UNIVERSITÀ DI PISA

DIPARTIMENTO DI INGEGNERIA DELL'ENERGIA DEI SISTEMI DEL TERRITORIO E DELLE COSTRUZIONI

RELAZIONE PER IL CONSEGUIMENTO DELLA LAUREA MAGISTRALE IN INGEGNERIA GESTIONALE

Strategic Alliances in the Electromobility Industry

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Sessione di Laurea Magistrale del 18/06/2020
Anno accademico 2019/2020
Consultazione NON consentita

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Sommario

Dalla fine degli anni 2000 l'industria automobilistica si è addentrata in una fase di incertezza tecnologica ed economica, conosciuta come "Era del Fermento", durante la quale è iniziata la transizione verso i veicoli alternativi con uno scenario plausibile di *disruption* del settore. Sottolineando l'importanza delle strategie collaborative nelle industrie emergenti, questo elaborato indaga le alleanze strategiche che si sono formate nel settore automobilistico. A tal fine è stato analizzato un originale database longitudinale costituito da 281 alleanze sottoscritte nel mercato delle automobili elettriche tra il 2000 ed il 2015. Il presente studio si focalizza principalmente sul ruolo degli attori nell'ecosistema con riferimento alla loro precedente specializzazione industriale ed al timing delle loro alleanze, le aree di competenza più rilevanti e la tipologia di accordi. Il network delle alleanze è stato analizzato per trarre informazioni sul potere e le interazioni dei soggetti coinvolti. I risultati suggeriscono che, durante tale periodo di incertezza, sono stati gli OEMs, quindi gli incombenti, a guidare la trasformazione del settore, proteggendo la loro centralità attraverso la formazione di alleanze con i fornitori e, successivamente, con i produttori di beni complementari.

Abstract

Since the late 2000s, the automotive industry has entered a phase of technological and economic uncertainty, known as the "Era of Ferment". During this period, the shift towards alternative vehicles has begun, disrupting the automotive sector. This thesis studies the alliances formed in the electric vehicle ecosystem, given the importance of collaboration strategies in emerging industries. For this purpose, a longitudinal dataset composed of 281 alliances in the electric passenger vehicle market initiated between 2000 and 2015 was analysed. This thesis discusses mainly the role of the actors in the ecosystem and their previous industrial specialization and their entry timing, the main key knowledge areas and the type of agreements. The network analysis was carried out to gain insights into the power and connectedness of the different players. Findings suggest that, during this period of upheaval, OEMs- i.e. incumbents- were the masters of disruption, protecting their centrality by forging alliances with suppliers and, later on, with complementors.

1. Introduction and Research Topic

This thesis aims to analyze the strategic alliances in the electromobility industry and to gain insights into the electromobility ecosystem and its development. It is part of a joint project between the University of Pisa and the Energy Strategy Think Tank (ESTT)[1] at the Vienna University of Economics and Business. I was awarded an ERASMUS+ scholarship to carry out my thesis at the ESTT headquarters, which unfortunately was cancelled because of the Covid19 pandemic.

2. Literature Review

To set the context, an initial phase of this thesis was a deep review[2] of the main scientific literature strands related to the research topic namely ecosystems, strategic alliances and the evolution of the automotive sector.

2.1 The Automotive Industry Evolution: from the last quarter of the 20th century to the recent history of electric vehicles

The automotive industry is one of the main manufacturing industries worldwide. It is the result of a long process of development in the Triad (Europe, North America, and Japan) economic sectors and more recently in the emergent industrial countries (China and India among them). The automobile manufacturers, commonly known as Original Equipment Manufacturers (OEMs), have always had a central role and a major bargaining power. The automotive supply chain was consolidated in a hierarchical structure during 1980s, following the Japanese model. Later, increasingly stringent regulation on Greenhouse Gas (GHG) emissions of vehicles pushed experimentation in alternative vehicle propulsion technologies. In the late 2000s, the electrification trend started to disrupt the traditional structure, transforming the vertically integrated automotive value chains into a horizontally structured ecosystem, threatening the ICE (Internal Combustion Engine) standard, and opening an “Era of Ferment”, which consists of many experimentations, begins with a discovery or a breakthrough and often ends with a dominant design. By shedding light on that disruption made by the EVs, it is necessary to underline that the extent and timing of the transformation are unknown.

