Managing external relations to impose an industry standard

Volvo and the self-driving cars: a case study

Francesco Cordeschi

Academic Year 2016-2017
Graduate School

Supervisor at GU: Evangelos Bourelos
Supervisor at LUISS: Federica Brunetta
Co-supervisor at LUISS: Karynne Turner

LUISS Guido Carli
LIBERA UNIVERSITA' INTERNAZIONALE DEGLI STUDI SOCIALI

VOLVO

UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Abstract

The present master thesis aims at studying the process of standard imposition under a relational perspective. After an analysis of the existing literature, a theoretical model is developed to study what are the optimal relationships an incumbent and influent firm needs to have with its industry, with institutions and with academia and universities in order to impose a new technology in the market as an industry standard. The model is applied to Volvo Cars and, in particular, to the development of its self-driving car, in relation to the global market and to the market of the City of Gothenburg, Sweden. Hence, tailored managerial recommendations are provided to the company management.

Keywords: *industry standard, technological trajectories, driverless technology*

Acknowledgments

This thesis has been an incredibly long and challenging journey. *Ex-post*, I am absolutely sure that it would have been impossible to complete it without all the people that assisted me throughout this experience and that now do deserve a special acknowledgment.

First of all, thanks to Marcus Rothoff, Tord Hermansson, Ola Ekman and Per Östling, for allowing me to realise this case study on Volvo Cars, constantly showing enthusiasm and availability.

Thanks to my parents, for believing in me and encouraging me to pursue this objective.

Last but not least, thanks to my sister, my friends in Sweden and in Italy, whose names don't need to be told: my pillars, support and guides.

Thank you,

Francesco Cordeschi

Contents

Table of figures

1. Introduction

1.1 Area of the research

When dealing with innovation, firms always need to think in long term perspectives, in order to retain and possibly increase their competitive advantage. One of the shades of this problem concerns surviving when a market, or the entire industry, is declining or when it is moving toward a different path or trajectory. This struggle can involve different kinds of innovations, strategies and solutions. It can be extremely hard to succeed in this challenge, and it can be difficult –if not impossible, to try to develop a general framework to successfully apply to different industries facing this scenario.
However, it is possible to study what kind of element, either internal or external, a firm can leverage on in order to try to shape the new trajectories of the market, or to exploit them to survive.

In a world where technical advancements are becoming an increasingly open process (Chesbrough, 2007), especially for firms in incumbent positions the interaction with external actors such as institutions, universities and the industry itself is a continuous process that deeply deals with internal resources and capabilities, shaping the firm's performance and strategies (Dosi, 1982) and providing inputs and possibilities. By properly managing these networks of relationships, a company might find a way to impose its product or service. If, then, the firm in question is an incumbent, it might have further possibilities to play a crucial role in the process of shaping the new trajectory of a particular market or a niche of it. A proper handling of these elements and relationships might therefore help in making a new product a standard solution for similar firms, and the developer of this might undoubtedly gain from the competitive advantage of being the first establisher. This might be a solution to incumbents' eternal dilemma of surviving in their industry.

Hence, every firm operating in a mature or declining phase of its product's life cycle (Klepper, 1997) should ask itself two kinds of questions.
First, what elements, both internal and external, it should exploit and leverage on in order to survive successfully in a changing market by gaining from the imposition of a new technology. Second, whether it is possible to make it a generalizable solution, namely if it is possible for other companies to adopt the same approach.

The managerial literature has developed several frameworks to study how a product can be turned into an industry standard and, therefore, how it can be used by a company to maintain and renovate its competitive advantage. Likewise, many models describing strategies to reduce costs, increase efficiency or, for instance, gaining market shares by involving external economic agents or institutions have been suggested by the academia. Nevertheless, academic research has left a grey area surrounding the modes an incumbent has to manage external relationships throughout the

whole steps of the development and the market launch of a product to impose it as a standard.
Hence, the purpose of this thesis is to contribute in filling the aforementioned blank by trying to develop a theoretical framework and applying it to a real case.

Among all, the car manufacturing industry seems, to the eyes of the researcher of this paper, to be one of the most interesting to be investigated. Cars are probably one of the most diffused good but, at least in some countries or regions, their market will soon change, as their ownership and usage "is now plateauing and declining" (Peter et. al, 2013, P. 283). A relevant example of this can be represented by the progress in the technologies used in the industry, such as the emergence of new solutions as the autonomous driving technologies.
In many cases, factors and agents external to the manufacturers themselves contribute in changing the competitive environment (Porter, Van der Linde, 1995). In the case of the car manufacturing industry, together with the increased importance of sustainability policies in both environmental and human-health terms, institutions are realizing that environmental and social care do affect the economy of a city (Kenworthy, 2006): in other words, the social responsibility aspect of businesses is gaining more and more attention by firms themselves and by shareholders. The former, therefore, needs to adapt their offer to this in order to maintain competitiveness.

The city of Gothenburg, Sweden, can be taken as a relevant example of this. The City of Gothenburg's Urban Transport Administration is working on offering an "efficient, safe and sustainable transport" (forlivochrorelse.se, 2016), and it is implementing policies to make the city grow sustainably and modern at the same time, with the aim of making it an extremely liveable place for all the citizens. This mid-long term plan's goal is, indeed, to make the daily life simpler for the most citizens (forlivochrorelse.se, 2016).
One of the main issues of this plan is to stimulate citizens to use public transports as well as environmentally-friendly and, most of all, safe means of transportations: with the Development Strategy Plan for 2035, approved in 2014, the Municipality has published a plan aimed at implementing a sustainable growth of the city which, among the copious objectives, also includes the limitation of car and polluting vehicles, in favour of cycles and public transportation (international.goteborg.se, 2017). In other words, the Municipality is working on favouring the accessibility and the safety of the street, with the aim of making the day-to-day life simpler (international.goteborg.se, 2017).
At a global level, the aforementioned pattern of development of this scenario can also be considered as a cultural change, and it may represent a declining phase for car manufacturers, although in a mid or long term perspective. These latter do consequently need to find a solution to either go with this trajectory or try to modify it. It is clear that innovation plays a fundamental role, and it is an urgent task for every single firm to find a solution.

Volvo Cars, as one of the car manufacturers established in Gothenburg and as an incumbent operating at worldwide level, will have to deal with this issue, although it has already started working on it. Indeed, it has implemented Drive Me, a large-scale pilot project in autonomous driving, which involves self-driving cars, that will be driven on public roads in 2017 (volvocars.com, 2017).
These "cars will be able to navigate without human input" and they will be "equipped with sensors that read the surroundings, adapting to changing traffic conditions" (volvocars.com, 2017). The company, therefore, wants to integrate this driving technology into citizens' daily life, still maintaining its quality and safety standards. Hence, security seems to be a common objective, central in both the institution's and the company's main future goals and it might represent a shared target to leverage on to jointly endorse this revolution in the transportation industry.

For the development of this new product, the company has continuous interactions with different actors.
Firstly, are authorities. Being safety one of the most important issues when it comes to transportation, laws and regulations do set minimum criteria and general rules the company has to take into account.
Secondly, the academia and universities are important, as they provide strategical hints and R&D inputs for the development of the technology (D'Este, Patel, 2007).
Last but not least is the industry itself, which of course cannot be disregarded, as the company operates in a changing and dynamic competitive environment with many actors and exogenous variables (Porter, Van der Linde, 1995).
These constitute a network within which Volvo is a central hub, receiving and providing inputs and outputs that are all related to each other. Consequently, it would be interesting to study what are the internal or external elements, namely the strategies the company should leverage on in order to manage these interactions to impose the autonomous driving technology in the market and in Gothenburg and make it as a standard in the future, with the aim of surviving in the long term. Indeed, this research will be based on the study of the variables that, according to the managerial literature, are essential to impose a market standard. Therefore, its aim will be to allow the company to try to impose its own solutions and to substantially gain competitive advantage, by gathering the benefits of a first mover, both in the local market of Västra Götaland and on a larger scale.
The research question is:

" What is the best set of external relationships Volvo Cars can have to impose its autonomous driving technology as a market standard? "

Moreover, considering the particular plans characterising the City of Gothenburg's urban development, and the historical relationship between the Municipality and the company, it seems appropriate to introduce a sub-research question, regarding this specific market. This is:

" *What is the best set of external relationships Volvo Cars can have to impose its autonomous driving technology as a standard in the market of Gothenburg? "*

Hence, as the purpose of this project is to develop a theoretical model suitable for Volvo Cars, and to suggest tailored best practices the company might follow to cope with the actors in the local and global market and with the new trajectories of Gothenburg's scenario, this paper can contribute to the firm's development of competitive advantage in the long term. In other words, it is aimed at providing the company with managerial recommendations to actively shape the aforementioned technological trajectories and benefit from them.
The suggested solutions will be created by studying the theoretical solutions found in the first part of the research and filtering them through primary (e.g. interviews) and secondary data (e.g. company's website and articles) concerning the company.
What is more, considering that other markets are likely going to follow the same path, the results of the present research might be applied in the future to other markets. For this reason, the results of this study might be relevant and valuable for this and other companies in the coming years.

1.2 Thesis disposition

After the present introduction to the thesis and to the research questions, follows the *Theoretical Framework*. This chapter provides the reader with an overview about the existing theories useful to address the research questions and touches upon the most debated issues and most widely recognised models in the academic literature. The main topics mentioned are the concepts of Technological Trajectories, Standard imposition and strategies to manage relationships with Academia and Institutions. Eventually, the development of a model to impose a product as a standard in the market is presented.

The following chapter contains the *Methodology.* This is a fundamental part of the study, as it describes how the author addressed the research questions and it explains the criteria that were used to select the research's design as well as to gather and analyse data.

The primary and secondary empirical data collected about Volvo Cars and the development of the self-driving technology are then explained in the following section, *Empirics*.

In the *Analysis,* the outcomes of the theoretical matrix developed in the first chapter are finally evaluated and compared to the data collected about the company, which are also further explained. This will provide the reader with a higher understanding of the managerial challenges the company is facing.

The *Conclusions*, which end the research, deliver the outcomes of the research by presenting the

most important results of the study. Indeed, the research questions will be addressed and the managerial and academic relevance of the thesis will be discussed, together with the limits of the project and some suggestion for future researches.

2. Theoretical framework

This chapter provides the reader with an overview of the major theoretical frameworks that constitute the base of the present thesis. The literature review gives a comprehensive audit over the topics of emerging technological trajectories, the imposition of dominant designs, standards and the strategies to deal with industrial, academic and institutional agents. Eventually, a comprehensive model to study how to manage external relationships to impose an industry standard is proposed.

2.1 Industry life cycles and technological trajectories

Industries are dynamic, and they are subject to ever changing mechanisms, which might be labelled evolution. For instance, in one of his famous papers, Klepper explains how products' and industries' lives are subject to cycles. When a product is firstly introduced in the market, an early state of development is set, where the technology and the product itself is in its early development: its basic features are not finalised yet (Klepper, 1997).
A second intermediate development stage is reached when the technology is improved and the definition of the product if further sharpened. The end of this process is finally represented by a third stage of maturity, where the features of the product or the technology are defined. Although the market might grow in this phase, the evolutionary process becomes more stable and partially more predictable (Klepper, 1997).

When it comes to analysing the technological change throughout the development of a product and its industry, Clark defines this development as a transition from a "fluid" to a "rigid" state: when this transition occurs, the "technological diversity gives way to standardization" (Clark, 1985, P. 236). A complex interaction between innovation processes, existing constraints -which might be either internal or external to the firm, uncertainty and the market itself contribute in shaping the trajectories the market undertakes. This means that at the early stages of a product's life, product development activities are of course predominant, as the "stability" of a "design" is required (Clark, 1985).

In other words, as Dosi clarifies, a given technology undertakes a direction of change, namely a technological paradigm, on which a new market trajectory is grounded (Dosi, 1982). The scholar assesses that there are several factors influencing a market's trajectories. Indeed, institutions and social pressures, the efforts put in R&D activities, as well as factors related to competition and rivalry, together with changing economic conditions can set constraints and influence the activity of a firm that is willing to modify or shape a particular trajectory. Dosi notices how sometimes the establishment of trajectories within a market leads to the "clustering of groups of innovations" (Dosi, 1982).

What is more, academic researches have extensively demonstrated that technologies and, in general, new products and services emerge from technological discontinuities. These evolve following a certain development, which can be summarised in the life cycle dynamics mentioned above and that culminate in the emergence of a definitive standard, which dominates -if successful, over the market until a marginal breakthrough is brought to existence (Tushman, Anderson 1986). This can even happen when a new technology addresses the exact same needs as the former but using an entirely new knowledge base. An example of this is the switch from silver halide to digital photography, or the one from vinyl to compact discs (Schilling, 2005): in those cases a new product has substituted an older one, although having the same function.

When dealing with this kind of analysis, it is always fundamental to keep in mind the element of time: while reading about dominant designs and standard imposition, indeed, a naive reader might risk to think about a simple and time-limited process. On the contrary, it can be slow and it is likely to be extremely gradual. This perfectly matches with the aforementioned concept of progressive incremental enhancements of technology, for which an initial design is unlikely going to correspond exactly to the final standard imposed in the market.
Tushman and Anderson clarify that the steps in the breakthrough process are:
- technological breakthrough;
- emergence of dominant design;
- emergence of a standard (Tushman, Anderson, 1986).

In the car manufacturing industry, for example, after the breakthrough represented by the introduction of the car as a new innovative mean of transportation, different designs such as the gas motor, the steam one and the battery powered engines were adopted until the standard of the internal combustion engine was eventually fixed (Anderson, Tushman, 1990).

2.2 Dominant designs

Tushman and Anderson provide a clear distinction between the concepts of design and standard. The former is defined as an “architecture that establishes a dominance in a product class” (Tushman, Anderson 1986, P. 613). An affirmed dominant design is adopted by most of the producers in a given market, and constitutes a stable basis on which the industry will focus its efforts (Schilling, 2005): in other words, when a dominant design emerges, it constitutes a sort of milestone on which any subsequent development is based, under the form of incremental improvements.
According to Schilling, in this phase, firms do focus on market penetration and efficiency, they offer variants of the product, maybe at different prices, and try to simplify the production (Schilling, 2005). As reported by the scholar, this is an extremely delicate phase: even if a dominant design has been established, and consequently the route to a definitive standard imposition has undoubtedly lost most of the risk it had before, firms do not have to stop thinking about different solutions, designs,

and architectures. Indeed, this might be determining for both resisting the following technological wave and adapting to the later changes of the established design (it is important to keep in mind that the very first version of a design is extremely unlikely to be the last and definitive one).

2.3 From dominant designs to standards

At this stage, it is however necessary to clarify what is the difference between standard and dominant design, as it seems to be sometimes fading and vague.

So far, it has been put in evidence that innovation waves lead to technological improvements and to new trajectories that are somehow characterised by the emergence of one (or sometimes more) dominant design(s), and eventually to the imposition of a standard (whose definition will be provided below). Hence, these two concepts are deeply related and they can often even be bounded by a causal relationship, as one can constitute the basis for the existence of the other and standards can be important elements of dominant designs (Gallagher, 2007) or, as Funk pointed out, standards can be component of dominant designs (Funk, 2003).

Srinivasan states that designs are non seldom made up by multiple standards converging together (Srinivasan et al, 2006). Also, some empirical findings have demonstrated that *de facto* standards are more likely going to favour the emergence of dominant designs (Srinivasan et al, 2006): this demonstrates that the direction of the transition from design to standard can work in the opposite way, being these two separate but complementary concepts.

According to Funk, the main difference between the two is the way they emerge: the behaviour of the firm and network externalities are indeed fundamental for standards, while technical factors are more relevant for designs (Funk, 2003). For this reason, the scholar states that the standard is something referred to an interface, whilst a dominant design is a “product architecture and technical solution” (Funk, 2003, P. 1327).

Therefore, the distinction between these two figures can be blurred and not always easy to be understood. Sometimes, for some product categories, the two concepts are equivalent (Narayanan, Chen, 2012) and for others there might be several standards and no dominant designs. In the academic literature, however, even when a difference occurs, the two labels are many times used interchangeably: consequently, finding a substantial difference between the two can be extremely difficult. Hence, to the author of this research, it seems reasonable to stick to Suarez’s thought, according to which, regardless the definition, what matters is the phenomenon that concerns the emergence of a “dominant technological trajectory” (Suarez, 2004, P. 271).

2.4 Standards

A standard can be defined as a format, an interface or a system that has the function of allowing interoperability (Grant, 2016): it can therefore be seen as a set of features that allow compatibility and integration (Tushman, Anderson 1986), which are not easily ousted. Hence, it is possible to state that it has the trait of creating stickiness within given technological features (Tushman, Anderson 1986).

Narayanan and Chen clarify that as standards emerge from the interaction of different social actors such as institutions, producers, consumers and political entities, they are, in a sense, a "collective choice" (Narayanan, Chen, 2012). What is more, they provide an interesting insight about the distinction between standards from a supply side and from a demand side. The former can be seen as the concentration of specific figures within the design logics aiming at organising functional and hierarchical variables around a particular product. The latter concerns the willingness of consumers to have a uniform and unique template that allows integration and interchangeability (Narayanan, Chen, 2012).

What needs to be put in evidence from the beginning is that there are different kind of standards. For example, they can be public or private (Grant, 2016). Private standards usually do not involve intellectual property, unless the access to it is made free by the owner. An extremely relevant feature of public standard is the fact that they can sometimes be mandatory standards, namely they are made compulsory by the government and by the law (Grant, 2016). This is particularly relevant for the purpose of this research, as mandatory standards are extensively used when the innovation and the technology involve issues related to safety and environment protection. Sometimes, on the other hand, public standards can be voluntary and be imposed by industry associations (Grant, 2016). These can, for instance, be set by industry associations such as ISO (Industry Standard Associations) or the European Telecom Standard Institute, that established the GSM as a standard in the European industry of telecommunications (Grant, 2016).

Private standards, on the contrary, are related to the dimension of ownership of the technology or the design (and, for this reason, they are also labelled proprietary standards). The advantage that is provided by this kind of standard is mainly related to the monopolistic position of the owner of the technology or design that lies behind the standards and the profits the company owns from selling or licensing it (Grant, 2016). In the telecommunication sector, for example, Apple's iOS and Google's Android are the two major rival standards (Grant, 2016).

Within the category of proprietary standards, there is a class that deserves particular attention. This is the category of *de facto* standards. This is a typology whose pattern of emergence is characterised by the fact of being spontaneous. This means that producers and consumers voluntarily start adopting a given product, design, or technology. However, according to Grant, this kind of standard

might need extensive time to emerge and might therefore lead to a postponement of the establishment of the market (Grant, 2016).

In the academic literature, however, there are many other classifications. An important one is reported by Suarez, and concerns the difference between quality and compatibility standards. The former expression is used to indicate the convergence toward specific characteristics, while the latter is usually adopted to specify that a product can be used together with other specific technologies (Suarez, 2004).

In their research, Tidd and Bessant state that the acceptance of a company's standard has three effects: first, it does widen its market, secondly, it can substantially contribute in raising barriers against the firm's competitors. Last but not least, it can lead to a winner-takes-all situation. (Tidd, Bessant, 1997). These stress the importance of this topic in strategic management.

