure the elements and attributes of the product and its complementarities (e.g., design choices for battery configuration and charging infrastructure) (Sodemkamp et al., 2019).

Within this ecosystem, segmentation studies and approaches for the EV market still rely on several practices, described in the following subsections.

6.7.1. The EV as a product and its supporting infrastructure as a service (EV segmentation) rather than customer/user segmentation (driver segmentation)

Current segmentation strategies and practices segment the EV market as a product and its attached infrastructure, considering criteria such as electric reachability, load to the electric grid, and distance that can be driven electrically. Because they segment the EV instead of its user, these studies do not distinguish among driver segments and treat 'drivers' as a homogenous whole (Sodenkamp et

al., 2019). The aggregated results are, hence, limited to a macro-level perspective or to an isolated assessment of the recruited driver sample, which reduces forecasts' validity with respect to specific groups of adopters and their regional impact on the grid (Sodenkamp et al., 2019).

6.7.2. Segmentation variables for the ICE audience that rely on traditional consumer perceptions and conventions

Segmentation variables for ICE audiences rely on traditional metrics because people have been driving cars for over a century and their experience has been primarily based on ICE technology (Taylor-West et al., 2013). Brand et al. (2017) consider the most important distinguishing factors for consumer groups within the new EV market to be related to many of the barriers/enablers of EV uptake: for example, its running costs, its high price premium over non-EVs, its limited supply in terms of vehicle segments (e.g., supermini, small family) and brands, the limited availability of charging infrastructure (at home and in public), shorter range and longer charging times, and the lack of receptiveness to and acceptance of EVs or any incentives.

6.7.3. Simple demographic segmentation strategies

Within the demographic and geographic segmentation approach, firms consider clusters or groups of EV drivers based on common variables such as age, sex, income level, employment, and education. The current, exaggerated use of these variables leads to low-quality, homogenised segmentation that does not allow EV firms to clearly differentiate among consumer groups by their specific EV-related needs and behaviours. Several segmentation studies rely on the growth of new segments that are shaped by new combinations of these poor general sociodemographic variables (e.g., millennials, Generation Z, Generation Alpha); they fail to consider the important differences within these groups in terms of product use and perceptions, benefits sought, and the role of self-expression in EV use. EV firms should use more enriched, detailed segmentation variables that include all relevant customer behavioural and psychographic variables related to their use and perceptions of the offered EV: for example, the driver's lifestyle, purchasing and consumption habits, driving behaviour, routines and frequency of use, and values on and attitudes towards the EV and its benefits. According to Lin (2002), firms should combine both common and enriched variables, like demographics and psychographics, to create more precise information on 'hidden' market niches, sub-markets, and sub-segments. Psychographic aspects of the consumer can provide researchers and managers with more descriptive insights into consumers and their lifestyles (Lesser & Hughes, 1986), and can even help predict future behaviour regarding EV use and perceptions (Sandy et al., 2013).

According to Kotler and Keller (2013), behavioural segmentation divides consumers into groups on the basis of (1) EV knowledge; (2) attitudes on EVs; and (3) a specific use of the EV. These new, more specific segmentation variables measure how a consumer can respond to a specific EV model because these variables are closely related to the EV products/services and their attributes. For example, when an innovative EV model launches in the marketplace, the firm's first priority should be to raise awareness and educate consumers and potential buyers. In this case, firms should understand that consumers can simultaneously be at various stages of readiness—unaware of the new firm's offering; aware; informed, interested, and desirous; or fully ready and already having the intention to buy—and differentiate accordingly (de Villiers et al., 2019).

6.7.4. Macro-level segmentation

For this case study, I must also differentiate between and apply macro- and micro-level segmentation. Macro-level segmentation includes geographical, political, economic, social, and cultural data that have been collected across countries, and automotive firms have widely used this approach to identify global market segments while ignoring within-country heterogeneity. By contrast, micro-segmentation seeks to enhance market responsiveness by responding to each market's needs and wants (Hollensen, 2020), as well as recognises countries' unique cultural and social heritage and different local meanings of EV adoption. Worldwide, road-based transport and urban transport needs, functional behaviours, and trends are highly diverse, with many required and preferred vehicle types and use patterns. Regional variations in mobility trends rely on macroeconomic developments, regulatory developments, local infrastructure, and customer behaviour that evolve in different ways depending on location (Hausler et al., 2020).

Additionally, assessing EVs' applicability and adoption as an alternative technology requires a detailed micro-segmentation analysis since attitudes towards technology differ by country and region due to the significant differences in consumers' internal context (e.g., culture, mentality, education) and additional external contextual factors (e.g., the economic situation, local policies and incentives to support adoption, social pressure surrounding sustainability). While EVs are highly topical in developed countries (Schade et al., 2012), they remain unpopular in developing regions with the exception of China (Rajper & Albrecht, 2020). For example, many consumers from developing countries have no car-ownership experience, and they may be more open to new vehicle technologies and mobility concepts than consumers in the mature markets of developed countries (Schade et al., 2012). Additionally, EV diffusion is slower in developed countries because technological scepticism is more widespread among consumers, the market for passengers is more saturated, and consumers tend to compare EVs to conventional vehicles due to their extensive experience using ICE vehicles (Schade et al., 2012).

By relying heavily on these criteria, all potential EV customers that fall into a specific product or market segment (e.g., mothers, millennials, Parisians) would be marketed to identically—giving EV firms a blurry image of those customers' real expectations, needs, and sought-after benefits. Consequently, firms' subsequent targeting, innovation, and promotion strategies would be biased. This information is necessary, but taken alone would lead the company to a vague image of their customers; these customers would identify and perceive the EV and brand erroneously because the EV/brand would not match their real, more individualised expectations, which are simultaneously closely related to acceptance factors for new EVs. At the same time, EVs are perceived differently by different consumer groups and are likely to be attractive to different people (Anable et al., 2011). Brands would receive few indications as to whether and how consumers might be interested in firms' EVs and their value propositions. According to Brand et al. (2017), neglecting the heterogeneity and dynamic nature of the new EV market slows down the pace and extent of EVs' market adoption (Brand et al., 2017).

These invalid marketing segmentation approaches and variables limit the correct identification of relevant profiles, groups of users (drivers), and these user groups' specific needs, expectations, EV acceptance factors, and driving habits and behaviours. Hence, these approaches do not support decision-makers in identifying the segment-specific vehicle and infrastructure requirements that are crucial for innovation in this sector. These static and non-updated segmentation strategies are blocking the market transition to EVs because new EV consumers are not receiving adequate messages and communication from EV makers and because EV firms are not properly or regularly listening to potential consumers. Hence, these firms are not adapting their offerings and value propositions to their wider and changing audiences because these are still anchored on the

static, traditional segmentation of the traditional vehicle that has lasted for more than 40 years. These strategies are confusing the EV consumer, who is not perceiving the real differences and advantages of EVs versus ICE vehicles.

EV firms should develop and expand their segmentation strategy into novel segmentation approaches that follow several guidelines, described as follows:

Enhancing behavioural profiling and segmentation of customers. The correct application of behavioural segmentation variables within the segmentation of drivers (people) will help ecosystem decision-makers to correctly identify, understand, and differentiate these value segments of drivers and their specific insights and behaviours. This segmentation will allow firms to track their specific brand performance on a finer level and identify precise opportunities for growth. Research by Taylor-West et al. (2018) suggests that marketing departments should rethink their data capture methods to collect more relevant, individual consumer information; this information should be more related to behavioural aspects rather than psychographic information because psychographic information is more difficult to identify and collect information on. For these reasons, EV firms should concentrate their consumer profiling and behavioural segmentation approach and research on analysing consumers' previous experience, expertise, involvement, exposure, and familiarity with EVs instead of following the contemporary trend of collecting data on needs, attitudes, and motivation variables (Taylor-West et al., 2018).

It is also crucial to discover behaviour-based driving patterns or styles using trajectory or trip segmentation, in which each segment may represent a specific type of movement pattern, phase, or behaviour and the availability of these large transportation data sources (Brambilla et al., 2017; Moosavi et al., 2016). For example, segmentation procedures can be implemented for a segment-wise analysis of drivers using GPS mobility data, data on the frequency of use and nature of travel (satisfied needs), and so on; one could also add data from psychographic segmentation variables such as driving style (how drivers' characteristics affect driving style).

Implementing a dynamic segmentation approach. To apply this new perspective, firms must exploit data collection—for example, during drive. According to the previous approach, segmentation that clusters drivers with similar behaviours should be dynamic because consumers' behaviour and reactions change over time and as the various phases of the product life cycle progress. Modern customers are not static, and segmentation models should not be either (Irwin, 2019). However, most brands still use a fixed group of descriptive, static segments that are updated on a very slow schedule. A key question is the degree to which preferences remain stable and how changes in individual attitudes and social norms diffuse over time and space (Shove, 2010; Schwanen et al., 2011). This is particularly relevant within the EV ecosystem because the EV is about to enter the phase of fastest growth within its life cycle.

Within the dynamic approach, segmentation should be flexible and adaptative because it will be dynamically checked and updated by dynamically assigning customers to segments that exhibit a certain level of behavioural persistence as predefined by continuous data analysis (Reutterer et al., 2006). Thus, firms can determine immediate customer value (Dullaghan & Rozaki, 2017) and extract valuable insights from the data (Moosavi et al., 2016). Additionally, firms will be able to predict customer segments based on the propensity to take a specific action—grouped by the most important shared characteristics revealed for each segment—because they change dynamically in real-time based on new data from customer interactions (Irwin, 2019). That will allow firms to predict the

extent to which social situations or collective behaviours are the result of individual actions alone, and the role of larger institutions and other actors (e.g., governments, insurance companies) that configure new EV acceptance and use (Shove 2010; Schwanen et al. 2011).

This methodology is based on persistent behavioural-based data-mining methods that use a systematic analysis (Dibb, 1998; Wu et al., 2015) and involve extracting customer profiles and behaviours. This methodology is becoming increasingly available due to the ubiquity of devices that collect data during drives or when consumers consult information on firm websites or share their EV-related experiences on social media (e.g., on usage-based insurance, EV battery optimisation, fleet management, navigation of connected vehicles, or car safety). This segmentation approach should be a collective and collaborative effort among ecosystem participants and stakeholders, and it should provide a common generative digital infrastructure and platform. This platform should share all collected customer data and facilitate interactions (fortuitous, intentional, and calculated) that will enhance and accelerate the generativity of value co-creation (resource integration) among ecosystem participants (Nambisan et al., 2017), thus becoming a central focus of innovation within this ecosystem (Yoo et al., 2012).

Increasing the niche level of segmentation. Firms must increase this unit of segmentation analysis since consumer choice and behaviour in social science tend to start at—and remain focused on—the individual and psychographic level rather than the collective level, especially when assessing the introduction of a new product that is going to be highly disruptive and change our future, economies, jobs, personal lives, health, homes, environment, politics, and so on. Niche markets consist of smaller consumer groups within the larger segments who have similar demographics, buying behaviour, and/or lifestyle characteristics but who may have differing motivations and whose needs are not fulfilled—essential elements for marketing and innovation (Akbar et al., 2017: Thilmany, 2012). Niche segmentation should outline not only such concepts as utility and preference but also all psychographic aspects such as personal attitudes, morals, and values regarding the EV and its wider consequences (e.g., social, economic, environmental). Within this niche segmentation, it is also important to address the new roles of consumers' self-expression when projecting their self-identity and self-worth to others through EV consumption and use. It is fundamental to assess the different consumer identities by analysing the different types of associated self-identities regarding the EV, such as social self-identity based on new social patterns of consumers' self-construal theory about individualism/independence and collectivism/interdependence regarding EV consumption. Firms must also take into account the development of green self-identity (Barbarossa et al., 2015) or pro-environmental self-identity (Whitmarsh & O'Neill, 2010), which is the overall extent to which individuals perceive themselves to be green consumers.

It is also fundamental to assess self-identity regarding one's lifestyle-technology fit, measuring the influences affecting the formation of beliefs and attitudes on a new technology, including technology acceptance and perceived enjoyment of the new technology (Coursaris & Van Osch, 2015). Firms should also enhance research on these consumers' psychographic variables within the framework of sociology (Kashima et al., 2014; Stets & Biga, 2003) by assessing the role of multiple, diverse self-identities across social contexts and the cross-influences from relevant others on individual pro-environmental or pro-technological consumption choices and attitudes (Barbarossa et al., 2015). Understanding these multiple niche identities and their relationships in different cultural contexts will allow firms to correctly identify consumer groups and the real drivers of EV consumption therein. For example, EV firms should group their customers based on lifestyles and on consumers' aspirations to those lifestyles in relation to the self-identities projected by the EV.

Enhancing the fusion of macro- and micro-segmentation approaches within psychographic and behavioural approaches. Steenkamp and Ter Hofstede (2002) recognise a key conceptual problem in international segmentation: General/macro (domain-specific) behavioural and psychographic segmentation bases tend to be more (less) construct-equivalent and yield more (less) accessible and stable segments, but also tend to be less (more) actionable and responsive. The authors suggest a two-step model combining macro- and micro-segmentation. Firms have to create new relevance, cultural connections, products, and stories to engage both global and local audiences. For example, EV firms should take into account that new COVID-19-related consumer behaviour trends may vary by region, and so responses and outcomes for mobility players should differ by location.

To cope with this diversity and complexity of the proposed new dynamic and multivariate segmentation, EV firms should continuously launch extensive market research programmes for EV development and conduct field trials to test new technologies (Schade et al., 2012). Firms should use these efforts to explore and monitor consumers' acceptance, reactions, expectations, and dynamic behaviours (e.g., driving style) within their cultural context—and thus, enhance value co-creation in that context (Akaka et al., 2015). For example, consumer research indicates female automotive shoppers consider more practical features such as affordability, reliability, fuel efficiency, and safety, while men tend to focus on performance, styling, interior, and other aesthetic features (IEA, 2020).

At the same time, these leading firms should identify and understand those value segments through the new segmentation patterns of dynamic segmentation, which would allow firms to track brand performance on a finer level and to precisely identify real-time growth opportunities across contexts. This would allow firms to fine-tune their marketing and innovation efforts while making consumer targeting more precise and efficient. Exploiting this new type of dynamic segmentation could significantly impact product/service customisation; it could also greatly impact the development of supermodular complementarities of both consumption and production (Autio & Thomas, 2019; Jacobides et al., 2018) related to road safety, business models related to driving (such as 'pay how you drive'), insurance policies, and vehicle rentals. For example, knowledge on driving style could be used to encourage better behaviour through immediate feedback while driving or by scaling auto insurance rates based on the aggressiveness of the driving style (Brambilla et al., 2017).

Finally, these leading and focal firms must develop and improve successful, new, and evolved models of innovation and mobility solutions (Schade et al., 2012) by generating value-in-cultural-context that uses value proposition framing and business model adaptations to different contexts in order to meet emerging and changing consumer profiles and requirements. This would reduce uncertainty and promote a nascent ecosystem over that of incumbents and focal firms (Snihur et al., 2018). These models should regulate perceived value among these different contexts. They could also facilitate productive innovation and idea exchange in their own right, as shared institutional logic across the supply chain can homogenise business and cultural assumptions, evaluation methods, mental frameworks, and rules of exchange within EV brand-consumer dyads (Thomas & Autio, 2019).

6.8. BIASES RELATED TO EV PRODUCTS, TECHNOLOGIES, AND COMPLEMENTARITIES BLOCKING THE EMERGENCE OF A REAL VALUE CO-CREATION ECOSYSTEM

EVs' design, architecture, and performance attributes remain key challenges to market penetration due to several factors. EVs have many advantages over ICE vehicles, like simplicity,

reliability, compact dimensions, and motors' fewer moving parts meaning they require less maintenance. However, whether EVs are superior to ICE vehicles throughout their life cycle remains debatable (Wilken et al., 2020). According to Donkers et al. (2020), more research is necessary to understand EVs' energy performance. Additionally, the ongoing divergence of opinions and assumptions confuses the consumer, and above all, there is a lack of compelling business cases that can be presented to the consumer. Additionally, it is necessary to compare EVs and ICE vehicles from the perspective of life cycle assessment to avoid problem-shifting or rebound effects, to quantify the environmental impact from raw material extraction to the end of life (Egede et al., 2015), and since an EV can be also considered an investment. Within this new perspective, and even though it seems that EVs have already reached cost parity with ICE vehicles from a total-cost perspective (including upfront payment, maintenance, depreciation, and fuel costs), EV performance is not robust enough and depends on a wide variety of interconnected factors; for example, an EV's performance and energy consumption depend heavily on the duty cycles of the electric engine, driving conditions, and traffic (IEA, 2020).

Additionally, the environmental performance of both battery-electric and conventional combustion vehicles and the relative performance of the two powertrains (gas and fuel) depend heavily on the future energy scenario. At the same time, the industry has not yet converged on a single, optimal, and widely accepted EV design and architecture . For example, no convergence has occurred on core EV powertrain design; there are different battery-cell designs with different geometries (cylindrical, prismatic, and pouch) and multiple chemistries, and large variance in the design approach to thermal management, such as four battery-cooling solutions (IEA, 2020). Due to this lack of a standardised, shared design and architecture, I have found significant variability of EV performance attributes among the design solutions that have been developed and adapted in parallel. For example, EVs' environmental performance is strongly influenced by battery size, the energy required in the battery production phase, and how electric energy is produced (Ellingsen et al., 2017; Peters et al., 2017; Cox et al., 2018; Schmidt et al., 2019).

The EV is not an isolated product and, its performance depends on the combination of several distinct factors that can each exert more or less influence. Innovation in the EV ecosystem does not only focus on replacing conventional vehicles with those equipped with electric engines and batteries. These factors are controlled by diverse EV ecosystem stakeholders—private and public—that can also regulate and manage EVs, producing different effects in terms of not only EV performance but also the degree of consumer EV acceptance. This expresses the codependence that exists within this ecosystem and among actors and stakeholders, brought about by their mutual co-specialisation (Teece, 1986; Alexy et al., 2013; Kapoor & Lee, 2013). For example, since EVs' performance depends on factors such as driving style, weather, traffic, and infrastructure (Donkers et al., 2020), it is necessary to add complementary EV driver-support services related to—for example—navigation, vehicle support, advanced charging, WiFi inside vehicles, shared mobility, and insurance. As an example, beyond delivering a vehicle with superior performance-as-developed, it should entail the emergence of sufficiently robust complements (Adneer & Kapoor, 2016); thus, alongside battery performance and charging time, the availability of charging infrastructure is somewhat associated with driving range performance, which is one EV attribute (Zulkarnain et al., 2014). The performance of complements that users integrate with the EV focal technology determines the as-used performance of EV technology (Adneer & Kapoor, 2016). In this sense, fast and smart charging stations are expected to propel EV growth (IEA, 2020) because of the slow EV charging times compared to the simplicity of filling up at a gas station (Gnann et al., 2018) and due to the inclusion of different pricing and technical charging options of time-of-use pricing, which encourages consumers to move their charging from peak to off-peak periods.

The rise and rapid development of new technologies with in-vehicle systems and applications are constantly transforming the value propositions brought by the EV. This is due to the rise in these new technologies' affordances and properties, which are emerging through new demanded interactions among drivers, EVs, and these technologies (Gibson, 1979). These novel technologies introduce major architectural innovations (e.g., fully electric drivetrains). They are also shaking the sector's traditional core competencies and resources (e.g., through artificial intelligence for autonomous driving), fostering new business models (e.g., internet-based ride sharing platforms), and dissolving ecosystems boundaries (e.g., between automotive and IT). Novel technologies are also driving automotive firms to more dramatic, disruptive innovation that is radically changing the sector and creating new businesses, models and major categories, as well as completely redefining the competitive environment (Birkinshaw et al., 2011; Goffin & Mitchell, 2016; Goffin et al., 2010). For example, advances in communication and digitalisation have transformed EVs into mobile digital devices or platforms that enable and foster new kinds of interactions (e.g., with the internet, people, other vehicles, and road infrastructure) by integrating hardware and software systems and support devices such as sensors, cameras, and radars for different purposes (e.g., active safety, driving assistance, entertainment).

The application of these developments is improving, adding new EV product and service attributes and delivering new experiences to both drivers and users. These new features are transforming the concept of a car, and they demand new types of co-specialisation and collaborative arrangements within and outside the ecosystem with other related ecosystems (e.g., technological ecosystems) that demand new forms of governance and new structures. The application of these developments also generates new opportunities for firms and entails an underlying competition. For example, the global race to be the first company to bring a fully autonomous vehicle to the marketplace depends on a number of systems and subsystems coming together and being integrated (Faisal et al., 2020). These new technologies also allow for the creation of new business models with new complementarities; for example, car-sharing services are more cost-effective and beneficial to society since they reduce traffic, decrease the demand for parking (Conner-Simons, 2017; Kiron, 2013), and/or reduce consumers' transportation costs. The introduction of these services is driving different use patterns between car-sharing EVs and private ones, since car-sharing services help optimise all EV operations and infrastructure. For example, new technologies allow firms to introduce a pay-per-use system within these new systems of car-sharing services.

The introduction of these radical innovations and new perspectives is shaking the established order, structures, formalities, and focal firms in the automotive ecosystem. However, it is also introducing disorders that constrain actors' ability to achieve a clear, deep, and immediate understanding of the complex problems, challenges, or situations about to emerge during ecosystem transformation; these problems are due to the constant development and implementation of changes transforming all ecosystem stakeholders (end users included), their relationships, and value-creation processes. I observe that these new drivers of EV ecosystem interaction are blurred by EV ecosystem participants' traditional perceptions of their environment, hence amplifying the value gap and generating a blind spot in that ecosystem (Thaler, 2015). These blurred perceptions also inhibit gathering all actors' insights, especially through intuitively apprehending and understanding crucial emerging relationships within the ecosystem. At the same time, the evolution of traditional automotive ecosystems is typically viewed as the evolution of more traditional, linear value chains (Adner & Kapoor, 2010, 2016; Jacobides et al., 2018), which has implied a supply-and-production-centric perspective on value creation in which the end user's role is generally reduced to that of a more or less passive recipient buying the system-level orchestrated offering (Autio & Thomas, 2019).