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[1] The ESTT is a cooperation between Wien Energie GmbH and the Institute for Strategic Management of Vienna University of Economics and Business. It aims to promote management research on strategic challenges in the energy industry, to educate students for management positions in the energy industry, and to foster the exchange between energy industry research and practice. https://www.wu.ac.at/ism/energy-strategy-think-tank

[2] Please consult the thesis for the references to the articles mentioned.

2.2 The Ecosystem Theory and the Importance of Alliances in the Emergent Industry

The literature, in the last years, has defined the electromobility industry as an ecosystem. The ecosystem is a recent term in strategy and innovation theories, in which firms co-evolve capabilities by working cooperatively and competitively for a focal value proposition (Moore, 1993; Adner, 2017). They must deal with their complementarities by building a specific structure of relationships to create value (Jacobides, 2018). During the birth of an ecosystem, the feasibility of innovation needs to be assured and to start an improvement process a leader must emerge (Moore, 1993; Suarez, 2004). For these reasons, a cooperative approach is preferable (Moore, 1993). Ecosystems emerge for projects which require radical innovation (Donada and Attias, 2015), and as suggested by the literature, interfirm collaborations have a crucial role in complex and challenging environments. Reviewing the ecosystem theory and the relevance of strategic alliances has been decisive for establishing the context of this thesis.

3. Research Questions Formulation

3.1 Understanding what it is known in literature and what is not

Electromobility is an ecosystem in which the challenges of components and complements linked to the focal innovation are both extremely high. Although many studies mention this sector as a prime example of an emerging ecosystem, and while a few studies have attempted to explore the strategic dynamics at play in particular on the formation of strategic alliances, there is not yet a complete description of the emergence of the electric vehicle ecosystem. The study of this emergence could inform not only research on the electromobility ecosystem, but could also draw interesting conclusions for other ecosystems that face similar challenges. Who leads the disruption during discontinuous technological changes has been a central topic in the literature and has been addressed from different points of view. One of those refers to the creative accumulation as “the innovating capacity of the incumbents that appear to master such turbulence” (Bergek et al., 2013). The main points (critical or missing) that emerged during the analysis of the literature, regarding the emergence of the ecosystem, have become the research questions of this study.

3.2 Defining the research questions

Given the lack of an agreed framework to examine ecosystems, in order to formulate research questions, see Table 1, we find it useful to adopt the classical inquiry method based on five questions (“five Ws”) followed by a modality question (the “how”).

Table 1 5W and 1H method and the Research Questions

5W and 1 How	Focus on	Questions	Status in literature
Who	Stakeholders	Which companies have formed alliances for EVs and in which industrial area did they previously operate?	Critical
What	Technological Goals	In which key knowledge areas have firms formed alliances over time?	Critical and Missing
Why	Business Goals	In which business area (R&D, Manufacturing, Supply, Marketing-Sales-Operation) were these alliances formed?	Critical and Missing
When	Entry time	When did focal firms, components suppliers, and complementors form alliances on EVs?	Missing
Where	Geographical area	Where did these alliances form?	Missing
How	Power and connectedness of partners	How did the network and its main measures evolve?	Missing

4. Data and Methods

The input of the analysis is an original database built by the ESTT and the University of Pisa, containing passenger car market alliances, that I first critically studied to identify useful information for this work and to highlight any missing data. Figure 1 shows the method used to review, clean, integrate and analyze the data. To the best of my knowledge this dataset is the only source covering alliances in the EV ecosystem and is an original contribution of the collaboration between Vienna University of Economics and Business and DESTEC.