Different kinds of situations and dynamics can lead to different kinds of standards and diversified patterns they evolve through before emerging. However, it seems that all of them are shaped by common variables.
According to Grant, the first prerequisite a market needs to have to see the emergence of standards is the presence of network externalities[1], as compatibility is essential for using the same product within a network. The presence of network externalities, however, implies the existence of a network, the availability of complementary products and the advantage given by avoiding switching cost (Grant, 2016). This means that the user of a given technology X will not have to face costs to purchase a second technology Y to interact with another user who purchased a different good, if both of them adhere to the same standard. However, this has a negative feedback, represented by the fact that the standard imposed in the market might not be the best one and, even worse, by the fact that it can be too costly for the whole set of actors operating in that industry to switch to the optimum technology: therefore, there are many situations in which the actual standard is not the most desirable one (Grant, 2016). A classic example of this is the QWERTY typewriter, which has become a market standard although it is not the fastest possible (David, 1985).

2.5 Competing for standards

When competing for standards, a firm has to investigate about two key elements.
The first is to understand how many standards the market will converge toward, by analysing the sources of the network externalities (Grant, 2016). The second involves relationships, as it concerns

[1] In "Contemporary Strategy Analysis", Robert Grant defines network externalities as the effect by virtue of which "the value of a product to an individual customer depends on the number of other users of the product" (Grant, 2016. P. 257)

feedbacks. A firm facing such a competition, indeed, will win if, and only if, it will be able to exploit the positive feedbacks arising from positive externalities[2]. In this sense, Shapiro and Varian identify the possibility of creating a bandwagon effect by (Shapiro, Varian, 1999):

- Alliances
- Market pre-emption
- Expectations management

What is more, the scholars focus on the key resources that a firm needs in order to win a standard war[3] (Shapiro, Varian, 1999), which are:

- controlling the base of customers
- owning intellectual property rights (IPRs)
- being able to innovate to adapt to technological advances
- gaining early-mover advantages
- having good manufacturing abilities
- being strong with complementarities
- having a good brand name

Those are technological possibilities that, at a first glance, do seem to be related to both the external and/or internal research and development activities and to the "state of the art", but that work with governmental, individual and organizational factors (Tushman, Anderson 1986). When it comes to converting an emerging design into a standard**,** however, some other factors are described to be alternative means. The market power of a dominant producer, the creation of an industry committee or different kind of alliances are recognised by Tushman and Anderson as possible elements firms can leverage on, especially if they are supported by the government (Tushman, Anderson 1986).

Maximising the installed base[4] is another goal the literature has recognised to be fundamental for the strategy of technological imposition. According to Hill, in fact, this strategy gives the possibility of spreading the habit of using a given solution to a market need, and helps creating a "self-reinforcing community of users and suppliers of complementary goods" (Hill, 1997, P. 10). The interesting aspect is that by leveraging on the installed base, even a product that is not the most efficient can become dominant. The QWERTY keyboard, for example, became the standard thanks to a mass adoption, displacing the more efficient Dvorak layout (Farrell, Saloner, 1986). In order to achieve this

[2] Grant identifies a process, the "tipping" process, that describes a winner-takes-all situation arising from positive externalities. According to this principle, after a given threshold, a standard will attract the whole market, leaving no space (or a small one) to the others (Grant, 2016. P. 258).
[3] By standard war, the literature means all the strategies that are undertaken by a firm in order to impose a standard in the market. They can involve, for example, the competition for platforms and, in some cases, direct cash payments. An example of this is the contrast between 2006 and 2008 between Sony and Toshiba, namely the competition between, respectively, Blu-ray and HD-DVD (Grant, 2016).
[4] By installed base, the managerial literature means the amount of users of a product (Schilling, 2005). For example, all the customers that bought the subscription for a premium TV channel and watch that constitute its installed base.

result, the scholar suggests four strategies, namely licensing agreements, strategic alliances, diversification into complementary products and aggressive positioning (Hill, 1997).

Although it might not be intuitive at a first glance, licensing can be a relevant strategic leverage when the agreement is done with a competitor. This contributes in diffusing the technology standard as it increases the number of companies adopting it and it can consequently enhance customers' expectations, as the product or service is diffused among more than one company. If the agreement is established with a competitor that owns resources, licensing acts as a co-optation mechanism and favours the process of marginalising a potential competing technology by discouraging competitors from developing it (Hill, 1997). However, licensing can lead to a modification or to a (total or partial) appropriation of the technology by the licensees, as it is not possible to develop a contract covering and protecting the licensee from all the possible fields of application. This can be, according to Hill, weakened by the development of a licensing contract that locks the licensee in a sponsorship obligation (Hill, 1997).

Strategic alliances have a cooperative trait and they are usually focussed on distinctive competitive dimensions, which usually are joint development and commercialization (Hill, 1997). The second takes to the same advantages described for licensing agreements but, according to Hill, it can be much more effective when the competitor, or the competitors, have an already developed technology that might threaten the run for the standard and when partners are willing to diversify into complementary products. This means that alliances are an opportunity to avoid a pure "war", and they represent a better scenario, as battles usually lead to lower returns for every competitor in the industry (Grant, 2016). They are therefore an excellent mean to get to synergies (Hill, 1997): Yahoo! and Amazon, for example, have many alliances to drive Internet traffic and to offer differentiated value to users (Aaker, 2009).

Strategic positioning is strictly related to the speed to which consumers adopt the new technology. Its main driver are penetration prices, which can be seen as a short run sacrifice aimed at gaining learning effects, economies of scale, and eventually the imposition of the standard. However, as Hill points out, the company needs to be able to handle the demand from a capacity point of view. Product proliferation, especially when it is achieved through customization in consumer niches, can also favour a strategic positioning (Hill, 1997).

The aforementioned solutions, however, do have trade-offs, which are represented by barriers to imitation, the capabilities of competitors (although potential), the complementary resources of the firm and the availability of supply of complementary products: these can have a different weight depending on the circumstances and on the strategy that is used (Hill, 1997).
In light of these contingencies, Hill (1997) provides four interesting suggestions about competitive

strategies that can be used by a firm willing to impose a standard.
- Aggressive sole provider: it is used when the company is the only supplier of the technology. Hence, alliances and agreements leave the floor to diversification and aggressive entrance modes. Of course, this works if the firm has potentially no (or few) competitors able to retain strategic resources and complementary products and if barriers to imitation are high.
- Passive Multiple Licensing: it is used if the licensees build the market for the technology, especially when the licensor can't raise barriers to imitation or does not have the control over complementary resources. This strategy allows the licensing firm to co-opt competitors, still using few resources.
- Aggressive Multiple Licensing: the company licenses the technology while assuming aggressive positioning. This boosts the expectations about the product to become a standard and, at the same time, diffuses the technology allowing other firms to invest in complementary products. This is suggested when the technology can be easily imitated but the firms does control complementary resources.
- Selective Partnering: when there are high barriers to imitation and few competitors that lack resources or capabilities to impose their technology as a standard, partnering with them might be the best solution (Hill, 1997).

Almost all the scholars that studied the imposition of designs and standards do think that trying to predict their ultimate traits can be extremely challenging, given the multiplicity of variables and actors involved in such a complex social-based dynamic (Dosi, 1982; Clark, 1985; Tushman and Anderson, 1986), especially if they are the outcome of political and social dynamics (Tushman, Anderson 1986).

An extremely different but relevant approach to the issue of standard imposition is provided by Suarez. The main difference of his analysis lays on the fact that he suggested a model that might help firms in establishing a standard by starting from an *ex-ante* perspective, instead of an *ex-post* one as, according to him, most of the scholars and academic do (Suarez, 2004). Indeed, he identifies five "milestones" in the process of technological dominance, and five consequent phases of the dominance struggle, characterised by different variables influencing the firm and the dominance process itself (Suarez, 2004).
The first milestone marks the beginning of the technological field, as it corresponds to the moment when applied R&D for the production of a commercial product or service is undertaken. This is often done by (or together with) universities, and it is sometimes labelled R&D race (Suarez, 2004). The production of a working prototype is the signal of the second milestone, as this shows the feasibility of the project to the market, competitors and to users (Suarez, 2004).
A third milestone is the launch of the first version of the product: this means that an early market is created, although it is usually a relatively niche market, being the early versions usually expensive and therefore not accessible to the mass market. This is relevant as it shows the presence of a "forerunner" in the market: the moment when the presence of this front-runner is clear is the fourth

milestone. It represents a turning point, as the possibility of creating an installed base is forged, and it generates an inertia in adoption, even though design, product improvement and market management are still essential (Suarez, 2004).
The fifth turning point is represented by the moment when a technological trajectory achieves dominance. Here, the main issue in literature is determining when it is possible to assess that the design is actually dominating. The threshold suggested by Suarez is the occurrence, during the fourth stage, of one or both of the following events:
- "clear sign that the most closely competing alternative design has abandoned the active battle, thus acknowledging defeat" (Suarez, 2004, P. 281).
- a design has gained a market share advantage and "market trends unanimously suggest that this advantage is increasing" (Suarez, 2004, P. 281).

During the first phase (R&D build-up phase), the key features of the technological field are developed. These are the factors and basic traits of the technological trajectory that will characterise the product and its future development. Hence, this implies the importance of the ability to reach agreements and to cooperate for the competition itself (Suarez, 2004). Together with this, the main key elements to be controlled at this stage are complementary assets and credibility (namely firm-level factors). All the aforementioned elements are crucial in this early phase and it is therefore essential to mitigate the risk of technological uncertainty and to attract key technical talent. This can be done more easily by large firms, that are usually the main actors in this phase, especially the ones that are competent in a linked technology. However, new entrants are sometimes involved in this early stage, too (Suarez, 2004).
Last but not least, appropriability plays a fundamental role in R&D build up, as it determines the extent to which firms can try to shape the technological trajectories still being unchallenged (Suarez, 2004).
The second phase (technical feasibility) is characterised by the increased importance of firm-level factors and technological superiority, that can sometimes make a technology emerge. Moreover, at this stage, the environment often plays a fundamental role. In particular, the role of regulations come to be central: regulators non seldom intervene when progress has demonstrated a given technological trajectory to be feasible but has not hit the market yet (Suarez, 2004).
Phase three is labelled "creating the market" and sees a firm-level variable, strategic manoeuvring as the most important one. This element includes (as stated) firm level elements required for a dominance battle, as timing of entry, pricing strategies, and expectation management (Suarez, 2004). At this stage, it is necessary for the firm to gain the position of first-mover in order to gain reputation advantages and access to key resources. Penetration pricing can result to be a winning strategy, especially thanks to the few information available to consumers: marketing is crucial. Last but not least, a careful focus on the relationships with producers of complementary goods or services is essential and needs to be strongly developed in this phase, as usually producers wait for

the trajectory to be clear before supporting it (Suarez, 2004).

In the fourth phase, the “Decisive battle”, the installed base, which is determined by network effects, starts being decisive, especially in combination with other key drivers: complementary assets and credibility. This latter is fundamental to gain the market share corresponding to the late and sceptical adopters (Suarez, 2004).

The fifth and final phase, namely the post-dominance stage, starts when a technology has clearly been imposed as dominant and it is protected by a relevant installed base. Hence, competition is focussed within the boundaries imposed by the standard itself, and mainly concerns process innovation. This phase only ends with the emergence of a new dominant technology (Suarez, 2004). At this stage, the strategic variables to keep under control are therefore the installed base and network externalities, together with switching costs (Suarez, 2004).

2.6 Technological dominance and innovation actors: the Triple Helix

Innovation and, therefore, the start of new technological waves can often come from small firms and start-ups (Grant, 2016), being those dynamic and founded with the purpose of exploiting a new technology (Shane, Stuart, 2002). Hence, it can be tough for an established, incumbent and mature company to catch up it terms of dynamism. Nevertheless, an incumbent that is aware of this can potentially keep its status of pioneer and consequently try to shape the future competitiveness, and the direction of the development of the market (Rosenbloom, Cusumano, 1987). According to part of the literature, this is especially likely to happen if technological discontinuities come from competence enhancing innovations deriving from incumbents (Tushman, Anderson 1986). Trying to impose a standard can consequently be a way to keep a dominant position, as being a well known company with a big market share does not automatically save from this declining destiny. Apple Computers itself, for example, could initially not impose its operating system as a standard (Hill, 1997).

What does not need to be forgotten, however, is that throughout this processes of product development, R&D and engineering, a company has relationships with different actors that can have a diversified influence on the firm’s activities. Indeed, any firm needs to operate, compete and survive with constraints as well as opportunities that arise from competitors, institutions and authorities. In 1995, for example, Dell Computer Corporation was inspected by the US antitrust authority for exercising undisclosed patent rights against competitors adopting the VL-Bus standard[5], to enforce its own patent against other firms willing to adopt the standard (Shapiro, 2000): in this case, an action by an incumbent caused an authority to intervene and, consequently, this induced a change in its competitors’ strategies.

[5] A mechanism to transfer information from the computer’s CPU and its peripheral components, as disk drive or display screen (Shapiro, 2000).

At the same time, especially in the last years, many firms have increased their relationships with academia and universities to gain knowledge inputs and advantages. This was done through incubators, venture capitals and the establishment of physical connection centres, also by institutional initiatives. In Italy, for instance, INFM (National Institute for Physics of Matter) has established since the '80s different research laboratories in liaison with Italian semi-conductor firms (Etzkowitz et al., 2000).

There are several models that analyse this kind of relationships and, to the knowledge of the author, the most relevant seems to be the Triple Helix Model. This can be defined as a paradigm that describes the increasing interdependence between university, industry and government. In particular, the focus is on the network between these three actors, that are not necessarily synchronized and whose interaction stimulates progress and innovation (Etzkowitz, Leydesdorff, 2000). A crucial concept behind this model is the presence of an instability in the equilibrium between these three elements that lead to a continuous necessity for reorganization. According to Etzkowitz and Leydesdorff, the consequent set of processes that flow from these interactions is "composed of subdynamics like market forces, political power, institutional control, social movements, technological trajectories and regimes" (Etzkowitz, Leydesdorff, 2000, P. 113). This means that every action that is performed by any of these three actors might have a consequence on the others, potentially triggering a chain of modifications and improvements.

What is really important to focus on, in other words, are the "interlocking dynamics" (Etzkowitz, Leydesdorff, 2000, P. 114) that can constitute a causal relation among the inputs and the outputs flowing to and from every element (namely, actor) of this triangle. If a firm, for instance, thanks to the collaboration with a certain department of a given university develops a new technology and creates a product that might have a market -provided that it can solve a consumer need, the industry would select and process the feasibility of the launch of this product, through a series of network and market dynamics. These might be influenced by the government, which could be interested in the promotion (or in the stoppage) of its diffusion (assessing whether or not, when and how this is legitimate is beyond the scope of the present research): the authorities might therefore intervene to contribute in the trajectory shaping process and (or) in the creation of a market. Last but not least, a regulation can be done to set limits or to give further possibilities to both universities and firms, according to what the government judges to be appropriate.
The system that is described by this model is therefore dynamic and works on the wave of the interactions between its own agents (Etzkowitz, Leydesdorff, 2000).

This network of relationships coexisting with each other can form a so called business ecosystem, where relatedness and interconnectedness connect different actors, to the point of making them

share their destiny (Peltoniemi, 2006). In the development of a new technology, firms can therefore operate cooperating and competing at the same time, developing complementary capabilities and strategies all contributing to the creation of a new technology, acting within an ecosystem of inter-industries members, rather than as individual entities (Moore, 1993). Between 2000 and 2007, for example, Chinese mobile services providers created a competition-collaboration ecosystem by leveraging on their different value-adding services and managed in promoting the growth of the sector (Zhang, Liang, 2011).

An interesting aspect and application of the Helix model has recently been provided by Leydesdorff and Deakin. According to the scholars, the Triple Helix model can fit with the cultural and social change that is affecting many cities on the planet and that pushed institutions and municipalities toward seeking and trying to get smarter cities. In other words, given this cultural change, the Helix approach can allow governments to create vibrating and dynamic networks of interactions between government, industry and universities to create local and productive innovation systems (Leydesdorff, Deakin, 2011).

2.7 Dealing with institutions

As stated above, firms need to operate within the constraints that are set by institutions. However, companies can sometimes exploit the relations they have with the institutions themselves, as well as their dominant position as incumbents or as experts in a certain field of expertise to try to either shape or take advantage of policies and regulation (Ahuja, Yayavaram, 2011). Ahuja and Yayavaram made an extremely interesting study about this issue. They identified some market and ordering mechanisms, namely information asymmetry, power asymmetry, agreement consummation, individual incentives and collective actions as recurring obstacles to good functioning of markets. At the same time, they diagnose three classes of market pathologies that arise from those: Institution Failure, Failure of Market Ordering, Failure of Institutional Complementarity. These leave some gaps in regulations and social contexts, whose exploitation by firms leads to “influence rents” (Ahuja, Yayavaram, 2011). Those can be collected by undertaking two classes of strategies: Avoidance Strategies and Manipulation Strategies.
Among the first class, the scholars list the strategies displayed in the following table:

Strategy	Description
Delaying	"Delaying the institution from coming into existence or beginning to function" (Ahuja, Yayavaram, 2011, P. 1641). In a context such as the one framed by this study, an incumbent with enough influence might try to ask for clarifications about the chart of the institution (Ahuja, Yayavaram, 2011) that is going to create the legal framework regulating the market of the new technology. It could do this, for instance, arguing that the organs of the institution itself are not skilled enough in that field of expertise to set specific rules which might damage the market and consumers. This could also be done cooperating with other competitors that might have the same interest in delaying the institutional set up.
Defanging	Defanging is the reduction of the institution's power once it has emerged. However, if a firm is interested in introducing a product that, although revolutionary, has the same functions of the old standard good, the legitimacy of the institution over the new technology is likely going to be as valid as it used to be in the past. In this scenario, it is extremely possible that the defanging strategy does not work. This can be the case of the self-driving car, for instance.
Substitution	Substitution consists in the pre-emption of institutional power by building private or social orderings the firm controls, with the aim of stating that state control is not required. This kind of strategy does not seem to be applicable to a scenario where the object of the regulation is a new revolutionary good dealing with citizens' safety.
Arbitragive morphing	Arbitragive morphing implies the modification of the company's charter or domain to make it be outside the competence and the restrictions imposed by a specific institution. When developing a radical product innovation, an influential company might leverage on the different nature of the new product, and therefore the illegitimacy of an institution to legislate over it.
Jurisdiction shopping	This strategy is undertaken by seeking of a geographic location with more agreeable institutional setting (Ahuja, Yayavaram, 2011). An incumbent operating at worldwide level willing to launch a product on the global market might find it very hard to apply and gain from this strategy. This would be even harder if the company needs to test beta versions or prototypes near its headquarters during its R&D phase as, for instance, Volvo Cars is doing with the Drive Me project.

Figure 1. Avoidance Strategies. (Ahuja, Yayavaram, 2011)

Among the category of Manipulation strategies, on the other hand, the scholars name:

Strategy	Description
Subversion	Consists in using an institution for objectives it was not intended or opposite to the ones it was created for (Ahuja, Yayavaram, 2011). For instance, a company might persuade an agent or agency to use its product(s) within its institutional functions. This might prove the usefulness of the adopted item to the regulating actors, which might therefore be more likely to approve it. Moreover, this would implicitly function as a marketing campaign for the company. An influential incumbent such as Volvo might use its privileged societal recognition to adopt this strategy.
Starvation	This strategy is implemented by trying to constrain the institution's access to resources (Ahuja, Yayavaram, 2011). This implies the institution to be (even partially) dependent on the firm, which is an extremely rare case, especially when it comes to central governments.
Perception management	The foundation of this strategy lies on the fact that the authority of an institution is dependent, to a great extent, on its perceived legitimacy. Hence, by trying to erode the reputation of an institution, its effectiveness can dwindle. The outcome of this kind of strategy can also be a reduced aggressiveness of the institution and an obstacle to its seek for resources or talent. It can be pursued by creating a "reputation cascade" among experts (Ahuja, Yayavaram, 2011). Again, when the institution in question is the central government of a country with political stability and a stable economy (or a representative of it, such as a Municipality), undermining its reputation and effectiveness can be tough.
Co-optation and Capture	This regards the pressure that a company has on the institution's choices, although it can sometimes even lead to or reveal to be corruption (or to more "soft" forms of interaction, but still ambiguous features). An example of this strategy is the use of "academic studies, consultants or lobbyists to establish a certain point of view" (Ahuja, Yayavaram, 2011, P. 1643), to make decision makers think they are taking optimal decisions, even when those are uneven for some actors or companies (Ahuja, Yayavaram, 2011). This can be represented by a committee whose aim is judging the efficiency and functioning of a new technology, such as the Drive Me project.