All these factors are altering and disrupting the structure of the automotive industry while simultaneously undercutting century-old assumptions of technological supremacy being the sole differentiator (Ferràs-Hernández et al., 2017). Analysing EV penetration requires a holistic approach that integrates all these factors instead of isolated, focused approaches to the different themes and topics. This holistic approach should focus on several differentiated key challenges and strike the right balance between wide-scale and in-context deployment. altering the structure of the industry's ecosystem. When discussing EVs, one cannot simply refer to 'a robust model', 'architecture', or 'design' but must, in essence, account for the different EV ecosystem stakeholders and how they build the EV market value chain.

To implement this new approach, the automotive industry as a sector—which has been focused on either market-based transactions or supplier-mediated arrangements—must migrate to a real value co-creation ecosystem concept that intends to capture the links among a core product, its components, and its complementary products/services ('complements') (Jacobides et al., 2018) through collaborative arrangements among focal firms and their complementors (Kapoor & Lee, 2013; Leten et al., 2013). The current problem—and an important bias—is that the EV ecosystem's supplier relationships remain contractually governed due to the automotive sector's inertia and status quo, although the value of the focal firm's offerings for the customer strongly depend on the availability of complementary products and services (Adner, 2017; Adner & Kapoor, 2010). To become a new EV ecosystem and increase the pace of EV adoption, the automotive sector should carry out the strategies and changes described in the following subsections.

6.8.1. A holistic new approach

All EV ecosystem participants should introduce a holistic approach to all strategic and vision analysis of private and public ecosystem actors and participants. Automotive managers not only have to focus on strategic decisions regarding their product, services, audience, technology, infrastructure, and company vision; they also have to research and analyse how these dramatic changes will affect other stakeholders' processes and the entire ecosystem's structure and governance, as well as how other technological ecosystems will interact with their company and ecosystem. EV firms should also develop dynamic new capabilities to integrate, build, and reconfigure internal and external competencies in order to create new competencies for addressing rapidly changing environments and new technologies (Teece, 2018). This approach should lead to a shared strategic blueprint. The most important question here is: Who should lead the construction of this shared blueprint?

6.8.2. Global standard designs and architecture with common technical norms

EV firms need to develop global standard designs and architecture that use common technical norms. This would help to avoid localised, incompatible solutions involving isolated EV technologies, to achieve in-context efficiency with global economies of scale, and to implement the shared strategic blueprint. In this new ecosystem, it is essential to finish configuring and agreeing on a shared industry architecture or overarching architecture (Tee & Gawer, 2009; Jacobides et al., 2016) within the EV ecosystem that can be set by a global hub (Jacobides et al., 2018). This shared architecture would finally map the EV ecosystem architecture (Zulkarnain et al., 2014), which is fundamental to increasing the pace of EV adoption. According to Jacobides et al. (2018), all focal firms, producers, and complementors should be bound together through some interdependencies—by all adhering to certain standards. For example, the lack of standardisation for charging

infrastructure is likely to hamper the market since these standards are needed to ensure EVs can be easily connected to the power network in order to recharge the energy storage system (IEA, 2020).

6.8.3. Open innovation platforms

Furthermore, participants must develop adequate, diverse open innovation platforms along the EV supply chain that would act as innovation hubs connecting the specialised supply chains that cross the EV ecosystem. This would enhance cross-ecosystem collaboration by specialised stakeholders and complementary product producers (Kim & Mauborgne, 2005) from those specialised supply chains and, thus, facilitate and increase the value co-creation of EV product complementarities. For example, this type of cooperation could foster the adequate development and adaptation of new forms of combined solar power generation-and-storage home systems or new forms of flexible leasing.

6.8.4. More customisation

EV ecosystem participants should further customise value proposition by allowing consumers to choose among the components (or elements of offering) and product complementarities supplied by each participant from a set of producers or complementors—as well as, in some cases, choose how they are combined (Jacobides et al., 2018). To achieve this customisation, it is necessary to reinforce EVs' technological and architecture modularity among complementors, as this will allow them to produce interdependent and interchangeable EV components with limited coordination required (Baldwin & Clark, 2000; Jacobides et al., 2018, Autio & Thomas, 2019). This new approach requires new partnerships and strategic alliances among the ecosystem's actors and other leading foreign ecosystems' actors. These firms could lead new forms of relationships that are less transactional and based on multilateral relationships with different set of partners (Adner, 2017). For example, by applying big data, marketing intelligence systems, and flexibility in manufacturing systems, battery producers could supply customised battery sizes for a selected EV model, which could be tailored to the travel needs of each user. In this case, the vehicles and batteries are unique complementarities in consumption because the two modules are more valuable when consumed together (Autio & Thomas, 2019). At the same time, EV makers could complement the EV offering by supplying additional types of charging stations with different sizes, speeds, powers, and so on (e.g., level 1, level 2) according to the customer's expressed driving routines and charging locations (e.g., home, workplace, public) that entail different requirements.

To facilitate all of these new processes, all involved firms should design a co-alignment digital device or platform that would enable the sector's digitalisation, and thus, the rapid development of appropriate integrated solutions—rather than products and services, non-contractual governance mechanisms, collective coordination, and unconstrained collective and individual-level action—and strike a balance between output variety and standardisation within this ecosystem according to the continuous framing of value propositions (Huber et al., 2017; Wareham et al., 2014). In this digital platform, value co-creation would be enabled by digital affordances opened up by digital infrastructures (Majchrzak & Markus, 2013; Nambisan et al., 2017). An affordance would offer the potential for a subject (e.g., an individual stakeholder) to propose and perform desired actions and execute desired functions (Felin et al., 2016).

6.8.5. New focal value propositions focused on end-to-end integrated mobility services and solutions

Automotive companies should switch from an offered value proposition focused on the EV as a product to a new focal value proposition focused on end-to-end mobility services and solutions based on the ecosystem's holistic approach. According to service-dominant logic, the service provider is not the sole value creator; rather, the provider makes resources available to the service beneficiary for integration and value creation (Vargo & Lusch, 2004). EV firms should no longer perceive the vehicles they manufacture as simple finished products. Rather, they should see EVs as one more element in new, integrated mobility solutions that respond not only to consumers' emerging and growing individual mobility needs but also to the new needs and changes occurring simultaneously in society, the new consumer-centric economy, and the environment.

Transport demand is no longer a mass market, and our mobility needs are no longer one-size-fits-all since we all have different mobility needs, time pressures, driving styles, price sensitivities, and so on. Given different driving functionalities, trip circumstances, and mobility effects (e.g., cost, pollution), the new ecosystem should offer more personalised, integrated, and efficient mobility services and end-to-end solutions in order to streamline all stakeholders' needs (Casady, 2020) and consumer preferences. All ecosystem stakeholders (e.g., battery suppliers, insurance firms, and government) should be part of this integrated solution and participate in this value co-creation process. For example, given that fully charging using state-of the-art technology can take a minimum of nearly 30 minutes, charging station operators can offer smart applications (apps) online—allowing advance reservations for their clients to avoid queues and uncertainty over charging sockets' availability, for example—or offer on-site complimentary services to these clients to mitigate the wait time's effects (e.g., expanding food and retail offerings to include maintenance services that can be accessed while charging). These solutions would simultaneously improve the management and quality of power flow since operators could, for example, balance the power load and shave the peak load (Heredia et al., 2020). These solutions would drive operational benefits to both drivers and electric companies, as well as to retailers as co-beneficiaries and to value co-creators since they can configure pre-order and pre-pay solutions in stations' service package to minimise, for example, the coffee queues.

6.8.6. New localised, sustainable, and balanced business models

Within the configuration of integrated mobility solutions, EV stakeholders should develop different localised and sustainable business models for EVs. These models should balance, integrate, and align attributes from various complementarities in context (e.g., environmental) and from standardised integrated mobility solutions to leverage all stakeholders' shared resources. Since mobility changes will differ dramatically depending on geographical traits and since no mobility paradigm is expected to dominate (McKinsey & Company, 2016; Transport for New South Wales, 2016; Smud et al., 2017), different transportation and mobility services will coexist in these models and can be tailored to location-specific conditions (Bouton et al., 2015). These models can be carried out with the support and implementation of these new technologies (e.g., big data, artificial intelligence, connectivity).

Within each model, government policies and regulations, emerging technologies, evolving consumer preferences, and innovative business models will influence how different mobility states play out (Bouton et al., 2015). For example, when addressing attributes of a specific charging system (e.g., selected locations, charging modes and times, and wait times in charging stations [Tan et al., 2014]); their potential effects on EV and driver performance (e.g., driving range, routing patterns);

and their effects on the specific regional/city networks (e.g., degree of congestion), major stakeholders such as EV makers, governments, power distribution firms, and charging station manufacturers should develop a specific traffic-user equilibrium model in context that fosters sustainable development (Bahrami et al., 2017; Luo & Qiu, 2020). For example, one could configure a specific efficient traffic flow and optimal energy consumption-based model for smart cities (urban mobility). Additionally, new mobility models with new mobility modes and patterns could be developed due to emerging changes related to connected, shared, and autonomous mobility and could significantly reshape roads and city transport over the coming decades (Krueger et al., 2016), with important implications for EV adoption (IEA, 2020). For example, and within these macro models, governments should switch from a transversal policy based on solving congestion by building more roads and expanding public transport (Casady, 2020) to different types of cross-stakeholder policies. Governments could reshape and modulate different complementarities in context by developing appropriate policies (e.g., on EV infrastructure construction), regulations (e.g., on CO_2 emissions), and incentives (e.g., on EV purchase subsidies) that could reinforce attributes of other EV complementarities—for example, the low electricity prices of power firms (Hu et al., 2020). Additionally, these policies could be based on personalised discretionary incentives for EV purchase, and other type of policies could be based on enhancing certain mobility practices to increase electric power systems' flexibility (IEA, 2020).

6.8.7. Conclusion

These conclusions on product biases reinforce my conviction that the EV ecosystem must also develop a new core business model to embed the emergence of this new ecosystem. This new business model should not be based on a reformulation of the classic ICE vehicle business model that essentially enables firms to develop the capabilities to adapt to a changing business environment (Teece, 2010). Rather, it should be based on business model innovation (BMI) and sustainable business model innovation (SBMI). This is because the value-proposition reframing within this new ecosystem involves relevant changes for consumers and their habits and is altering 'the way actors and participants do business' rather than 'what they do' (Shakeel et al., 2020) since it goes beyond simply changing and amending offerings, products, and processes (Amit & Zott, 2012).

Thus, this transformation requires a complete reinvention of the business model to dynamically transform it into a new BMI (Geissdoerfer et al., 2018) or SBMI, which should also underpin sustainable development (Roome & Louche, 2016) through value and knowledge creation, delivery, and capture (Geissdoerfer et al., 2018). Thus, BMI for the EV ecosystem should be an iterative and adaptative business model of constant experimentation and gradual refinement. It should enhance value proposition framing to meet emerging and changing stakeholder requirements, enable the co-discovery and legitimatisation of new blueprints, and reduce uncertainty (Ansari et al., 2016; Snihur et al., 2018). This ecosystem demands a dynamic and adaptative business model since, for example, we do not know if the new business model will ultimately be based solely on one dominant technology that will impose itself on the others or be based on the coexistence of several technologies adapted to each segment and context according to the contextual technological affordances and constraints. According to the 2019 IEA report, for the foreseeable future, on- and off-road transport will be characterised by a mix of solutions involving ICE, battery, and hybrid powertrains, as well as conventional vehicles powered by ICEs. These innovation models should also predict societal changes and dilemmas, allow all ecosystem participants to make collaborative arrangements to deal with these new challenges, and jointly respond to sustainability and economic issues (Loorbach & Wijsman, 2013) with new quests for innovation.

All previous demands, required changes, and overall integrated mobility solutions and models will require a metamorphosis in the near future. Additionally, in the current context of interdependent technologies, substitution must be viewed not as a race between a new technology and an old technology, but rather as a race between a new technology ecosystem and an old technology ecosystem (Adneer & Kapoor, 2016). This will probably lead both the traditional automotive sector and the newborn EV ecosystem into new Mobility-as-a-Service (MaaS) ecosystems (Hensher, 2017; Hensher & Mulley, 2020) that fuse both ecosystems and exhibit layered modular architectures with the coexistence of related technologies and architectures (Autio & Thomas, 2019).

According to Autio and Thomas' (2020) classification of ecosystems, I categorise this new ecosystem as a type of platform innovation ecosystem that has a platform or shared connectivity interface and focuses on a specific class of technologies (in this case, technologies related to mobility) with shared technological compatibility standards and dependencies (Adner, 2017; Autio & Thomas, 2020). This ecosystem would offer users a centralised digital platform that co-aligns all personalised value proposition framing, as well as optimises and follows up on all operations related to registering, planning, booking, e-ticketing, and paying for an entire chain of public and private multimodal service offerings (Kamargianni et al., 2016; Goodall et al., 2017). Ongoing Mobility-as-a-Service developments will rely heavily on digitally connected customers, available mobility modes, and system interoperability, as well as network sustainability with mobility management players, public and private transport providers/operators, and local officials, managers, and city planners (Giesecke et al., 2016; Polydoropoulou et al., 2020).

6.9. POLICY AND GEOSTRATEGIC BIASES WITHIN THE ENERGY TRANSITION

Political action is fundamental to EV uptake: If policy support is lacking, EV sales will slow down (Lévay et al., 2017, Hardman, 2019; Nykvist et al., 2019). EV adoption requires policy interventions since it is a technological change facing market, system, and institutional failures (Weber & Rohracher, 2012). Current EV adoption rates are generally low in countries with no or weak policy interventions in this area and higher in countries with strong policies (Sierzchula et al., 2014; Hardman, 2019; Rietmann & Lieven, 2019), which suggests that policy interventions can contribute to changing behaviour (Tummers, 2019). The policy environment provides an important set of contextual factors for consumers (Zhang et al., 2018), and it may even stretch beyond directly affecting consumers' EV adoption to include interacting with consumers' psychological factors moderating their relationships with EV adoption (Steg & Vlek, 2009). For example, perceived behavioural control may lead to high EV purchase intentions only when financial policy instruments sufficiently reduce the price gap between EVs and ICE vehicles (Huang & Ge, 2019).

It seems that current policies and objectives are not efficient enough since they are costly and incongruous with each other, as well as with the environment and current ecosystem conditions (Greene et al., 2014). Public administration appears to lack knowledge and overall perspective on consumers' perceptions and current situations, on the apparent barriers to entry for EVs, and on the relationships, conflicts of interest, and synergies within this ecosystem. Some governments are suffering from a kind of paralysis, inaction, and lack of initiative because they cannot see the real drivers, constraints, and knowledge gaps that coexist in this new EV ecosystem. They are unaware that their role is fundamental as an important ecosystem participant that leverages value co-creation. Additionally, these policies appear unrealistic and inadequate to promote uptake since the market prospects of EVs are highly uncertain (Gómez Vilchez et al., 2020), and at present, it is difficult for governments to quantify policies' effects and determine which policy is more effective (Hu et al., 2020). Thus, predictions on the market penetration of alternative drivetrain technologies are controversial regarding both forecast market shares and applied scientific methods (Jochem et al.,

2018). Several authors assert that an important research gap remains in terms of empirically analysing the effect of policies on EVs (Hu et al., 2020). Within these models of prediction, Jochem et al. (2018) identify that hybrid data-driven models combining macroeconomic and microeconomic variables should be empowered instead other methodologies (e.g., agent-based) that have delivered biased predictions; however, there is still no agreement on which method is the most appropriate.

Within this context, though, different types of policies that can more or less directly influence EV uptake can be designed and implemented. The following subsections describe these policies, as well as relevant policy-related biases and knowledge gaps.

6.9.1. Fiscal incentives due to the high EV purchase price

According to O'Neill et al. (2019), there is a contradiction in the literature regarding the effectiveness of fiscal incentives related to EVs' high purchase price: While some authors believe reducing the price does not encourage EV uptake, others assert it is effective. However, the literature does share a belief that financial incentives' effectiveness may be significant only above a minimum threshold (Sierzchula et al., 2014; Jenn et al., 2018). The most important bias within this type of incentive is that the majority of governments and public authorities focus too heavily on designing and applying fiscal incentives directly to the end user while ignoring such incentives for car dealerships, whose attitudes towards and motivations for EV sales are also pivotal to EV penetration (O'Neill et al., 2019). High EV market penetration depends on EVs' acceptance by both consumers and businesses (Wallis & Lane, 2013). Car dealers hold a certain resistance to change because, as stated by Kress (2015), EVs do not require the level of parts and service provision needed for ICE vehicles. In addition, the sales transaction for an EV can take twice as long as that of a conventional vehicle (Richtel, 2015). Also, consumers often buy EVs as a second household vehicle in some countries (Cahill et al., 2014), and I have also observed car dealers' lack of awareness on some regulatory and technological EV-related issues (Evarts, 2014).

6.9.2. Policies to support charging infrastructure investment and deployment

Policies related to charging infrastructure face a bias based on the 'chicken-and-egg' dilemma (Zhang et al., 2014): Consumers are reluctant to choose EVs if charging infrastructure is inadequate, and potential providers are reluctant to invest significantly if EV market uptake has not been established (O'Neill et al., 2019). Again, public administration should support and incentivise private charging infrastructure operators to accelerate EV uptake.

6.9.3. Educational, mobility, and R&D policies

Most countries have forgotten to develop appropriate, up-to-date programmes and norms that include practical, real-world cases of EV use; for example, mandatory driving lessons in an EV could promote EVs as the 'conventional' vehicles of the future (O'Neill et al., 2019). At the same time, government agencies could develop information and awareness campaigns about sustainable transport.

Mobility policies deal specifically with promoting or penalising certain modes of transportation—such as public transportation, fuel transportation, private mobility, shared or ownership mobility, and specific policies of regulation and public investment on infrastructure and networks (e.g., public transport, urbanisation, and road construction)—to regulate the mobility of

different modes of transportation that use the same or alternative infrastructure. For example, governments could enhance certain mobility policies (e.g., travel restrictions based on the last digit of a vehicle license) to increase the flexibility of electric power systems or promote the existence and development of procurement programmes to stimulate EV demand and to enable an initial roll-out of publicly accessible charging infrastructure (IEA, 2019).

Additionally, R&D investment policies can support the investment of R&D funds and the improvement of R&D capabilities. Hu et al. (2020) state that the 'dual-credit policy' simultaneously uses reward and punishment mechanisms to block the development of the fuel-vehicle industry and promote the development of new-energy vehicles. Another possibility, especially for emerging economies, is public investment in the domestic automotive industry. Investments such as favourable financing or requiring local manufacturing to qualify for subsidies have proven effective in EV development that meets the local population's needs (Government of India, 2018).

6.9.4. Policies related to business models and the economics of charging networks and power firms

These policies can be based on different models, such as public investment and ownership, control and management, public concessions to private operators, or total market liberalisation with private firms or hybrid models. These policies need to align with fuel station policies on, for example, locations, regulations, and taxes. Additionally, government should be involved in the regulation and control of the electricity supply and power rates or in the investment in public charging infrastructure.

6.9.5. Fuel price regulation and fuel tax (e.g., diesel taxation)

When the fuel price changes, consumers and firms respond by optimising both their driving patterns and their vehicle and fleet choices (Berry et al., 1995; Tan et al., 2019). For example, consumers prefer to buy more fuel-efficient vehicles (composition effect) and drive less (utilisation effect) as fuel costs increase. Tan et al. (2019) conclude the fuel tax is a good choice among quotas (travel restrictions) because it can not only control the number of vehicles but also decrease vehicle use and its associated externalities, such as air pollution and traffic congestion.

6.9.6. Emission standards for new vehicles

Vehicle emission standards require automakers to reduce the average greenhouse gas emissions intensity of vehicles they sell each year (Long et al., 2020). Additionally, low-carbon fuel standards require fuel suppliers to progressively reduce the average life cycle carbon intensity of transport fuels sold in a region as compared to conventional petroleum fuels, such as gasoline and diesel. The most common low-carbon fuels are alternative fuels and cleaner fossil fuels, such as natural gas. For example, European emission standards define the acceptable limits for exhaust emissions of new vehicles sold in the EU, with a series of EU directives staging the progressive introduction of increasingly stringent standards. At the same time, several countries and states have implemented zero-emissions vehicle sales mandates. For example, in October 2020, the governor of California signed an executive order saying that all new passenger cars and trucks sold in the state must be emission-free by 2035 (Valdes-Dapena, 2020).

6.9.7. Policy-related biases/knowledge gaps and opportunities

By analysing the literature on EV policies, regulations, and norms, I have identified different biases or knowledge gaps within the ecosystem's policies that also present clear opportunities to exploit following deeper research and assessment to fully understand their influence on EV uptake.

Policy packages. The most important overall political bias is that EV policies should not be configured and implemented alone but in coherent packages or policy mixes that exploit their synergies and avoid their areas of discord, with several policies crafted at the same time, taking macroeconomic and microeconomic variables' effects into account (Gómez Vilchez et al., 2020). Guzman et al. (2015) and Hu et al. (2020) assert that evaluating transport policy synergies remains an understudied and under-researched topic. It seems logical that the policies approach should not be partial, narrow, and static; however, existing policy research tends to examine how different policy instruments can individually encourage consumer EV adoption (Hardman, 2019; Wang et al., 2018). Within this partial perspective, governments and researchers alike have overlooked the real trade-offs, interactions, and synergies among policy instruments and stakeholders, as well as their impacts on policy objectives and EV uptake (Rogge & Reichardt, 2016). This bias is leading all stakeholders to limited, ambiguous, and inconsistent findings, inappropriate and ineffective policy settings, and oversimplified recommendations on how to accelerate EV diffusion (Li et al., 2020). In their study of Ireland's public policies on EV promotion, O'Neill et al. (2019) found that even giving predominance to higher up-front financial incentives for EV purchase (present bias) without changing the framework of emissions-based taxes (i.e., an absence of government action or clear signals on diesel taxes) generated an overall diminishing disincentive toward ICE vehicles as EU mandates requiring reduced vehicle emissions took effect.