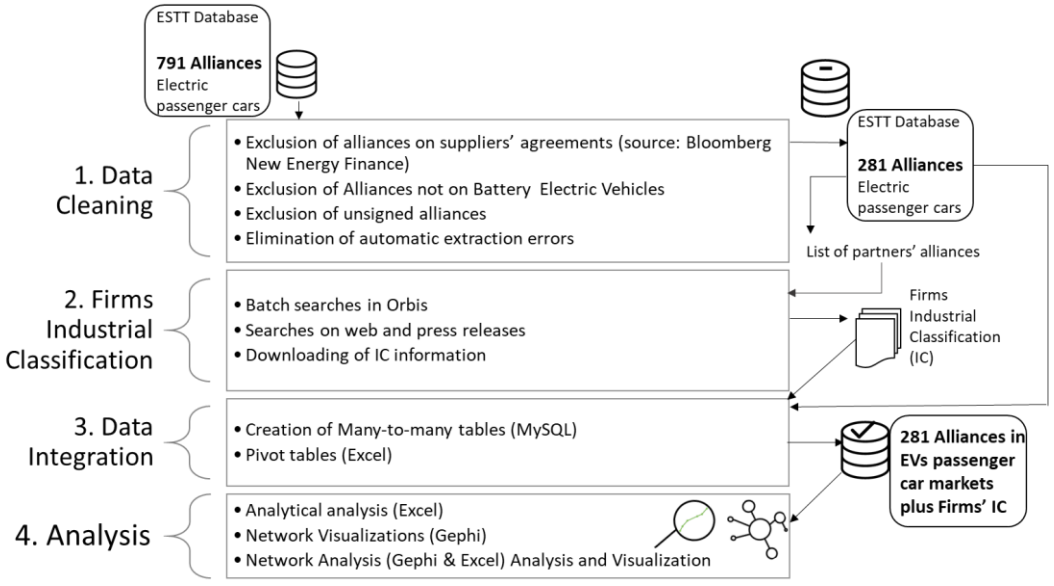


Figure 1 Method

4.1.1 ESTT Database Cleaning

The ESTT database includes an exclusive list of alliances formed in passenger car markets from 2000 to 2015. For each alliance, it reports information that can be logically grouped in the following areas: alliance identification, alliance features, alliance business areas, alliance scope, alliance status, and information source. In this phase (see Figure 1 in the first block), supply agreements on existing models (source: Bloomberg New Energy Finance), unsigned alliances and alliances not on battery EVs (electric vehicles) were removed. Next, the detection of automatic extracting errors was performed. After this, the names of the partners involved in the alliances under analysis were extracted.

4.1.2 Classification of new data & Integration with the previous data

An important step of this work was the search for the industrial classification of firms in the database, as this enabled to study the background and competences of firms that were entering the alliances and when this was occurring for each group. The first step involved matching company names to their records in the Orbis database, to extract their industrial classification. The companies not matched in Orbis with maximum confidence were further evaluated through Web searches and in press releases to find additional information to uniquely identify them. If neither was successful, the firm was not classified. This method to collect data ensured a high confidence score, and therefore a high validity of the new classification. I decided to use the 2017 NAICS classification because it was reviewed in 2017 to take into account "rapidly changing economies" and, thanks to its hierarchical structure[3], it allows autonomous decisions on the level of detail with which to observe a firm. Depending on the frequency with which a 2017 NAICS Primary code repeats itself and the importance associated to the specific industrial group for the goals of the thesis, some groups of actors were taken at the sector level (e.g. Finance) and others were exploded into subgroups (e.g. Motor Vehicle Manufacturers were split into EV manufacturers and OEMs depending on whether they were previously producing ICEs or whether they were created for the purpose of building EVs). The firms' industrial classification was integrated with the data in the database, through the creation of many-to-many tables.

[3] The hierarchical structure of 2017 NAICS code is the following. The first two numbers indicate the sector, the first three the sub-sector, the first four the industry group, the five the NAICS group and the entire code (6 numbers) the national industry.

5. Results

5.1 Overview of EV Alliances

Figure 2 shows the number of new EV alliances per year and the cumulative curve. From 2000 to 2005, the number of alliances is relatively low. For this reason, this period has been called "Phase 0". From 2006 onwards the number of alliances per year increases reflecting the emergence of the EV sector.