Institutional proliferation	This last strategy is undertaken by the creation of alternative institutions whose scope is solving the very same problem as the original one, weakening it. It can also be used by creating different competing standards which, if perceived as good, can obscure the initial one to the eyes of the consumer (Ahuja, Yayavaram, 2011).

Figure 2. Manipulation Strategies (Ahuja, Yayavaram, 2011)

The relevance of these theories for the present study is represented by the fact that a firm that covers the position of incumbent in a market and that is willing to impose its own technology as a standard in the aforementioned context, might be able to leverage on its position and to use institutions at its own advantage. Also, an incumbent might to try to make institutional actors set rules and regulations that are particularly favourable to the firm itself. This means that a company might have the possibility, by undertaking these strategies, to make an institution be a "collaborator", rather than an "obstacle" to its business. A firm can therefore do this by undertaking policies aimed at enforcing the security of its products and making social campaigns out of it. This, for instance, might be done either starting massive marketing campaigns which can improve the reputation of the company or directly sponsoring governmental initiatives such as social advertisement spots.

2.8 Dealing with universities and academia

Interactions between universities and firm have increased in importance as well as in frequency, to the point that some firms have become similar to research centres, while some universities got more and more entrepreneurial (McKelvey, Sharmistha, 2015). There is a plethora of collaboration modes among industry and universities, and they can be divided between classic technology transfer mechanism and collaborative and informal modes of interaction. Among the second category (whose modes can still be formalized with contracts), the three most important paradigms are joint research, contract search and consulting (D'Este, Perkmann, 2011).

In a paper written together with Patel, D'Este provides a full categorization of the relationships that firms have with universities. The scholars, in fact, do create the following five categories that comprehend both classic and informal modes of interactions.

Category	Description
Meetings and Conferences	This category comprehends a set of personal and informal relationships that occur when meetings, conferences are set about certain specific topics. (D'Este, Patel, 2007).
Consultancy and Research Agreements	These modes represent formal research activities that are commissioned by the firm and, especially when it comes to research agreements, the study is only conducted by researchers from the university. Especially concerning R&D, this solution is usually used by firms for competition and commercialization goals. Indeed, it is explicitly commissioned by companies and regards applied issues. Hence, consultancies and research agreements are usually not supported by the government, financially speaking. With the expression "Consulting", instead, the literature labels research or advisory services provided by universities (D'Este, Perkmann, 2011; D'Este, Patel, 2007).
Physical Facilities	In this category are spin-off companies and facilities such as campus laboratories, incubators and cooperative research centres (D'Este, Perkmann, 2011; D'Este, Patel, 2007).
Training	These modes involve both postgraduate trainings in the company, such as PhDs and training processes for employees (D'Este, Perkmann, 2011; D'Este, Patel, 2007).
Joint Research	Collaborative (or joint) research are a set of formal research agreements aimed at establishing a collaboration on R&D projects and they are sometimes supported by public funding (D'Este, Perkmann, 2011 and D'Este, Patel, 2007).

Figure 3. Firm – University collaboration modes. (D'Este, Patel, 2007; D'Este, Perkmann, 2011)

For the sake of completeness, it is relevant to notice that many scholars, such as George, Shaker A. Zahra, and Robley Wood have pointed out that, many times, industrial and firm level objectives can be completely different from academic ones (George et al, 2002): hence, any of the aforementioned relationships can potentially lead to frictions and hinder firm's R&D and commercialization activities, instead of boosting them. Nevertheless, especially in light of the Triple Helix approach, it is possible to consider this only as an eventuality. An initial assumption of the

theoretical framework of this thesis is, indeed, that collaboration with academia, institutions and industry is helpful to a company.

2.9 A model for imposing a standard

All the aforementioned theories about the imposition and the emergence of dominant designs and standards, the collaborations a company can have with the industry, with institutions and universities throughout the development process of a new product or technology can be merged to create a paradigm that can be used by firms trying to develop a technology they want to impose as a standard in a given market.

In other words, it is possible to select the most suitable elements from each theory to create a model that describes what kinds of relationship the firm should have in every phase of the life cycle of the new technology, in order to have more chances to impose it as a standard in a certain market.

Different models can be merged into a matrix, displayed below.

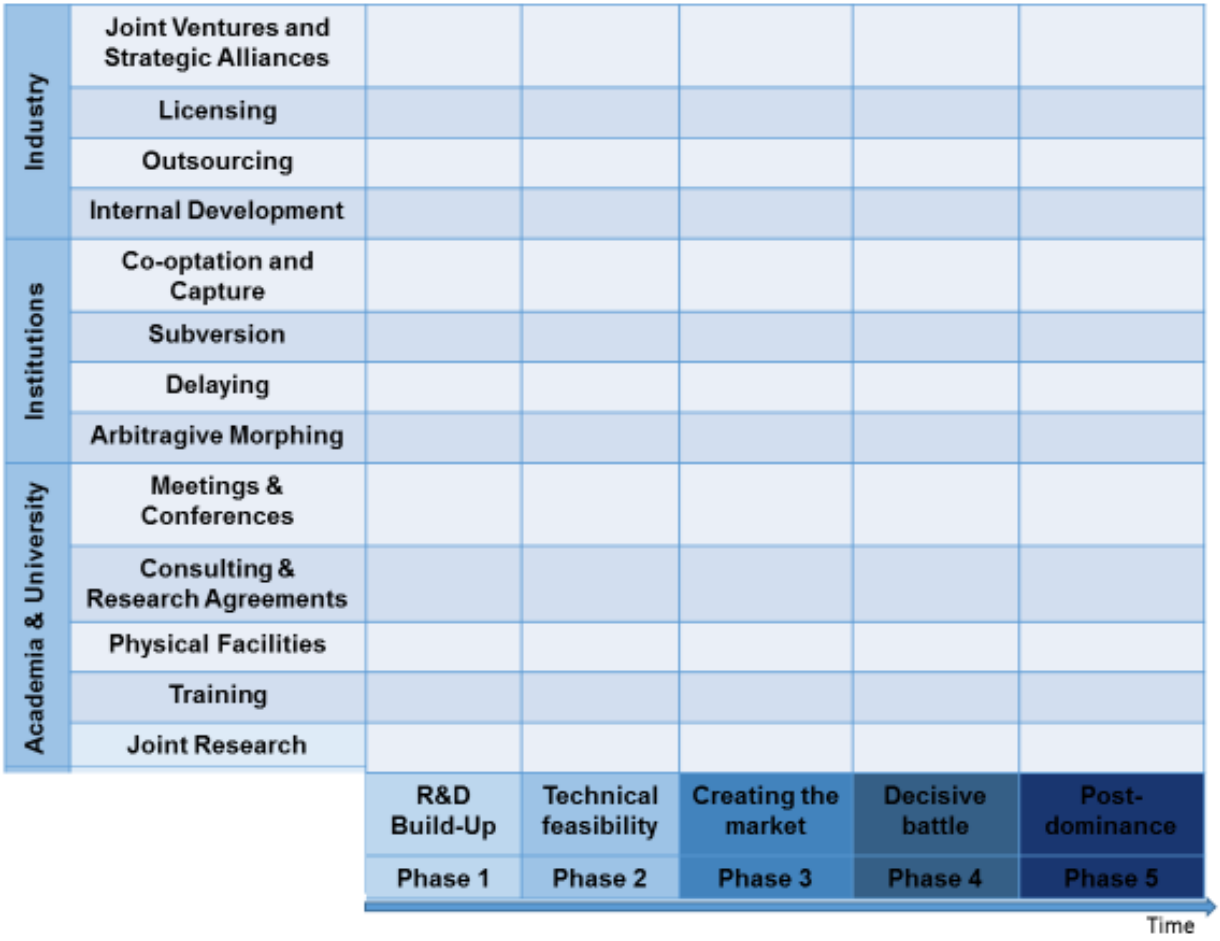


Figure 4. Relational matrix (Tushman, Anderson, 1986; Shapiro, Varian, 1999; Suarez, 2004; Schilling, 2005; D'Este, Patel, 2007; Hill, 2007; Ahuja, Yayavaram, 2011; Grant, 2016)

The horizontal dimension is represented by time, depicting the different milestones of the process of technological dominance suggested by Suarez (2004). “Relationship modes”, on the other hand, is the vertical dimension, as it describes different ways a company can deal with institutions, academia and industry.
As mentioned before, the strategies that allow a firm to manage its relations with institutions were taken by Ahuja’s and Yayavaram’s framework (2011), while the academic side refers to D’Este’s and Patel’s (2007) categorization. The main sources of industry-related strategies were the models, papers and books by Schilling (2005), Grant (2016), Hill (2007), Shapiro and Varian (1999) and Tushman and Anderson (1986) as presented in the first part of the theoretical framework[6].

This approach allows a company to list and compare all the advantages of every relation with every actor belonging to the “macrocategories” of the Helix model (Industry, Academia and University, Institutions), and in relation to the specific phase of the business (namely, the status of the technological development of the new product). This allows to merger Suarez’ *ex ante* perspective (Suarez, 2004) with the comprehensive Triple Helix’ approach (Etzkowitz, 2008).

In his paper, Suarez develops a list of factor types and specifies which are the most important in every phase of the technological development (Suarez, 2004). The findings are summarised in the table below.

[6] For the sake of completeness, it is necessary to specify that the relationship modes that are considered in the matrix are not all the possible ones. Those have indeed been selected as they are the most common ones and the most recurrent in the consulted literature. In other words, they have been selected as they are all feasibly applicable to an incumbent firm willing to deal with central as well as local governments, actors from its industry (also considering upstream and downstream agents along the value chain) and universities.

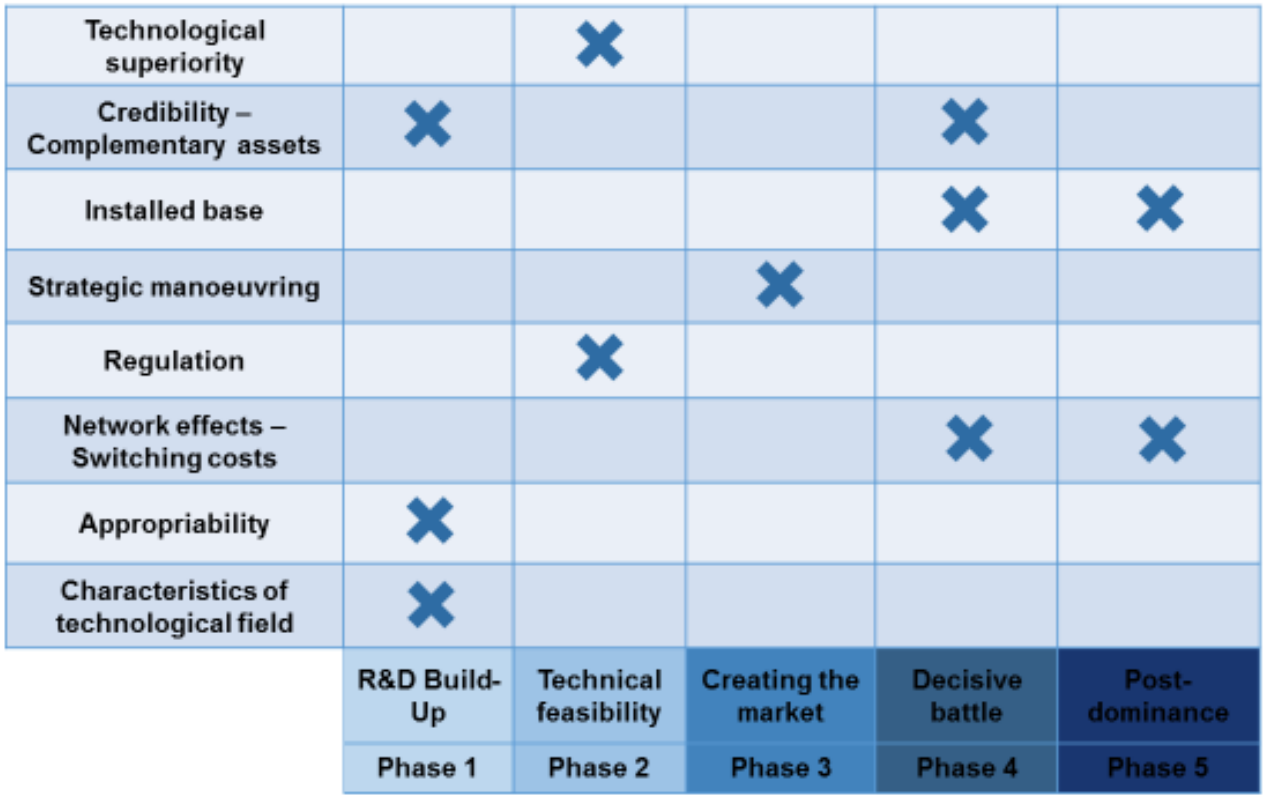


Figure 5. Key variables for dominance battles (Suarez, 2004)

As every factor has a different weight in every phase, when completing the cells of the matrix with the advantages of the different relationship modes, some can be considered more relevant and, more importantly, better suitable than others. Among the modes of the same category, the one with the highest number of features corresponding to the "critical factors" suggested by Suarez can be chosen as the best relationship mode for that specific phase.
Also, in every stage, it is possible to attribute a higher priority to the relation with one agent rather than to another, according to the urgency of that specific relationship and the relative advantages in every phase.

For example, it might result from the literature that in a given phase, the relationship with one actor, for instance universities, might be more important and might lead to more advantages than the one with another, like industry, but at the same time less advantages than a third one -institutions, according to our example. Hence, the "priority order" would be:
1) Institutions
2) Universities
3) Industry

Consequently, the managers of a company can select the relation mode that gives more advantages in every phase. By selecting one mode for each category -which means one relationship mode for institutions, one for industry and one for university, the model provides the mix of approaches that maximise the probability of imposing a standard in every phase of technological struggle and the possibility to favour one in particular.

This approach allows a company to have an *ex ante* approach. Hence, it can be used by a firm willing to launch a new technology to decide how to handle its relationships with external actors. However, it can also be taken as a guide by firms which are already in this technological struggle and that are willing to change their strategy *in itinere*.

Of course, this model has its limitation, starting from the fact that the company in question needs to have some power, especially when it comes to institution shaping. For this reason, it can be particularly suitable for a firm with reputation and brand awareness, which is more likely to be an incumbent.

Additionally, for the sake of clarity, it is necessary to put in evidence from the beginning the fact that this framework does not take into account all the existing possible alternatives a company has in terms of relationship modes. Some of them have been excluded for feasibility reasons, given type of company object of this study. The alternatives suggested in this model are therefore the most important and the most recurrently suggested by literature, among the feasible ones.

On the path of Suarez's description of the phases and the most important elements to leverage on in each of them, it seems reasonable to assume that analysing the matrix column by column is the easiest and more complete way to implement the model.

The following paragraphs will clarify what are the relationship modes' advantages and disadvantages that have been found in literature per every step of the dominance battle. Matching those with the variables that, according to Suarez, are fundamental in every phase, it will be possible to evaluate which is the optimal one in every step. For further clarifications and information, as well as supplementary explanations and motives behind the choice of the optimal modes, the reader can consult Appendix I.

2.9.1 Phase 1: R&D Build-up

Industry

In this phase, the technological field and trajectories are developed, and the number of participants is essential to determine the future competition in the market that will be created (Suarez, 2004):

hence, the focus on the industry does not need to be undervalued. What is also important at this stage, however, is speed in research.

Joint Ventures and Strategic Alliances. Especially in this preliminary stage of research and development, this form of collaboration helps in increasing the speed of research (Tidd, Bessant, 2013) keeping costs relatively low, being those shared with the partner(s) (Schilling, 2005). Moreover, joint ventures and alliances can make the firm gain new competences and complementary assets (Tidd, Bessant, 2013), although they can lead to information leaking and therefore to competitiveness losses. Appropriability is uncertain and not always optimal, as control over the development process is shared with joint ventures and low with the other forms of strategic alliances (Schilling, 2005). According to Schilling, collaboration in R&D is particularly important for firms developing products new to the market, rather than new to the firm (Schilling, 2005): in particular, they help in reaching a new market by leveraging on co-specialized resources (Tidd, Bessant, 2013). Last but not least, alliances enhance flexibility and help in getting to a demonstration of feasibility (so to the creation of a prototype) (Tidd, Bessant, 2013 and Schilling, 2005).

Licensing. This form of relation is not optimal when there is uncertainty about the technology, as it can lead to opportunistic behaviours and to increases in transaction costs (Schilling, 2005): this latter element means that some resources are used to fix and arrange the transaction, rather than being dedicated to R&D efforts, making the progress of this latter much slower.

Nevertheless, if the knowledge behind the technology is not tacit, licensing is cheaper and less risky than alliances. When using licensing, acquiring capabilities can be fast. However, both licensing-in and licensing-out modes do not ensure a high control over the technologies: hence, although it should be a primary focus, appropriability is not a strong point at this phase. (Schilling, 2005).

Outsourcing. It can be useful to acquire competences, facilities and it can be especially relevant for manufacturing (Tidd, Bessant, 2013 and Schilling, 2005). One of the advantages of outsourcing is that product and process design can be outsourced to experts: this can prevent the firm from acquiring fundamental knowledge and capabilities. This mode does not ensure complete control over the technology, it has medium costs and medium speed (Schilling, 2005).

Developing the technologies internally. This avoids leakage of information and the loss of ownership and control (Schilling, 2005). However, especially when in a situation of technological change, “sourcing technology externally is a superior strategy to relying entirely on internal capabilities”, unless the technology is cheap and fast to produce (Schilling, 2005, P. 465). This mode enhances the chances of protecting proprietary technologies and the possibility of controlling more directly the development of the technology itself (Schilling, 2005), which means that appropriability is high. Although this mode guarantees a higher control over a technology, it can be costly and it is usually slow (Schilling, 2005).

Industry – Phase 1 (Credibility and complementary assets – Appropriability – Characteristics of technological field)			
Mode	Key features	Correspondence to key variable	Variables met
Joint Venture	Speed of research	Characteristics of technological field	2/3
	Lower costs (shared)	Characteristics of technological field	
	New competences & complementary assets	Credibility & complementary assets	
	Knowledge leaking (competitive losses)	Appropriability	
	Appropriability uncertain/non optimal	Appropriability	
	Flexibility	Characteristics of technological field	
	Reach new markets		
Licensing	Non optimal with uncertainty (Transaction costs and less resources to R&D)	Characteristics of technological field	1/3
	Cheaper (if knowledge is tacit)	Characteristics of technological field	
	Acquire capabilities	Characteristics of technological field	
	Weak appropriability	Appropriability	
	Credibility (if partner has good reputation)	Credibility & complementary assets	
Outsourcing	Competence and facilities acquirement	Credibility & complementary assets	2/3 (but slower)
	Medium speed	Characteristics of technological field	
	Medium costs		
	Control over technology not ensured	Appropriability	
	Design outsourcing: optimal characteristics by experts	Characteristics of technological field	
Internal development	High control over information and ownership	Appropriability	1/3
	Slow R&D	Strategic manoeuvring or Characteristics of technological field	
	Costly	Strategic manoeuvring or Characteristics of technological field	

Figure 6. Relations with Industry, phase I (Suarez, 2004; Schilling, 2005; Tidd, Bessant, 2013; Grant, 2016)

Academia and Universities

Meetings and conferences. In this phase, one of the advantages of co-locational agreements is that they are usually product oriented and allow the firm to retain control over IPRs as well as over employees activities. Also, they allow the research to be specific on what the company needs (Bell, 1993). If a university discloses information and technologies with sponsorships, the firm can get the information, but it will not retain any right on the intellectual property (Brannok, Amanda, 1998).