Additionally, even with the effectiveness of fuel taxes, vehicle quota systems, and driving restrictions in controlling new vehicle sales, their effects on reducing traffic congestion and air pollution remain unclear since these policies do not encourage reduced vehicle use (Tan et al., 2019). Another example of an effective policy mix could be fiscal incentives coupled with regulatory measures to enhance EVs' value proposition (e.g., waivers to access restrictions, lower tolls or parking fees) (IEA, 2019). Governments should develop coherent, coupled policy mixes or packages of several policy instruments (Braathen, 2005), as well as assess and follow up on the instruments' performance by measuring their consistency, coherence, credibility, and comprehensiveness to address EV uptake (Rogge & Reichardt, 2016). According to Li et al. (2019), the research on policy mixes is limited and, hence, there is an urgent need to further examine the role of policy mixes in promoting EVs. Additionally, there is a need for informed, holistic, data- and science-driven government policies that promote a managed, realistic transition to sustainable future energy systems (Reitz et al., 2019). We can use data analysis to adjust the taxes applied to oil-based fuels and revise the road-use charges (e.g., tolls) applied to vehicles with different environmental performance (IEA, 2020). We can also track the location-specific distance-based approach to support the long-term transition to zero-emissions mobility while maintaining revenue from transport taxes and managing the impacts of disruptive technologies in road transport, including those related to electrification, automation, and shared mobility services (IEA, 2020).

Discretionary policies. States, governments, and local authorities should promote discretionary policies to enhance a smooth and gradual transition, since the effects of policymakers' ad hoc judgements will exceed the policy effects of predetermined rules that, in this ecosystem, are essentially based on preconceived ideas involving imprecise predictions of EV uptake. This is also

an important market bias that requires coordination between the automotive industry and public authorities. According to a McKinsey & Company report on COVID-19's effects on mobility, as with other financial contractions, people will postpone discretionary purchases and increase their savings as they anticipate harder times (Hertzke et al., 2020). These discretionary purchases and behaviours of EV users demand a new type of discretionary policy based on, for example, the segmentation of consumers, infrastructure or locations, and vehicles. Thus, we can develop and apply specific policy packages that use different ratios and measures for different market segments or locations, which can be integrated and aligned with those aforementioned localised and integrated sustainable EV models.

According to Greene et al. (2014), governments should decrease the mainstream market bias of current policies that mainly focus on general consumers and enhance a targeted policy of cultivating niche markets (e.g., car-sharing and B2B customers, such as postal fleets and courier firms) and early adopters, including green consumers. These authors argue these mainstream policies are inefficient, costly, and ineffective. Each niche needs an adequate, personalised policy mix or package based on strategic niche management that simultaneously addresses—for example—accessible, appropriate loans, financing, and incentives (fiscal incentives); R&D improvements, such as to batteries (R&D policies); and charging infrastructure investments (infrastructure policies). For example, Chinese drivers will respond more to a fuel tax than American drivers will (Tan et al., 2019). Additionally, implementation of these policies should be gradual to effectively overcome the barriers and current perceptions on substitution of the ICE vehicle. Governments could promote combined and hybrid policies that could be introduced gradually with different steps: for example, first promoting the use of hybrid vehicles (plug-in hybrid electric vehicles and hybrids) (O'Neill et al., 2019).

Political harmonisation. Within a specific territory, city, or context, the relevant policies and regulations designed by different public administration entities, institutions, and agencies should be aligned and harmonised to avoid inconsistencies and contradictions. New forms of policy alignment must be forged within and across increasingly interdependent systems (Lee et al., 2018; Savage & O'Connor, 2019), with aligned policy goals, processes, and content. Without this alignment, there will be problems leading to waste, tensions, inefficiencies, and poor outcomes (Savage & O'Connor, 2019). For example, in Barcelona, Spain, different regulations and policies coexist: those from the municipal government, the Catalan autonomous government, the Spanish government, and the EU. In such cases, it should be a priority for one institution (probably the one that is most local and closest to the specific context) to monitor all these regulations in order to ensure there are no inconsistencies and also to further cooperation. All these institutions should promote greater policy-sharing, collaboration, and co-design across systems to break down silos between governments and agencies and to promote enhanced policy learning through the cross-pollination of evidence-informed ideas and practices (Ansell & Torfing, 2015). Additionally, there is an absence of EV deployment plans in areas such as goals, objectives, strategy, modes, phases, timing, criteria, and deployment performance metrics (IEA, 2020), which public agencies must address.

Pull policies. It is important to consider that different policy instruments' effectiveness and efficiency may be similar depending on their design and robustness from a purely economic viewpoint, as well as due to their political feasibility and their effects on public opinion, according to Brückmann and Bernauer (2020). The authors state that pull policies (e.g., subsidies) attract more public support than push measures (e.g., fuel taxes, travel restrictions). Thus, there is considerable

political room to manoeuvre for more ambitious pull measures, such as the large-scale expansion of public charging infrastructure and mandatory energy information.

Policy synergies. To increase the pace of EV transition, countries must prioritise shaping gkey markets and jointly implement synchronised policy packages to enhance policy synergies and effects among countries. Although different prediction models (e.g., the agent-based model) have been designed for national-level EV diffusion, no truly global diffusion model has been agreed upon and developed to investigate EV uptake (Gómez Vilchez et al., 2020). All the previous biases discussed also demonstrate that this sector still lacks the full perspective, structure, and governance of an ecosystem, as policy coordination also requires integrated cooperation not only by public, national, and international authorities but also among ecosystem stakeholders and participants. For example, these negotiations require the full involvement of global players such automotive multinationals.

The implementation of policies that enhance a global energy transition, reduce oil consumption and price, address the increased public concern over and opposition to fossil fuels based on their environmental impact, and address the rise of circular economies will break the delicate macroeconomic, microeconomic, sustainable, social, and geostrategic equilibrium of regions and countries that depend heavily on exporting fuel commodities (including natural gas and coal, as well as oil and oil products). This policy implementation is also fundamental. At the same time, this transformation is going to affect those countries and regions with large reserves of the rare and new materials and minerals that are necessary to manufacture EVs and electronics (e.g., lithium, cobalt). Even though this shift represents important opportunities for these countries to grow and prosper, it will also generate serious disputes between governments, firms, multinationals, and others to gain control of these mining resources and on important environmental, social, labour, and health risks due to the exploitation of these scarce and strategic resources (e.g., soil contamination, toxic dust, migration, child exploitation). Pamela Coke-Hamilton, the United Nations Conference on Trade and Development's director of international trade, says, 'Most consumers are only aware of the "clean" aspects of electric vehicles…[and] the dirty aspects of the production process are out of sight' (United Nations Conference on Trade and Development [UNCTAD], 2020). This is because while most EV consumers live in industrialised nations, the lion's share of the raw materials is concentrated in a few developing countries (e.g., the Democratic Republic of the Congo and the Republic of Bolivia).

6.9.11. Conclusions

All these changes will affect international trade, diplomacy, and agreements—as well as the microeconomic environment—with new strategic alliances and lockdowns, firm conversions, and other actions that will affect those multinationals and stakeholders in the automotive ecosystem (e.g., OEMs, suppliers, extractors of raw materials) (Jacobides et al., 2016). These disruptions will generate major political, economic, social, and sustainability concerns and instabilities; trade-offs among these will hide the important overall geopolitical and environmental biases that must urgently be addressed globally (IEA, 2020). It is necessary to develop and implement new global and integrated policies, rules, and agreements using a holistic approach in order to smoothly transition, mitigate these potential risks, and thus ensure a true energy conversion that will result in a new order. The development and control of policy implementation should likely be led by global institutions, such as the World Trade Organization and the United Nations Framework Convention on Climate Change secretariat. For example, these global

actors could develop subsidies for investing in sustainable mining techniques and technologies to allow mining firms to more effectively recycle the raw materials found in spent lithium-ion batteries (UNCTAD, 2020). Additionally, they could design policies that promote R&D investments for replacing graphite in batteries with widely available silicon. All these policies would bring new solutions at lower battery prices, which could lead to even more EVs on the road.

6.10. EV SOURCING BIASES

6.10.1. New supply chain and manufacturing biases

Due to the rapid development of EVs, the traditional supply chains of ICE vehicles are currently being replaced with new forms and models of supply chains. Despite the relevance of these new supply chains, few studies have investigated their management. The existing literature on EV supply chains has only studied EV technology, energy supply, and sales (Wu et al., 2019), leaving aside fundamental aspects such as the supply of raw materials, the control and performance measures of the supply chains, and recycling/reuse or reverse supply chains (Kalaitzi et al., 2019). These supply chains and manufacturing facilities are suffering a deeper transformation because they have had to rapidly absorb the demand for new and lesser-known materials, components, and spare parts with different costs.

Traditional suppliers have had to convert since they have moved from supplying parts such as gearboxes, exhaust pipes, or injectors to delivering battery materials, electric motors, and regenerative braking systems. Other components—such as air-conditioning units, water pumps, brakes, and steering systems—will have to be adapted (Valentine-Urbschat & Bernhart, 2009). Furthermore, new suppliers and sources have emerged and replaced traditional ones that have not been able to convert. There is also increased demand for new and scarce raw materials and metalloids (e.g., cobalt), with important mining constraints and dramatic price increases that are necessary to manufacture EVs and improve all needed electronic devices. Firms should enhance the traceability and transparency of these new raw material supply chains, as these supply chains are key instruments to address the critical issues associated with raw material supply by fostering sustainable sourcing of minerals. Additionally, new forms of relationships and strategic alliances have emerged—both intra-industry (between stakeholders) and inter-industry (from different supply chains or ecosystems)—to form new industry clusters or innovation platforms. There are new alliances and forms of cooperation between private and public participants, including joint ventures, licensing, collaborations, and R&D consortia. The embedded nature of new EV technologies has forced firms to view technologies as competencies (clearly, some technologies will be more embedded than others). This has resulted in an increasing number of alliances, whereas previously a technology licensing or purchase agreement might have been used.

At the same time, the constant development and application of simpler, innovative EV design architecture (e.g., compared to ICE vehicles, EVs have more compact motors and many fewer moving parts) is redesigning and constantly reshaping the new EV manufacturing platforms in light of new business models for the automotive sector. The transformation of vehicle ownership models also requires a change in manufacturers' vision. For example, 3D printing can revolutionise production plants' business models by establishing retail micro-factories capable of meeting diversified demand and by decoupling manufacturing activities through modularisation, leading to greater efficiency and flexibility (Nieuwenhuis, 2018; Wells, 2013; Fredriksson, 2006; Klug, 2014). I have also observed that an increasing number of OEMs have declared their intention to electrify the models they offer, not only for cars but also for other modes of road transport, such as motorbikes (Jacobides et al., 2016).

These new supply chains and manufacturing facilities remain very unstable because they entail new and numerous complex links, uncertainties, and inefficiencies, making their management highly complex. Additionally, within these supply chains, there are many tensions and conflicts caused by the mismatch between the increased demand for EVs and the scarcity and inconsistency of the supply of these new raw materials. This is because construction of the EV value chain has not been completed and EV supply chains are under construction (Masiero et al., 2017). Supply chains and their strategies must be engineered to match and accommodate the product's changing requirements, relationships, and impacts along the different stages of its life cycle (Aitken et al., 2003) in order to articulate a supply network flexibility framework (Purvis et al., 2014) and to sustain a lean and agile supply chain (Naylor et al., 1999). To facilitate this match, firms must constantly monitor and assess the different variables from the DWV3 model to classify demand chain types (Christopher & Towill, 2002). At the same time, these new supply chains must coexist with the traditional ICE vehicle supply chains. However, these supply chains are in different life cycle stages, face different problems, and have different performance schemes. One of the most important biases is that EV supply chains are not yet resilient enough to absorb those inherent major disruptions and supply/demand interruptions that coexist in this ecosystem (Jabbarzadeh et al., 2016). Firms must carefully assess the potential impacts of environmental uncertainty on EV supply chain flexibility (Purvis et al., 2014) and on the key elements of supply chain resilience and the relationships among them (Ponomarov & Holcomb, 2009).

All these factors are bringing great risk to the EV industry, and firms cannot control and solve these problems and risks alone. Due to the fragility and unknown complexity of these supply chains, certain events and risks—such as those emerging from suppliers' supply, customers' demand, new infrastructure and processes, and logistics or information systems—can easily disrupt supply chains' stability and performance with financial losses, negative corporate image, or loss of demand (Thun & Hoenig, 2011). Additionally, there is imperfect information across the EV supply chain since decisions must be made simultaneously, and it is difficult for players to balance all possible outcomes when making a decision (Gu et al., 2019). Within the EV supply chain, some information is private (like the vehicle manufacturing cost), which makes the information imperfectly transparent. Wu et al. (2019) found three categories of outcomes risks in the EV supply chain: the technical risks caused by the uncertainty of technology in technological activities (e.g., battery manufacturing risks, assembly line setting risks, logistics risks); market risks related to demand fluctuations and supply risks; and environmental risks associated with the uncertainties surrounding acquiring enough funds or policy risks.

These risks hinder EV development. To overcome them and stabilise these supply chains, EV firms should implement the following strategies:

- **Agreed-upon risk management method.** Supply chain participants should develop a specific, agreed-upon risk management method. This should involve developing and designing a method to monitor and assess the different risk indexes of the EV supply chain that will allow them to understand and predict the different risks and their causes, relationships, potential effects, and cross-effects along the supply chain. The method should then allow them to implement preventive measures and strategies.
- **Shared process-oriented performance measurement system.** EV firms must design a unique, agreed-upon, and shared process-oriented performance measurement system along the EV supply chain to monitor and control the KPIs of the supply chain's main processes and resources (Neely et al., 2000). This would help identify, for example, value-added and non-value-added tasks and bottlenecks. Introducing such a system is fundamental to this type of supply chain since the chain cannot be reduced to static and quantitative financial KPIs.

Thus, these firms should also add KPIs on organisational cultural attitudes, behaviours, values, and commitments to the performance measurement approach along the entire supply chain and its participants. Actors such as firms' business units, suppliers of components and batteries, distributors, and logistics and OEM subcontractors often represent obstacles to meet a shared unique performance measurement objective (Forslund & Jonsson, 2009), and so some must pursue an orchestrator role by offering direct support and guidance (Kalaitzi et al., 2019).

- **Cause-effect relationships between risks indexes and KPIs.** Supply chain actors must determine the different cause-effect relationships between the different risk index actors and the performance measurement system KPIs. Understanding these relationships will allow firms to develop appropriate preventive measures and programmes to enhance the entire supply chain's performance. Additionally, following up on these indicators will allow firms to detect their internal and external biases related to their organisational culture and, hence, exploit this process-oriented approach within the EV supply chain. These cultural biases constrain supply chain performance and are related to (for example) internal social norms, communication methods, values, and expectations (Sułkowski, 2012). These indicators should also track supply chain actors' internal operations and processes to ensure a smooth transition. With these, these firms will be able to identify, correct, or eliminate issues such as their quality errors, quality inspections biases, production rate and time-intensive activity constraints, logistics biases, selection criteria of suppliers' biases, and confidentiality agreements. It is also a priority to monitor their marketing activities related to, for example, consumer preferences and biased market demand predictions, which will assist upstream companies in their R&D programmes (Wu et al., 2019). Additionally, firms should control the flow of information, materials, and data, and—for example—the biases constraining timely and accurately information that could help companies to make supply chain decisions. It is also fundamental to monitor the environment's biases related to predicting and analysing policy changes to avoid their risks and changes in the capital market.

It is important to highlight that developing these shared standards of control is crucial for the EV industry since the industry is facing large transversal problems, such as excessive structural capacity, disorderly competition, and lower barriers to entry (Wu et al., 2019). Additionally, cooperation in the EV supply chain is necessary because EV firms cannot efficiently solve these problems alone (Wu et al., 2019). Among participants, cooperation will facilitate processes such as resource allocation, make-or-buy decisions, the exchange and co-creation of knowledge and value, process standardisation, open innovation performance, and operations efficiency; it will also allow a more solid, tidier ecosystem value proposition to materialise (Adner, 2017). At the same time, EV firms should seek new strategic alliances and partnerships with firms from other ecosystems to create and improve cross-industry solutions (Kim & Mauborgne, 2005) because there are several critical areas of focus for incumbents and new entrants from different sectors wanting to keep pace amid the changes ahead. In fact, solutions and business models developed in different ecosystems are being adapted and implemented within the EV ecosystem: for example, advances in communications and digitalisation, advances in support services (e.g., cameras, sensors), and implementation of the sharing economy and the circular economy.

There also appears to be overall supply chain biases because the EV supply chain differs from that of the traditional automotive industry. Therefore, the EV supply chain cannot be seen as a simple extension of or improvement to traditional supply chains. EV supply chain management cannot strictly refer to the traditional automobile supply chain (Wu et al., 2019). Additionally, a reverse supply chain and logistics should be designed and integrated into the EV ecosystem supply chain to provide useful components for the secondary market, help save raw materials, reduce energy

use, and thus alleviate greenhouse gas emissions and avoid environmental degradation, especially for those rare materials present in EVs (Gorji et al., 2020; Wang et al., 2020). Circular strategies should include remanufacturing, reuse, repair, refurbishing, energy and materials recovery, and reconditioning. For example, this reverse supply chain could cover battery end-of-life management—including second-life applications of automotive batteries and uncovered standards for battery waste management. At the ecosystem level, EV stakeholders should develop and implement a shared, integrated, and transdisciplinary model of the circular economy within the EV ecosystem that includes the following aspects: reverse supply chain, product/service design, business models, end-of-life recovery, and product/service use and policies (Alamerew & Brissaud, 2020).

6.10.2. Biases related to energy supply and power supply chains

The increased demand for electricity due to the greater number of EVs will transform the existing conventional electric-power supply chains. The increase in EV loads and electricity demand will lead to the development of new EV charging methods, and charging facilities and their corresponding supporting infrastructure must be built to distribute this electricity (Lucas et al., 2012). Within this new infrastructure, numerous equipment protection and management devices must be added or upgraded (Heinrichs & Jochem, 2016). Additionally, the increase in EV loads will lead to the replacement or conversion of gas stations into EV charging stations and to the development of a new network of charging stations. At the same time, the increase in electric load will lead the balance between electricity generation and consumption to destabilise due to the rise in potential risks and negative impacts in the operation of power supply and distribution systems. This is because the increase in EV loads alongside electrical resource limitations can lead to issues such as power quality problems, steady-state voltage increases, overloading of cables and transformers, steeper ramps, electrical losses, and new patterns of consumption that involve higher consumption, peak loads, and charging costs (concentration of the highest power consumption patterns in low-demand periods, such as at night, can constructively impact the load profile in a power system) (Fernández et al., 2011; van Vliet et al., 2011).

All this presupposes that traditional power supply chains have to accommodate and adapt to this new EV scenario and that, therefore, they must be transformed into new EV power supply chains with different stakeholder needs. To minimise and avoid these impacts, maintain a fluid procurement-generation-transmission-distribution-consumption-storage interconnection (Chen et al., 2014), and optimise the entire new power supply chain's effectiveness and efficiency for all stakeholders (including the charging processes for consumers), it is necessary for EV firms to develop and implement a managerial approach to this new power supply chain by applying and adapting knowledge of supply chain management. In this sense, several strategies have been developed to improve the performance of these new power supply chains:

- **Charging-network and -load planning.** EV ecosystem participants should develop charging-network planning (Liu et al., 2013) to estimate local demand at specific time intervals, which would allow them to determine the optimal location of charging stations. These firms must design EV charging-load planning and management that involves managing charging patterns to coincide with low demand periods (Zhong et al., 2014) and EV discharging control (Bitencourt et al., 2017).
- **New electricity suppliers.** New companies can be created to produce, share, and store electricity to meet upcoming diversified electricity supply and demand (Kalathil et al., 2019)
- **Price and/or contract coordination.** Ecosystem participants must agree on the introduction of price and/or contract coordination, such as time-of-use electricity rates, that would be

transferred to downstream stakeholders and ultimately to EV users. For example, optimal time-of-use pricing can support the charging-discharging behaviours of residential users and reduce the cost of the entire electric power supply chain (Zhou et al., 2020).

- **Direct government investment**. Government can develop more intervention policies, such as direct investments in the main supply chain actors (traditional energy-generation firms, renewable energy-generation firms, or power grid firms), providing specific soft, long-term loans for investments, liberalisation and privatisation of the sector, and regulation of electricity prices and rates.
- **Innovation strategies within the power supply chain.** Promoting innovation strategies based on technological developments and investments across the power supply chain could enhance performance and achieve energy conservation, reduced consumption, and reduced emissions, thereby gaining social economic benefits (Wu et al., 2019). An example is the development of smart grids.

The main problem is that these strategies, policies, and proposals have been developed and implemented by lone individual stakeholders based on specific technical scenarios and cases of EV market penetration (Lefeng et al., 2020). It is difficult to use these to compose an integrated picture or holistic approach that results in integrated development and design of the new power supply chain.

To enhance these new supply chains' performance, environmental sustainability, stability, and interconnection, EV ecosystem participants must develop mixes of hybrid strategies and models that combine private and public initiatives alike. These mixes must integrate diverse stakeholders' needs and be tested, analysed, and adapted to each context condition (e.g., driving patterns and habits, available infrastructure, electric maximum capacity, electricity costs). However, accurately predicting customer behaviours and mobility changes in the new scenario appears to be highly complex, as does predicting how the electrical network will respond to these new patterns with higher electricity consumption and different peaks of consumption. Configuring and agreeing on a common, stable, and ideal solution appears to be an insurmountable challenge. Instead of an ideal solution, we can now depict only reasonable, instructive, and feasible paths with packages of two or three policies that could at least avoid negative impacts and exploit potential benefits.