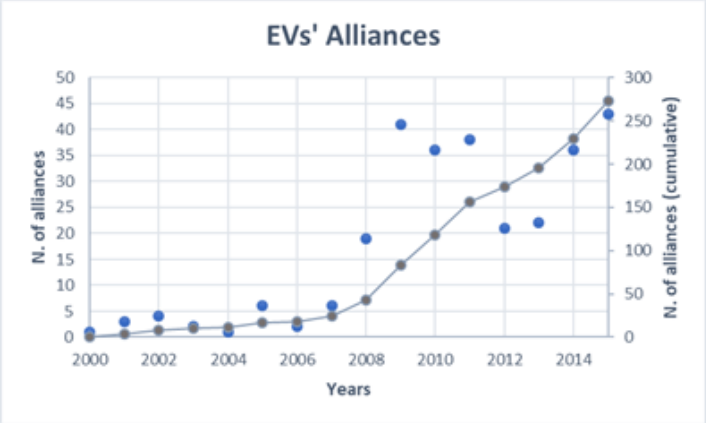


Figure 2 EV Alliances during the timeframe (2000-2015)

To assess how many actors are at stake, the number of new companies forming their first alliance was computed per year. The average number of firms per alliance in each year decreases over time. This indicates that the density of the alliance network increases over the period. Alliances were mainly formed in the USA, China, Japan, and Germany. From 2006 to 2010, there were also a significant number of alliances in India, and from 2011 to 2015 in France. This geographical segmentation is driven by the high participation of OEMs in alliances; mirroring both the traditional automotive manufacturing countries as well as China and India which are fast growing electrical vehicle markets.

5.2. Firms in the EVs Alliances' Ecosystem: Industrial Area and Ecosystem Role.

The NAICS classification and web-searches mentioned previously were used to identify 11 industrial areas: Motor vehicle manufacturing, Energy generation, Chemical manufacturing; Automotive equipment rental, Dealers and other distributions, Battery manufacturing and ICT being the most relevant. Besides defining in which industrial area firms previously operated in, an important step to gain information on the ecosystem was to define which ecosystem role these companies occupy. According to Adner and Kapoor's model (2010), the ecosystem is represented by four macro-groups: focal companies, components suppliers, complementors, and end-users. For this purpose, the technological areas in which firms have formed alliances were taken into consideration. This choice is supported by the fact that

during the phase of uncertainty, firms form alliances based on where they wish to acquire competences in the new technology or according to the distance from existing competencies (Sierzchula et al. 2015). Table 2 shows the correspondence between companies' industrial areas and their role in the ecosystem. Focal firms were confirmed to be Motor Vehicle Manufacturing companies, complementors came mainly from energy and digital backgrounds whereas suppliers are more heterogeneous.

Roles in the Ecosystem	Industrial Areas of Companies
FOCAL FIRMS	Motor Vehicle Manufacturing (OEMs & EVs Manufacturers)
SUPPLIERS	Electrical Equipment, Appliance, and Component
	Computer, Electronics and IT
	Production and Distribution of Traditional Components and Machines[4]
	Energy Generation, Distribution and Related
	Battery Manufacturing and Chemical Manufacturing
COMPLEMENTORS	Energy Generation, Distribution and Related
	Charging Infrastructure[5]
	Computer, Electronics and IT
	Electrical Equipment, Appliance, and Component
OTHERS	Other Services (e.g. road operators, hotel)
	Finance Services
	Engineering, Research and Consulting Services
	Universities and Research Institutes
DEALERS AND RETAILERS	Automotive & Non-automotive

Table 2 Industrial Areas and Ecosystem Roles of Participating Firms

The thesis points out that the electromobility ecosystem is made up of a myriad of actors coming from sectors even quite far from the traditional automotive sector, among the most relevant: Battery and Chemical Manufacturers, Energy Companies, Charging Infrastructure Firms, and Computer and Electronics Manufacturing, which would not have played such a role in the ICE era.

[4] This area gathers both direct and indirect automotive supply groups which traditionally operated in the automotive industry.

[5] This group was created thanks to searches on firms' website.