Consulting and research agreements. Consulting is optimal for solving rapidly R&D activities and problems (Perkmann, Walsh, 2007): hence, it lets the firm define the characteristics of the technological field. Additionally, these modes can contribute in boosting the credibility of the managerial choices. Indeed, consultancy can be used to validate externally the new R&D activities (Perkmann, Walsh, 2008).
Moreover, consulting can help a firm to acquire tacit knowledge and to reduce the costs and the time required (Perkmann, Walsh, 2008): in a R&D build-up phase, this can mean shortening the time required to develop a prototype, for example.

Physical facilities. Incubators can create knowledge spillovers that facilitate the creation of complementary and related products (George et al, 2002), as well as new products and prototypes (Cyert, Goodman, 1997). They can lower R&D costs (George et al, 2002) and provide credibility to the firm (Hisrich, Smilor, 1988). Strategic manoeuvring is also boosted by incubators, as they make problem solving activities faster, therefore shortening time to market (Hisrich, Smilor, 1988). However, research institutes were sometimes found to be unresponsive of industry requirements (Brunham,1997) and they haven't always been found to be responsive to short-term needs of the firm (Cyert, Goodman, 1997): hence, they are not always recommended for specifying and creating characteristics of the technological field.

Training. Can help in focussing the research on a field specified by the firm (Gluck et al, 1987), hence this mode can boost the development of the characteristics of the field.

Joint research. This mode helps lowering R&D costs (George et al, 2002) and can lead to a deeper and practical understanding of technology, which means that it contributes in the definition of technological field and facilitates the creation of new knowledge and its transfer (Cyert, Goodman, 1997), which implies that it is good for appropriability.

Academia & Universities – Phase I (Credibility & complementary assets – Appropriability – Characteristics of technological field)			
Mode	Key feature	Correspondence with key variables	Variables met
Meetings & Conferences	Control over IPR	Appropriability	1/3
	Specificity of research	Characteristics of technological field	
Consultancy	Rapid R&D problem solving	Characteristics of technological field	2/3
	Credibility and external validation	Credibility	
	Tacit knowledge transfer		
Physical facilities	Credibility and reputation	Credibility	2/3
	Lower costs		
	Shorter time-to-market	Characteristics of technological field	
	Not always ideal for short term R&D needs	Characteristics of technological field	
	Spillovers and creation of complementary goods	Characteristics of technological field	
Training	Focussed research	Characteristics of technological field	1/3
Joint Research	Low R&D costs	Characteristics of technological field	3/3
	Control over IPR	Appropriability	
	Reputation if partners have a good one	Credibility	

Figure 7. Relations with Academia and Universities, phase I (Gluck et al, 1987; Hisrich, Smilor, 1988; Bell, 1993; Cyert, Goodman, 1997; Brunham, 1997; Brannok, Amanda, 1998; George et al, 2002; Suarez, 2004; Perkmann, Walsh, 2007, 2008)

Institutions

Co-optation and capture. In this phase, controlling directly the institution might lead to the creation of favourable conditions for R&D. Nevertheless, no exact framework covering this particular relationship mode referring to this phase of product development has been found in the academic literature.

Subversion. Institutions such as universities might be used to get precious information to be used in R&D. Nevertheless, academia does not provide indications about this particular relationship mode concerning this phase of product development.

Delaying. In a phase of research and development, it might be important to monitor the institutional scenario: if a company (for reasons that are beyond the scope of the present model) gets to know about the future creation of any kind of institution (for example a set of regulations, or the implementation of a change in a given environment wanted by the government) that might hamper the adoption and the usage of the product the company is working on, it might want to try to make this change happen as late as possible, or never. Hence, a firm can ask for clarifications about this new institution's charter and debates about its scope: these strategies can indeed be used as means to delay the functioning of the institution (Ahuja, Yayavaram, 2011).

Arbitragive morphing. A company can adopt a "normatively desirable standard" (Ahuja, Yayavaram, 2011, P. 1642) to appear in line with the constraints set by an institutions. A way to do this is, for instance, adopting green policies to accomplish legitimacy. This kind of strategy is often used to leverage on legitimacy and fair trade (Ahuja, Yayavaram, 2011) and can therefore boost credibility, as a marketing plan would do.

Institutions – Phase I (Credibility & complementary assets – Appropriability – Characteristics of technological field)			
Mode	Key features	Correspondence to key variable	Variables met
Co-optation and Capture	Favourable conditions for R&D	Characteristics of technological field	1/3 (Weak evidence)
Subversion	Info to use in R&D	Characteristics of technological field	1/3 (Weak evidence)
Delaying	Monitor institutional scenario: feasibility	Characteristics of technological field - Appropriability	1/3
Arbitragive morphing	Legitimacy and fair trade	Credibility	1/3 (Weak evidence)

Figure 8. Relations with Institutions, phase I (Ahuja; Yayavaram, 2011)

2.9.2 Phase 2: Technical Feasibility

Industry

Joint Venture and Strategic Alliances. These can increase technological superiority, as two or more firms pool knowledge and know-how but, on the other hand, they can reveal too much to allies (Schilling, 2005). This means that, considering the most relevant variables characterising the second

phase of the technological development, this solution is positive for technological superiority but nothing has been said by the literature about the effects on the regulatory side.

Licensing. By licensing its own technology, a company can reach more niches and markets (Schilling, 2005). Nevertheless, this also means that the technology is available to more companies, which makes the superiority smaller. This solution allows in this phase to leverage on existing competences, showing technological superiority.

Outsourcing. No exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Internal development. This mode enhances the chances of protecting proprietary inventions and control over the technology and its trajectory (Schilling, 2005). This latter element can be potentially considered as an enhancement of the technological superiority of the innovation, although it is extremely dependent of the specific situation of the firm and of the market.

Industry – Phase II (Technological superiority – Regulation)			
Mode	Key feature	Correspondence to key variable	Variables met
Joint Venture	Technological superiority by knowledge pooling	Technological superiority	1/2
	Risk of knowledge leaking (especially long term)		
Licensing	Reach more niches		0/2
	Technology available to more companies	Technological superiority	
Outsourcing	No advantage was found specifically for this phase		0/2
Internal Development	Appropriability		1/2
	More chances to control technology	Technological superiority	

Figure 9. Relations with Industry, phase II (Tushman, Anderson, 1986; Shapiro, Varian, 1999; George et al, 2002; Suarez, 2004; Schilling, 2005; Grant, 2016)

Academia and Universities

Meetings and conferences. No exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Consulting and research agreements. Consulting can often provide suggestions about optimal strategies regarding new and emerging markets, especially when risk and uncertainty are relevant and predominant elements. Once the initial basic features of the new product are defined, consulting can help accelerating the development among the technological path (Perkmann, Walsh, 2008): this can be considered technological superiority.

Physical facilities. For the companies that are new to a market (or for those operating in an early born one), universities' business centres can lower the costs faced by the firm (George et al, 2002). Incubators provide shortened learning curves (Hisrich, Smilor, 1988) making problem solving activities faster, therefore shortening time to market (Hisrich, Smilor, 1988) and they can therefore be a key factor in the development of prototypes.

Training. It can help in boosting commercial productivity, in transferring tacit knowledge (Gluck et al, 1987) and in expanding technological superiority. Training partnerships can help in making information flow in the company fast and copiously, considering the high "turnover" of students that go through academic programs every year. Eventually, it is convenient as, despite being cheap, it has averagely lots of results. Hence, it is cost effective (Etzkowitz, 2008).

Joint research. This mode boosts specialization and therefore technological superiority (Cyert, Goodman, 1997). Such a kind of relation can be extremely helpful to demonstrate the viability of the technology (Cyert, Goodman, 1997). Many times, a collaborative research is funded by the government (Perkmann, Walsh, 2007), which means that this mode can be used to better adapt to certain regulations or to deal with institutions.

Academia & Universities – Phase II (Technological superiority - Regulation)			
Mode	Key feature	Correspondence with key variables	Variables met
Meetings & Conferences	No data		0/2
Consultancy	Capturing emergent markets		1/2
	Accelerates product definition process	Technological superiority	
Physical falicilites	Lower costs		1/2
	Shortens problem solving in R&D	Technological superiority	
Training	Boosts commercial productivity	Technological superiority	1/2
	Boosts knowledge tranfer		
	Cost effective		
Joint research	Boosts specialization	Technological superiority	2/2
	Helps in demonstrating viability		
	Adaptable to regulatory issues	Regulation	

Figure 10. Relations with Academia and Universities, phase II (Gluck et al, 1987; Hisrish, Smilor, 1988; Cyert, Goodman, 1997; George et al, 2002; Perkmann, Walsh, 1997; Etzkowitz, 2008; Perkmann, Walsh, 2008)

Institutions

Co-optation and capture. This strategy is probably the one where a company needs to be as active as possible, among the manipulation strategies. In this second stage, where the role of institutions is particularly crucial (Suarez, 2004), manipulating them can be helpful to make them shape the trajectory of the path an early born market can take. To do this, academic studies, consultants and lobbyists-related strategies can be used to make a given point of view optimum to decision makers' eyes (Ahuja, Yayavaram, 2011).

Subversion. An institution can be used as a sponsor to validate the credibility of a given project, if there is collaboration with it. This might help enlarging networks and possible installed base (Ahuja, Yayavaram, 2011).

Delaying. Delaying the imposition of certain rules can help a company in exploiting a resource or a situation for a longer time. Nevertheless, no exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Arbitragive morphing. This strategy can be used in this phase to meet some requirements needed to achieve technological superiority, in case there are constraints concerning minimum standards to achieve (Ahuja, Yayavaram, 2011).

Institutions – Phase II (Regulation – Technological superiority)			
Mode	Key features	Correspondence to key variable	Variables met
Co-optation and Capture	Influence decisions	Regulation	1/2
Subversion	Leverage on credibility	Technological superiority	1/2 (weak evidence)
Delaying	Exploit key resource for longer time	Technological superiority	1/2 (weak evidence)
Arbitragive morphing	Meet requirements	Technological superiority	1/2 (weak evidence)

Figure 11. Relations with Institutions, phase II (Suarez, 2004; Ahuja, Yayavaram, 2011)

2.9.3 Phase 3: Creating the market

Industry

Joint Venture and Strategic Alliances. In this third step, pre-emption is important and it can be boosted by joint ventures or alliances, as different firms pool resources and competences to get to a more efficient result. However, especially if one of the firms involved has clear technological superiority, the alliance "helps" the other companies as the first mover advantage is shared, although the technological superiority has been created also with the alliance itself (Schilling, 2005). This can partially hamper the achieved technological superiority as well as the strategic manoeuvring.

Licensing. By licensing its own technology, a firm can usually reach niches and markets more easily (Schilling, 2005).

Outsourcing. As penetration prices in this phase can be relevant for developing a customer base and network effects, outsourcing can be used to optimize production and therefore to produce (and sell) at lower costs (prices), if transaction costs are not high (Schilling, 2005). Together with the boosting of network effects, this might consequently be used in order to have a better technological superiority, as well as a higher degree of strategic manoeuvring.

Internal development. This mode enhances the chances of protecting proprietary technologies and gives the possibility to have a stricter control over the technology and its trajectory (Schilling, 2005), but it presents a high risk of losing the possibility to capture first mover advantages (Deeds, 1996). Also, this leads to a slower innovation process (Schilling, 2005).

Industry – Phase III (Strategic manoeuvring)			
Mode	Key features	Correspondence to key variable	Variables met
Joint Venture	Market pre-emption (first mover advantages)	Strategic manoeuvring	1/1
	If one firm is superior, favour others in technological superiority and strategic manoeuvring	Strategic manoeuvring	
Licensing	Reach more markets and niches	Strategic manoeuvring	1/1
Outsourcing	Lower costs	Strategic manoeuvring	1/1
Internal development	Protect proprietary resources		0/1
	Slow	Strategic manouvring	

Figure 12. Relations with Industry, phase III (Suarez, 2004; Schilling, 2005)

Academia and Universities

Meetings and conferences. No exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Consulting and research agreements. Consulting can help the company in gaining advantages in terms of tacit knowledge's absorption: this enables the company to develop or codify technologies or know-how faster than competitors, therefore leading to a higher possibility of gaining first mover's advantages (Perkmann, Walsh, 2008).

Physical facilities. For firms new to a market (or for those operating in a market that is just being developed), universities business centres can lower the entrance and development costs that have to be faced (George et al, 2002), which means that firms can offer products at a lower price. If, on one hand, incubators can slow down commercialization due to bureaucracy (George et al, 2002), on the other hand, innovation centres can be used to shape policies and practices suitable for the firm (Cyert, Goodman, 1997), so they can help in strategic manoeuvring. For the sake of clarity, it is necessary to mention that this latter is also boosted by incubators, as they make problem solving activities faster, therefore shortening time to market (Hisrich, Smilor, 1988).

Training. No exact framework covering this particular relationship mode applicable to this phase of product development has been found in the academic literature.

Joint research. This mode can lead to lower R&D costs, as they are shared (George et al, 2002): this might lead to lower final prices and therefore to a higher degree of strategic manoeuvring (Suarez, 2004).

Academia & Universities – Phase III (Strategic maneouvring)			
Mode	Key features	Correspondence to key variable	Variables met
Meetings & Conferences	No data		0/1
Consultancy	Tacit knowledge absorption		0/1
Physical facilities	Lower costs	Strategic manoeuvring	1/1
	Bureaucracy		
	Help in shaping market policies	Strategic manoeuvring	
	Faster time to market and problem solving activities	Strategic maneouvring	
Training	No data		0/1
Joint research	Lower costs	Strategic manoeuvring	1/1

Figure 13. Relations with Academia and Universities, phase III (Hisrich, Smilor, 1988; Cyert, Goodman, 1997; George et al, 2002;Suarez, 2004; Perkmann, Walsh, 2008)

Institutions

Co-optation and capture. Manipulating institutions help in shaping the trajectory a market can take or the conditions that are set for the agents to act in a certain situation and or market. To do this, academic studies, consultants and lobbyists-related strategies can be used to make a given point of view optimum to decision makers' eyes (Ahuja, Yayavaram, 2011).

Subversion. Such a strategy can be adopted in this phase to use an institution to expand the market of the new technology. As strategic manoeuvring is fundamental at this stage (Suarez, 2003), a firm might try to exploit an institution to shape licensing policies, modify the conditions for having a more favourable entry timing, or to gain favoured relationships with supplies or producers of complementary products (Ahuja, Yayavaram, 2011). Nevertheless, no further framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Delaying. No exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Arbitragive morphing. A company can use this strategy to adapt itself to a market trend constrained by the institution, in order to be suitable for competing in the market (Ahuja, Yayavaram, 2011).

Institutions – Phase III (Strategic manoeuvring)			
Mode	Key features	Correspondence to key variable	Variables met
Co-optation and Capture	Shape decision making	Strategic manoeuvring	1/1
Subversion	Use institution to expand in a market	Strategic manoeuvring	1/1
Delaying	Delay decision hampering the duffusion of the product	Strategic manoeuvring	1/1 (Weak evidence)
Arbitragive morphing	Adapt to a market trend	Strategic manoeuvring	1/1 (Weak evidence)

Figure 14. Relations with Institutions, phase III (Suarez, 2004; Ahuja, Yayavaram, 2011)

2.9.4 Phase 4: The Decisive Battle

Industry

Joint Venture and Strategic Alliances. By choosing this relationship mode, a company that is running the last steps of the battle to achieve definitive dominance over a market can eventually increase its critical mass and stimulate network effects (Tidd, Bessant, 2013). Collaborating makes it easier to impose a standard, although it would be a shared one (Schilling, 2005). Moreover, alliances can enhance the flexibility of the company, making it more versatile and ready to respond to a higher number of both predictable and unexpected shifts in the market trends and development (Schilling, 2005).

Licensing. Licensing a technology helps in reaching more niches and markets (Schilling, 2005). Hence, this mode might be fundamental for improving network effects as well as to optimise installed base. What is more, being the technology used by many companies, those latter might create complementary products around it which, as explained by Suarez' framework (2004), is fundamental in this phase.

Outsourcing. Although, according to Suarez's framework (2004), this is only fundamental for the third phase, outsourcing can lead to lower prices and boost strategic manoeuvring (Schilling, 2005). No further advantages or disadvantages specifically suitable for this phase have been found in the consulted literature.

Internal development. The most relevant advantage reported by the literature which is particularly suitable for this phase is the fact that this mode enhances the chances of protecting proprietary technologies (Schilling, 2005).

Industry – Phase IV (Credibility & complementary assets – Installed base – Network effects and switching costs)			
Mode	Key feature	Correspondence with key variables	Variables met
Joint Venture	Increases base of adopters	Installed base	2/3
	Newtork effects (collaboration)	Network effects and switching costs	
	Flexibility		
Licensing	Reach niches and markets	Network effects, Installed base	3/3
	Reputation (if partner has a good one)	Credibility & complementary assets	
	Complementary products	Credibility & complementary assets	
	Faster exit strategy		
Outsourcing	Lower prices		
	Newtork and installed base	Installed base	1/3
Internal development	Protecting proprietary resources		0/3

Figure 15. Relations with Industry, phase IV (Suarez, 2004; Schilling, 2005; Tidd, Bessant, 2013

Academia and Universities

Meetings and conferences. No exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Consulting and research agreements. Consulting can boost the speed of R&D by suggesting targeted and tailored strategies to deal with risk and uncertainty. Also, a firm can use it to externally validate its R&D activities and the path of technological development (Perkmann, Walsh, 2008): this means boosting credibility as well as technological superiority.

Physical facilities. Incubators can create knowledge spillovers that facilitate the creation of complementary and related products (George et al, 2002), boosting network effects (Hisrich, Smilor, 1988), switching costs and increasing the size of the installed base. Lower R&D costs (George et al, 2002) provided by this same mode make this process easier. Research centres can therefore provide a network for commercialization, especially if they are kept for a long time (Cyert, Goodman, 1997).

Training. Trainings have a relatively low cost and they can provide the company with quite good results: they are usually very cost effective (Etzkowitz, 2008). For this reason this mode can be useful in this phase, as continuous changes in inputs can produce ideas to stay innovative at low price (therefore can also lead to lower prices and to an increase in the installed base or strategic manoeuvring strategies). Also, it can be useful to enlarge networks (Etzkowitz, 2008).

Joint research. This mode leads to sustaining lower R&D costs (George et al, 2002), creates mechanisms to monitor and redesign the measurement of the problem and facilitates the creation of new knowledge (Cyert, Goodman, 1997).