These paths and quasi-integrated solutions must align with the EV life cycle stage of development and with diffusion in that context (Lefeng et al., 2020). Lefeng et al. (2020) identify three stages of development that follow the S-curve of a new technology's diffusion: In the first stage, with a relatively small number of EVs and charging stations, solutions should focus on providing EV charging services using existing power system infrastructure and business mechanisms. In the second stage, due to service aggregation and the advantages of data analytics, contractors provide low electricity prices by scheduling and optimising EV charging and discharging. Finally, in the third stage, contractors supply smart microgrids enabled with advanced communications and data technologies that interact with people, vehicles, homes, and companies, and thus help optimise and ensure the reliability of the overall electrical grid. The paths and quasi-integrated solutions must also align with the current business models in place in that context and stage of development. At the same time, important investments are required across the supply chains, but these can be carried out gradually following the different stages and paths.

Another important bias is that these paths and quasi-integrated solutions should also integrate final users and contemplate all their specific needs. For example, these solutions should also provide compact ancillary services, such as specific devices for home energy storage that can be used later for charging one's car. Ancillary services could include leasing services for these devices and for solar panels. This is intuitive: To charge your car at home, you do not need immediate power and are simultaneously helping flatten the load curve in your location. Another example provided by Nian et

al. (2019) is to propose a cost-sharing scheme between the seller and the buyer. This model predicts partial car payment and buyer commitment to purchase electricity, with the commercial contract based on a minimum charging threshold that buyers must meet to cover the costs. These solutions should also contemplate the difficult conversion of current petrol station infrastructure into charging stations using different business models. Additionally, these solutions should address their impacts on the powerful lobbies behind petrol firms and on gasoline taxation, which represents important revenue for the state. It seems reasonable to integrate all of these concerns into relevant solutions and also facilitate oil companies' and gas stations' conversion. Strategies related to the new power supply chain should align with governments' and agencies' policies.

6.10.3. Battery and critical metals biases

Battery systems are an essential component in EVs. Although technological advances are delivering substantial cost reductions for batteries and changes in battery characteristics (e.g., chemistry, energy density, and battery pack size), various sources report that battery performance remains highly unstable, sensitive, inconsistent, unsafe, and costly. EV batteries are also constantly being improved by manufacturers and need to be replaced after several years. Their safety has attracted increasing attention (Liao et al., 2019), and compared to liquid fuels, most current battery technologies have much lower specific energy, and this often impacts vehicles' maximum all-electric range. Battery degradation permanently reduces battery performance, the amount of energy it can store, and the amount of power it can deliver. Additionally, EV batteries face the significant challenge of simultaneously meeting requirements in areas such as specific power, efficiency, life cycle, lifetime, safety, and costs (Pollet et al., 2012). At the same time, there are unmet environmental requirements for battery design that must be addressed since they are crucial to reducing the volume of critical raw materials needed for batteries and to limit the risk of shortages.

One cause of battery limitations is that these systems' architecture and manufacturing are highly complex and delicate. Hundreds or thousands of single cells are typically connected in series and/or parallel; hence, there is an initial inconsistency in the manufacturing process that can later affect their ideal working environment (Xiong et al., 2020) when working in extreme conditions to meet EV requirements for mileage and traction power (Ye et al., 2019). EV batteries also contain components of a different nature—such as data-acquisition sensors, thermal management system, and connectors—that all must be assembled. Additionally, their optimal environment to ensure adequate performance is highly demanding and must be continuously monitored and electronically adjusted in operation (e.g., its thermal environment) (Xiong et al., 2020). For example, the lithium-ion battery—which is the most demanded due to its high power density, high energy density, and low self-discharge rate—can only achieve maximum performance at a specific, narrow temperature range in operation. Too high a temperature may cause battery safety hazards, while too low a temperature will cause irreversible battery damage. These damages also often cause accidental fires due to the failure of some components.

This architectural and functional instability of battery systems can produce many types of component and subsystem faults, which can be random in the actual operation process (e.g., sensor, actuator, internal/external short circuit, overcharge/over-discharge, connection, insulation, or thermal management system faults or inconsistency). These faults can be gradual or due to abnormal behaviours (Xiong et al., 2020). Additionally, the various faults that may occur in battery systems cannot currently be detected or isolated effectively, and so research on the unknown multi-fault diagnosis method for the battery system remains unstudied. There also may be defects in distribution and structural design during the manufacturing process (Baumhöfer et al., 2014; Lyu et al., 2019).

At the same time and due to technological advances, EV manufacturing requires additional quantities of critical, scarce metals, such as the rare earth elements contained in electric engines, cobalt and lithium in high-voltage batteries, and tantalum and palladium in power electronics. Different researchers have concluded that the quantity of these critical metals in manufactured vehicles has increased with their electrification and higher equipment level, as well as concluded that the electric and electronic subsystem presents the largest quantity of these strategic metals (Cullbrand & Magnusson, 2012; Field et al., 2017). For this reason, there is also a relevant supply risk related to these critical metals and materials.

All the discussed factors hinder EV adoption and uncover two types of bias:

- **Ineffective and incoherent EV battery development.** An important ongoing knowledge gap relates to important product biases associated with effective EV battery development. These aspects demand high, strict, costly, and consistent quality requirements and inspections for their raw material supply and their design and manufacturing. EV and battery makers can solve these difficulties due to the increased application of big data, customising and determining the right size battery for each driver based on individual driving patterns (e.g., in the city, on the road), behaviours, and routines (e.g., daily distance). This customisation will allow firms to test and follow up on each customised battery's performance and specific configuration, also enabling them to improve and fine-tune their design and architecture. With this approach, they can also adjust the battery size of commercial EVs to the user's travel, size, and weight needs and thus avoid oversizing batteries, which is especially relevant for heavy-duty vehicles. This solution aligns with the learning-by-doing approach for technological innovations and adoptions, in which improvements may be achieved not only through learning-by-manufacturing, but also with the perspectives of cumulative learning-by-implementing and learning-by-operating that allow EV firms to access batteries' spillover effects (Arrow, 1962; Sagar & van der Zwaan, 2006).
- **Battery innovations at the consumer's expense.** Batteries have become a significant barrier to entry for EV purchase since, together with the EV's high cost, consumers perceive battery to be a key barrier. This perception is amplified by the fact that EV manufacturers seem to pass battery deficiencies and imperfections directly on to the consumer without offering a temporary solution that could mitigate their resistance to change. This gives the impression that manufacturers are too focused on and obstinate about the product (battery), finding an ideal battery, and realising battery innovations at the consumer's expense. However, despite great advances, battery improvements are not easy and still require time. In addition, the problem of batteries must be solved in a comprehensive, even global, way, and the current paralysis is slowing down EV adoption. This is an important service bias for EV manufacturers because while trying to improve the battery, they still do not provide a solution to the customer in parallel. To address this bias, EV makers should ask themselves: How can we guarantee EV users always have a battery that, even if not yet optimal, can at least guarantee them a certain minimum consistent battery performance without having to worry about performance loss, vehicle value, or battery replacement? This problem should be approached from a service delivery perspective rather than a product-sale or transaction point of view. These companies should prepare and provide service solutions to EV drivers while the industry is improving batteries. They must implement service-dominant logic, in which the service provider is not the sole value creator since the battery is created and designed by EV battery manufacturers; rather, service providers should make all types of resources available to EV users for integration and value creation (Vargo & Lusch, 2004). To create value in use, EV manufacturers must provide a specific added value to allow the

EV's potential value to materialise for consumers. This added value could be a specific kind of service: for example, being able to lease or rent the battery, which promotes constant battery substitution, replacement, and recycling that can also mitigate future supply and environmental risks (Iglesias-Émbil et al., 2020). Under this service, the battery might not be included in the purchase and companies would have an opportunity to provide specific battery leasing or rental contracts that also cover charging costs (Li & Kochhan, 2017; Ye et al., 2013). Under this type of scheme, a consumer preference analysis by Liao et al. (2019) shows, another type of business model could be driven by leasing EV vehicles and not just batteries. This perspective aligns with the business model of EV car-sharing, which has become a good method to support battery electric vehicle adoption and provide a cleaner mode of transport, especially in cities (Wang et al., 2017). Those who perceive EVs' added value are more inclined to purchase through leasing. Additionally, these business models can be complemented by government policies involving financial incentives.

6.11. CONCLUSIONS

This chapter has analysed factors and knowledge gaps that both support the EV innovation ecosystem as a whole and slow down ecosystem growth. It has shown that the most important impediment to EV uptake is that the industry has not yet converged on a dominant EV design that would create a co-aligned structure within the EV ecosystem to set shared technological compatibility standards (Thomas & Autio, 2020; Adner, 2017; Brem et al., 2016). The different types of biases described in this chapter demonstrate the complexity of relationships and interdependencies that currently govern the pace of EV transition. I assert that EV ecosystem participants have not yet deployed an appropriate shared systems perspective that would frame those complex systems relationships. Additionally, participants appear unaccustomed to addressing symptoms versus causes since there are still narrow and confined knowledge silos due to inheriting organisational behaviours from the ICE vehicle ecosystem (Lawer, 2018). Additionally, participants make superficial, short-term evaluations versus a scale and sustainability analysis that examines core elements, their complex relationships, and their root causes. The solution approach still focuses on the known, spatially confined spaces of traditional contexts—leaving aside exploration of those adjacent emerging spaces for opportunities that are in different leading ecosystems.

Like the other studied ecosystems, the EV ecosystem lacks a multistakeholder and a wider understanding of contextual problems in EV implementation. EV prototyping and idea iteration to improve driver experiences lack scale and wider perspectives, and they involve higher risks for EV transition. For example, to increase the pace of transition to EVs, countries with key markets must shape and jointly implement common, synchronised policy packages to enhance policy synergies and effects between countries (Gómez Vilchez et al., 2020). Although different prediction models have been designed for national-level EV diffusion, no truly global diffusion model has been agreed upon or developed to investigate EV uptake (Gómez Vilchez et al., 2020). The identified knowledge biases demonstrate that this sector still lacks a full perspective, structure, or ecosystem governance since policy coordination requires cooperation not only by national and international public authorities but also among the different ecosystem stakeholders and participants. These negotiations require the full commitment of global players, including governments and EV manufacturers. An extended charging infrastructure for EVs is, thus, equal in importance to the institutional infrastructure supporting the EV innovation ecosystem's resilience. Finally, the EV innovation ecosystem's sustainability depends on whether it is fuelled by green energy. Carbon-intensive electricity sources imply little improvement compared to ICE vehicles, and the use of climate-friendly energy, (e.g., biogas and biomass) is crucial to make the EV ecosystem part of climate action

(Karmaker et al., 2020). The support for such underlying energy infrastructure, hence, defines the climate impact of the EV ecosystem.

Finally, I assert that the EV ecosystem participants that are also dominant, mature business communities within the ICE ecosystem are now threatened by the rising innovations and opportunities of this new EV ecosystem (Moore, 1993). This generates blind spots and tensions among participants, constraining their capacity for coevolution. These participants must adapt to changing environments and undergo self-renewal by building new capabilities and leading more adaptive, creative organisational cultures that will allow them to co-create superior ecosystem interventions and technological interdependencies. They should implement a new systemic approach focused not only on improving outcomes but also on transforming both the inputs and outputs of the different participants and stakeholders from related ecosystems and societies. Participants must evolve through ongoing technological and resource variations, selection, adoption, and adaptation, and they must develop and display varying levels of resilience and sustainability driven by the rising diversity of audiences and contexts (Lawer, 2018).

CHAPTER 7. CONCLUSIONS

This multiple-comparative case study has involved analysing and synthesising the similarities, differences, and patterns across three case studies of innovation ecosystems with some common characteristics. First, they share a common focus or goal in terms of how innovation ecosystems are built and managed/orchestrated and in terms of how they generate focal value propositions. This makes it easier to generalise on whether, and to what extent, observed changes and transformations in these ecosystems are due to knowledge and value transfer processes within and across each when evaluated alongside other factors influencing these changes (Ritala et al., 2013). Second, the three case study ecosystems represent an appropriate impact evaluation design because this design is especially suitable for contemporary and exploratory settings (Yin, 2009), and I have realised that undertaking an experimental design would not be feasible due to these ecosystems' magnitude and extension, the great number of interdependencies among ecosystem participants within and across their borders, and the need to explain how these ecosystems' multiple, changing contexts and locations influence this knowledge transfer. Third, the case studies have involved in-depth examinations over time because understanding each case is important to thoroughly comprehend both the case and its contexts and to establish the foundation for the analytic framework used in this cross-case comparison.

Within the methodology of comparative case studies, I have emphasised my research on understanding the different cause-and-effect relationships of knowledge transfer and interactions within the ecosystem, across its related ecosystems, and with its environments. For example, I examined the extent to which new social trends, consumer perceptions, and customer-supplier relationships affect the knowledge transfer or generativity capacity manifested in these ecosystems. I also focused on identifying and understanding knowledge gaps due to cognitive biases that constrain knowledge transfer within and across each ecosystem and affect the strategic decisions and judgements their participants make when processing and interpreting information in their individual contexts. In particular, I sought to identify and evaluate the omission of knowledge from distant actors within these ecosystems and related ecosystems.

Based on my exploration of these ecosystems, I can consider all these ecosystems to be modular innovation ecosystems, following Thomas and Autio's (2020) classification and typologies of ecosystems that have helped reorganise the proliferating domain of management ecosystems. Even if each of the three studied ecosystems is a dynamic community of more or less hierarchically independent and interdependent heterogeneous participants, these ecosystems share that their participants collectively generate a specific ecosystem output and related value proposition offering that precisely targets concrete, defined audiences (Thomas & Autio, 2020). Additionally, the three case study ecosystems are also specialised supplier-based ecosystems that result from deliberate interaction, experimentation, and engineering by co-specialised parties and suppliers that work in competitive cooperation—'coopetition'; this coopetition occurs within and across industries and ecosystem borders in order for a focal value proposition to materialise and satisfy the certain, specific customer needs of defined audiences (Adner, 2017; Adner & Kapoor, 2010).

Within these ecosystems, dynamic communities create specific products, services, and complementarities that together constitute coherent end-to-end solutions and integration to satisfy the defined audiences' needs and wants. For this reason, each ecosystem is characterised by a specific focal value proposition (the desired solution) and a clearly defined—albeit changing—group of actors with different roles (e.g., producer, supplier, orchestrator, complementor). The EV ecosystem produces and delivers EVs with a range of specific services and complementarities that solve specific human and business problems in areas such as mobility, sustainability, safety, and reliability. The global clinical diagnostics ecosystem's final outputs are the test result reports provided to healthcare

professionals and clinicians in order to support patient diagnosis, as well as new knowledge that enhances scientific advances in medicine and healthcare. Within luxury fashion, the final output can be characterised by factors—such as the type of garments, ready-to-wear, or accessories—that satisfy several types of consumers' needs. Additionally, each of these ecosystems includes diverse B2B markets, systems, and supply chains that supply the different modules and complementarities and cross their respective participants and organisations. For example, the global clinical diagnostics ecosystem encompasses healthcare systems and human test results supply chains, as well as supply chains from other industries and ecosystems (e.g., pharmaceuticals, food processing and intolerances, and veterinary). The luxury fashion ecosystem also has specialised B2B markets and supply chains that deliver different types of fashion complements, goods, and services (e.g., shoes as complements, leather and silk as goods, prêt-à-porter as a service).

All this differentiates my studied ecosystems from the entrepreneurial and knowledge ecosystems, for which outputs are not framed and arranged for any specific audience and do not have a relationship with any specific business problem or customer needs. The output of the entrepreneurial ecosystem is the collective generation of BMI (Chesbrough, 2010) that can be applicable in virtually any sector and target any audience (Acs et al., 2008; Spigel, 2017) and that is initiated in new start-up ventures (Thomas & Autio, 2020). The knowledge system's specific output is all pre-commercial knowledge for creating shared resources that no single participant would be able to create independently (Järvi et al., 2018; Leten et al., 2013).

I argue that although considerable heterogeneity and differences exist in the nature and characteristics of each of the studied ecosystem's participants, resources, outputs, dominant interdependencies, governance, and knowledge application, this exploration of their current framework offers the promise of supporting insights that:

- Are distinctive relative to other concepts that describe collectives of organisations, such as those of 'industry', 'supply chain', 'cluster', and 'network';
- Express several performance similarities among these ecosystems because they share several attributes that each ecosystem expresses and deploys in different ways; and
- Define certain common dynamics within their changes, coevolution, and life cycles.

7.1. ECOSYSTEM CHARACTERISTICS

Within this multi-comparative case study, I have prepared several tables to summarise the main characteristics and features of these innovation ecosystems (see Tables 7.1 and 7.2). The tables highlight each ecosystem's most relevant characteristics in reference to the specific literature describing them. Table 7.1 features the main generativity characteristics, and Table 7.2 focuses on the development traits of these studied characteristics.

Table 7.1. Generativity characteristics of the studied ecosystems

	Global clinical diagnostics	**Luxury fashion**	**Electric vehicle**
Targeted audience (Thomas & Autio, 2020)	Patients waiting for a clinical diagnosis, physicians and researchers, hospitals, and B2B industries (e.g., pharmaceutical companies, food processing companies)	Different worldwide consumer profiles (e.g., HENRYs [high earners, not rich yet], millennials, Generation Z)	Worldwide consumers (e.g., drivers, families), courier and logistics firms, B2B firms, etc.
Typology of needs and wants	Personal and social well-being, safety, quality of life, accuracy of test results, speed, etc.	Self-actualisation, self-expression, belonging, personal experiences, etc.	Mobility, safety, savings, reliability, sustainability, etc.
Typology of outputs (Seppelt et al., 2011)	Test result reports and diagnostic services; new research-based knowledge	Garments, ready-to-wear, accessories, etc.	EVs and mobility solutions
Generativity of outputs (Zittrain, 2009; Cennamo & Santaló, 2019)	Increasing due to the rise of preventive medicine and the effects of the COVID-19 pandemic; focused on the development of new tests and techniques	High and focused on development of the product: new seasonal and capsule collections	Focused on the product (e.g., major architectural innovations within the EV, new models and variants)
Generativity of inputs and modules (Jacobides et al., 2018; Teece, 1986)	Focused on clinical research, economies of scale and automation, and reagent development	Rise of new sustainable raw materials and new collaborations (e.g., with artists, designers, clothing ateliers)	Rise of new technologies, flexible and modular manufacturing systems, improvements to battery specifications (charging and driving times), rise of new raw materials, etc.
Range of inputs	Very wide and focused on science-based knowledge (e.g., reference and specialised labs, research centres)	Very limited and tied to preconceived traditions and habits; most unexplored	Very wide (e.g., technologies, policies, regulations, power supply, charging stations)
Resource intensity	Technological intensity and knowledge intensity	Materials intensity and skilled labour intensity	Technological intensity and energy intensity
Generativity and intensity of complementarities (Jacobides et al., 2018)	Increasing due to the development of new medical treatments, therapies, etc.	Increase in garment and complement suppliers, hyperpersonalisation of clothing and services, tailoring and laundry services, packaging development, etc.	Very high and with great potential (e.g., customisation of batteries, home energy storage and leasing services for solar panels, battery leasing services, recycling services)
Generativity of innovative business models (Autio et al., 2018)	Emerging new business models (e.g., rise of new collaborative models between public and private sector provisions, increase in client-based business models instead of accession-based business models and pay-per-patient models)	Rise of new retail hybrid business models and business models for rental and secondhand markets	Increasing with great potential (e.g., internet-based ride-sharing platforms, new models of integrated mobility solutions, pay-how-you-drive insurance policies and car rentals)
Generativity of cross-industry/-ecosystem collaborations (adjacent ecosystems)	Increasing (e.g., with global and local logistics ecosystems, IT and communications ecosystems, packaging industries)	Increasing collaboration with sports firms, tourism and hospitality industry, gastronomy, arts and culture sector, etc.	Increasing collaboration with IT and communications ecosystems (e.g., artificial intelligence for autonomous driving), with light commercial transport, with the public sector for infrastructure development (e.g., smart cities), etc.