5.3 Alliances in the EV Ecosystem: Key Knowledge Areas and Type of Agreements

Key knowledge areas strategically relevant for EVs are battery technologies, electric drivetrains, innovative materials, and charging infrastructures (Sierzchula et al., 2015). In this work, the key knowledge areas are organized at two levels. The first one divides the innovation of EVs into two macro-domains: car and infrastructure technologies. In car technology, the most critical item is the battery technology, which impacts the driving range. In infrastructure technology, two are the critical items: charging stations and charging systems. Figure 3 shows alliances per year according to these domains. This shows an evolution of the EV ecosystem innovation, moving from the focal innovation to the complementary innovation over time. Analysing alliances at a more detailed level, during phase 0 there is no prevalence on car technology items; from 2006 to 2009 alliances mainly focused on battery technologies and the entire car, which reflects that these alliances aimed to manufacture the entire electric car. On the side of infrastructure, from 2007 to 2010, there were more alliances on charging stations than charging systems, later this trend was reversed, highlighting an advancement of the infrastructure technology. With respect to the type of agreements shown in Figure 4, alliances were mainly focused on R&D throughout the entire period, followed by Manufacturing and then Marketing, Sales, and Operations (MSO). Supply agreements are always a small percentage of the total. Since alliances could be multi-goal, it is interesting to analyze their combinations. Of the multiple alliances under analysis, the most common ones are R&D plus Manufacturing and R&D plus MSO. Between 2000 and 2010 the first type prevailed, while since 2010 onwards they were almost equally divided.

Figure 3 Technological Domain of EVs Alliances

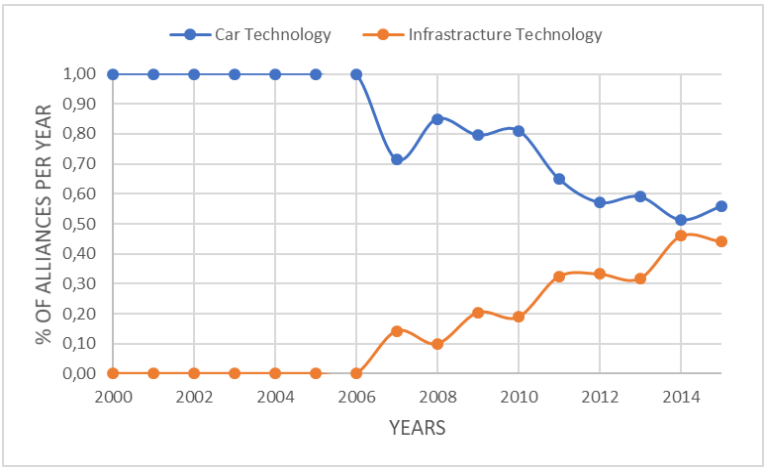
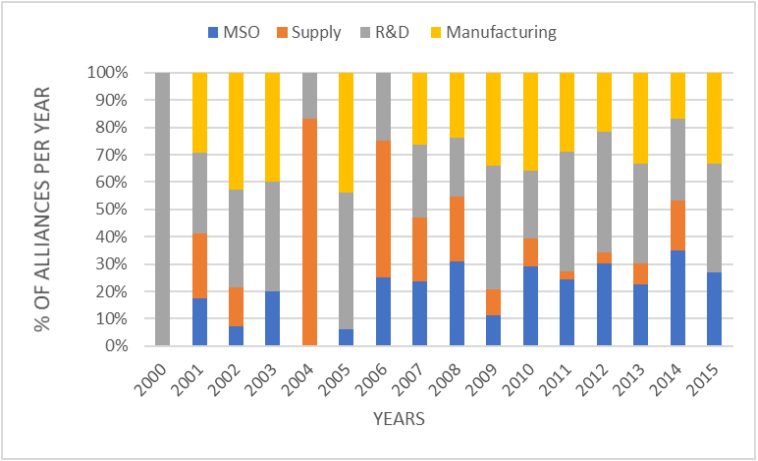


Figure 4 Type of EVs Agreements



5.4 Timing of entry

Examining Phase 0 it can be said that suppliers are among the most active. However, since the number of alliances was small, further research is needed to understand what OEMs were doing at that time. After phase 0, we can see that the focal companies were the main entrants, making alliances with suppliers and complementors, culminating in 2008 and 2009. After these years, the number of new complementors started to grow and the number of new suppliers remained high (see Fig 5). Figure 6 highlights that the new battery suppliers were a large amount compared to other types of suppliers.