Academia & Universities – Phase IV (Credibility & Complementary assets – Installed base – Network effect & switching costs)			
Mode	Key features	Correspondence to key variable	Variables met
Meetings & Conferences	No data		0/3
Consultancy	Boosts R&D speed		1/3
	Validates external R&D activities	Credibility	
Physical facilities	Boosts creation of spillovers and complementarities	Complementary assets & Network effects	3/3
	Network for commerialization and boost adoption	Installed base	
	Boosts network effects	Network effects & switching costs	
Training	Lower costs	Installed base	2/3
	Innovative ideas	Installed base	
	Used to enlarge networks	Network effects	
Joint Research	Decreases R&D costs	Installed base	1/3

Figure 16. Relations with Academia and Universities, phase IV (Cyert, Goodman, 1997; George et al, 2002; Suarez, 2004; Etzkowitz, 2008; Perkmann, Walsh, 2008)

Institutions

Co-optation and capture. This mode can be used to create favourable conditions to become dominant in the market. Nevertheless, no exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Subversion. This approach can be used by a company to leverage on social networks created by the institutions (Ahuja, Yayavaram, 2011). It can therefore boost network effects and credibility at the same time. For this reason, this strategy might be used together with perception management, through which a firm can enforce its public position via experts' opinions and conferences (Ahuja, Yayavaram, 2011).

Delaying. The present strategy gives the possibility to delay some rules that would hamper the diffusion of the product or the success of a solid market share. Nevertheless, no exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Arbitragive morphing. As for phase I, this strategy can be used to leverage on legitimacy, fair trade (Ahuja, Yayavaram, 2011) and therefore boost credibility with no (or low) costs.

Institutions – Phase IV (Credibility & Complementary assets – Installed base – Network effect & switching costs)			
Mode	Key features	Correspondence to key variable	Variables met
Co-optation and Capture	Create favourable conditions for diffusion	Installed base	1/3 (Weak evidence)
Subversion	Leverage on institution for the diffusion	Network effect – Installed base - Credibility	3/3
Delaying	Delaying rules hampering the product's diffusion	Network effect	1/3 (Weak evidence)
Arbitragive morphing	Leverage on legitimacy	Credibility	1/3 (Weak evidence)

Figure 17. Relations with Institutions, phase IV (Suarez, 2004; Ahuja, Yayavaram, 2011)

2.9.5 Phase 5: Post-Dominance

Industry

Joint Venture and Strategic Alliances. Joint ventures and alliances can be relevant in this phase, as they can be fundamental in keeping and possibly reaching the critical mass, entering new markets

by using co-specialized resources and in stimulating network effects. Nevertheless, especially when it comes to alliances, they can be unstable, leading to an increased risk (Tidd, Bessant, 2013). What is relevant, however, is that collaborating makes it easier to impose a standard, although in this case it would be a shared one (Schilling, 2005). What is more, alliances enhance flexibility which, especially in a long term perspective, can be extremely helpful for the firm to retain the capability of adapting itself and its offer to possible new unexpected technological trajectories (Schilling, 2005).

Licensing. The choice of licensing a technology helps in reaching more niches and markets (Schilling, 2005), which might be relevant at a stage where a dominance over the market needs to be kept safe. In a long term vision, however, this mode can lead to substantial knowledge and know-how leakages (even if, for the sake of truth, those are always present in the long run, when they can actively contribute in hampering the company's supremacy (Schilling, 2005)).

Outsourcing. Although, according to Suarez's framework, this is only fundamental in the third phase (Suarez, 2003), outsourcing can lead to lower prices (Schilling, 2005) and can consequently boost strategic manoeuvring.

Internal development This mode enhances the chances of protecting proprietary technologies (Schilling, 2005).

Industry – Phase V (Installed base – Network effects & Switching costs)			
Mode	Key feature	Correspondence with key variables	Variables met
Joint Venture	Boosts adopters mass	Installed base	2/2
	Network effects	Newtork effects	
	Unstable (risk)		
	Shared advantage		
	Flexibility (trajectories)		
Licensing	Agreements along value chain by reaching markets	Installed base	1/2
	Risk of knowledge leakages		
Outsourcing	Lower prices	Installed base	1/2
Internal development	Protect proprietary resources		0/2

Figure 18. Relations with Industry, phase V (Suarez, 2004; Schilling, 2005; Tidd, Bessant, 2013)

Academia and Universities

Meetings and conferences. No exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Consulting and research agreements. No exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Physical facilities. This kind of solution leads to lower R&D costs (George et al, 2002). In the long term, the creation of a company, especially when it is founded by the firm (that sustains costs) also provides consultancy, training and recruitment (Bell, 1993), although it is a fixed cost. Research centres can provide a network for commercialization if they are kept for a long time (Cyers, Goodman, 1997). The same is provided by incubators (Hisrich, Smilor 1988).

Training. The present mode has relatively low costs and provides relatively high and good results: it is usually very cost effective (Etzkowitz, 2008). For this reason, it might be useful in this phase as continuous changes in inputs might produce suggestions to stay innovative at low price (therefore, this solution can also lead to lower prices and to an increase in the installed base or strategic manoeuvring strategies). Also, it can be useful to enlarge networks (Etzkowitz, 2008).

Joint research. Besides leading to lower R&D costs (George et al, 2002) and therefore to a potentially higher competitive advantage in the long term, under a cost competition perspective, joint research creates mechanisms to monitor and redesign the measurement of the problem (Cyert, Goodman, 1997): this can help the company in staying innovative, adapting its offer to new changes and keeping the installed base high.

Academia & Universities – Phase V (Installed base – Network effect & switching costs)			
Mode	Key features	Correspondence to key variable	Variables met
Meetings & Conferences	No data		0/2
Consultancy	No data		0/2
Physical facilities	Reduces R&D costs	Installed base	2/2
	Networks for commercialization	Installed base, Network effects	
	Can provide consultacy, training in the long term		
Training	Cost effective	Installed base	2/2
	Helps enlarging networks	Network effects	
Joint Research	Low R&D costs	Installed base	1/2

Figure 19. Relations with Academia and Universities, phase V (Cyers, Goodman, 1997; Bell, 1993; George et al, 2002; Suarez, 2004; Etzkowitz, 2008)

Institutions

Co-optation and capture. No exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Subversion. This approach can be used by a company to leverage on social networks created by the institutions. It can therefore boost network effects and credibility at the same time. For this reason, this strategy might be used together with a perception management strategy, through which a firm can enforce its public position via experts' opinions and conferences (Ahuja, Yayavaram, 2011).

Delaying. Clarifications on the institution's charter and debates regarding its scope or purpose can be used for delaying the functioning of an institution (Ahuja, Yayavaram, 2011): this can be used to preserve the power when a restraining institutional agency is about to raise and interfere with a firm's

business. This strategy can in face be remarkably beneficial for incumbents trying to preserve their own market power (Ahuja, Yayavaram, 2011).

Arbitragive morphing. No exact framework covering this particular relationship mode in relation to this phase of product development has been found in the academic literature.

Institutions – Phase V (Installed base – Network effect & switching costs)			
Mode	Key features	Correspondence to key variable	Variables met
Co-optation and Capture	No data		0/2
Subversion	Leverage on institutions' netoworks	Network effect	1/2
Delaying	Defend company's power delaying limitative reforms		0/2
Arbitragive morphing	No data		0/2

Figure 20. Relations with Institutions, phase V (Suarez, 2004; Ahuja, Yayavaram, 2011)

2.10 Conclusions of the matrix

In light of the considerations exhibited above, it is possible to fill the matrix developed in this chapter with the solutions that, according to the literature, represent the optimal mixes of relationships with Industry, Institutions, Universities and Academia a company shall use to impose a new product as a standard in the market. This is studied per every step of the dominance battle, from the beginning of the R&D activities, to a post-dominance scenario.

It is worth to remind the reader that this framework is only valid for an incumbent operating in a mature but still evolving market, as it has been shaped over academic theories regarding this typology of companies.

What is more, although the present research has a specific company as a target of analysis, the results here shown can be generalised and they can be applied to any suitable firm, regardless the specific industry, that is willing to try to shape the technological trajectories throughout the different steps of the dominance battle. Indeed, it represents a set of strategies that can be used *ex ante*, as

well as in any step of the product's development and market diffusion.

The results are shown in the matrix below.

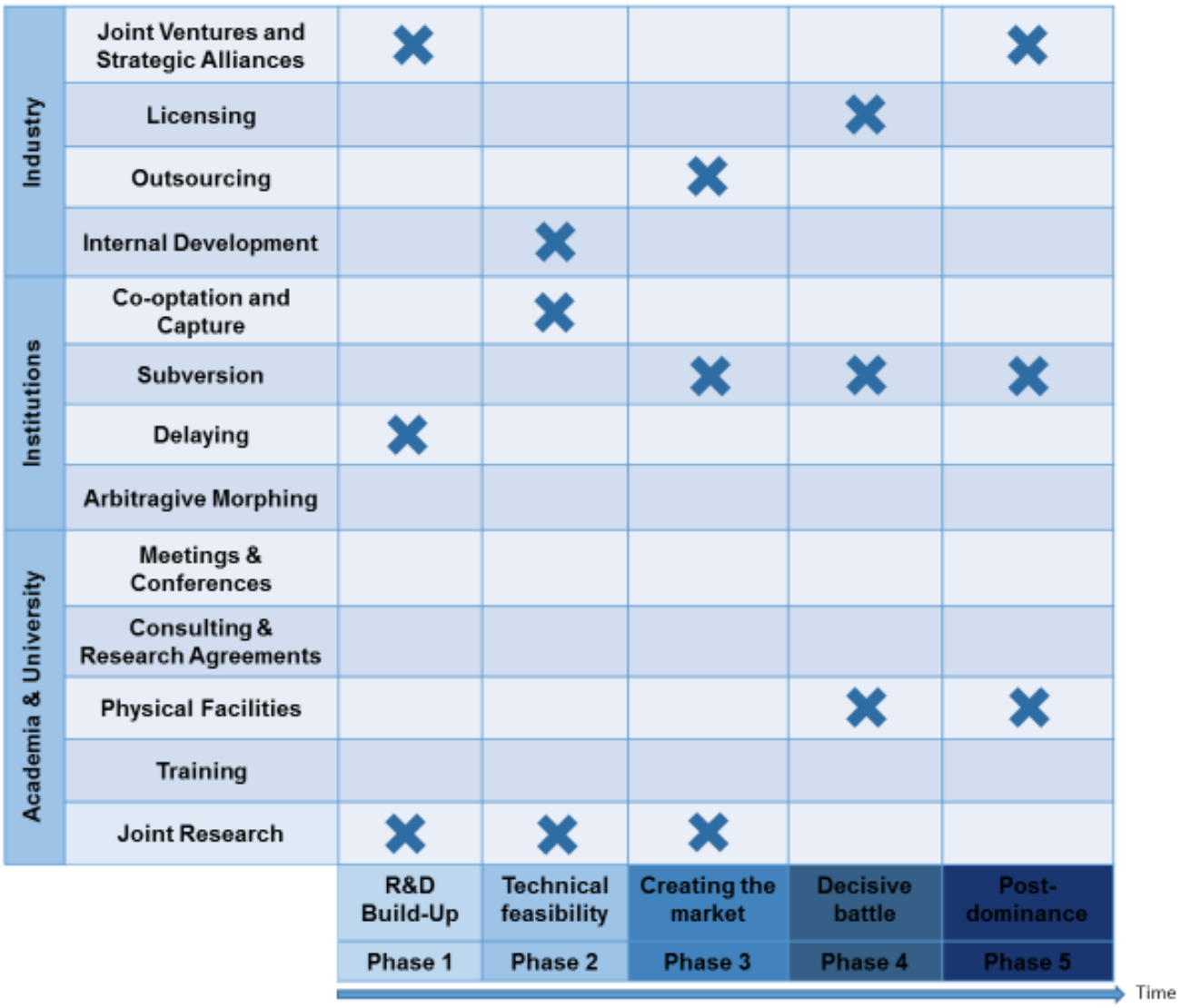


Figure 21. Relational matrix, optimal theoretical relationships (Tushman, Anderson, 1986; Shapiro, Varian, 1999; Suarez, 2004; Schilling, 2005; D'Este, Patel, 2007; Hill, 2007; Ahuja, Yayavaram, 2011; Grant, 2016)

3. Methodology

This chapter presents the methods the author chose to address the research questions. It provides information about the process of data gathering and discusses the reasons for the selection of the research design and strategy, the reliability and the validity of the research.

3.1 Research Strategy

The research strategy might be considered as the basis on which a social research is conducted. For this reason, it is particularly important to reserve importance to it, in order to ensure the quality of the research itself, in terms of connections between theory and empirics, as well as for the validity and reliability of the results (Bryman, Bell, 2015).

The present thesis has been thought to be a *qualitative* research. This kind of approach gives the possibility to provide the reader with a sufficiently broad and exhaustive picture of the specific empirical case analysed by the research. Its aim, in fact, is to generate a theory and managerial recommendations, instead of testing an existing framework or analysis. This means that the gathered data can contextualised and consequently interpreted. The material emerging from this process allows to gather more specific information (hence, to operate iteratively) that lead to the possibility of providing credible conclusions (Bryman & Bell, 2015). At the same time, this kind of approach implies and allows a higher flexibility in the setting of interviews, as well as in the utilization of the emerging data.

Indeed, once the problem has been framed, an extensive literature review has been conducted, in order to implement a model that would best fit the particular situation the author wanted to analyse. Having done so, empirical data have been collected and relevant findings have emerged from it. These latter have been compared with the theory, allowing the researcher to draw conclusions and provide managerial recommendations.

Therefore, the research has been conducted with an *inductive* approach, as the empirical findings have been “fed back into the stock of theory” (Bryman, Bell, 2015, P. 23). Data have been linked to theory, in order to create a framework that might be used by firms (with specified characteristics) to impose a standard in a market, or to maintain it, if it is already existing. However, although the research predominantly has an inductive approach, it also presents some *deductive* characteristics. In fact, the theory generated in the first part of the research is applied to the case study in question in order to address the research questions, which are extremely tailored for Volvo Cars and the launch of its driverless technology. In particular, considering the strategies planned by the company for the future as hypotheses, the research has tested them by filtering them through the developed model in order to asses whether they are optimal or not. Eventually, a suggestion has been inductively (Bryman, Bell, 2015) provided according to the model.

It is therefore possible to state that the present study has been conducted both with inductive and deductive approach.

3.2 Literature Review

The research questions have been defined with a progressive process. The broad topic was initially the only clear issue and it has been gradually narrowed with several personal brainstorming, meetings with the supervisor, by reading books, articles and journals about the imposition of standards and strategies related to this. However, it is possible to say that there have been two fundamental events that helped in the definition of the topic of the research.

First, the researcher of this study was connected to The ( ) Space, a First To Know's office located at Chalmers University in Gothenburg, whose goal is to fill the "gap between the academy, the business sector, the public sector, the cultural sector" (firsttoknow.se, 2017), namely an organization whose aim is to provide companies with connections to students for their research. There lied the opportunity to look for a company within The () Space's network that could be suitable for this kind of study. From this hub, it was possible to contact Volvo Cars' managers.

Indeed, a second decisive element that contributed the most to the definition of the research questions was the first explorative interview, where the issue of the relationship with industry, academia and institutions emerged clearly as an interesting, challenging as well as suitable topic, whose development might contribute in creating value for the firm, too.

The theoretical framework has been developed by collecting extensive opinions by the academia and the existing literature with the final goal of developing a model in order to create a theoretical basis to the research. In fact, articles, papers, journals and websites -especially regarding incumbents operating in mature industries, have been consulted by using different databases and crossing the findings from each of them. The principal platforms were Google Scholar, Science Direct, Elsevier.

The aforementioned topics, in particular standard imposition, technological trajectory shaping and incumbents' survival strategies were taken as inclusion criteria of the research, together with relationship modes between firms in an industry.

These criteria, were used to select sources and theory together with the following keywords:

- standard imposition/ product standard/ industry standard
- product life cycle
- technological trajectory/ technological trajectory shaping
- technological paradigm
- environmental technology
- technological change
- technology battles

- institutional rents
- industry relationship mode/ industry collaboration
- triple helix

The main findings and concepts from every article or website were summarised and eventually connected into a conceptual map. This helped in creating the theoretical framework comprehending the most general and broad managerial topics for the creation of a new theoretical model.

Many of the articles were found in the bibliographies of previously consulted articles: the research process has therefore often been a backward quotation procedure. Every article was also chosen considering the publication date and the number of citations. “The newer the better” was the basic criteria behind the selection of papers to be used in the building process of the theoretical framework. However, many exceptions had to be done, due to the importance of some articles representing milestones in a specific field of expertise.

3.3 Research Design

Given the specificity of the problem and the noteworthy interest in the company itself, the research has been conducted as a *single case study*. Indeed, this would allow to have a “detailed and intensive analysis” (Bryman, Bell, 2015, P. 67) of the case.
This choice was also influenced by the complexity of the projects the company is undertaking and the particular situation the research wanted to investigate on. Indeed, the focus is on a specific product by Volvo Cars and partly focussed on the specific market of the city of Gothenburg.

What is more, the research has combined different qualitative methods, such as empirical interviews and data collection from reports, official websites of different actors involved and databases. According to Bryman and Bell, the single case study is the research design that best allows this combination, allowing the researches to rely on different sources at the same time (Bryman, Bell, 2015).
Sticking to the definitions reported by Bryman and Bell, it is possible to further specify that the present research is intended to be an *instrumental case study* (Bryman, Bell, 2015). Although providing an in-depth analysis and relative specific recommendations that create value for the company is the ultimate goal of the researcher, generalization is also important to the eyes of the author. This thesis, indeed, analyses a particular challenge Volvo Cars is facing starting from Gothenburg, and that it is likely going to face again in the (near) future in different markets. Hence, providing a solution, namely a strategy that can be used again is, to the eyes of the researcher, a goal that will provide even more value to Volvo and to the research itself.

3.3.1 Validity

When it comes to the *external validity* or *generalizability* of the study of a single case study, it can be difficult to achieve extremely good results. As it is explained by Bryman and Bell (2015), a single case cannot be considered to be representative of a complex and ever changing world, especially when the analysis concerns a social phenomenon (Bryman, Bell, 2015). Hence, given the specificity of the topic of the present thesis, its findings can be generalised only if applied to an extremely similar firm with analogous characteristics and facing a similar environment. In brief, external validity is only partially met.

On the other hand, *internal validity*, which is met by the studies matching observations with the theoretical ideas (Bryman & Bell, 2015), represents an advantage of a qualitative research. In this case, it seems to be respected and met, as the empirical data been coherently matched with the theory, and managerial conclusions are eventually provided.

3.3.2 Reliability

Reliability is a criterion that is used in academic environments to evaluate the possible replicability of the study. For the sake of clarity, it is important to mention that it is a very difficult requirement to be met by a qualitative research. Bryman and Bell explain this by stating that, considering that a qualitative research tries to frame, describe and, in a sense, codify a set of social dynamics which, by nature, are always changing and depend on infinite variables, it is impossible to freeze them and to replicate exactly all the settings and circumstances (Bryman & Bell, 2015).
In other words, although social phenomena are always different from each other and although it is not possible to always treat them in the same way, the specificity of the study and the systematic exposition of the research criteria and methodologies that have been used let the author think that the present research is potentially replicable in a similar context. For this reason, it is arguable that this project does meet the principle of *external reliability*. This means that it can be replicated by a researcher dealing with an incumbent firm, operating in a global market where it has a good reputation for the quality of its products or services, that is often involved in consultancy activities by the government and that has contact and constructive relationships with external agents belonging to its industry and to academic environments.

What is more, it is relevant to put in evidence that there are two elements that boost the validation of the thesis itself.
The first is represented by the fact that both the interviewed managers had the possibility to go through what had been written out of their interviews and check their outcomes. One of the directors, in particular, was given the transcription of his interview. This enabled him to review whether transcribing or misunderstanding related errors had been committed.