Table 7.2. Development characteristics of the studied ecosystems

	Global clinical diagnostics	Luxury fashion	Electric vehicle
Modularity (Baldwin & Clark, 2000)	Increasing with the rise of autoanalyzers with scalable module-based solutions	Modular offerings available from horizontally related suppliers; increasing to adapt to localised tastes; rise of new service modules	Vehicle's modular body designs and services
Module integrator	Clinical/scientific societies and doctors	Consumers (end users)	OEM firms, regulatory agencies, and consumers
Type of co-alignment structure (Adner, 2017)	Shared IVD regulations and clinical standards; lack of an end-to-end lab testing digital/software platform	Changing aesthetics, fashion trends, styling	Shared technological compatibility standards; lack of an end-to-end automotive digital/software platform
Convergence on a dominant design (Anderson & Tushman, 1990; Suárez & Utterback, 1995)	Yes	Yes, but temporally built	Not yet
Stage of product/technology life cycle	Growing—gaining economies of scope and scale and automation; pandemic has revolutionised this sector (new opportunities and challenges)	Growing—development of new value propositions and offerings	Slow start with oversupply—unclear when the EV market will enter in the next life cycle stage with rapid growth
Nature of ecosystem contexts/ environments	High heterogeneity of health systems (regional, national, and supra-national healthcare systems) and socioeconomic contexts; subject to systemic environmental changes	High heterogeneity of sociocultural and economic contexts; subject to systemic environmental, global, and local changes	High heterogeneity tied to each context's regulations, policies, consumer practices, cultural meanings, infrastructure, scientific knowledge, supply and maintenance networks, etc.
Heterogeneity of participants (Autio et al., 2018; Jacobides et al., 2018)	Very high and rising	Growing but with limited typology of resources; mostly tailoring workshops	Very high and growing; wide diversity of resources and competencies
Typologies of co-specialisation	High science- and technology-based co-specialisations; high specialisation of production and services	High product and raw materials co-specialisation; retailing and omnichannel co-specialisations	Technology-based co-specialisations; high complementarity co-specialisation
Number of participants per specialisation	Low due to firms' concentration from mergers and acquisitions	Low and very limited	Still low but growing
Participant locations	Market's geographic diversity within developed countries and supply's geographic concentration	Market's urban and online locations and highly localised supplier-based sub-ecosystems	Market's urban locations within developed and developing economies; delocalised manufacturing and supply participants
Asset specificity (Williamson, 1985; Malone et al., 1987)	High physical, dedicated, and time asset specificity	High human asset specificity	High site specificity (raw materials for batteries) and dedicated assets
Typology of interdependencies among ecosystem participants (Autio et al., 2018; Jacobides et al., 2018; Thomas & Autio, 2020)	High knowledge, science-based, and roles and cognitive interdependencies; growing economic interdependencies	Strong roles interdependencies; high internal cognitive interdependencies that are growing; growing economic interdependencies (rise of economic externalities)	High technological and science-based and roles interdependencies, but low cognitive interdependencies

	Global clinical diagnostics	**Luxury fashion**	**Electric vehicle**
Nature of the interdependencies (Thompson, 1967)	Pooled and reciprocal interdependencies	Essentially sequential interdependencies	Mostly pooled
Main relationships and participant interactions	Public and private health institutions with research centres, universities, hospitals, and reference labs	Luxury houses and brands with manufacturing workshops and fashion-trend forecasters	Focused on essential stakeholders within the emergence of the ecosystem (e.g., lead customers, key suppliers, channels)
Types of participant interactions	Examine, check, assess, collect, inform, evaluate, communicate, collaborate, decide, research, provide support, orient, etc.	Research, compete, purchase, inspire, collaborate, stimulate, persuade, provoke, look for alternatives, negotiate, partner, deliver, promote, influence, lead, etc.	Educate, trigger, provide support, research, motivate, incentivise, collaborate, interconnect, lead, regulate, promote, engage, train, purchase, deliver, etc.
Ecosystem coordination and governance	Multilateral contractual governance with rigid regulations; bottom-up governance (derived from medical treatments and preventive medicine); within-ecosystem research linking changes in modularisation (added new tests)	Relationship-specific contracts that uniquely define bilateral relationships (luxury houses' dominant governance role); vertical rather than horizontal, which constrains generativity; rise of horizontal coordination	Multilateral, cross-industry/-ecosystem research linking changes in modularisation to ensure compatibility among ecosystem participants and components
Rules of engagement	Closed standards and open rules of engagement to enhance knowledge transfer	Less imposed and closed standards from luxury houses and more open engagement and interaction with consumers	Open rules of engagement and emerging standards and interfaces
Ecosystem dynamics and life cycle stage (Thomas & Autio, 2020; Moore, 1993)	With the pandemic, reached the leadership-role stage since it dictates the evolution of other related ecosystems; its dynamics of high generativity have allowed this ecosystem to not only survive but thrive	Coevolution and self-renewal with mutual adjustments of components due to the exhaustion and saturation of business models created in the growing era of luxury democratisation	Expanding and trying to outcompete the less sustainable ICE ecosystem

7.2. ECOSYSTEMS' COMMON TRENDS AND PATTERNS

Through analysing and comparing their respective characteristics, I have identified several commonalities and patterns within the dynamics and frameworks of my studied ecosystems, described in the following subsections.

7.2.1. New competition dynamics and arenas

Due to their emergence and growth, these ecosystems are all targeting ever-wider and more diverse audiences that include a growing number of customer profiles and behaviours. New needs are constantly emerging among these actors due to global occurrences within the ever-changing environments and contexts; this is fostered by significant shared technological and scientific improvements, high internationalisation of markets and companies, increased competitive pressure, the rise of consumerism within developing and emerging economies, and the massive influence of social media. These ecosystems share increasing complexity and ambiguity in terms of the relationships between new social patterns and consumers' self-construal behaviours surrounding individualism/independence and collectivism/interdependence.

Additionally, this growth is attracting many participants and collaborators from diverse specialisations and ecosystems, who are framing and adding new interactions and interdependencies within each ecosystem, and thus delivering more opportunities for cross-fertilisation of new ideas and knowledge. In an ever-connected world, all these new needs, expectations, and priorities are leading ecosystem participants to previously unseen business scenarios, participant behaviours, and competitive dynamics that can generate new business opportunities and thus affect their coevolution. Amid this transformation, the COVID-19 pandemic has brought both additional stress and opportunities to these ecosystems. For example, the pandemic has uncovered new and unexplored consumer habits, lifestyles that entail changing attitudes, and expectations for these ecosystems' value propositions. Within these ecosystems, these changes have also introduced new competition dynamics that are no longer limited to a zero-sum game in which all competitors compete for a market of a given size (Priem, 2007; Thomas & Autio, 2020); instead, these dynamics surround how each ecosystem participant can meet as many customer and social needs as possible (Cennamo & Santalo, 2013; Thomas & Autio, 2020). These changes should give room for all participants to explore new types of interactions and interdependencies. It is a time in which everything should be under discussion and reinterpreted.

7.2.2. Fatigue surrounding dominant designs

The new competitive dynamics have stimulated all participants to increase their generativity of outputs, modules, inputs, complementarities, business models, and cross-ecosystem collaborations. These unprecedented transformations are eroding and influencing all preconceived design hierarchies, standards, and interdependencies. The effects of this transformation have generated an increase in many classes of requirements and adaptations from all ecosystem participants—customers and organisations alike. Thus, all existing and preconceived dominant designs cannot simultaneously embody all these growing requirements. A dominant design lays down a co-aligned structure within each ecosystem to set shared technological compatibility standards (Thomas & Autio, 2020; Adner, 2017; Jacobides et al., 2018) and enhances incremental innovation to refine an ecosystem's products and offerings (Brem et al., 2016). At the same time, I have found that since these ecosystems' outputs essentially focus on the development and production of products and services, the ecosystems' dominant designs remain heavily influenced by the design

of these almost-unaltered products and their architecture, casting aside the exploration of new customer needs, business models, and within- and cross-ecosystem collaborations. This is because, I have observed, these ecosystems' dominant-design life cycles remain completely based on the life cycle of the main products and services that these ecosystems supply within their value propositions. Participants should not expect dominant designs to last forever, and they cannot try to extend one's life cycle with incremental innovation as if it were a mere product. I have also observed participants having a strong affiliation with these dominant designs as part of their identities and cognitive interdependencies. Thus, it appears that developing dominant designs should evolve to a new transition point or milestone within the coevolution of these ecosystems (Suárez & Utterback, 1995).

These flexible new dominant designs should be the result of beneficial combinations derived from the generativity and cross-fertilisation of new interdependencies and co-specialisations. New dominant designs should not be based on the latest and greatest technological model and design 'sweetness' (Suárez & Utterback, 1995) that all participants expect and wonder if they should wait for. As the three case studies show, this phenomenon is generating a kind of paralysis that is constraining these ecosystems' coevolution towards a renovated, adapted new dominant design and the development of collateral or co-specialised assets and complementarities that would, in turn, strengthen the emergence and dominance of new adapted models (Teece, 1996; Suárez & Utterback, 1995). For example, the luxury fashion ecosystem still relies on preconceived notions of a temporarily built and seasonal dominant design, notions that luxury fashion houses configured within their confined ecosystems and remain today. The EV ecosystem has not yet converged on a dominant EV design that would set a co-alignment structure within this ecosystem to set shared technological compatibility standards (Adner, 2017; Jacobides et al., 2018; Thomas & Autio, 2020).

7.2.3. Strong production- and firm-centric perspective

The design of these outputs remains heavily influenced by the original architecture and standards of the industries, supply chains, clusters, and networks from which these ecosystems emerged. This is because these new ecosystems started as spatially confined ecosystems within specific contexts (i.e., different entrepreneurial ecosystems and clusters), and they have undergone a gradual transformation while retaining the structures and processes that dominated those previous industries and networks.

All three innovation ecosystems were embedded in their own immediate and tightly constrained physical domains and affiliations due to the predominantly physical nature of their structures, organisations, infrastructure, inputs, and outputs. Additionally, when these new ecosystems emerged, they had a narrow scope of focal firms and immediately adjacent complementors, suppliers, and clients. For this reason, their main resources, inputs, and complementarities have been constructed from what previously existed due to resources and competencies' location-specific factors, such as the specific history of an industrial cluster based on an available raw material, transport infrastructure, or the expertise of a specialised, skilled labour force from all related industries. Simultaneously, the history of participants and industries within these ecosystems—with their affiliated social communities, organisations, and institutions tied to specific places—has conformed to the limits of firms' innovation in these ecosystems and has helped structure all entrepreneurial activities through the processes of geographic proximity, physical co-location, agglomeration, and firm and resource concentration and path dependence due to the density of local social and economic networks (Sturgeon et al., 2009). Additionally, these ecosystems' emergence as innovation ecosystems was facilitated by a strong transactional and contractual governance that limits any generative inputs that participants may make for the ecosystem (Autio &

Thomas, 2018). These ecosystems' emergence was heavily influenced by national and regional political institutions that created pressure for local content, which drove production close to end markets, where it tended to be organised nationally or regionally (Sturgeon et al., 2009).

For these reasons, these ecosystems' value co-creation processes remain heavily influenced by a strong supply-, production-, and even cluster-centric perspective, in which the end user's role is fundamentally constrained to providing information and to being a more or less passive recipient buying the system-level orchestrated offering, with the additional ability to create a customised package from complementary modules (Autio & Thomas, 2019). In both the luxury fashion and EV ecosystems, consumers integrate modules and complementarities; in the global clinical diagnostics ecosystem, however, it is doctors with their prescribing roles—not patients—who integrate modules and complementarities. The variety of EV models and modules on offer remains very limited, while luxury fashion is saturated with offerings. Within these industrial networks, this strong resource-based view and the presence of compelling organisational identities and stories that have privileged positions as value creators within their transactional approaches have revealed a strong organisation-centric perspective among participants, which has resulted in the customer being considered a passive recipient of value. This firm-centric approach allows participants to control (and therefore manage) and continue to hold all value-delivery processes. For example, the final outcome of the EV ecosystem appears to not actually be due to technological limitations since it is a consequence of this ongoing firm-centric managerial orientation and its underlying assumption that customer relationships can be managed and controlled by supplier firms, as still happens in the ICE ecosystem.

As a consequence of these approaches, these ecosystems' strong industrial and transactional governance traditions—which continue to frame ecosystem dynamics—have generated powerful spatially confined and anchored cognitive interdependencies among their participants. This is actually influencing—and constraining—the development and generativity of new competencies, knowledge, and cognitive interdependencies within these ecosystems' new globalised and delocalised context. Due to their accelerated expansion and to leadership dynamics that ended with the traditional competition between individual products or services (Moore, 1996), these ecosystems have quickly hatched and transformed into huge, complex, unbound, global, and non-spatially confined ecosystems. However, they have kept their previous structures of confined ecosystems and, therefore, require active agency in order to be reconfigured (Thomas & Autio, 2020) and co-aligned with new contexts that have become more diverse and delocalised. For example, the EV ecosystem's dynamics, interdependencies, and standards have been developed from the ICE ecosystem's premises because the EV ecosystem emerged from the ICE ecosystem's structures and affiliations. Even so, both ecosystems are now competing with each other. For this reason, the EV ecosystem cannot yet completely outperform the ICE ecosystem since their couplet and paired structures and their inherited dynamics constrain the generativity of differentiated offerings and new interdependencies of the EV ecosystem.

This decoupling is amplifying the value and knowledge gap, especially from distant ecosystem participants, and has generated a blind spot within these ecosystems (Thaler, 2015) since it constraints participants' ability to find the real new drivers of these ecosystems' interactions and limits their ability to achieve a clear, deep, and immediate understanding of complex problems, challenges, or situations about to emerge in increasingly complex ecosystems. These blurred perceptions also inhibit the gathering of new insights, especially through intuitively apprehending and understanding the crucial new and emerging relationships within the ecosystems and across their related ecosystems.

7.2.4. Increasing competition among large, growing ecosystems

When the three ecosystems under review emerged as spatially confined innovation ecosystems, they were not exposed to specific, tight market conditions and pressures determined by users' changing needs and choices. Since they have become outbound, these ecosystems have needed to operate in different market contexts that are increasingly competitive and dynamic. Thus, they should constantly develop updated value propositions that more directly target specific audiences (Thomas & Autio, 2020). These ecosystems' competitive dynamics have been disrupted and accelerated by the parallel emergence of new outbound innovation ecosystems, which now compete with the studied ecosystems since the targeted audiences and their needs overlap. For example, the luxury fashion ecosystem started in different confined and localised reduced ecosystems within Europe, but now this enormous, expanding ecosystem is competing with other unconfined ecosystems like leisure, hospitality, and tourism. Rather than occurring at the level of products and ecosystems, strong competition now plays out among ecosystems that span multiple traditionally defined product markets that target the same customer needs and expectations (Cennamo, 2019; Rochet & Tirole, 2003).

In this context of expansion, entities in the three studied ecosystems should understand that they are now also competing with other ecosystems to control strategic markets, dominate key market segments, and 'capture new territory'. To achieve a prestige leadership role within this fierce competition, these ecosystem participants should focus their co-generativity on also developing and integrating new business models and collaborations across ecosystems. This will allow these ecosystems to develop compelling new visions for the future and maintain strong bargaining power in relation to competing ecosystems (Moore, 1993). Due to the pandemic, for example, the global clinical diagnostics ecosystem has reached a stage involving a leadership role since it currently dictates the evolution of related ecosystems. Its present dynamics of high generativity have allowed this ecosystem to not only be resilient but also thrive. However, the greatest paradigm of this coevolution is: How can the participants of the three studied ecosystems manage the complex interplay between competitive and cooperative business strategies within and across the new and expanding ecosystem boundaries?

7.2.5. Soft cognitive and reciprocal interdependencies across ecosystem boundaries

Analysing and comparing these three ecosystems' co-alignment structures, the ecosystems all reflect and share strong roles and technological interdependencies (Thomas & Autio, 2020) since none of the ecosystem participants alone is able to create the ecosystem output and robust technological interdependencies (Adner & Kapoor, 2010) that reflect powerful co-specialisations within the studied ecosystems. As a result, for example, the technological interdependencies in the EV ecosystem should be reinforced and new ones should be explored to help develop renovated modules and new complementarities in both production and consumption. I have also identified important internal cognitive interdependencies between participants within but not across these ecosystem boundaries. New and renovated 'internal' cognitive interdependencies should be developed within these ecosystems to close the growing cognitive gap among participants due to the increasing heterogeneity and differences in specialisation, expertise, and competencies as these ecosystems expand (Wareham et al., 2014). This will reinforce the ecosystem's collective identity and its group belonging role (Gawer & Phillips, 2013; Thomas & Ritala, 2021). Within these innovation ecosystems, I have found that collective identity—embedded in the main participants' prestige, historical roots, and histories—is fundamental since it ties together these participants and newcomers and it helps provide them with cohesion and coordination. These cognitive dynamics

related to collective identity are a strong characteristic of these innovation ecosystems since they were born in confined ecosystems and clusters. Taking the luxury fashion ecosystem as an example, fashion houses' prestige exerts this pressure on the remaining participants and acts as a powerful cognitive co-alignment structure. In global clinical diagnostics, participants are tied to the prestige of the incumbent medical director who created a laboratory. These identity dynamics are constraining the development of new forms and rules of governance, engagement, and coordination among the increasing number of newcomers. They are also limiting these ecosystems' coevolution and, thus, amplifying the blind spots of these ecosystems.

New cross-border cognitive and technological interdependencies should be explored to generate additional relationships between related innovation, entrepreneurial, and knowledge ecosystems in order to enhance their interactivity and generativity. At the same time, the cognitive interdependencies with end users (consumers) must be fostered and strengthened to cope with the effects of consumers' changing needs. An exception is global clinical diagnostics, which has cognitive interdependencies that also reflect significant knowledge- and science-based interdependencies. For example, in the EV ecosystem, cognitive interdependencies with consumers should be renovated since they still rely on socially constructed historical patterns of use, assumptions, values, and rules from the ICE ecosystem, which are continuing to provide the formal and informal rules of action, interaction, and interpretation that guide and constrain consumers' and firms' EV-related decision-making (Thornton & Ocasio, 1999).

When analysing the nature of these interdependencies, I have observed that a large proportion of pooled and sequential interdependencies continue to be generated among participants due to the high degree of standardisation and regularisation. Additionally, a large proportion of the economic interdependencies achieved by these ecosystems when they were spatially confined began to expand due to globalisation. This inertia in my studied ecosystems is actually constraining the development and implementation of reciprocal interdependencies that are necessary to coordinate the types of mutual adjustments that would enhance the ecosystems' generativity since all participants must constantly adjust to each other's actions as the situation and context changes (Schwarz, 2017). The EV ecosystem inherited the pooled interdependencies and interactivity dynamics of the ICE ecosystem, but its participants should foster the development of reciprocal interdependencies to enhance open innovation practices and processes. The strong regulations and standardisation of the global clinical diagnostics ecosystem ties up these pooled interdependencies, meaning participants should develop parallel structures to develop and implement the reciprocal interdependencies that are necessary to speed up the development of new tests and techniques. This occurred with the disruption of the COVID-19 pandemic since this emergency has pushed all ecosystem participants to develop such structures and procedures.

I also conclude that the development of interdependencies is another competence that define innovation ecosystems' performance since it helps participants to develop, for example, new outputs, inputs, and business models. I consider this development to be a dynamic capability for participants who integrate an ecosystem; it is an ability they can learn, train, and develop for crafting, refining, implementing, and reconfiguring these interdependencies to address changes in the business environment (Teece et al., 1997; Teece, 2007).

7.2.6. Lack of digital platforms for integration

Within the studied ecosystems, the players interact directly and not through a digital central platform or shared connectivity interface. This is unlike the platform ecosystems that are a typology of innovation ecosystems focused on enhancing the value offering of platforms as their co-alignment

structure (Ceccagnoli et al., 2012; McIntyre & Srinivasan, 2017). This type of interaction constrains ecosystem participants' ability to interact with participants from other ecosystems that share the same audiences and their ability to integrate and deliver end-to-end solutions to customers. Implementing these digital platforms across the boundaries of related ecosystems will promote interoperability among participants by enabling not only communication among them but also the integration of value propositions and applications from the different ecosystems that address the same target audience (Serbanati et al., 2011).

Additionally, the potential for consumer data appears to not be fully exploited due to the three studied ecosystems' organisation- and production-centric approaches. The development and implementation of these platforms would also allow all participants from related ecosystems to apply a user-centric approach, which would aim to unlock such potential by enabling these participants to control the gathering, management, use, and sharing of data about them (Moiso & Minerva, 2012). For example, due to the disruption of COVID-19, it has been necessary for the healthcare system to rapidly develop integration platforms for different regions' or countries' health information systems to allow collaboration among authorised agents from different but related ecosystems (e.g., caregivers, patients, public and private health organisations, testing labs, research centres, universities, pharmaceutical companies, logistics firms, and clinical societies). These platforms have aimed to achieve patient-centric healthcare delivery and a multidimensional view of the patient's health status. These underpinning digital co-alignment structures (Thomas & Autio, 2020) could enable healthcare innovation ecosystems to shift from organisation-centric to patient-centric ecosystems and business models that deliver specialised and localised applications that align with the specific contexts.

7.3. KNOWLEDGE BIASES

When analysing these ecosystems, I have also identified important cognitive biases that hinder their knowledge flows, generate important knowledge gaps for participants, and thus constrain their generativity processes and new interactions. These disorders are creating blurred and erroneous perceptions of the most crucial drivers of coevolution and of the main factors and facts surrounding the evolution of their environments and contexts. Analysing these cognitive biases has enabled me to provide a theoretical framework of biases within modular innovation ecosystems, all of which are based on the knowledge that participants possess or lack in a specific area: sourcing-based biases (knowledge on ecosystem resources and modules); market-based biases (knowledge on ecosystems' different target audiences); complementarity-based biases (knowledge on the development of ecosystem complementarities); data- and information-based biases (knowledge on the ecosystem's data and information systems); technology-based biases (knowledge on emerging technologies); finance-based biases (knowledge on the ecosystems' finances); industry-based biases (knowledge on the different industries' ecosystem-related dynamics); environment-based biases (knowledge on the ecosystem's environmentally related political, social, regulatory, or fiscal issues); strategy-based biases (knowledge on the ecosystem's core strategies); organisation-based biases (knowledge on ecosystem organisational behaviours); and service-based biases (knowledge on ecosystem services). Within this framework, I have identified cognitive biases and proposed strategies to mitigate their rising effects within these types of ecosystems (see Tables 7.3 to 7.5).