Figure 5

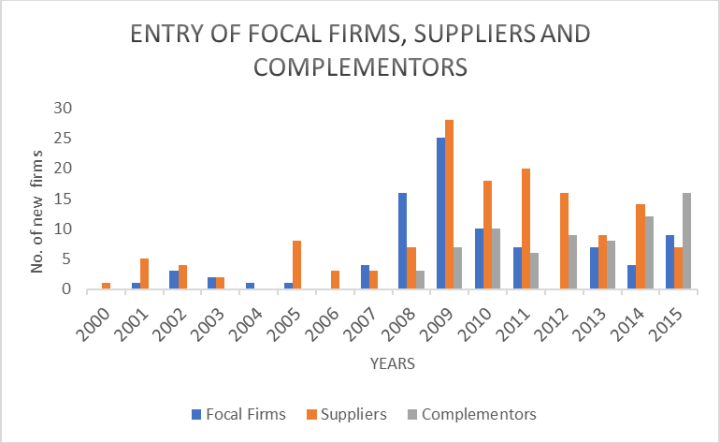
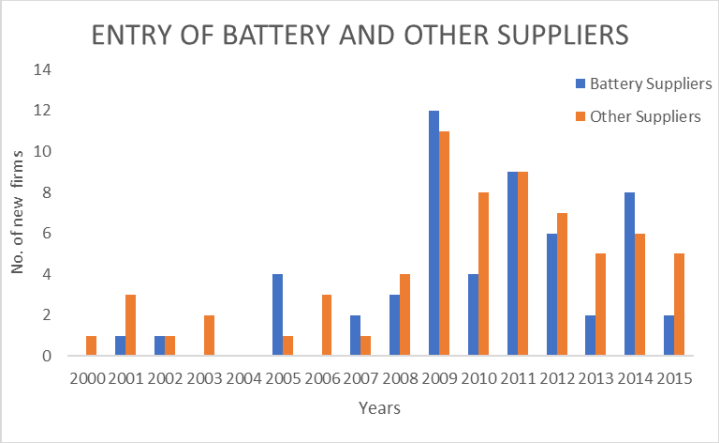


Figure 6



5.5 EVs Alliance Network and Measures

Although there is not yet a systematic method to analyze ecosystems, network visualization and measurements are important to gain insights of an ecosystem's development. The position of firm in a network is an important factor to understand its power and connectedness. In the network, firms are represented as nodes and their alliances as edges. I decided to represent the network based on the ecosystem's role and to enhance the key knowledge areas in which alliances were formed. I decide to represent with different colors OEMs and EVs Manufacturers, even if they belong to the same category to better separate incumbents from new entrants in the sector; the same for battery suppliers and all other suppliers also for their criticality for the development of EVs. Concerning key knowledge areas, Charging stations and Charging systems have been combined into one category, being part of the complement side, and battery technology alliances were differentiated from others because of their criticality for the development of EVs. The size of the nodes is proportional to their number of connections (Degree Centrality). The network was analyzed in three periods of 5 years each and the analysis is cumulative, as shown in Fig. 7, 8, 9. Fig. 7 shows a

mismatch between the nature of participating firms in terms of their industrial background and the objective of the alliance. In Fig. 8, the number of OEMs (blue nodes) has increased, and a large central group (cluster 1) has formed in which many OEMs collaborate with each other and with EV manufacturers, battery manufacturers and other suppliers, and with a few complementors. In this figure cluster 3 emerges, which focuses on the charging infrastructure. In Fig. 9, cluster 1 has grown, incorporating many other companies and the previous cluster 3. Here, the complementors (green nodes) became notable.