Secondly, it is important to consider that, during his first interview, the Triple Helix model has been mentioned by one of the managers himself (Mr Rothoff): he has in fact stated that that the company takes the dynamics described by that framework into account when dealing with institutions, academia and industry. This represents an extremely important milestone for the quality of the present research: such a fact means that the theoretical framework and the model here developed are suitable for the context they were created for, namely analysing Volvo Cars' markets. Indeed, it demonstrates that theories used in this research do frame properly the reality in which firms operate and that, consequently, they are a good and reliable base to provide a firm with suggestions (to be consequently considered as valid) and with serious and grounded managerial implications.
For all the aforementioned reasons, it is possible to state that the reliability criterion is met.

3.4 Data and sources

3.4.1 Case selection

The company that is object of this case study was selected for several reasons. As it was mentioned above, thanks to the Gothenburg University's connection, the author of the present study was able to access The () Space's network, which gave him the possibility to propose a research project to different companies, having the possibility to choose among different industry and markets. Given the initial interest in investigating how standards can be imposed in an industry, and taking into account the author's personal interest in transportation industries, the possible connection to Volvo Cars has immediately been taken into consideration. Thanks to extensive researches, mainly on the company's and on the Municipality of Gothenburg's websites, the possibility of developing an interesting and useful project appeared clear to the researcher. Therefore, thanks to The () Space, it was possible to directly contact a manager at Volvo Cars and propose this project.

3.4.2 Primary data and interviews

In order to develop this research, both primary and secondary data have been used.
Primary data were have been the main source of information about the company and about the strategies that will be implemented in order to develop the self-driving technology. They involved two managers.

The first is Marcus Rothoff, the Autonomous Car Program Director. His contact was initially provided by The () Space, and the information that he provided can be considered extremely valuable, as he is directly involved in the development of the technology object of the present study.
The second is Tord Hermansson, the Research and External Contracts Director at Volvo Cars. His contact was provided by Mr Rothoff, in order to allow the researcher to have extensive information about the company's external relationships. Given Mr Hermansson's position and its role within the

company, the author considered the information that he provided to be very relevant and fundamental for the considerations on which the managerial recommendations are based on.

Marcus Rothoff was interviewed on February 27th, 2017 (1 hour) and on March 22nd, 2017 (70 min). Tort Hermansson was interviewed on March 22nd, 2017 (40 min). The interview guides are reported in Appendix II. This gives the possibility to replicate the study and to understand how the analysis was undertaken.
All the interviews took place at Volvo Cars' headquarters in Gothenburg. They were conducted entirely in English, they were recorded and transcribed in order to minimize the errors and to avoid forgetfulness and personal, although non voluntary, misinterpretations of the facts. The goal of the interviews was to gather data and information directly by competent managers directly involved in the project the thesis is analysing, in order to get specific authentic insides which do boost the quality of the analysis itself. Avoiding leading questions was one of the main priorities, as it was necessary to avoid biasing the interviewed, in order to maintain a high quality of the study.

After being transcribed, the texts of the interviews were carefully scanned and their content was re-organised in new separate documents on a *per topic* base, rather than on a *per interview* base. This allowed the author to study the gathered data, compare and integrate them. This process was of course facilitated by the structure of the interview guide and by the nature of the questions, which were relatively general and that were coherently addressed by the interviewed managers. The categories of topics used to cluster information from different interviews were:

- Drive Me: what it is, how it works, its history, current status and future;
- Current status of the driverless technology: how this level has been achieved and what are the future forecasted trends and projects;
- Relationships with industry: past, present, future;
- Relationships with universities and academia: past, present, future;
- Relationships with institutions: past, present, future.

This set of guidelines corresponds to the structure and different sections of the chapter regarding the empirical findings. This latter was planned before the interviews, together with the scheduling of the interview guides and it was eventually adapted according to the diversified collected information.

Being this a qualitative study, semi-structured interviews were thought to be the most suitable approach to collect primary data. This category on interview, in fact, allows a researcher to interview the same person more than once, or to ask for the same information in more than one occasion, in order to get data about the different aspects of the same event, strategy or decision by the company with the aim of going deeper in relevant topics without risking to bias the answer. This allowed the interview sessions to be extremely flexible in terms of contents and allowed the gathering of more

details which were important to the eyes of the interviewed. Considering the importance of the key people that answered the questions, it is possible to state that this approach boosted the quality of the findings.

The questions touched the most relevant topics that needed to be addressed in order to understand the planned relational strategies the company is willing to undertake and, therefore, touched all the aspects of the R&D processes, the status of the research and extensive details about the external relationships in the past, present and future. The theoretical model developed in the literature review has been the general original guideline of the interviews, as they were also aimed at understanding what element found in theory was also present in the reality of the firm. What is more, the specificity of the answers collected gave the possibility to shape the direction of the research and to ask for more specific information in the following interview, after a theoretical preparation. Hence, it is possible to define the process of data analysis as iterative and self-reinforcing.

3.4.3 Secondary data

On the other hand, secondary data were collected from the official websites of the company or from the Municipality of Gothenburg, from the websites of the company and from influential and respected journals. This, of course, was done to try to keep the quality of the data used in the research as high and authentic as possible. What is more, both the Municipality's website and articles from experts in sustainable city planning and development (such as Kenworthy, listed in the bibliography) were used in order to contextualise the innovation in issue within the social and cultural change that is characterising the self-driving car's innovation wave.

3.5 Data analysis

In order to make the methodology completely transparent and clear to the reader of this paper, it is necessary to clarify how the data analysis process was conducted. For the sake of clarity, the research has been structured on the path of the most common approach used in literature for qualitative studies, namely grounded theory. As mentioned before, the process of data gathering was based on an iterative approach, in order to have a systematic collection of data whose analysis could lead to conceptualisation and constant comparisons with the theory, accordingly to Bryman and Bell's framework. In this process, in other words, the collection of information and the analysis proceed together, basing their pillars on each other (Bryman, Bell, 2015) and reinforcing each other.

3.6 Theoretical Framework, Empirics and Analysis: setting

After completing the research concerning the literature review, the theoretical optimal relationship modes were selected by using iteratively the same rational per every phase of the dominance battle and by using schemes and conceptual maps. The advantages and disadvantages of every form or

relation collected from the literature were gathered and matched with every specific mode in every specific phase and were eventually filtered through Suarez' strategic variables. This means that when a specific advantage (or disadvantage) was found in literature, it was matched with the most suitable phase(s). Some logical considerations were sometimes done in order to study what that variable could lead to. For example, if the literature provided evidence that a certain strategy might lead to enhance the credibility of the firm, this information was collocated in the grids of phases 1 and 4 as, according to Suarez's paradigm, this variable is specifically strategic in those moments. This methodology allowed to select the most suitable solution, being coherent with the framework at the basis of the matrix developed in the theoretical framework. The second part of the Theoretical Framework chapter, indeed, evaluates which are the optimal modes in every phase by studying how many key variables they match in every step. Appendix I clarifies further concepts and considerations that were helpful for the selection process.

Once the empirical data had been collected and transcribed, they were studied systematically, and the contents of the different interviews were compared to check whether the emerging information would contrast with each other. The content and the gathered data were then integrated and organised in order to present organically the information regarding the company, the development of the driverless technology and the actual status of the project. Last but not least, the pillars around which the development of the self-driving car is evolving were presented in order to organically go through the external relationships the company has for this scope. This was therefore done taking into account the temporal validity of the relationship and to put in evidence the different formality, nature, advantages and disadvantages of every important relation.

The main rational behind the construction of the analysis, on the other hand, was to allow to draw conclusions about the managerial meaning and the significance of the empirical findings. This allowed, in that chapter, to state the similarities and, consequently, the differences between what the theory suggested and what the company is actually planning to do. Hence, this can be considered as the central part of the research itself, as it contains the final lines of reasoning that did lead to the conclusions of the thesis.

4. Empirics

This section of the paper contains a systematic exposition of the data gathered about the company, the self-driving car and its development status, as well as about the relationships Volvo Cars has with external agents, with a particular focus on the driverless technology. This is predominantly done by using the information obtained through interviews, and it should allow the reader to get the whole set of information she needs in order to understand how the company is acting to introduce this new product into the market.

4.1 Volvo Cars

Volvo Car Corporation, usually referred as Volvo Cars, is a car manufacturer that was originally part of Volvo Group AB. It was founded in Gothenburg, Sweden, on April 14th, 1927 by Assar Gabrielsson and Gustaf Larsson, as a spin-off from SKF (Svenska Kullagerfabriken AB) (volvoclub.org, 2017). The company sells its cars in about 100 countries and in 2016 it had about 31 thousands employees around the globe (media.volvocars.com, 2017).
In 1935, Volvo AB was listed on the Stockholm's stock exchange market and SKF, eventually, sold its shares of the company. On January 28th, 1998, the buyout of Volvo Cars was originally announced and it was bought in the following year by Ford Motor Co (autoevolution.com, 2017).
In 2010, Volvo Cars has been acquired by Geely Holding (Zhejiang Geely Holding) of China. Currently, the company is headquartered in Gothenburg, and its production takes place in Sweden, Belgium, China and in Malaysia (volvocars.com, 2017).

Innovative projects have always been a central focus of the company's mid and long term strategies, as Volvo has tried -since the very beginning of its history, to achieve the status of leader in security and in quality (media.volvocars.com, 2017). The vision of the company is, indeed, "*to be the world's most progressive and desired premium car brand. And we* [Volvo Cars] *believe our global success will be driven by making life less complicated for people, while strengthening our commitment to safety, quality and the environment*" (volvocars.com, 2017).
Hence, the company works to make people's life easier and comfortable, as it wants to be a firm that is built "around the individual" (volvocars.com, 2017). One of the most important and probably innovative projects that mirrors this approach is the plan of implementing and introducing self-driving cars in the market.

4.2 Self-driving Cars

Volvo has been implementing many different projects aimed at developing technologies, features and functionalities of the cars that would increasingly assist the drivers, in order to help them travelling increasingly safely. Some examples of this are the adaptive cruising technology, which

makes sure the car keeps a suitable and safe distance to the car in front -especially in cities' traffic jams, or the park assist pilot, a technology that makes the car steer and brake by itself when parking (volvocars.com, 2017). However, the project that appears to be the most futuristic is probably the one involving self-driving cars.
A car can be defined autonomous when "it is able to navigate without human input, equipped with sensors that read the surroundings, adapting to changing traffic conditions" (volvocars.com, 2017). This means that those cars do contain a set of features that allow the driver to rely on the car itself to steer, brake and accelerate, without controlling the vehicle directly and actively.

For the sake of clarity, it is important to mention that this innovation does not come out of the blue. For years, in fact, Volvo has already been trying to support drivers, assisting them with different kinds of technologies. All of them, however, did not exclude human intervention from the driving process as the self-driving car does.
Volvo Cars has started Drive Me, a project based in the city of Gothenburg, that is taking care of the development of this technology (volvocars.com, 2017).

Moreover, the self-driving car represents a further step in the environmental sustainability challenge undertaken by Volvo Cars. As reported in the mission of the company, in fact, care for the environment is among the three central objectives the firm pursuits and it does so in every model of vehicles it produces. The driverless technology, however, will "optimise the use of the engine or brakes, reducing fuel consumption. By eliminating unnecessary acceleration", the driverless car will enhance the respect for the environment (volvocars.com, 2017).

This technology will have different kinds of applications, as Marcus Rothoff, the actual Autonomous Driving Program Director at Volvo Cars Groups, pointed out. Indeed, there will be two different markets for this product that will reflect its different usages. The first one will be the market for the shared mobility, where the driverless car will be used instead of taxi services or car ownership, for instance, to lower the cost per kilometre in passenger transportation services, as there will not be the necessity to pay a driver. This will start being adopted in urban areas, given the higher predictability of those environments. For this market, a partnership with Uber has been created. For that purpose, the companies fixed a project with given due dates and precise objectives regarding software implementation research activities.
The purpose of this research is, however, to focus on the second market Mr Rothoff spoke about: the private ownership market. For this, the company needs to find a product solution that private citizens can afford and that, most of all, they will be willing to adopt. As a consequence, given the revolutionary characteristic of this innovation, at the beginning, the self-driving feature will be optional, in the sense that this functionality will be included in cars and it will just need to be activated by the driver to start working. Hence, the company will try to introduce it to the users extremely

gradually, in order to try to let it become part of consumer's habits and consequently needs. It is possible to compare this to the introduction of cameras in mobile phones: although taking pictures is not what a telephone is created for and even if the user does not have an urgent need for that, this feature has become so usual (and so many complementary products or services have been created around it, from phone covers to Instagram) that nowadays it is a standard and nobody would probably buy a phone with no camera.

4.3 The Drive Me project

The Drive Me project is a partnership between Volvo Car Group, the Swedish Transport Administration (Trafikverket, responsible for the roads over the national territory), the Swedish Transport Agency (Transport Styrelsen, responsible for the legal framework concerning mobility issues and therefore fundamental for the regulation about the allowance of having self-driving cars), Lindholmen Science Park, Chalmers University, the City of Gothenburg, Autoliv and it is also backed by the Swedish Government.
Mr Marcus Rothoff explained how the idea of developing a fully autonomous car came out of different projects, almost as a natural consequence of the technological development efforts achieved by the company. He describes Drive Me as a multifaceted project, resulting from the convergence of different ideas and projects working on different technologies.

In 2012, Volvo Cars finished working on a European based platooning project[7] (which was actually also focussed on and applied to trucks) called Sartre. This was, according to the manager, the spark that enlightened the company's brains and gave the idea to the researchers. From this, as Rothoff stated, "managers could see some possibilities in the further development of the technology". Namely, instead of having a line of cars following semi-autonomously each other, a type of car capable of driving by itself could reveal to have an extremely big potential. Hence, stated the manager, several steps were undertaken, from the research of partners that would help the company in developing this technology, to the presentation of the project in December 2013 in Stockholm. In this occasion, the company had the chance to show for the first time -in an official event with media and authorities, all the potential and the possibilities that this kind of product might take as a whole set of benefits to the society.
Since then, different technologies have been implemented in parallel. Indeed, according to Mr Rothoff, "it is not correct to think about the development of the driverless car as a unique product": different projects and typologies of technologies are being integrated and will eventually converge

[7] A platooning system is a technology that allows one or more vehicles to follow autonomously a leading car or truck on a road, allowing the drivers to do different tasks, without caring about driving. This technology leads to ecological benefits, increased safety and reduced traffic congestion and it is a step towards the complete autonomy of cars (sartre-project.eu).

toward a unique product. Indeed, the research and development for the self-driving car can be considered as an iterative process comprehending the integration of different paths.

Another fundamental characteristic of the Drive Me project is the fact that it is a test-bed for this product. Being Volvo Cars' headquarters and R&D centres mainly based in Gothenburg, given the optimal relationships that the company has with the municipality, also as a consequence of the historical importance of the company for the city, the Drive Me project is being developed there, although some pilots will also be started in the United Kingdom and in China (volvocars.com).
Indeed, a group of streets constituting a ring in the city has been selected, of course in agreement with the local institutions, to allow autonomous cars to drive for the first time in 2017. Of course, an advantage of this is the physical proximity to the headquarters and to the offices of the company. A second benefit of this consists in the fact that they do represent the typical kind of street where drivers are more likely to get stuck in traffic, and where, consequently, the autonomous car might create the highest value for users, by making the drivers save time and giving them the possibility to do other tasks while being in the car.
Additionally, this typology of street is common in mostly every city, and it is therefore possible to test the car in the market area, considering it as a general and "universal" environment. The outcomes of the tests are consequently considered by Volvo's management to be replicable in other contexts.

Even from a go-to-market and managerial perspective, one of the most important issues and challenges Drive Me was created for is finding out what elements create the biggest value to the customer. Especially considering that this is an innovative and different product, its introduction implies a big change in the habits of the consumer, as well as a big shift in the value proposition of a car manufacturer. One of the main variables that will drive the diffusion of this big change is certainly a cultural shift that is spreading throughout cities and municipalities and that is trying to limit pollution, the use of private transportation and to boost safety and liveability of the cities.

Last but not least, it is necessary to put in evidence polyhedral composition of the members of the agreement.

Autoliv Inc: is one of the world's leaders in automotive safety suppliers. The company develops, produces and markets protective systems such as airbags, camera vision systems, as well as pedestrian protection systems. With a market share of 39% of the global market, it is committed to the creation of the driverless car. Its mission is "to be the leading supplier of Safety Systems for future cars, well integrated with autonomous driving" (autoliv.com, 2017). To Volvo Cars, the presence of this company in the agreements means having a qualitatively

excellent technical support which, from an autonomous driving perspective, also leads to a reduction of accidents (volvocars.com, 2017).

Chalmers University of Technology: is one of the two universities in the city of Gothenburg. It represents an extremely important centre of scientific and applied research, producing advancements of knowledge and collaborating with industry and society (chalmers.se, 2017). Chalmers's participation in Drive Me will vehicle the new technology to the society and it will produce research to be used for future mobility solutions (volvocars.com, 2017).

Lindholmen Science Park: is an "international collaborative environment for research, innovation and education within the areas Transport, ICT and Media" (lindholmen.se, 2017). In other words, it constitutes a platform where academy, public sector and companies can collaborate to create innovation. As for the transportation industry, it focusses its projects on safety, environmental and efficiency related issues (lindholmen.se, 2017). Its contribution to the Drive Me project is represented by the connections of expertise it provides from industry, academia and community (volvocars.com, 2017).

Trafikverket: the Swedish Transport Administration, is the responsible for transport system management for every kind of traffic over the national territory. Also, it handles transport infrastructures such as public roads and railways and it is responsible for the tests to obtain private and professional driving licenses. Trafikverket's ultimate goals are safety and sustainability (trafikverket.se, 2017). Within Drive Me, Trafikverket will "establish how roads, infrastructure, traffic management and connectivity can fully realise the benefits of autonomous cars" (volvocars.com, 2017).

Transport Styrelsen: is the authority that shape regulations and take care they are followed. Moreover, it officially grants permissions, manages vehicle related taxes and other bureaucratic issues (trafikverket.se, 2017). Roads, shipping, aviation and railways are its four domains, where it tries to guarantee accessibility, quality of transportation and safety (transportstyrelsen.se). Among the agents involved in the project, Transport Styrelsen will shape the regulative framework that will allow autonomous cars to circulate (volvocars.com).

The Municipality of Gothenburg: is the administration of the city which, of course, also manages traffic, streets and roads (goteborg.se, 2017). Being also committed towards sustainability and environmental issues, it integrates these two goals. Being the home of academic institutions and of automotive industry partners, it will collaborate to shape the project and make it happen within legal and administrative boundaries (volvocars.com).

4.4 Current status of the technology

During the summer of 2016, a first prototype was produced. According to Marcus Rothoff, however, the R&D process is far from being concluded. As it was mentioned above, indeed, the development is a continuous iterative process that integrates different parallel projects aimed at solving disparate issues and at exploring diversified paths of development.

Nevertheless, having one (or more) prototype in hand has a considerable strategic relevance, as it allows the company to get started in having tests and, most of all, external leasing customers to be used in order to try to study what potential users would want, what would they expect from this kind of product and what they like. In fact, it is possible to state that this iteration embodies a trial and error process, whose goal is to verify what features users like the most and which ones they dislike. Of course, this is still a possibility to try the product, in order to have a concrete idea about what aspects need to be further implemented.