Table 7.3. Knowledge biases within the global clinical diagnostics ecosystem

Situation of global clinical diagnostics ecosystem	Omitted knowledge source	Bias	Strategies for ecosystem participants
Increase in the preventive medicine and treatment practice maps overlaid with new health practitioner types and new technology user profiles	End users and consumers (von Hippel, 1986)	Market bias	Appreciate the needs of the different health ecosystems and their functioning in order to understand the provision of different health care services, disease screenings and prevention, diagnosis, treatments, and monitoring
Unexplored adjacent social ecosystems where factors arise that prevent or reduce their ability to cope with new diseases and new medical treatments	Social environment	Environmental bias	Develop a more strategic mindset to develop a multistakeholder approach based on complete evidence
Existence of orbital transportation routes and solutions to avoid different tiers of transportation franchises and local intermediaries	Different tiers of suppliers	Sourcing bias	1) Research the rising opportunities and new value propositions offered by the different tiers of suppliers because of their interactions with external participants of the ecosystem 2) Increase interactions with other participants of the ecosystem within and across its boundaries
Existence of climate monitoring and data documentation systems when transporting samples	Complementary product producers (Kim & Mauborgne, 2005)	Complementary product bias	Explore and increase the development of different types of complementarities to deliver significant potential related to value propositions and to avoid the delivery of partial or piecemeal solutions
Transportation considered auxiliary	Service suppliers	Service bias	Enhance the implementation of service-dominant logic to mitigate the higher information asymmetry that has dominated the consumer-provider interaction within this ecosystem
Fishing industry used superior transportation solution	Cross-industry solution (Kim & Mauborgne, 2005)	Industry bias	Expand their search for emerging problems and challenges by looking into new adjacent spaces, contexts, and possibilities beyond the status quo and the traditional spatially confined spaces of this ecosystem
Attempted extensions of current technology	Technological innovation	Technological bias	Co-create superior ecosystem technological applications by generating new relationships with participants from the emerging technological ecosystems
Existence of direct government funding available for the development of large investment projects	Credit institutions	Financial bias	1) Enhance value-based medical care and emphasise cost-effective decisions and provision of healthcare services 2) Develop new models of reimbursement and insurance (e.g., capitation payment model, bundled payment)
Modifications to specific regulations for sample transportation implemented by IATA and WHO	New legislation	Legal and political biases	Develop policy and regulation packages to synchronise them with a multistakeholder and systems problem perspective

Table 7.4. Knowledge biases within the luxury fashion ecosystem

Situation of luxury fashion ecosystem	Omitted knowledge source	Bias	Strategies for ecosystem participants
Consumers' cognitive impairment and fatigue due to the growing gaps between the current ubiquity and excessive democratisation of luxury fashion, the rising importance of consumer individuality, and traditional notions of luxury	1) Changing, uncertain, unpredictable, volatile conditions of the business environment (e.g., market) coming from unexpected directions with unprecedented customer expectations (Bailey et al., 2019; Gunasekaran et al., 2019; Sheng et al., 2019) 2) Value-in-cultural-context (Edvarsson et al., 2011)	Market bias	1) Enhance environment research, both locally and globally 2) Enhance market and consumer research to gather and understand new consumer insights and the complexity of their new behaviours associated with the post-pandemic period
	1) BMI (Teece, 2010) 2) SBMI (Shakeel et al., 2020)	Strategic industry bias	1) Research and develop multiple, more personalised, and more sustainable value propositions—both forward and backward in the supply chain 2) Analyse how luxury firms should renovate this sector and develop new business models and collaborative networks
Emergence of new behaviours and consumption habits due to the COVID-19 outbreak and its impact on consumers' values, priorities, and self-extensions related to luxury fashion products	Emergence of consumers' new, unusual, and uncertain needs and forms, boundaries, and reactions of socialisation (Kirk & Rifkin, 2020) due to an environmentally imposed constraints perspective (Hamilton et al., 2019)	Environmental bias	Research how, for example, COVID's health and pain effects, restrictions, and access to basic needs have affected consumers' consciences, well-being, values, beliefs, solidarity, and life priorities regarding luxury consumption
Inadequate segmentation and targeting strategies that constrain luxury firms' value co-creation abilities	The significance of time dependence within international markets' segmentation and targeting (Lemmens et al., 2012) and the concerns of new and diverse dynamic sociocultural contexts (Steenkamp & Ter Hofstede, 2002)	Strategic marketing and innovation biases	Develop and implement strategic multi-segmentation of markets based on dynamic combinations of micro-/macro-, behavioural, and psychographic variables that enhance the value proposition framing in the cultural context
Excess of logomania, imagery, and communication strategies that has relegated luxury fashion apparel to pure merchandising products that generate a false illusion of exclusivity and status for the consumer and a confusion about the essence of each brand	Decoupling and misalignment between the different product life cycles' management and the brand-management life cycle for the brand to which the products belong; the blind spot of an unnoticed corporate-heritage dynamic brand paradox (Cooper et al., 2020)	Product and brand biases	1) Enhance differentiation strategies for product and service development, which focus more on the physical attributes of design, aesthetics, and craftmanship and also intangible social and ethical attributes 2) Align these attributes with the original, pure essence of the brand for a sustainable competitive brand-management advantage over the changing conditions of the environment and to get away from fast-fashion practices
The rise of the secondhand market altering the personal value and motivations for luxury consumption among sellers and buyers since luxury items might also be used as a basis for self-extension, self-worth, and self-representation	Perceived secondary-market risks for luxury fashion brands	Market bias	1) Develop appropriate marketing and innovation strategies to match resellers' and secondhand buyers' needs 2) Design appropriate integrated digital platforms with supporting systems to efficiently operate and control the secondhand market 3) Research new forms of selling (e.g., clothing rental)

Situation of luxury fashion ecosystem	Omitted knowledge source	Bias	Strategies for ecosystem participants
Misalignment of constituents' perceptions of the quality dimensions of this ecosystem's resources and their relevance	1) Delocalised small suppliers in different economic and sociocultural contexts and environments 2) Contractual governance mechanisms and 'structural' stream of the strategic management perspective within this ecosystem (Adner, 2017) 3) Collaborative networks (Swafford et al., 2008; Chesbrough & Garman, 2009; Baldwin & von Hippel, 2011)	Sourcing biases	1) Promote the importance of the sources and the craftmanship origin of these products, and invest in and develop adequate and delocalised intellectual properties and assets 2) Develop new sourcing-related shared value propositions to enhance the co-creation of sustainable social and ethical value across the entire supply chain by mitigating the environmental and social impacts of design, sourcing, and manufacturing 3) Develop and implement collaborative blockchain systems to trace the origin and craftmanship of products and their raw materials 4) Adopt and adapt a shared circular model of sustainability within this ecosystem 5) (For luxury houses) Become cultural platforms to globally promote sustainability, art, culture, and design
Several specialised suppliers and agencies from the ecosystem and related ecosystems still considered auxiliary (e.g., communications firms, photo and video agencies, modeling and casting agencies, laundry companies, leading delivery and packaging companies, app development firms, tailoring firms, technological and IT firms, show production firms, public relations firms, make-up firms, stylist agencies)	Service suppliers; supermodular complementarities in consumption and in production (Jacobides et al., 2018)	Complementary product bias	Explore further collaborations involving these specialised partners from the ecosystem and related ecosystems and develop new complementarities or modular offerings from these suppliers' different supply chains to provide new value propositions to diverse ecosystem users
Isolated and misaligned information and control systems across the supply chain (e.g., for monitoring performance and market intelligence) that cannot anticipate future needs and share knowledge because they focus on the internal needs and characteristics of their owners and designers rather than the ecosystem's overall needs	Information systems perspective to ecosystem value co-creation (Autio & Thomas, 2019)	Data and information biases	1) Agree on and develop a digital affordance information-systems platform that would allow supply chain constituents to connect and interact, thus enabling the generativity of recombinative innovation and value co-creation 2) Agree on and develop unique process-oriented propositions across the supply chain of shared indicators and ratios to enhance alignment, standardisation, and open innovation 3) Integrate consumers into these platforms to mitigate their current cognitive impairments and enhance their role as active constituents and contributors to ecosystem innovation
Luxury fashion firms implementing some fast-fashion retailing solutions	Cross-industry solution (Kim & Mauborgne, 2005)	Industry bias	1) Develop strategic alliances with other firms of the luxury sector (e.g., food, automotive) or related firms (e.g., sportswear) to boost new collaborations (e.g., limited editions with co-branding), complementarities in consumption, and modular offerings that encompass inputs of different natures 2) Enhance research in other luxury sectors to identify good practices of value co-creation that can be adapted to the luxury fashion segment to reinforce brand identity

Situation of luxury fashion ecosystem	Omitted knowledge source	Bias	Strategies for ecosystem participants
Inability of luxury fashion firms to enhance their adaptative capacity, reduce their resistance to change, and disrupt their autopoietic processes because their decisions are self-referential	Firms' actions to spur their environments to hang on, grow, and innovate but that also constrain their strategic decision-making (Weick, 1988; Varela, 1996)	Industry core strategy bias	1) Develop and implement risky decisions coupled with new strategies and take some dangerous and unexpected actions; in exchange, this would allow for a greater understanding of the current situation 2) To better understand the current situation and biases, first try to foresee the next stage and then work backwards; this would allow them to redefine their visions and detect and reduce all current strategic blind spots
Lack of pairing between mass luxury (focused on exploiting current capabilities, resources, structures, and knowledge) and connoisseur luxury (should be more focused on exploration practices of management)	The quest for ambidexterity in organisations (Raisch et al., 2009)	Organisational bias	Develop a new organisational design that is culturally balanced to match and facilitate the implementation of both perspectives and approaches without losing the firm's essence and identity within the different international contexts in which it operates
Luxury brands' reluctance to adopt technology-enhanced multi-actor interactions at the customer interface because they thrive on their heritage (Kapferer & Bastien, 2012) and want to control the dyadic service encounter through front-line employees (Dion & Borraz, 2017)	Technological innovation and the effects of risk, ambiguity, and uncertainty on new technologies and processes adoption	Technological bias	1) (For luxury houses) Develop a set of value propositions that combine the physical, digital, and social realms by adopting and adapting digital multi-actor interactions to augment brand image and simultaneously expand the consumer's self-extension 2) (For luxury houses) Accelerate digitalisation

Table 7.5. Knowledge biases within the EV ecosystem

Situation of EV ecosystem	Omitted knowledge source	Bias	Strategies for ecosystem participants
Consumers' decision-making paralysis induced by overthinking; consumers' cognitive impairment and fatigue due to the knowledge gap between the democratisation of technological progress/ICE vehicle-related updates and the new essence, symbolism, and social and environmental concerns for the EV	1) Cognitive dissonance-increasing consumer behaviour (Reibstein et al., 1975) 2) Technology and innovation sociocultural legitimacy (Geels & Verhees, 2011); performance of the technology as used by consumers rather than as-developed (Adner & Kapoor, 2016) 3) Consumers seeking an optimal or perfect value proposition (Kurien et al., 2014) 4) Consumers' energy-related investment decision-making perspective (Kastner & Stern, 2015) 5) Consumers' pro-environmental decision-making perspective (Bamberg & Möser, 2007) 6) Consumer decision-making not only depending on his/her rational assumptions (e.g., technology acceptance model) but also on his/her individual concerns, values, priorities, unconscious renewal inertia criteria, social norm-directed motives and rules, and irrational assumptions (e.g., simplified mental models and mental shortcuts) within his/her specific sociocultural context	Market bias	1) Call for certain online and offline consumer actions to collect and assess consumer perceptions and, thus, apply data mining market research strategies for gathering consumer insights by segment about their resistance to change, change drivers, and EV preferences 2) Then, jointly collect, develop, and deliver appropriate knowledge, good-enough business cases, and more compelling EV value propositions and solutions by taking a systems or ecosystem perspective rather than a product perspective that focuses only on technical attributes and by assessing the context and complementarities of the entire technology ecosystem on which EV performance depends. It is also necessary to focus on the emotional appeal of EVs for different market segments. All these new value propositions will greatly enhance potential consumers' ability to explain vehicle choice and the EV transition
Poor market deployment and state-of-the-art development of electric LCVs despite e-commerce and home delivery being more important than ever	Omission of the growing needs of B2B end users (von Hippel, 1986) and the added value that electric LCVs can provide to B2B users (e.g., economies of scale)	Market bias	1) Invest more in R&D for electric LCVs and use big data to accommodate electric LCV designs to the different needs of each fleet, infrastructure, and context; take advantage of these tests and new designs in order to exchange and share advancements in electric LCV design and performance with advancements in electric passenger car design (learning by doing) 2) Enhance the interchangeability of vehicle architecture and components between electric LCVs and EVs 3) (For governments and institutions) Develop adequate and harmonised mixes of policies, regulations, and investments in infrastructure and mobility to enhance the introduction of electric LCVs in each local context
	Strategic relevance of electric LCVs' development and deployment since they have great potential to leverage the transition to EVs	Strategic industry bias	
Strong, consensual, and global political and social pressure on environmental and sustainability objectives, interventionist transport policies, and market saturation, all fostering a global energy transition from the current fossil fuel-based economy towards a sustainable society and economy within planetary boundaries	1) Paradox of consumer's choice (Schwartz, 2005) 2) Erosion of the consumer's perceived decision-making freedom (Walton & Berkowitz, 1985) 3) Ignoring consumer empowerment at their peril (Wright et al., 2006)	Market bias	1) Understand the different contexts, influences, and pressures in which consumers exercise their choices and make their views known; they must fine-tune and re-evaluate their consumer expectations and their own marketing orientation 2) Develop different information and educational campaigns on responsible transport to shape transport policy and practice responses in order to highlight the importance of the consumer's rational and ethical decision-making freedom as an individual citizen (Budd & Ison, 2020)

Situation of EV ecosystem	Omitted knowledge source	Bias	Strategies for ecosystem participants
	Complex global sociotechnical transition rather than a mere technological transition; emergence of a new socioeconomic model (Schwanen et al., 2011)	Environmental, social, and political biases	(Private and public EV stakeholders alike) Investigate and agree on which institutional arrangements and synchronised policy packages could foster durable reconfigurations of the current regimes for enhancing this transition towards circular economies
1) Energy interdependencies constraining EV introduction due to the implementation of renewable energies and the water-CO_2 trade-offs in new electricity generation planning and power supply chains 2) The EV being a fast-evolving technology facing disruptive innovations, including improved performance, which affects the stability of its circular economy and constrains its efficiency and uptake	1) Holistic analysis of all environmental trade-offs and hidden impacts in electricity generation, distribution, and consumption by EVs in context 2) The interplay among building blocks of the circular economy and the various influencing factors and information about dynamically related legal, economic, social, business, and environmental aspects	Environmental bias	1) Select, develop, and implement the right mix of technologies, policies, and infrastructure according to local or regional circumstances and enact safeguard procedures to mitigate and monitor the potential impacts of power generation to enhance EV introduction 2) Develop and implement a shared, integrated, and transdisciplinary model of circular economy within the EV ecosystem, including reverse supply chain, product/service design, business models, end-of-life recovery, product/service use, and policies
Static, unchanged, macroaggregated, and based on intuition segmentation that still relies on consumer perceptions and conventions related to the old technology, isolated targeting, and one-size-fits-all marketing messages	1) Ignorance of the heterogeneity of consumer identities, acceptance factors, behaviours, and perceptions—and of the dynamic, disruptive nature and impacts of the new EV market on consumers—that limit decision-makers' ability to identify segment-specific vehicle and infrastructure requirements 2) Value co-creation in the cultural context (Akaka et al., 2015)	Strategic marketing and innovation biases	1) Develop and apply a dynamic, multivariate, and context-specific segmentation approach based on systematic and persistent behavioural-based data mining and analysis of consumers' propensities and insights 2) Identify and monitor those more valuable segments to enhance customisation and develop supermodular complementarities (e.g., related to road safety, auto insurance) and new, more efficient mobility solutions based on the generation of value-in-cultural-context
1) EVs' total energy and environmental performance not being sufficiently robust and consistent because the EV is not an isolated product; it depends on a wide variety of interdependent factors controlled by co-specialised ecosystem stakeholders and, therefore, requires the development and innovation of different complementary services 2) Some complementarities, infrastructure, and new technologies with in-vehicle EV systems remaining at the beginning of the stage of their introduction 3) The industry not yet converging on optimal, standardised, and widely accepted EV design and architecture 4) The currently limited number of consumer choices of EV brands and models compared to ICE vehicle models, which hinders consumers' perceived decision-making freedom	1) Performance of the technology as used that also depends on the complements users integrate with the focal technology (Adner & Kapoor, 2016) 2) Decoupling and misalignment between EVs' product life cycle management and the life cycle management of the different complementarities supporting the EV 3) Existence of relevant codependencies and compatibility standards (Adner, 2017) due to the mutual co-specialisation among incumbents of the EV ecosystem (Teece, 1986) 4) BMI as a means to describe the design or architectural processes of value creation, delivery, or capture (Teece, 2010); SBMI, which is configured based on sustainable value innovation within the entire ecosystem (Shakeel et al., 2020) 5) Consumers' desire for product variety and finding an ideal match (Botti et al., 2008; Chernev, 2003)	Product and strategic biases	1) Introduce an holistic approach with more research on the development of new technologies and service complementarities to enhance the formation of new types of collaborations among incumbents within and outside the EV ecosystem to generate new business models 2) Migrate from the classical reformulation of business models related to the ICE vehicle to the more dynamic and adaptative BMI and SBMI approach 3) Develop global standard designs and architecture with common technical norms to avoid incompatible localised solutions of isolated EV technologies and to achieve in-context efficiency with global economies of scale 4) Enhance and facilitate the customisation of value propositions through a co-alignment digital platform by allowing consumers to choose among components and complementarities that each participant can supply from a set of producers and complementors 5) Develop new focal value propositions focused on end-to-end and integrated mobility services and solutions (Mobility-as-a-Service, MaaS) to fulfil not only consumer needs but also social and environmental needs

Situation of EV ecosystem	Omitted knowledge source	Bias	Strategies for ecosystem participants
1) Deeper, constant transformation and conversion of automotive supply chains (due to—for example—constant development of simpler innovative EV design and architecture, new and scarce raw materials and components with different suppliers and costs, changing customer behaviours, new production plant business models, new forms of relationships and intra- and inter-industry strategic alliances and collaborations) that generate major risks, disruptions, supply/demand interruptions, etc. 2) Inefficient and underdeveloped reverse supply chains that are complex to manage 3) Destabilisation of the balance between generation and consumption of electric power 4) Unstable battery performance, complex manufacturing, and use deterioration	1) Impacts of the product's changing requirements along its life cycle and of its S-curve of technology diffusion on supply chain performance (Aitken et al., 2003) 2) Impacts of environmental uncertainty on supply chain flexibility (Purvis et al., 2014) and resilience (Ponomarov & Holcomb, 2009) 3) Conditions of imperfect information flow across the supply chain 4) Multilevel and integrated reverse supply chain	Sourcing biases	1) Ensure EV supply chains and their strategies are continually engineered to match the product's changing requirements, relationships, and impacts along the different stages of its life cycle (Aitken et al., 2003) and to articulate a supply network flexibility framework (Purvis et al., 2014) 2) Foster collaborative activities to increase supply chain resilience via increased visibility, velocity, and flexibility 3) Develop a shared risk management method and a shared performance measurement system to determine and monitor standards of control and the cause-effect relationships between risk indexes and KPIs across the EV supply chain 4) Develop an optimal reverse supply chain under the new multilevel supply chain scenario that should integrate remanufacturing, reuse, repair, refurbishing, reconditioning, and materials and energy recovery 5) Develop hybrid packages of shared and integrated strategies, policies, and infrastructure to sustain fluid and consistent processes of power generation, distribution, storage, and consumption to ensure efficiency and alignment among all stakeholders
Development of EV complementarities (e.g., new forms of combined home systems for solar power generation and storage, new forms of flexible leasing)	Complementary product producers (Kim & Mauborgne, 2005)	Complementary product bias	Enhance collaboration with stakeholders from specialised supply chains that cross the EV ecosystem and develop adequate open innovation platforms that act as hubs, interconnecting the supply chains
Battery problem needing to be approached from a service delivery point of view instead of a product-sale or transaction point of view	Service-dominant logic and product customisation	Service bias	(For EV automakers) Design and deliver solutions and services to consumers (e.g., battery customisation according to drivers' needs and driving habits, battery leasing, and home replacement service)
Isolated and misaligned information and control systems across the supply chain that gather and analyse different types of data (e.g., for monitoring the performance of market intelligence, mobility trends, infrastructure data) that cannot anticipate future needs or share knowledge because they focus on the internal data and process needs and on their owners' and designers' characteristics rather than the ecosystem's overall needs	Information systems perspective to ecosystem value co-creation (Autio & Thomas, 2019)	Data and information biases	1) Agree on and develop a digital affordance information systems platform that would allow supply chain constituents to connect and interact, thus enabling the generativity and full analysis of complex scenarios, recombinative innovation, and value co-creation to configure fully integrated mobility solutions that can reshape road and city transport over the coming decades 2) Agree on and develop unique process-oriented propositions across the supply chain, involving shared indicators, ratios to enhance alignment, standardisation, and open innovation, with important implications for EV adoption 3) Integrate consumers and their data into these platforms to mitigate their current cognitive impairments and cognitive dissonance and to enhance their role as active constituents and contributors to EV ecosystem innovation

Situation of EV ecosystem	Omitted knowledge source	Bias	Strategies for ecosystem participants
Several critical areas of focus for incumbents and new entrants from different sectors wanting to keep pace amid the disruptive changes ahead; the existence of solutions and business models that have been developed in different ecosystems that can be adapted and implemented within the EV ecosystem (e.g., advances in communications and digitalisation, advances in support services like cameras and sensors, implementation of the sharing economy, circular economy)	Cross-industry solution (Kim & Mauborgne, 2005)	Industry bias	Develop strategic alliances and partnerships to enhance cross-industry solutions
1) The EV industry remaining much more accommodating to incremental innovation rather than breakthrough innovation since it has never had to deal with truly disruptive changes (e.g., technological substitution) and new global megatrends (e.g., autonomous driving, sustainability) 2) Current period of coexistence of new and old technologies	1) New ecosystem's automakers and stakeholders needing to not just look at the new EV technology itself but also have a broader, holistic view of the new ecosystem and complementarities that will support it (e.g., charging stations, new regulations, new standards) (Adner & Kapoor, 2016) 2) Emergence of technological setbacks within the introduction and deployment of the new technology of the EV (Kapoor & Klueter, 2020)	Industry core strategy bias	1) Develop and implement risky decisions coupled with new strategies and take some dangerous and unexpected actions; in exchange, this would allow them to have a greater understanding of the current situation 2) To better understand the current situation and biases, first try to foresee the next stage and then work backwards; this would allow them to redefine their visions and detect and reduce all current strategic blind spots
Technological innovation and the effects of risk, ambiguity, and uncertainty on new technologies and process adoption	1) Technological innovation 2) Additional influence of macro-level or landscape developments (e.g., broader economic, demographic, cultural) on technological innovation	Technological bias	(For incumbents) Promote innovation strategies based on technological developments and investments across the entire supply chain to incorporate technological progress and setbacks
EVs' premium price over non-EVs', constraining their uptake	Credit institutions	Financial bias	Develop new business models in EV adoption (e.g., battery leasing, vehicle leasing, car sharing)

The identification of these biases has revealed commonalities and differences, described in the following subsections.

7.3.1. Low understanding of the changing, complex consumer needs, perceptions, and codes of consumption and their new drivers: Unclear value propositions

Analysing the evolution of my ecosystems, I have uncovered relevant changes in the audiences' own values, priorities, self-extensions, and expectations. Particularly in the last decade, these entail important changes regarding the emergence of new, unusual, unexpected, and uncertain consumer needs, perceptions, assumptions, and behaviours related to the consumption and use of my ecosystems' value propositions. These changes are leading to unclear and ineffective value propositions, and they are due to these ecosystems bearing the full impact of the emergence of new social, ethical, and environmental needs, norms, values, and symbols that frame all these new behaviours. The new socialisation and culturalisation patterns have particularly affected the audiences of ecosystems that produce consumer goods and that have grown significantly due to the democratisation of consumption and market globalisation (e.g., the EV and luxury fashion ecosystems). Additionally, the rampant growth of the three studied innovation ecosystems has fostered an uncontrolled mass consumption approach, which is essentially driven by volatile trends and the influence of powerful, repetitive communication and branding strategies that have become the most important affiliations for my ecosystems' end users.