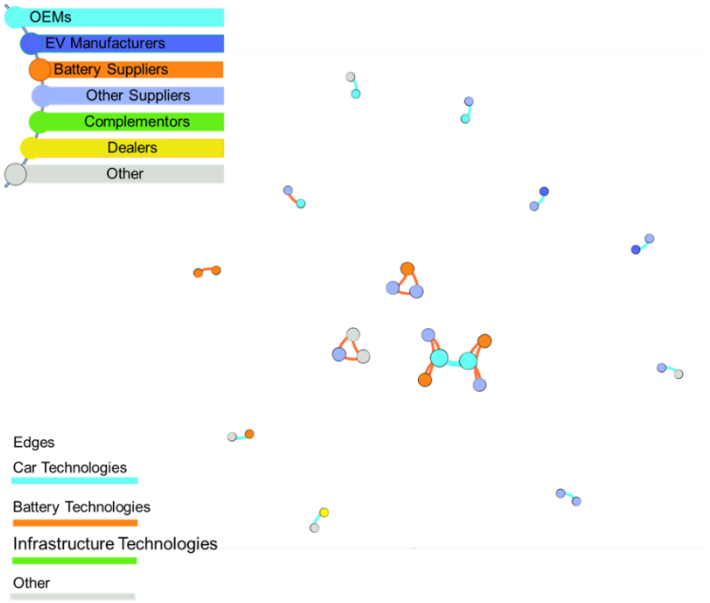


Figure 7 EVs Alliance Network 2000-2005

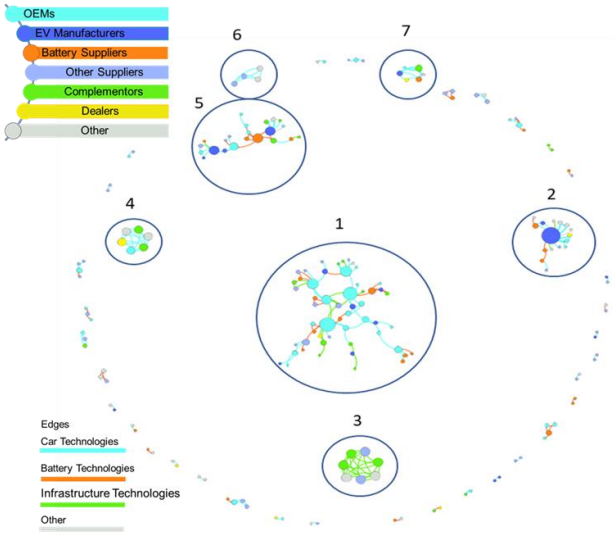


Figure 8 EVs Alliance Network 2000-2010

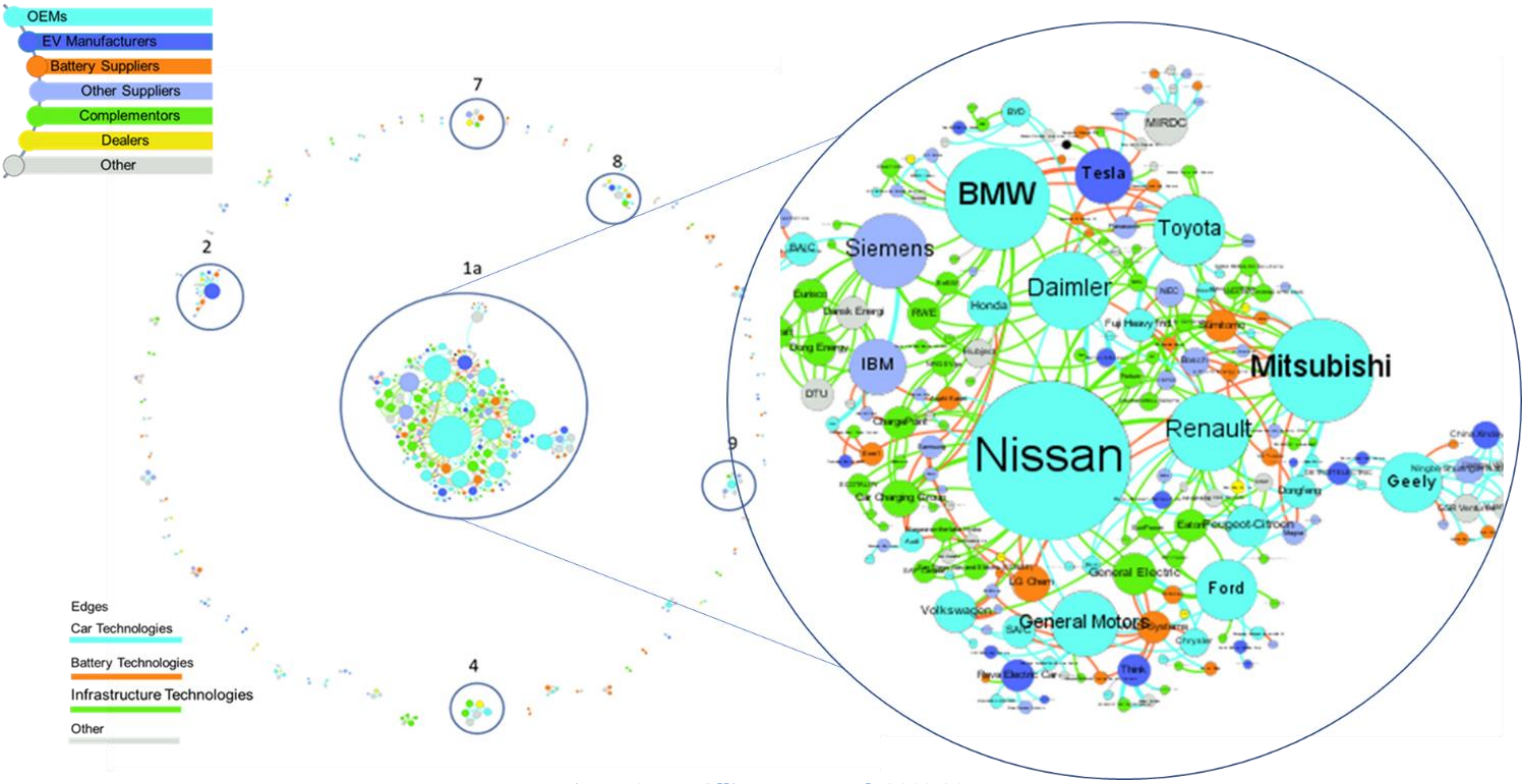


Figure 9 EVs Alliance Network 2000-2015

As suggested by literature, a 4-year moving window was assumed to calculate the network measures. For each year, the average Degree Centrality of OEMs is higher than the other firms, except for 2004 and 2009. In 2004 the measure is not significant given the small number of alliances. In 2009, on the contrary, it's interesting to note how the Degree Centrality of complementors (i.e. charging station and charging system companies) slightly exceeds that of OEMs, signalling the importance of including complementors within the ecosystem alliance networks. In addition to the number of connections, another important information is given by the Betweenness Centrality that identifies "bridge" nodes, which link together different parts of a network. This measure is also greater for OEMs, indicating that they may have more power over other groups in the network. Suppliers have a higher Betweenness Centrality than complementors, therefore suppliers are better placed in the alliance network, due to their closeness to the OEMs.

6. Conclusions

Considering the existing literature on EVs (Bergek et al., 2013; Sierzchula et al., 2015; Hannah and Eisenhardt, 2018; Lepoutre, 2019) and the analysis conducted in this work, this thesis advances the following propositions:

1) *During an era of ferment in the automotive industry, OEMs are the main players in the formation of strategic alliances, forging alliances, first with suppliers, then with complementors*.
2) *OEMs first created R&D and Manufacturing alliances, both vertically and horizontally, with a goal to develop a new automotive architecture (focal innovation) incorporating electric propulsion.*
3) *When complementors entered in the alliances, OEM enlarged the strategic goals and addressed the commercialization and delivery of the focal innovation to the end customers.*
4) *OEM implemented a dynamic management of alliances, by changing over time the main goals and knowledge areas (from R&D to Manufacturing to Marketing and Sales) and the main partners (from suppliers to complementors).*
5) *The dynamic management of alliances has been a major strategic move to protect the position of incumbents from disruption from new entrants, preserving the network and industry centrality.*

An interesting follow up to this thesis may be to analyse the strategies of OEMs that are not present in this database because they have avoided strategic alliances in this field. Moreover, it may be interesting to integrate financial performance, product launches and sales to determine whether strongly interconnected OEMs have had a positive outcome from their alliance strategy in terms of performance and market share.