From a first series of trials and verification tests, the staff is increasingly trying to improve the existing car from a model that is able to drive autonomously to another that does not require any supervision, for example. All the different projects existing at the moment will therefore converge toward the final product. Hence, the current status cannot be fully described as a mere R&D phase, since a prototype exists but, at the same time, it is still far from being a definitive model and research, development and time are still required. What is important is that this preliminary but fundamental stage is aimed at understanding the requirements of the technology. This is to prepare the market, namely to make it be ready for self-driving cars and one of the most important elements to achieve this goal, stated Rothoff, is credibility, which means social acceptance “even from a very initial R&D moment, when the customer is not really involved yet”.

According to Mr Rothoff, there are currently three pillars that drive the development of the self-driving car: the partnership with Uber, Zenuity and the Drive me project.

The first does contribute to the advancement of the technology, although it is mainly based on the development of the software that will be used by the company to provide its own service.

Zenuity, whose role and importance to the Swedish car manufacturer will be deepened below, is a joint venture that has been created by Volvo Cars and Autoliv, the leader in automotive safety

system. It is mainly aimed at developing software for the sensors the autonomous cars will be equipped with and assistance systems for the driver. This new company has a strategic relevance both for the mutual exploitation of complementary competences retained by the two companies for the development of such a new product, and for the future of this car, once it will be launched. Last but not least, as stated above, Drive Me can be considered as an initial platform whose role is to collect competences, making them converge toward a unitary task force.

Regulation plays a crucial role in the status of the technology. Given the fact that this is an extremely innovative product that has no precedents, institutions need to create a legal framework that allows car manufacturers to introduce driverless cars in the market. At the same time, however, producers need to fulfil the legal requirements such as minimum pollution and safety standards. Being this latter inexistent, the two fields evolve in parallel and are, in a sense, complementary. In other words, a legal framework is necessary for the launch in the market, as the advancement in technological expertise is partially dependent on the legal framework.
The company is therefore dialoguing with the institutions but is also trying to boost the development of the autonomous car by finding the best partners, both locally and globally. In the mean time, most of the product development is undertaken in Gothenburg.

Mr Rothoff declares that Volvo's target is to be able to launch the first commercial offer of the car in 2021. The "where" is not well defined yet, as it mainly depends on the legal frameworks in different countries, but what is sure is that the company will launch the product on a global scale where and when it will be legal. The car will be a unique model, as it will be a solution that can work globally and that will slowly be brought to new markets as soon as they will be ready.
Still regarding the "global feature" of the car, assuming that a given country will request minimum requirements, different from the others, the research will still aim at creating a global solution fitting all the legal frameworks and, in particular, the objective is to have as a reference the one with the highest requirements, in order to be superior in all the others, still being able to sell the same product everywhere. This, of course, excludes complementary country-specific features such as different light requirements, side markers or right hand traffic (Rothoff, 2017).

Hence, although in 2017 some cars will be released on the streets in Gothenburg, there will not be an early local launch: this market, clarified Mr Rothoff, will only be used as a trial platform, and will be treated as all the other markets. The likelihood of the local success might be influenced by the prior trial process, but the company is not leveraging on this element.

4.5 R&D at Volvo Cars

It is worth to dedicate some time to understand how research and development activities work at Volvo Cars.

Marcus Rothoff explained that, as every innovative firm, Volvo does have the necessity to innovate continuously. That is, of course, because in competitive environments it is essential to try to always be successful and to come up with newest and unique features.

Hence, when the company decides to develop a new product, it starts R&D activities until a first prototype is build, then it improves it with further research efforts until it creates a final commercial product to be launched in the market. Before doing this, however, the company wants to be sure that all the features and characteristics of the product are definitive, as it is clearly not efficient nor optimal to commercialise an incomplete or defective car.

In order to avoid this last scenario, the company innovates iteratively. This means that the idea of a dedicated and time-defined R&D phase is only a concept. Rather, stated Mr Rothoff, it is much more efficient to have a perpetual research, development and perfection phase throughout the whole life of a given product, as it is shown in the diagram below.

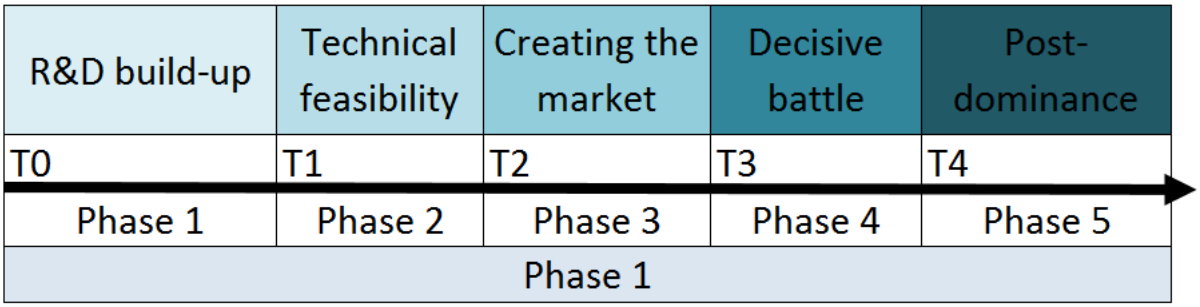


Figure 22. R&D phase at Volvo Cars (Suarez, 2004; Rothoff, 2017)

When a prototype is working properly, indeed, the company starts improving it, for example wondering what additional functions might be added, or whether that car might be developed to drive on different kinds of roads. Hence, it is necessary to "do it all over again, starting from the beginning, to see how the research can be expanded" (Rothoff, 2017).

According to the manager, "this iterative process every time leads to a superior level of performance" and it is extremely relevant from an innovative perspective as it characterises, in a sense, all the relationships with external agents. Also, this approach frames and represents the company's mission of achieving technological superiority, especially when it comes to safety.

4.6 Relationships with the external environment

4.6.1 Volvo Cars as a central hub

As many other firms, Volvo Cars deals with and operates in a competitive environment, that is composed by different actors pursuing diversified and sometimes conflicting goals. From what Mr Rothoff and Mr Hermansson said, this company has an interesting position within its own network. Indeed, both the managers confirmed that Volvo Cars can be considered as a central hub in a set of relationships composed by institutions, academia and the industry itself. Marcus Rothoff himself, in fact, mentioned the Triple Helix model to explain these dynamics. Hence, the company needs to manage the contacts with these three agents in the most efficient way, trying to achieve synergies and advantages out of them.

If we consider every interaction between Volvo and these agents, we obtain three bidirectional flows of data. However, it is necessary to take into account that each of these actors have relationships with all the others: this lead to other bidirectional flows of information in the system. This set of relationships is displayed in the figure below.

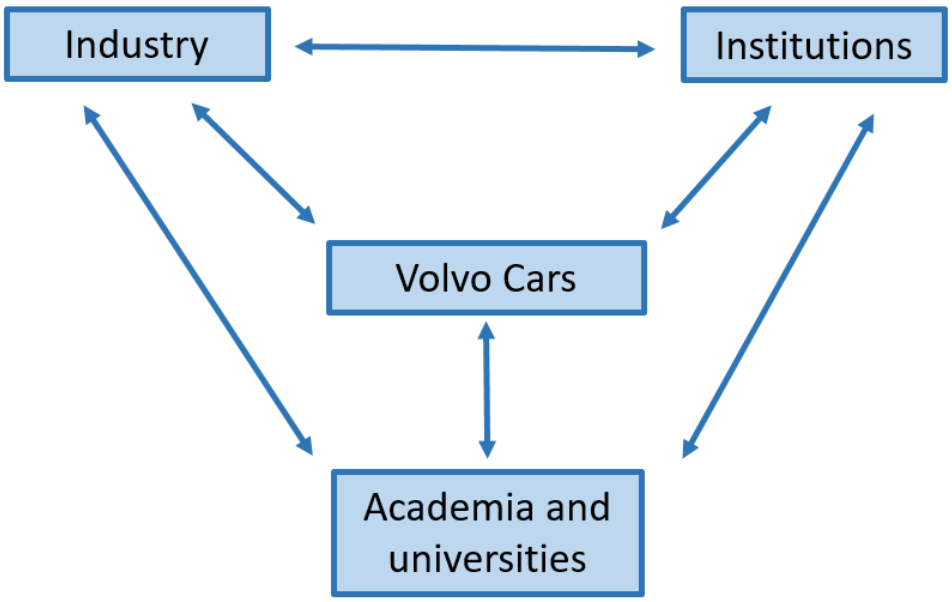


Figure 23. Volvo Cars as a central hub

Although focussing on this might seem not to be particularly relevant, this kind of situation is fundamental for the company and for its R&D, as well as its commercialization and leadership strategies, to the point of being defined by Tord Hermansson as “crucial for the development of the driverless car, both in the mid and long term [..] in the process of accessing resources, competences and in recruitment”.

Marcus Rothoff provided a very interesting example of how this dynamic influences the project he is working on. To develop the autonomous driving technology, Volvo Cars has, of course, internal

research and development centres and laboratories, as well as a high degree of technical expertise. However, the firm does have relationships with academia and universities to get further ideas and technical support. At the same time, it is necessary to deal with other car manufacturers, both in terms of protecting the company's work from the exploitation by these latter and in terms of collaborating for gaining mutual advantages. Last but not least, institutions set constraints to the research in terms, for example, of safety or emissions.

All these dynamics are interdependent and affect each other. Let's assume, for instance, that the government sets a minimum requirement about pollution rates from newly developed cars. Volvo Cars would need to take this into account when doing research, but it would also need to consider this when asking universities to develop a given project or part of the research. At the same time, these limits will need to be considered by the company when choosing whether to establish joint research programs with a competitor, rather than with another one. It is therefore possible to say that the firm is a hub in a network of complex relationships which need to be managed properly and efficiently.

4.6.2 Relationships with the Industry

Given the necessity of developing a new innovative and technological product and, as Mr Hermansson pointed out, provided the fact that the firm operates in a competitive environment where it both needs to defend its own competitive advantage and, at the same time, to try to get access and benefits from other firms' specialized knowledge -even upstream or downstream in the value chain, the development of the self-driving car cannot disregard competitors and other actors in the industry.

Indeed, as explained by Tord Hermansson, although Volvo Group is a very big and influential employer in Sweden, Volvo Cars is still a small actor, when considering the entire car industry. For this reason, it is undoubtedly highly dependent on collaboration with others, especially when it comes to the introduction of a new (probably revolutionary) technology, whose development is likely to be expensive and technically complicated.

At a broad level of analysis, the firm collaborates for collecting data with other car manufacturers in the EU framework programs in non-competitive areas dealing with standardization issues or more general EU based research questions.

Moreover, added Mr Hermansson, Volvo Cars works and cooperates extensively with suppliers. This kind of collaboration can benefit the company not only when it needs to fix, improve and relaunch existing goods, but also when it has the necessity of developing other distinctive new features or an entirely new product.

When asked about the relations with other actors in the industry -including upstream and downstream actors, specifically about the autonomous driving project, Mr Rothoff emphasized that the company does have the necessity to look for the best suppliers to achieve technological superiority since the research and development phase. In this case, some components will probably come from Autoliv (this, of course, matches with the presence of this latter company in the Drive Me agreement), given its reputation and the quality of its product. At the actual status, Volvo Cars "needs to identify what sensors and processors, calculation power" are needed in this kind of car, and consequently needs to "to integrate the suppliers in the project" or to stipulate different kinds of agreements, said Rothoff.

Given the "global target" of the project, the suppliers selected by the Drive Me project (and, most of all, those that will be selected in the future) are being chosen on a global scale, which means that they are not only being chosen among the ones in Västra Götaland[8] for the reason that the R&D activities are mainly located in Gothenburg.

In any case, stated Rothoff, the company already has a clear view about what suppliers to pick and about the fact that there is going to be a "normal contractual relationship" with them, that does not imply structured partnership nor knowledge exchanges, as "excluding the joint venture, it is going to be mainly an internal development process with formal relationships, which means that it is basically going to be outsourcing" (Mr Rothoff).

Evaluating the future, namely market strategies that will involve actions of achieving and keeping the dominance in the market and the consequent suitable industry relationships is, even for Rothoff, an extremely tough guess. The original plan, in fact, is to keep a standard contract-based network of suppliers on a global base to produce and sell driverless cars. The whole strategy, however, will depend on the legal framework, which will clarify what will be required in different countries to sell the car and whether there will be adaptations that will be needed to readjust the product to country-specific requirements.

One of the most relevant relationships with the industry is at the moment represented by the Drive Me, which is described by Hermansson as a "consortium" that can be considered as an "umbrella agreement", under which "there are specified project agreements which are separate from each other: some related to the car itself, some dedicated to the cloud services. For example, there is a project only for the self-parking cars: so they are dedicated project agreements" with different kinds of partners that do not take active part in every project that is developed within the consortium itself. This seems to confirm Rothoff's statements, according to which different projects will converge toward one single final product. Indeed, Hermansson agreed on the fact that there might be synergies among the projects and he specified that one of the reasons why they stipulate

[8] Västra Götaland is one of the "regions", or län, Sweden is made up by. Gothenburg is the most important city in the region.

agreements is because they do need to control efficiently this idea flows and output: although Volvo Cars is in a very good position in the market, it is “still in competitive advantage”, so it needs “to have a progressive environment but, at the same time, Volvo cannot spread too many data or results that are important for the business” (Hermansson, 2017).

As mentioned above, a second milestone representing the relationships that Volvo Cars has with the industry is the partnership with Uber. Although this project has been created to develop new features for the self-driving car, it is mainly focussed on a software that will be exploited by Uber and does not directly concern the research for the private market technology. Rothoff defined it as a “typical project” with a starting and an ending date: this latter will be ended before the mass production will start, as the company needs to get to a final solution before starting producing the product.

Last but not least, among the main industry-relation pillars is Zenuity. This is a joint venture started (as mentioned above) by Volvo Cars and Autoliv, both contributing with 50% of the equity, aimed at developing and perfecting the software for the autonomous car: in particular, its goal is to develop an advanced driver assistance systems (ADAS) and autonomous drive (AD) systems to be used in Volvo cars and to be sold by Autoliv to car manufacturers on its global market. The revenue will be shared by both companies (media.volvocars.com, 2017).
Zenuity will therefore continue existing after the launch of the product in the market, and it will even be a new entrant, able to exploit the knowledge and the competences of two giants of the car manufacturing and car safety systems industries (media.volvocars.com, 2017): as Mr Rothoff stated, indeed, the new company will be focussed on competence build-up. It will work with updates and it will aim at learning how to improve the solution to make it more efficient and to get more value as well, becoming the world leader in autonomous driving software development: the managers do believe that the reputation of the two companies together will allow the new joint forces to introduce the technology fast in the market (media.volvocars.com, 2017). Autoliv will function as supplier and distribution channel, while Volvo Cars will source the goods from the early born company, although there will be no exclusivity granted to any particular customer nor to the owners (media.volvocars.com, 2017).

During the interviews, of course, this raised the issue of appropriability. Mr Hermansson explained that, as stated above, the company does keep -or at least tries to, the highest extent of secrecy, especially when the firm undertakes outsourcing or licensing contracts with other agents operating in the market. On the other hand, within the consortium, there is a high degree of sharing and collaboration. Mr Rothoff, in fact, explained that both Volvo Cars and Autoliv are moving over some patents into Zenuity in order to give the employees of the new-born company full access to a bigger amount of knowledge and technology. At the same time, however, Zenuity itself is creating new

patents that will be kept by the firm, as it will continue existing as an independent company (media.volvocars.com, 2017).

According to Hermansson, when it comes to industry relations for the development of the driverless car, given the current status of the project, the relationships with the different agents in the market shall be aimed at implementing the amount of knowledge, increasing its base in order to have technological advances and to understand how the company can use existing technology, as well as to discover what needs to be further developed to achieve technological superiority.

4.6.3 Relationships with Institutions

When interviewing the two managers from the company and framing Volvo Cars within a network composed by the industry, universities and academia, the firm itself and institutions, the bidirectional flow of information appears to be even more effective and relevant than expected (Mr Hermansson, 2017).

As mentioned above (and as it was confirmed by Mr Hermansson during the interview), Volvo is an important actor in the Swedish economic system and it also does have a global resonance as it has, as Rothoff stated, an "ongoing dialogue with different institutions at worldwide level". Its relationships with authorities can in fact be considered as "a parallel track to make sure we [Volvo Cars] can sell wherever". The company uses trials and tests to demonstrate to authorities and stakeholders the validity of its projects, and Drive Me is an excellent example of this. As stated above, Gothenburg is a test to verify the features of the products. What is more, Mr Rothoff declared that the company also has an ongoing dialogue with the authorities in China, in the US and in Europe.

To be more specific, when analysing the relationship the company has with authorities, there are two different levels that should be taken into account.

First are the dialogue and the contacts with international commissions of regulative frameworks or authorities in a field of expertise, or promoters of socioeconomic integration among countries. The ones listed by Marcus Rothoff are SAE[9] (Society of Automotive Engineers), ISO[10] (International Organization for Standards), UNECE[11] (United Nation Economic Commission for Europe): to the

[9] "SAE International is a global association of more than 128,000 engineers and related technical experts in the aerospace, automotive and commercial-vehicle industries providing cross-sector learning opportunities" (sae.org, 2017)

[10] ISO is an independent, non-governmental international organization pooling shared knowledge and that aims at creating consensus-bases for the creation of standards at worldwide level in order to stimulate innovation and technological advancements. (iso.org, 2017)

[11] UNECE is one of the commissions of the United Nations, and it can be considered as a "multilateral platform" that "facilitates greater economic integration and cooperation among its member countries" (unece.org, 2017). Today it has 56 member States from Europe, North America and Central Asia (unece.org, 2017).

manager, for the purpose of the autonomous driving technology, these can be considered "institutional alliances that might help in the standardization of the product". In fact, some of them will actively contribute in setting up the legal framework required for the creation of the market - therefore setting rules about how, where and when this product should be sold.

Secondly, there is a parallel dialogue with local and central authorities. When it comes to this, it is better for a company, states the manager, to have dialogues with the central government rather than different contacts with local municipalities, as the former is the one that makes the laws and enables a company to sell a product in the whole national territory. The exception, of course, are federal states. In the US, for example, federal laws can concern the car itself, "but for how it behaves on the road, then it's with the central government" that it is necessary to deal with (Rothoff, 2017).

The dialogue with the institutions is fundamental for Volvo Cars and for the driverless' technology in general, as the existence of a legal framework and the commercialization of the car itself are complementary and, of course, one cannot exist without the other. When asked whether or not, in their opinion, Volvo Cars could influence the process of the creation of the legal framework, both the interviewed gave a positive answer.
Mr Hermansson agreed on the possibility for the company to influence the decision making of the authorities and further specified that, although communicating with local authorities would probably be easier, speaking to the central government might be more efficient especially when it comes to small countries such as Sweden. This is possible because it is convenient for both the parties to be in good relationships for mutual advantages: both the actors, he explained, need to have a common view on the strategy for the project, on how to keep R&D in Sweden (and in Gothenburg, for Drive Me), how to access and recruit new personnel to the company, how to attract students and resources to Sweden and join the company, which is fundamental in a small country like Sweden as well as for a car manufacturer like Volvo Cars.

It is however difficult to state to what extent and how a company, although a giant such as Volvo, can influence the decision making process of a government. The interaction between the company and the central government, explained Hermansson and Rothoff, consist in the explanation of the facts, in a consequent dialogue, questions, clarifications and, of course, proposals and suggestions by the company. It is an open dialogue, as there is no self-driving car yet and no one knows exactly how they will work. Consequently, since the authorities do not know exactly what to regulate, they are interested in knowing by a competent and influential actor how the products will probably work, how it has to be built, and what are likely to be its strengths and weaknesses.
What is fundamental to keep in mind, however (and both Rothoff and Hermansson pointed this out), is that, of course, the regulation will not be shaped exactly according to what Volvo Cars explained, as it is an influencing actor as many others that are interviewed at the same time: Volvo Cars is

indeed only one of the stakeholders that are consulted, together with lawyers, the police, and all the other institutions in Sweden.
In a sense, stated Mr Rothoff, Volvo is acting as a consultant for the Swedish government. In March 2016, the government started developing proposals for legal frameworks aimed at testing self-driving cars and, in November 2017, a proposal of an accurate legal framework to sell self-driving cars in Sweden will be launched.