Also of note, there is growing concern within the targeted audiences regarding individual well-being, self-expression, wellness, health, and life priorities ahead of other concerns like group and class belonging. This has generated, for example, different life priorities and lifestyles among the targeted audiences. These concerns are especially growing within the global clinical diagnostics and luxury fashion ecosystems, and the EV ecosystem should prioritise addressing this concern since EV adoption should not be perceived as a social imposition that constraints the individual's subjective sense of freedom of choice. Another cause of these changes is the increased number of communication channels, together with the digitisation of the media and the enormous influence of social media on audiences. These communication-related changes have bolstered interactivity between consumers and participants, caused an excess of information, and increased the number of information sources, the heterogeneity of information, and the number of opinions received. These changes are affecting the audiences' processes of knowledge capture and decision-making, and hence, are impacting consumers' understandings, interpretations, and preconceived notions of those value propositions in my studied ecosystems.

At the same time, consumers are constantly receiving information about new products, models, collections, and improvements. This is due to the constant development and implementation of new innovation and complementarities because of, for example, technological advances and new collaborations. However, this oversaturation of information is causing consumers to overanalyse (or overthink), which is overwhelming them because of their rising perceived risks around buying, using, and disposing of these offerings (e.g., in terms of adoption of new technologies, safety, and interchangeability). This issue also produces a certain consumer overexpectation and decision-making paralysis since this accelerated pace of change makes the consumer wait for a better proposal to emerge. These effects occur in all the studied ecosystems.

All the effects discussed thus far have been enhanced by the rise of competition among participants within ecosystems and across competing ecosystems, as well as by the imposed and changing conditions of the different contexts and environments that my ecosystems inhabit (e.g., technological context; economic, fiscal, and infrastructure conditions; social coverage). Within these

innovation ecosystems, all these sociocultural changes have deeply affected the different targeted audiences; their consumption priorities and preferences; and the roles, meanings, relevance, and perceived essence that the value propositions now imply for them. These new offerings have also become extensions of these audiences' own personal identities. Additionally, the rise of new consumer segments with new needs has taken the studied ecosystems into new competitive contexts that entail new and unexplored dyadic dynamics between the audiences and the focal firms.

The emergence of these new interdependencies implies the development of cognitive barriers that are now constraining the knowledge flow between these new end users and the ecosystem participants. All these new competitive markets are shaking ecosystems' preconceived knowledge, assumptions, standards, methodologies, and structures, and they are pushing ecosystem participants to quickly adapt their stringent standards and methodologies to these new contexts. I have identified that changes were implemented rapidly but without accounting for all the diverse, complex relationships and interdependencies that have emerged among all participants within those new competitive contexts. The analysis of these complex new interdependencies should have relied on the premise of value creation in context. For example, in the EV ecosystem and within the new competitive markets, the end-to-end solution should not only rely on selling a car with several improved functionalities, but also on the supply of various personalised configurations and complementarities according to the context of product use and enjoyment (e.g., battery customisation, supply of portable batteries, installation of a charging point at home, a battery leasing service, an insurance pay-per-use service).

I concluded that due to the latent success caused by mass market inertia and the emerging high competence, current focal firms have tried to enact the new contexts' effects in order to secure growth and innovation. However, this has constrained and blurred their visons and strategic decision-making. These changes demand a new approach that focuses on the generativity of value in context by developing new business models for these emerging audiences (BMIs and SBMIs) that can deliver appropriate and feasible end-to-end solutions with specific participants, services, modules, and complementarities (e.g., secondhand market in the luxury fashion ecosystem or carsharing services in the EV ecosystem).

7.3.2. Limited scope of segmentation strategies

Audience segmentation remains too focused on demographic and geographic approaches—and even on the product characteristics or its infrastructure (e.g., EVs)—rather than on the behavioural and psychographic perspectives. Macro-level segmentation is also overused in place of the micro-segmentation and multivariate perspectives. These issues inhibit an accurate understanding and interpretation of consumers' changing needs, expectations, and perceptions and limit firms' ability to anticipate and predict them and measure their effects. These effects directly impact innovation within these innovation ecosystems.

7.3.3. Low exploitation of growing opportunities related to concurrent and potential new combinations of modules and complementarities

All three ecosystems share the constant emergence of new opportunities that continuously arise from the potential combinations and integrations of new and diverse modules and complementarities, which are continually developed and improved by producers and suppliers in the ecosystem or in related ecosystems. The constant occurrence of these new combinations can generate different perceived values of the final offerings due to new cognitive and multidimensional

interdependencies among consumers that emerge within these new integrations. The issue, I have found, is that some of these opportunities go unnoticed by the focal firms and main participants since they are still anchored on the traditional combinations of dominant designs. Searching for and exploiting these potential new combinations would enhance output personalisation, product replacement, and new business model development. These opportunities can arise from the constant pursuit and growth of new collaborations and interactions, creating the room to develop new or improved competencies and expertise, resources, materials, technologies, and support services from specialised participants within or outside of each ecosystem.

These lost opportunities constrain the generativity, interactivity, and development of new interdependencies in the studied ecosystems and, thus, expand their blind spots. Within the studied ecosystems, I identified several cases of potential cross-industry and cobranding collaborations and solutions that would help generate these new complementarities. At the same time, I have identified important knowledge biases related to how the growing needs of audiences belonging to related ecosystems are affecting the studied ecosystems (e.g., the effects of e-commerce's growth on the development of LCVs within the EV ecosystem and the effects of new preventive medicine and therapies in the development of new tests within the global clinical diagnostics ecosystem).

7.3.4. Soft service-dominant logic

All these ecosystems must emphasise the role of the consumer as an active participant in value co-creation and the development of value propositions. These ecosystems continue to consider consumers to be operand resources (targets) rather than operant resource (co-producers) (Hollensen, 2020). This non-service-dominant logic perspective constraints the generation of better value propositions, more personalised interactions with consumers, and the communication and exchange of value with their consumers. Due to this approach, firms cannot anticipate emerging and changing trends and consumer preferences or the key insights and motivational forces behind consumer behaviours.

7.3.5. Low organisational ambidexterity

There is also an abuse of exploitation practices surrounding the exploration of new relationships, interdependencies, and collaboration to develop new competencies, resources, and knowledge. This abuse anchors them closer to the primary industries from which they emerged (e.g., EV ecosystem with the ICE ecosystem) and even to competing ecosystems (e.g., luxury fashion with the fast-fashion retailing ecosystem). These practices are constraining the development and generativity of new value and knowledge processes, as well as increasing the knowledge gap for these ecosystems (Valkokari, 2015). Luxury fashion should look to other ecosystems than fast fashion, which would allow them to implement exploration practices.

7.3.6. Low understanding of emerging trade-offs within ecosystems' different competitive contexts and sociocultural environments

The expansion of these ecosystems—and the development of new economic interdependencies of scope and scale—have triggered concurrence on shared standards and globalised business models and strategies. However, these standards, models, and strategies have ignored competitive contexts' heterogeneity in terms of factors such as available resources,

regulations, education, environment, consumer needs, cultural and social contexts, government and social initiatives, and available infrastructure. At the same time, changes within the studied ecosystems' macroeconomic and microeconomic environments have caused differentiated new threats to emerge in the different contexts, as well as new opportunities. By ignoring these differences and heterogeneity, and their rising and differentiated trade-offs within these ecosystems, participants are losing opportunities for market growth, product acceptance, and the cross-fertilisation of new interactions and interdependencies within specific spatially confined ecosystems. These spatially confined interactions and collaborations would provide the space to develop spatially confined entrepreneurial sub-ecosystems, which would develop innovative new business models (BMIs and SBMIs) and the new ventures that embody them (Thomas & Autio, 2020); this is because spatially confined entrepreneurial ecosystems would enhance market responsiveness by responding to each market and context's needs and characteristics. The advantage of these confined entrepreneurial sub-ecosystems is that they can enhance the adaptation, interplay, and agility of all actors and resources. They also tend to emphasise linear technology-push innovation, in which all entrepreneurial agents translate research advances into specific commercial applications addressing the specific audiences of that context (Thomas & Autio, 2020).

The newly created ventures would tap into others' experiences to discover new business model practices that might be profitably used (Autio et al., 2018). These sub-ecosystems would serve as the testing grounds to develop BMIs and SBMIs that could later be exported and adapted in other confined sub-ecosystems. For example, the EV's applicability and adoption should be analysed as an investment from an alternative technology within a confined context with localised constraints, drivers, and trade-offs (in terms of, for example, infrastructure, resources, social needs, regulations, and stakeholders such as the government and public). As another example, the luxury fashion ecosystem also requires spatially confined analysis and approaches to differentiate contexts in terms of product sourcing, consumption, and use (e.g., developing versus developed countries). At the same time, developing and reinforcing resilience in healthcare ecosystems is tied to the coevolution of localised regulations, practices, resources, infrastructure, and knowledge of the different regional and national healthcare systems.

7.3.7. Rising effects of increased time dependence on both internal and external ecosystem interdependencies

I have observed the increasing effect of relationships' and interdependencies' dependence on not only space/location but also time. The constant, rapid emergence and concurrence of new innovations and discoveries within the changing, new, and uncertain—but also globalised and connected—environments also trigger many new and differentiated challenges for all ecosystem participants. Additionally, the diversified contexts of the studied ecosystems—as well as their competing ecosystems—are now less isolated and spatially confined than ever. Hence, the contexts' external factors (e.g., political, technological) are becoming more interrelated. The main question is how these participants can not only detect these changes and disruptions in advance but also:

- How can they find the interrelations between external variables of the different contexts and environments in each ecosystem and in competing ecosystems?
- How can they anticipate and estimate the potential effects of interrelations with their environments for their target audiences and structures, not only in their ecosystems but also in the competing ecosystems that share these audiences?
- How can they easily, rapidly, and jointly co-absorb, co-adopt, and co-adapt these changes to enhance the generativity of new interrelations among actors, as well as innovative new

activities to produce and deliver better and/or new modules and complementarities that would increase their value proposition?

As I have observed in the three studied ecosystems, important knowledge gaps arise from not being able to anticipate and to be fully prepared to absorb and capture all of the changes, opportunities, and new knowledge that continually arise. At the same time, and since these participants are not synchronised in their readiness to capture new knowledge, these changes generate important instances of decoupling that further separate their interrelationships and previously linked and integrated systems—pushing them to operate independently. As a consequence, these instances of decoupling are constraining the coevolution of these ecosystems.

7.3.8. Rising risks associated with necessary new context-scale approaches: Knowledge asymmetries

Several factors have become central to innovation management: the growth of environmentally imposed constraints, the rise of radical innovations, the growth of hierarchically independent yet interdependent ecosystem communities of participants with their own dynamics, and the challenges of non-contractual governance and needed context-scale approaches. These changes have triggered the requirement for complex interaction and collaboration processes among those actors. I have observed that these processes have generated different typologies of associated risks that entail different types of biases. These growing risks have become new challenges for these ecosystems, and they encompass knowledge asymmetries, high-intensity generativity, new socioeconomic equilibriums, high diversity and levels of interaction and integration, and prestige balances versus power imbalances.

Knowledge asymmetries are due to the arising knowledge capture, creation, and transfer asymmetries, which can occur simultaneously and include:

- Differences in knowledge between holders of technological and industrial know-how and holders of local and contextual knowledge (e.g., on market conditions or sociocultural, political, and environmental context)
- Differences in the knowledge held by different types of participants and their specialisations within the ecosystems (co-specialisation knowledge asymmetries)
- Differences in the knowledge held by different groups of local participants (e.g., among customer segments, distributors, or regulators)

High-intensity generativity is caused by rising demand for constant, high-intensity generation—for example, of outputs, inputs, and new complementarities—which places pressure and stress on participants. This high intensity reflects these tensions' extent and complexity amid large-scale resource and localised knowledge spillovers.

New socioeconomic equilibriums are emerging, and they pose risks from the increasing demand of delicate local equilibriums to keep momentum within these ecosystems since their contexts are constantly changing and unstable. For example, these ecosystems demand additional new resources and assets, but the participants must simultaneously attempt to stabilise the rate of using these resources to reduce environmental impacts. At the same time, higher risks are perceived due to the growing diversity and levels of interaction and integration. Increasingly, these ecosystems are mobilising participants at various scales—from local to regional, national, and international—and across an increasing number of domains, areas of expertise, details, technical difficulties, methodologies, regulations, standards, and organisational cultures, all of which can sometimes collide but also enhance generativity and serendipity.

Additionally, new risks are emerging as a consequence of the growing gap between prestige balances and power imbalances. Within the delicate balance between cooperation and competition in these ecosystems, power imbalances remain when some participants that are powerful and dominant—due to, for example, historical reasons or size—do not want to collaborate (e.g., share knowledge) with the other participants engaged in a specific collaboration because:

- They want to dominate decision-making and knowledge to assert power in ways that disadvantage other partners;
- They are not interested in achieving the collaboration objectives (The Partnering Initiative, 2020); or
- They do not have the necessary resources to participate in this collaboration.

These power imbalances are destroying equity and resulting in poorer decision-making, low commitment, unsustainable collaborations, and lower innovation performance (Liu et al., 2018). Within the studied ecosystems, these tensions normally happen between focal firms and the remaining participants, and they constrain knowledge flows and, hence, extend blind spots. I argue that these relevant participants must switch from their traditional role of influence and power—inherited from the previous stages of spatially confined ecosystems—to a prestigious new role by enhancing their self-actualisation, which great leaders need. This new role will allow them to increase cohesion and coordination among ecosystem participants. In the luxury ecosystem, this power imbalance is exerted by established luxury houses; in the global clinical diagnostics ecosystem, it is exerted by the large, established healthcare multinationals that supply reagents and autoanalyzers to laboratories and also dominate related health ecosystems.

7.3.9. Self-referential technologies, products, and service architecture: Knowledge and know-how familiarity

Decisions related to product and service development within these ecosystems remain self-referential and tend to reflect how the producers and suppliers see and think about themselves (Goldstein, 1988), which is also influenced by a strong knowledge familiarity. Their product and service configurations tend to hold organisation-internal relationships and interdependencies within the ecosystem rather than organisation-customer relationships, as these decisions are basically guided by preconceptions and pre-configurations (e.g., related to customers or product features and uses). Additionally, these ecosystems sustain century-old assumptions of technological and science supremacy as the sole differentiator, with actors believing in only their own product improvements. These configurations still act as strong affiliations since they continue to be powerful elements of union among incumbents (e.g., suppliers, regulators) since they facilitate governance and coordination. This powerful, self-referential architecture is constraining the generativity and development of new outputs and business models to meet new customer needs across contexts. Product and service architecture should be co-regenerated.

7.3.10. Heavy dependence on longer, specialised supply chains: Low supply chains resilience

I have detected important knowledge gaps within the information and knowledge flows across the increasingly long, complex, and globalised supply chains that cross the studied ecosystems. New supply chains, suppliers, and raw materials have emerged and are replacing traditional ones. These supply chains were born in the beginning of these ecosystems' expansion, and they have become specialised linear structures that remain influenced by traditional, bilateral, vertical, and contractual relationships and strong standards. Even new participants with new roles

and specialisations have been added to these chains. This kind of inherited coordination and governance is constraining knowledge flows, the development of a holistic analysis, and the emergence and development of new relationships and networks that foster innovation among participants in different contexts. The magnitude and complexity of these supply chains within these innovation ecosystems is hindering participants' ability to control, manage, and align all sourcing, quality, ethical, and sustainability processes and their ability to develop appropriate and up-to-date shared visions and objectives.

For these reasons, and even with the development of shared standards of control, these structures cannot currently act as effective co-alignment structures to enhance multiple multilateral relationships since their shared information essentially relies on isolated information and control systems that the participants own, design, and operate. The development of digital platforms within these ecosystems would enhance participant coordination, data and knowledge transferability, the generativity of new interactions and collaborations, and the development of holistic models. The extreme rigidity of these supply chains—and their associated contractual relationships—make them less flexible and resilient. For example, I observe that it is difficult for these supply chains to adapt to the demand for new materials, resources, and components. It is also complex for these supply chains to become delocalised since these structures are still highly confined and tied to their current contexts and their resources. I also assert that it will be extremely difficult to convert them into reverse supply chains.

7.3.11. Growing diversity of organisational behaviours

Given the growth of required specialisations, firm roles, and collaboration and competition with other ecosystems, the increase in ecosystem participants has caused a great diversity of organisational behaviours and structures to coexist (e.g., values, organisational culture, customer focus, and decision-making). This is hampering co-specialisation coordination among these participants, which would streamline all these behaviours, perceptions, and objectives. This issue is an important source of knowledge gaps that constrain effective collaborations and initiatives. The fact that these ecosystems do not have a digital platform as a co-alignment structure is also hindering this growing governance challenge.

7.3.12. Strategic knowledge gap

Participants' strategic knowledge strongly depends on their own experiences, perceptions, and even interpretations of their relationships, competitive arenas, and environments—all of which are heavily influenced by the characteristics and premises of their own specialisation and field of expertise. This creates an important strategic knowledge gap. Additionally, each participant has its own core competencies and resources, competitive advantages, and strategic decision-making mechanisms and procedures that have been configured based on its specific strategic know-how. Within their coevolution, ecosystems must constantly align themselves to achieve a delicate strategic equilibrium and shared new visions and strategies that match new opportunities with the strategic demands arising from the constant knowledge disruptions and the internal and external changes that continually shake these innovation ecosystems (e.g., technological, social, political, macroeconomic). This new strategic approach requires new forms of governance, coordination, and co-alignment structures at the strategic level. I believe these ecosystems require different types of elastic co-alignment structures at different levels, or 'units', of analysis, both at the spatial level (e.g., by location) and non-spatial level (e.g., by functionality).

7.3.13. Conclusions

Studying the biases in these ecosystems has enabled me to identify innovation hyperopia as a barrier to successful ecosystem innovation. The identified ecosystem cognitive barriers or biases are antecedents to innovation hyperopia, which blurs focal firms' and participants' perceptions of the ecosystem situation. The identified biases can be conceptually compared with marketing myopia, a concept introduced by Theodore Levitt (1960) suggesting 'that businesses will do better in the end if they concentrate on meeting customers' needs rather than on selling products'. Myopic company cultures, Levitt postulated, would pave the way for a business to fail due to a short-sighted mindset and illusion that a firm is in a so-called 'growth industry'. This belief leads to complacency and losing sight of what customers want. There is a greater scope of opportunities and new ideas to connect as the industry changes. Meeting customer needs trains managers to look beyond their current business activities and think outside the box. Firms that focus on marketing strategy, various predictive techniques, and the customer's lifetime value can rise above myopia to a certain extent. This can involve using long-term profit objectives (sometimes at the risk of sacrificing short-term objectives).

I expand and apply Levitt's marketing myopia concept to the entire supply chain in my studied ecosystems, both forward to the consumer from the bottom up and backward from the consumer to the extractor of raw materials. Thus, in this type of ecosystem, an organisation must concentrate on meeting not only its immediate customer's needs but also the needs of its customer's clients—and even more, its end user's needs. At the same time, the company must research backwards through the different tiers of suppliers and service providers to establish relationships with them in order to look for fresh market or environmental biases. All these additional sources of information and knowledge are strategic and must not be neglected.

A firm that suffers from this second type of bias ignores the importance of listening to and learning from all the supply chain's environments and actors, starting with the consumer and ending with the different suppliers. I thus define innovation hyperopia as the omission of knowledge from distant actors in an innovation ecosystem. Firms in innovation ecosystems must control and balance marketing myopia and innovation hyperopia. I can apply what Kivetz and Keinan (2006) posited for organisations and participants in this type of ecosystem: Companies should reconcile myopia and hyperopia and construct a unified model of self-control. By combining the approaches of marketing myopia and innovation hyperopia, firms can enhance an ecosystem's potential disruptive leader to develop and orchestrate an iterative and adaptative business model of constant experimentation and gradual refinement, which will reduce uncertainty and enhance the co-discovery and legitimation of new blueprints (Ansari et al., 2016).

7.4. RESEARCH LIMITATIONS

As with all studies, this thesis is not without limitations, which essentially relate to its qualitative nature. While I have discussed innovation ecosystems in the stage of expansion (Moore, 1993), the results may not apply in different stages of ecosystem evolution (e.g., emergence or leadership). These stages could also be included in future studies, and I believe the results presented in this thesis provide interesting avenues to further study the evolution of innovation ecosystem frameworks and the typologies of knowledge biases that constrain their coevolution. Additionally, the present study of modular innovation ecosystems only concerns supplier-based/manufacturing-centred ecosystems, and so I cannot conclude if these findings are limited to this type of ecosystem or which findings could be exported and generalised to other types of ecosystems (e.g., the platform innovation or entrepreneurial ecosystems). I have studied a supplier-based ecosystem, and future

research incorporating other types of ecosystems is likely to identify additional types of ecosystem bias.

Additionally, the overarching concept of innovation hyperopia is generalisable across ecosystem types, locations, and industrial settings since it encompasses all cognitive biases against knowledge from ecosystem participants with which the firm does not have a direct relationship. Possibly, different ecosystems suffer from innovation hyperopia to varying degrees, and quantitative research could study the degree of hyperopia's impact on innovation outcomes. It would be particularly interesting to evaluate how these ecosystems' differentiating characteristics influence each of my conclusions within the ecosystems' knowledge flow and performance. It is impossible to determine here if other ecosystems share the same types of bias or which would be the most important. Analysing the factors that define any ecosystem—such as the level of heterogeneity, number of participants, dominant typology of interdependencies, type of co-alignment structure, type of output, rigidity of regulations, level of asset specificity, and mode of governance—must be considered when assessing this comparison and any new study, as these factors can become unnoticed drivers or obstacles depending also on the external influences driven by their specific contexts and competing ecosystems.

These cases share a powerful resource intensity that frames all types of relationships, interdependencies, and value creation processes within that ecosystem. However, they do not all share the same type of resource intensity. While the global clinical diagnostics and EV ecosystems share a strong technological intensity, the luxury fashion ecosystem has a strong materials intensity and labour-skill intensity. Additionally, the EV and global clinical diagnostics ecosystems have a strong knowledge intensity and the EV ecosystem an energy intensity. Further research could also employ quantitative methodologies to evaluate and weigh, for instance, the diverse nature of interdependencies and their varying forms with the external factors affecting these cognitive biases from the perspective of different ecosystem participants. Further study could also focus on the drivers instead of the barriers related to coevolution of these innovation ecosystems. For instance, studies to investigate and discuss attracting new participants would be interesting, as would studies on events or facts leading to the expansion of an ecosystem or a fusion of ecosystems. Finally, while I examined ecosystems from the leading-actor perspective, future studies could take a more focused approach to a certain set and typology of participants within the entire ecosystem to gain a more in-depth view of the existing cognitive biases from their perspective.

7.5. FINAL CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

The present expansion and coevolution of my studied innovation ecosystems follows a complex scenario involving the growing interplay of numerous, new, and diverse participants, needs, resources, and competencies. This interplay is taking place within simultaneously differentiated and interrelated contexts, an enormous multidirectional process of integration, and experimentation across a large and uncertain landscape. In my analysis of characteristics and knowledge biases, I observed that these types of ecosystems have reached a turning point requiring attention since there has been a certain inaction and reaction. The coevolution of innovation ecosystems should result in a gradual but steady amalgamation of the diverse, rich community dynamics and structures that are spatially confined in the different and emerging sociocultural contexts that integrate these innovation ecosystems. These specific community dynamics involve diverse traditions and also constant changes and adaptations of technical know-how, forms and structures of governance, availability of resources and infrastructure, financing structures, and forms of pre-commercialised knowledge transfer and creation, policies and regulations, negotiation, and relationships with the environment. Scholars (e.g., Autio et al., 2018; Kenney & von Burg, 1999) have affirmed that these community

dynamics enhance mutual adjustments via co-learning and knowledge spillover processes that foster coherent coevolution and the transformation of pre-commercialised knowledge.

However, the question emerges: Why have these ecosystems not sparked this transformation? What is holding them back, and what strategies should they develop and implement to enhance these changes? These questions require further investigation. Based on my current research, I conclude that these ecosystems appear to have several cognitive barriers that—together with the identified knowledge biases—constrain participants' ability to coevolve and implement the new dynamics, forms, and structures that are necessary for transformation (Moore, 1993). Further research is necessary to identify and describe these barriers that rely on established behavioural patterns (Arribas-Ibar et al., 2021) and their cause-effect relationships within the coevolution of these types of ecosystems. A co-(r)evolution (Gomes et al., 2016) and self-renewal (Moore, 1993) appear to be necessary. Within my study, I have arrived at a final conclusion: Several factors inhibit the development of new and better interdependencies within this kind of supplier-based/manufacturing-centred ecosystem, and these factors—described in the following subsections—are actually the most important challenges that my ecosystems must confront and reframe for their own renewal and growth.

7.5.1. Products and technologies not being the sole differentiators of innovation

To evolve, these supplier-based ecosystems need to break with their traditional assumptions of product and technology as the sole differentiators of competitivity and innovation. They should also realise that their offerings are not only integrated with isolated products or services. An offering's attractiveness and functional value should rely not only on improvements to the product's performance, technology, and attributes. It should also rely on the development and combination of several distinct factors and complementarities that exert more or less influence and deliver a solution to their audiences. These factors are controlled by the different and growing co-specialised participants of these ecosystems, which are producing relevant effects in terms of not only the performance of the offered products and services, but also the degree of audiences' acceptance of the changes introduced and solutions provided by these offerings.

7.5.2. Early participant involvement in developing an ecosystem's design and architecture

At the same time, participants within this type of ecosystem should be more involved and aligned in the early development of ecosystem design. This is because the lack of a shared, standardised design and architecture generates important differences and variances among the offerings, modules, and design solutions that are developed and improved in parallel and also their performance attributes. These perceived differences generate important perceived risks and cognitive barriers regarding the solutions and changes, which hinder all participants' (including customers') decision-making and generativity and, hence, reduce incremental innovation to refine the product (Brem et al., 2016). These differences do not help these supplier-based ecosystems to capitalise on the increasing opportunities provided by all possible positive changes that can be generated by the different and growing interactions among the co-specialised participants and also with their changing environments and competing ecosystems.

7.5.3. Rigidly asset-specific arrangements of these ecosystems

Another important final conclusion is that these ecosystems' rigidly asset-specific arrangements are a barrier to the ecosystems' coevolution. These ecosystems remain based on rigidly asset-specific arrangements of inter- and intra-organisational collaborations. They predominantly depend on rigid physical assets and also intangible ones (e.g., brands, goodwill, copyright) that act as strong self-reinforcing controls but also erode the flexibility needed for adaptation—leading participants to a kind of 'rigidity trap' (Carpenter & Brock, 2008). This trap appears to be reinforcing participant perspectives that emphasise some aspects of coevolution but de-emphasise others, and this is creating systematic neglect of some coevolution principles and premises that might productively challenge existing notions and expand 'out-of-the-box' thinking (Stedman, 2016). For example, the luxury fashion industry relies heavily on localised tailoring workshops and brand equity, the global clinical diagnostics industry relies on the installation of specialised clinical laboratories and patents for testing techniques, and the EV industry is strongly focused on patent development.

7.5.4. A new customer-centric, holistic approach

It is also a priority for these ecosystems to develop a new, customer-centric holistic approach. The value networks of innovation ecosystems must shift from organisation- and supply-centric to customer-centric networks in order to enhance multidisciplinary and multilateral interactions and collaborations within and across ecosystems' participants. The global clinical diagnostics and luxury fashion ecosystems are more focused on the organisation-centric perspectives, and the EV ecosystem is more focused on a supply-centric approach. These approaches do not allow participants to achieve a holistic, deep, and immediate understanding of those complex problems, challenges, or opportunities that are constantly emerging within these ecosystems and their contexts. This new approach should enable participants to co-develop new forms of spatially confined BMIs and SBMIs to materialise this coevolution. The development of new business models within these ecosystems remains heavily influenced by the development of traditional business models relying on linear, unidirectional supply chains and their contractual relationships. New model development should instead focus on developing new BMIs and SBMIs based on the dissolution of ecosystem boundaries in terms of new resources, technologies, participants, and integrated policies and regulations, as well as on experimentation and innovation focused on temporally built spatially confined contexts.

7.5.5. Temporally built entrepreneurial and knowledge sub-ecosystems

To support this coevolution, I argue that different temporally built entrepreneurial and knowledge sub-ecosystems must be built within these types of innovation ecosystems that are supplier-centred. These entrepreneurial and knowledge sub-ecosystems would foster the development of spatially confined community dynamics in order to engage all participants in joint exploration and also prompt mutual adjustments and collective discoveries (Lewin & Volberda, 1999). Positive agglomeration externalities are expected to enhance the performance of firms located inside an industry cluster (Romer,1986; Arrow, 1962). These sub-ecosystems would develop and test these new BMIs and SBMIs due to the spatial and contextual affordances (Autio et al., 2018). These sub-ecosystems would incentivise a distinctive cluster-level learning dynamic that is expressed in each specific context through the creation and scale-up of business models and new ventures (Autio et al., 2018). The output of these sub-ecosystems would be new innovation inputs to the innovation ecosystems.

During the COVID-19 pandemic, diagnostic tests—especially point-of-care—have been essential to enabling front-line health workers to determine a diagnosis quickly and accurately, as well as to reducing the risk of further spread of the virus. Different projects have been launched to exploit environmental metagenomes, with a focus on viral genomes, in specific spatially confined ecosystems that entail a community of participants and stakeholders (e.g., schools, firms, patients, hospitals, testing labs, IT firms, manufacturers, or pharmaceutical companies). Business models can be developed that use specific sequencing technologies, bioinformatics solutions, and products for biotechnical applications developed by project partners for COVID-19 detection and research (European Commission, 2020).

7.5.6. Digital platforms as new co-alignment structures: The need for 'platformisation'

Within this demanding new holistic approach to coevolution, ecosystem participants must integrate the many changing contextual characteristics and factors. For this reason, I assert that it is vital to develop digital platforms as new co-alignment structures within this type of supplier-based ecosystem. This 'platformisation' would allow participants to scale and provide additional resources for the orchestration of resources and competencies (Athique & Parthasarathi, 2020). This is because knowledge creation processes in these ecosystems depend on the ecosystem's specific context (e.g., social, cultural, technological) and on the stimulating conditions within the organisations of participants belonging to that ecosystem (e.g., leadership, organisational culture, learning).

Tracking, understanding, and forecasting the contextual factors that constantly frame the spatially confined community dynamics can allow these communities of participants to estimate cause-effect relationships, detect new opportunities and threats, and reassess and co-adjust their interdependencies accordingly. For these reasons, ecosystem participants must develop a co-alignment structure based on a digital platform that would act as a structuring and normalising element, especially at the strategic level. This smart specialisation platform would act as a new building block for innovation-related collaboration among sub-ecosystems, which could stimulate the constructive use of these communities' diversity to build globally leading virtual innovation hubs to develop common or complementary modules and complementarities. This platform would ensure fluid, constant interactivity and generativity among all ecosystem participants with the diverse communities embedded in their different entrepreneurial sub-ecosystems. It would enable more flexible, dynamic, organic, coevolving, and emergent collaborations among the spatial and virtual communities of organisations that are simultaneously attached to the entrepreneurial sub-ecosystems and the global innovation ecosystems.

7.5.7. New forms of governance and structures

To implement all these changes, it is clear, these ecosystems also demand new forms of governance and new structures to enhance their co-(r)evolution. Within the increasingly rapid development of new technologies and their applications within and across ecosystems, the current structures and dynamics of these innovation ecosystems are constraining their participants' ability to rapidly co-learn and capture new technical knowledge from these innovations and to construct all new cognitive and technological interdependencies that are necessary for all participants to exploit and apply all new knowledge properly and synchronously. It also appears that the current processes of technology adoption and adaptation remain strongly influenced by contractual supply-centric approaches that focus on 'close' technological suppliers with strong economic interdependencies. At the same time, the development of new technologies has become more multidimensional than ever

and should now encompass a growing heterogeneity of—for example—knowledge, resources, materials, techniques, and expertise. These changes require new capacities and new community dynamics and forms of governance to quickly resolve these technological disruptions and develop strategic shared visions. But the question becomes: Who is going to lead the development of these new forms of governance that will break these ecosystems' traditional forms of governance?

7.5.8. Lack of a full perspective or picture: The need for a conductor

All the previously identified factors demonstrate that this type of ecosystem still lacks a full picture of all potential interdependencies. It also lacks effective coordination of shared strategies that require more cooperation and commitment not only from the ecosystem's participants and stakeholders but also from actors in other ecosystems. These factors are constraining ecosystems' visions and overall strategies to cope with all the evolution. Based on this perspective, I conclude that a governance gap exists in these ecosystems compared to—for example—platform ecosystems, in which the solid internet protocols, the strong role of technological interdependencies, and the role of the platform owner (who can also act as an adjudicator of platform interactions) ensure adequate coordination and maintenance of the necessary capabilities and standards for the full alignment of all participants. The main questions here are: Who should lead and orchestrate this new perspective within these supplier-based ecosystems? Should it be the focal firms, or should a new kind of orchestrator with new roles be created? Or should the focal firms' roles be reconfigured and adapted to each phase of the evolution of this type of ecosystem?

The new conductor's main responsibility within this crucial stage of evolution would be to understand the big picture and convey it through new forms of governance and structures so transparently that all participants in these growing and now symphonic 'orchestras' understand it perfectly. Most importantly, this conductor should serve as a messenger for the big picture so those participants could then transmit a unified vision of the ecosystem (e.g., to the audience, stakeholders, and suppliers). The conductor could also assume different roles across multiple, related ecosystems. This conductor should unify and bond all participants, project engagement by its own prestige, set the tempo to synchronise participants, listen critically, and shape and transmit the new 'sounds' of these ecosystems to produce richer ecosystem outcomes. They can also promote the development of these digital platforms within these supplier-based innovation ecosystems.

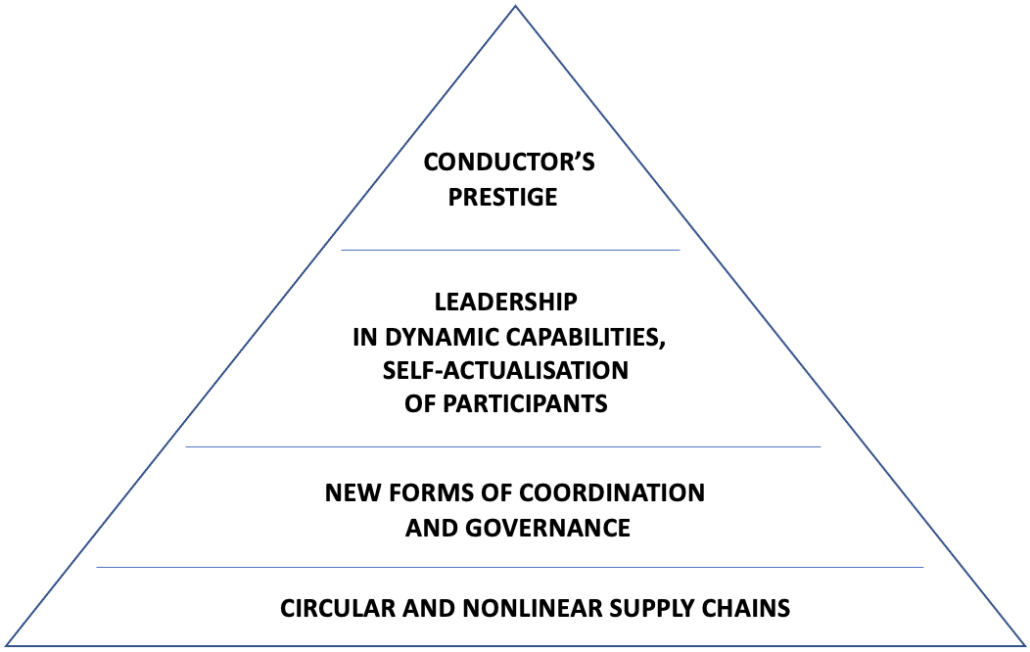
7.5.9. A new framework for supplier-based/manufacturing-centred ecosystems

Ultimately, I conclude that these ecosystems require a new framework that would allow ecosystem participants to focus on their new stage of coevolution and self-renewal by leaving their current imprisonment in the 'Room of Confusion' following the 'House of Change' metaphor (Janssen, 1996). It seems that while ecosystem participants and focal firms have realised that something is different and changing very rapidly, they have now finally recognised that change is needed and must be embraced. However, they still do not know how to respond appropriately. Diverse emotions and perceived risks are arising among the different participants, but these tend to create a certain anxiety or fear as participants also try to assess the full picture. However, participants also perceive that change is difficult to achieve with their current structures, dynamics, regulations, and competitive environment—all of which are constraining their effective governance and strategic management. These incumbents would be expected to conduct a great deal of analysis in this 'room' around the correct direction to move forward. But it seems that, following Janssen's metaphor, they are paralyzed in a kind of cellar below the 'Room of Confusion': the 'Pit of Paralysis',

a dungeon, since the participants become overwhelmed with the options for how to respond to change and their strategic knowledge gaps. They are also paralysed by their own uncertainty, blind spots, and confusion about the best way to move forward.

This new framework of supplier-based and innovation ecosystems should focus on the needs that must be satisfied to enter the self-renewal phase, which is based on Maslow's view of human motivations and needs. As with Maslow's (1943) model, too much attention to one factor would be detrimental to the remaining factors. Figure 7.1 describes the new framework for supplier-centred modular innovation ecosystems.

Figure 7.1. A new framework for supplier-centred modular innovation ecosystems



At the bottom of the pyramid, I believe these ecosystems should coevolve to develop new forms of nonlinear supply chains and networks based on reverse supply chains and platform-enabled ecosystems that connect communities of participants. This is necessary to allow participants to interact more openly and directly and would provide all participants with greater insights, allowing them to become more responsive to the continuous fluctuations and disruptions within and across the ecosystem's boundaries. At the next level of the pyramid, these networks should facilitate the development of new forms of governance and coordination with the definition and ownership of new types of roles, rules of engagement, and standards. These new forms would keep participants together, avoid the loss of momentum, and minimise the vulnerability of small communities and participants. At the next level of the pyramid, participants need to be seen as the respective leaders within their dynamic capabilities specialisation rather than their resource specialisations; this occurs by constantly accumulating and assimilating new knowledge that enables them to build these capabilities in an evolutionary cycle to maintain an edge in an ever-changing ecosystem's environment and context (Tushman & Rosenkopf, 1992; Teece et al., 1997). At the top of the pyramid, a visionary conductor is needed that retains and enhances the ecosystem's prestige and diffusion, as well as serves as the pivotal player leading this renewal. This conductor sustains the power of vision and maintains cohesion by coordinating 'the mélange of disparate sounds and timbre' from each community of specialised participants and supply chains (Lang et al., 2020).

7.5.10. Final overall conclusions

To conclude, within their coevolution, the studied ecosystems should likely turn into those platform innovation ecosystems and successful digital ecosystems and—at the very least—assimilate the structures, forms, and dynamics that must be expressed and adapted differently. This assimilation would greatly help the three studied ecosystems to inherently scale up since much of the needed new network-based operational and research complexity could be outsourced to new service and complement providers through the platform. Within the studied ecosystems, the network effects are strong and growing, and the ecosystems need to bring in expertise from other industries to advance. Thus, the value provided by a digital platform will continue to rise sharply with the number of participants and will allow the ecosystems to thrive (Zhu & Iansiti, 2019). According to Jacobides et al. (2019), 83 per cent of digital ecosystems involve partners from more than three industries, and 53 per cent involve partners from more than five. These new service providers could be new actors within the three ecosystems or actors from platform ecosystems that must develop specific new competencies to match the three ecosystems' specific characteristics. The studied ecosystems' participants—and especially the conductors—need to explore new alliances and collaborations with related ecosystem platforms to enhance the growth of more interdependencies and the construction of this new type of innovation ecosystem within this constant coevolution.

The research question of this thesis focused on identifying different types of knowledge bias that hinder different types of knowledge flows within supplier-based/manufacturing-centred innovation ecosystems. This inquiry has been thoroughly and efficiently responded to, with different knowledge biases and cognitive barriers having been identified, synthesised, characterised, and applied to the studied ecosystems using specific examples and cases. This study's deeper, comparative, exploratory research has clearly shown these biases' existence, inductively demonstrating through its analysis of the cases that these biases hinder the emergence and creation of different types of opportunities for cross-fertilisation of interdisciplinary knowledge and insights. The analysis and response to the research question affirm that these biases constrain these ecosystems' coevolution and generativity, as their participants suffer a kind of cognitive confusion and strategic paralysis because they feel overwhelmed by the diverse options for responding effectively to the current contextual challenges and demanded changes due to the knowledge gaps generated by these biases. These ecosystems share different types of knowledge biases that are related to the low understanding of the complex new codes of consumption and their new drivers, the emerging trade-offs within new context-scale approaches, and the rising opportunities for concurrent and potential new combinations of modules, complementarities, and technological disruptions, adoptions, and adaptations.

At the same time, the growing omission of knowledge from distant actors in these ecosystems is also influenced by the rising risks associated with knowledge asymmetries, which are growing due to the increasing demand for high-intensity generativity in these ecosystems; the effects of the growing power and role imbalances among ecosystem participants that are breaking different types of founded and subtle equilibriums of cooperation and competition; the effects of self-referential technologies; product and service architecture that continues to influence the dominant designs and business models of these ecosystems; and the growing effects of time dependence of both internal and external interdependencies of these innovation ecosystems. This study has also uncovered causes of these knowledge biases, such as these ecosystems' strong organisation- and supply-centric approach, their greater dependence on specialised but longer supply chains, the growing diversity of organisational behaviours, low organisational ambidexterity, and a soft service-dominant logic or the lack of new elastic co-alignment structures and digital platforms at different levels (or 'units') of analysis at both the spatial and non-spatial levels.

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DOCTORAL THESIS

What could global diagnostics, luxury fashion, and electric vehicles—such different supplier-based ecosystems—have in common? After all, according to our preconceptions, these ecosystems are monolithic, belong to different areas of expertise, and target different audiences and needs. However, economies in which all three ecosystems are now embedded have become global knowledge societies and systems since they depend heavily on their potential to generate and transfer new technological, cognitive, and social knowledge. This rampant transformation, its growing context-dependency, and the demand of greater knowledge intensity are also constraining the ecosystem participants' ability to achieve a clear, deep, and immediate understanding of complex problems or challenges about to emerge in these evolving ecosystems.

This thesis uses an exploratory study to investigate these three supplier-based ecosystems, concluding that these ecosystems share different types of knowledge biases that hinder those knowledge flows. These biases are related to a limited problem understanding of their changing audiences and contexts and the lack of a system-wide vision, leading them to develop unclear value propositions. These biases are also caused by an absence of a common language, misaligned innovation strategies and change management plans, and participants' entrenched assumptions and behaviours. All of these are anchored on their knowledge familiarity and their self-referential technologies, their products, and the supply chain architecture from which these ecosystems have emerged and that still influence their business models. At the same time, participants' perceptions are also blurred by the rising risks associated with the knowledge asymmetries growing due to the demand for high-intensity generativity, the increasing diversity of organisational behaviours, the low levels of organisational ambidexterity, their strong dependence on an organisation- and supply-centric approach, and the growing power and roles imbalances in their knowledge development relationships. This thesis also analyses these biases' effects on the three ecosystems' current stages of coevolution and proposes strategies to mitigate the effects of these biases.

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