Hence, the company is formally helping the government in shaping a legal framework, and it has all the interests in making this being approved fast, as it is the *conditio sine qua non* the firm can launch the product.
Rothoff claimed that changing some charter or regulation within the company is not a strategy that Volvo will use to adapt to regulations, as its goal is to be above the legal requirements, not to sneak through its deficiencies: the interest is to make it legal and dominating in quality terms, rather than laying on "the legal floor" of minimum requirements. It is however possible to say that the strategy the company will adopt is more manipulative than adaptive. From Hermansson's words, in emerges that this is also what the government wants the company to do, as it seeks Volvo's competent opinions.
In any case, the Mr Hermansson explained that, when contributing to developing this legal framework "today, when there is no regulation, we need to be very active".

He also revealed that there has been a recent discussion between the company and local institutions to develop a mobility project where new types of products and cloud services can be tested, as well as alternative regulations at policy level. This can be considered as an interesting proof of the fact that companies and institutions can collaborate not only bringing a technology to the market to see how it works and whether it can be useful in practice, but also to have a set of rules as a pilot test. This is very difficult for the government, but it can be a strategy to adapt rules to support new technological advancements. The manager used this as an argument to state that the company has a good dialogue with the government.

A similar behaviour will be used in the future. It is intention of the company to be equally involved in future consultancies when new regulations will be needed. Of course, this interest will depend on the issue the new regulation will be about and whether or not it will affect the car. This will be done both by providing advices to governmental offices and to other kinds of institutions promoting research, for example.
Only in the future, the company might be able to try to delete the application of a regulation if it is clearly damaging the consumer (even just leading to higher costs and/or prices) or does not respect technical necessities the government does not know about.

To conclude, it is possible to make a reflection about Drive Me. Both the managers mentioned it as a good example to be used to study the communications between the company and institutions. The responsible of the project stated that Volvo "is using Gothenburg as a test-bed to prove how our solutions work": to sum up, this means they can use facts and findings as communication tools with the authorities at both local and global level. The difference is that in the Municipality, several projects (for example the one about self-parking software) are currently running in parallel and frequent meetings with the components of the Drive Me platform are arranged to discuss about new projects for the future. This is mutually useful to find out what is important for Gothenburg and what is important for Volvo.

4.6.4 Relationships with Universities and Academia

Last but not least come the relationships with universities and academia. As expected, their importance emerged several times during the interviews: in a sense, it is from this pillar that the sustainability of the company is shaped and created.
In fact, as Hermansson pointed out, apart from the technical knowledge that the company gains from consulting these "knowledge centres", those relationships are also "dedicated to research, education and recruitment". Hence, the company also uses these links to address specific research questions, and it "deals with research institutes to validate tests and demonstrate to the market new technologies and new knowledge" (Mr Hermansson).

Volvo Cars does have many academic collaborations with different kinds of universities and faculties, both in Sweden and at worldwide level. However, for historical and geographical reasons, collaborations with GU's Handelshögskolan and Chalmers University of Technology seem to be particularly rooted in the company, as they are physically close to the company's research centres: the former is the School of Business, Economics and Law (Handelshögskolan) from the University of Gothenburg (GU), while the second is the university of Applied Sciences in Gothenburg.
Due to the biggest need for technical support, the relation with Chalmers is, among the two, the most relevant, and it has been defined by Mr Hermansson as "a very good relationship", also comprehending "written agreements at CEO level". According to the manager, therefore, Chalmers can be considered as the most important academic partner the company has.
Speaking about the relationships with universities, although in relation to the Swedish territory, the manager classified them into three different categories.

First are collaborative research agreements. The most important ones, mentioned by the interviewed, are with Chalmers university and the one with KTH[12]. These are joint research projects

[12] Kungliga Tekniska Högskolan, namely the Swedish Royal Institute of Technology in Stockholm

for which the company does apply for funds from the Swedish government. These represent a substantial part of the external collaborations.

Secondly, the company has informal relationships where Volvo “provides Chalmers (or the academic party) with research questions” or problems that arose internally about technological issues concerning advancements that the firm sees and forecasts for the future. This sort of consultations or meetings are “still at a very academic and basic research level”, where the firm does not join in collaborative research but points at different application areas which are considered to be interesting for the mid and long term: in other words, this mode concerns fields of expertise and topics toward which the company needs to put research efforts. Hence, Volvo provides inputs and suggestions to academia to make them have ideas in that specific direction.

The third element is education and recruitment. This is, according to Hermansson, one of the most important elements of the firm/universities collaborations as those centres are considered as a pool where it is possible to find knowledge and competences to be recruited and hired. This is mainly important considering the flexibility and adaptability of academic environments to social and cultural changes.

Depending on what kind of project is running, on the particular objectives of the company and the needs that are required in a given moment, these three pillars are differently important to the company, as they get different weights in different occasions.

In general, as it is confirmed by the example provided by the manager in reference to the Drive Me project, when a program is still in its purely development phase, then the relationship needs to be deeper, as more technical knowledge is required. For this reason, the relationship is more likely going to be collaborative research.
The same kind of link to the academic world is likely to happen in the phase of prototyping of a project, probably as technical support is still extremely needed, especially considering the fact that in that case the technology is still not fully developed.

Especially when it comes to the relations with Chalmers, the company has a lot of informal relationships, arising from the fact that many employees working at R&D projects for Volvo Cars had their education at that institute. For this reason, the company can exploit networks and channels out of the contractual agreements: according to the managers, this is an important resource for the firm. However, as Hermansson clarified, it is not always correct to label the relationship between Volvo and a given institute as either formal or informal, as they do change throughout the time. Indeed, Mr Hermansson is currently starting a relationship with Berkeley, California. Although everyone is of course aware of who the partner is, the connection is still starting at an informal level “like theses,

PhDs and projects with students" in order to allow the parties to get to know each other and understand the new partner's capabilities. If and when both the parts will be satisfied, it will then be possible to start levelling up, "maybe with some collaborative MBAs or collaboration agreements". This is to say that, at least when it comes to Volvo Cars, collaborations might be considered "progressive processes".

A very sensitive issue every agent acting in a competitive environment has to face is information disclosure and networks and capability sharing. These are therefore extremely relevant even when it comes to academia and universities, rather than actual competing rivals. In Volvo Cars, the extent to which information, resources, capabilities and networks are shared "is project specific". Consequently, stated Hermansson, the two parties agree *a priori* on this distribution and about who will contribute to the program and with what resources. In general, the company does not will to share any information and, for this reason, does so only after stipulating a suitable and fair agreement such as Drive Me and the consortium behind it, as Hermansson suggested.

To conclude, it is quite difficult to label the relationships Volvo Car has with different universities or academic partners, as the company does research at different level with different actors at the same time.
Normally, small projects with academia are undertaken in order to be able to do research with different actors. For almost every interaction (that involves resources and personnel) there are project-specific formal agreements, where all the financial and methodological detail are specified.

Furthermore, even according to Mr Rothoff, the concentration of formal and structured agreements with academic partners is stronger in the first phases of new product developments. At that stage, in fact, the technology needs to be defined together with is technical details and features. At later stages, especially after the industrialization and commercialization of the product, when the technology is defined, it is necessary to mainly work on cost efficiency or other kinds of process innovation, rather than product innovation. Hence, given the fact that internal research goes on regardless the relations with universities and institutes, partnerships and collaborations turn to be more important at the earlier stages of a product's life cycle. This means that, stated the manager, there is a cyclical process of relationship importance.

5. Analysis

The present chapter aims at comparing the theory with the empirical situation of the company. This allows to notice the differences between the two and, therefore, to understand if, how and to what extent Volvo should change its strategies. Hence, the Analysis applies the theory to Volvo Cars and comprehends a comparison between what theory suggests and what Volvo Cars is currently doing.

5.1 Current phase of Volvo Cars

As it was put in evidence by the empirical findings, Volvo Cars has a progressive and iterative research and development phase. In particular, when it comes to the commercialization of the self-driving car, advancements are made thanks to different parallel research activities that, at the current status, already do envisage the use of prototypes, despite the commercial launch is still far. For this reason, it seems reasonable to assume that Volvo Cars does have one only phase that embodies what Suarez labelled "phase 1" and "phase 2". For the sake of simplicity, this comprehensive new step will henceforth be labelled "Pre-market Phase".

Now, still about R&D activities at Volvo Cars, it is relevant to keep in mind a second difference that exists between Suarez' framework and the company's activities. In the former scenario, Phase 1 is isolated and time-limited, while in the second one it is perpetual, as it goes through the whole set of the dominance process' stages.

Hence, on one side Phase 1 is merged with Phase 2 in the time horizon that goes from the beginning of the R&D activities (T0) to the launch in the market (T1) but, on the other side, it is also perpetuated potentially in every step. This relevant finding is displayed in the figure below.

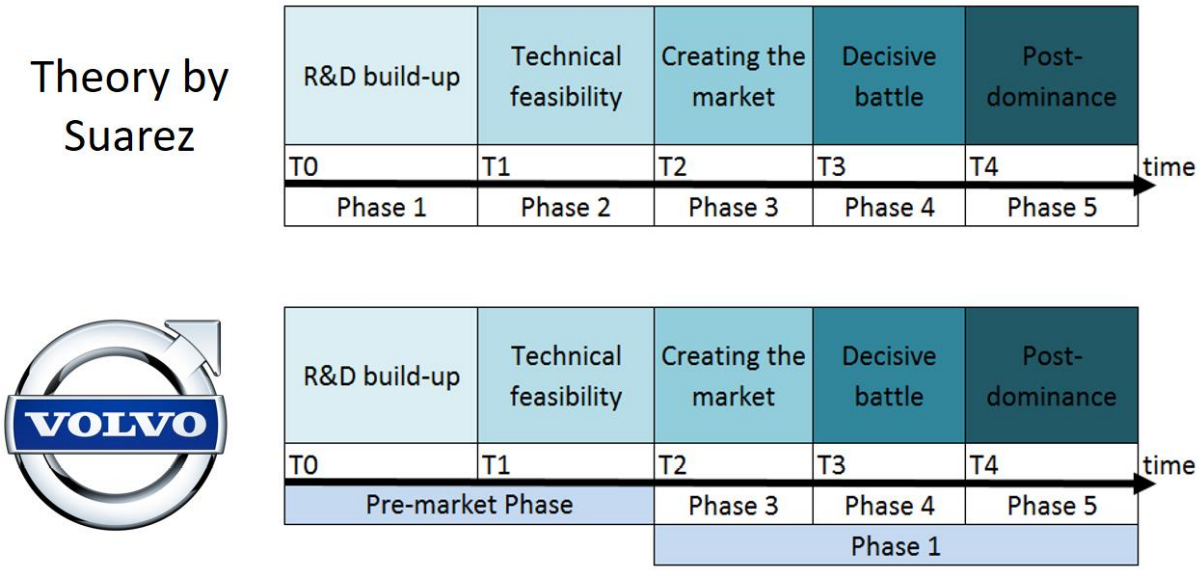


Figure 24. R&D according to theory and at Volvo Cars (Suarez, 2004; Rothoff, 2017; Hermansson, 2017)

5.2 Relationship modes

Empirical findings revealed the existence of three pillars that permit the development of the driverless car: the creation of Zenuity, the partnership with Uber and the Drive Me project. Given the diversity of the actors participating in the third, it does become impossible to make a separate analysis for the relationships Volvo Cars has with industry, academia and institutions, as they are all involved at the same time.

Consequently, the analysis will not follow the structure used above, but it will focus on each single pillar, in order to study their role and relevance throughout the time.

5.2.1 Drive Me

Given the nature and the scope of this project, it is assumable that it will be fundamental in the Pre-market phase only. Nevertheless, it is not possible to provide a common description of the nature of the relationships existing within this agreement. The parties, in fact, belong to all the three categories of actors considered in our model. Hence, it is possible to group them according to that framework.

5.2.1.1 Industry: Autoliv

Autoliv is the only partner representing the industrial category, although it is not a direct competitor, as it operates at a different level along the value chain. Volvo Cars uses Autoliv's know-how in safety issues in order to ensure high quality features to the new car. Although a joint venture (Zenuity) is being created between the two companies, collaborating since the first stage can ensure the companies the possibility of taking the right technological direction from the beginning, as it allows the firm to access Autoliv's critical complementary capabilities and to get tailored inputs that allow the creation of new knowledge and solutions that, in this particular case, are in line with Volvo Car's safety and quality targets, considering Autoliv's core business.

As stated in the empirics, the diverless car represents an extremely important advancement in the technology, as it pursues security and environmental care at the same time: it is arguable that a collaboration between Autoliv and Volvo Cars can enhance this dual characteristic even further, considering the focus on security from the former and the sustainability-based policies of the latter. In light of the increasing importance of the environment in institutions' plans at worldwide level (Kenworthy, 2006), it is possible to argue that developing a technology that simultaneously solves security and environmental issues is a step that car manufacturers have to undertake to survive in their changing industry.

What is more, this "preliminary" relationship, characterised by the presence of other diversified actors, provides the chance to adjust and calibrate pooled resources and collaborations, keeping together flexibility and diversified competence sharing in ever-changing new market dynamics.
This collaboration can therefore be defined as a strategic alliance. By using a pool of dedicated resources (to be seen both in human resources and asset sharing), test-bed facilities which, in this case, is the dedicated ring of streets in Gothenburg, the companies do have the possibility to create a common language, routines and coordination that also constitute a basis for the future long term relationship, namely the joint venture.

Considering the merger between the first two phases of our theoretical framework into the Pre-market phase, and taking into account that theory suggested, respectively, "Joint Ventures and Strategic Alliances" and "Internal development" for R&D build up and Technical feasibility, it is possible to state that the current firm-industry relationships do match theoretical findings. Indeed, as it was pointed out by the managers, Volvo Cars always has ongoing internal R&D activities, especially in its headquarters in Gothenburg.
These findings are summarised in the table below.

Phase	Theory	Empirics	Match
R&D build up / Technological feasibility (Pre-market phase)	Joint Ventures and Strategic Alliances / Internal development	Strategic alliance and parallel internal development	Yes

Figure 25. Theory - Empirics comparison: phase I, Industry

5.2.1.2 Universities and Academia: Chalmers and Lindholmen

Chalmers and Lindholmen Science Park are the two connections embodying the firm-academia relationships. For the sake of completeness, it is important to mention again that Volvo Cars does have other academic partners[13] but, given the higher importance of these two and the deep similarity of the relationships, it appears correct to simplify the analysis by restricting the reflections to the two mentioned in the present paragraph.
Empirical evidence shows that structured and deeper collaborative relationships are needed in the initial phases of a product's development, while "maintenance" connections focussed on process, rather than product innovation dynamics, are needed after the industrialization and

[13] As it was noticed in the previous chapter, Handelshögskolan vid Göteborg and KTH, in Stockholm, are two other historically rooted partners in Sweden. In addition, the company has international firm-academia connection at international level: an example is the now-born relation with Berkeley, California.

commercialization step.
The agreement with Chalmers, at the actual status, provides different kinds of outcomes at different levels. On one hand, it constitutes a form of collaborative research, both aimed at developing an high-quality and technologically efficient output and at trying to root this innovation into the society. This, especially in light of the Drive Me project, allows a perfect match between Volvo's resources and Chalmers' up-to-dated technical research and competences to boost technological feasibility, superiority and credibility (considering the reputations of both the entities), still keeping a suitable level of appropriability.
On the other hand, project-based researches are being conducted in a form that, category wise, can be allocated in the area of consulting and research agreements. In fact, they are less persistent in time and less structured than the core aforementioned research, and they embody what Rothoff and Hermansson defined as parallel research converging toward the definition process of the final product.
On top of this, training activities are held with education and recruitment goals.
The last two categories, however, existed before the Drive Me project and can therefore be considered, even in a study focussed on a single product such as the self-driving car, as activities permanently done by the company.
It is stateable that all the aforementioned relations between Chalmers and Volvo Cars create synergies between each other, which make their total value higher than the mere sum of the single results, as they create an overall harmony that results in a deep respect, geographical complementarity and, most of all, in a dynamic and creative, technologically sustainable environment in the short and long term. In fact, this multilevel system provides solutions to immediate problems and continuous inputs for future ones. Having as a reference point the driverless car, and marking a distinction between Pre-market phase and the others, however, it is possible to assign different weights to those relationships.
Pre-market phase sees joint research as the principal relationship mode, although, as specified, consulting and research agreements as well as training are present. The opposite scenario can be found for phases 3 to 5, where Lindholmen appears to acquire importance.

In fact, an analogous line of reasoning can be used for analysing the relationship with Lindholmen Science Park. It is possible to state that the main difference with the former entity is that, being a Science Park, it provides more extensively contacts and networks with industry, academia and community. Hence, to the author of this study, it seems reasonable to state that its importance to Volvo Cars is mainly provided by the fact that it constitutes a physical centre, namely a cluster, where laboratory-based ideas meet applications and, most of all, users willing to adopt them. As the theory pointed out this means, especially in the mid-long term, the possible creation of spillovers, the boosting of strategic manoeuvring-related policies and, most of all, a theoretically potential infinite

number of new connections, markets alliances and commercialization advantages. The most important among these is the possibility of enlarging the installed base and therefore the possibility of creating network effects. For this reason, it seems reasonable to state that this alliance acquires its strongest potential and relevance in a market-based phase, namely from the commercialization moment on. Considering that, for what concerns the current status of the technology behind the driverless car, the interviewed managers mainly focussed on activities conducted together with Chalmers, and that the partnership with this university and with Lindholmen is an element that is always present in Volvo's R&D activities, regardless the Drive Me project, it is possible to assume that Volvo Cars itself will mainly exploit the partnership with Lindholmen after the commercialization of the self-driving vehicle.

To conclude, it is reasonable to assume that while consulting and training are present in every phase of the dominance battle, from the start of the R&D activities to a post-dominance scenario, joint research is preponderant in a pre-market phase, while physical facilities will be more relevant from the commercialization on. This partially meets theoretical findings: although consulting and training never emerged as particularly relevant (while here they do contribute actively in creating the sustainability of the innovative ecosystem Volvo operates in), joint research was assumed to be the ideal option for R&D build-up and technical feasibility steps (therefore for the pre-market phase) and physical facilities as the best for phases 4 and 5, namely decisive battle and post-dominance. The only significant discrepancy, therefore, is for the third phase, "creating the market".
These findings are summarised in the table below.

Phase	Theory	Empirics	Match
R&D build up / Technological feasibility (Pre-market phase)	Joint research	Joint research, consulting, research agreements and training	Yes, with extra features in the empirics
Creating the market	Joint research	Physical facilities, consulting research agreements and training	No
Decisive battle	Physical facilities	Physical facilities, consulting and training	Yes, with extra features in the empirics
Post-dominance	Physical facilities	Physical facilities, consulting and training	Yes, with extra features in the empirics

Figure 26. Theory - Empirics comparison: Academia and Universities

5.2.1.3 Institutions: Trafikverket, Transport Styrelsen and The City of Gothenburg

As for the relationships with academia, Trafikverket, Transport Styrelsen and the Municipality of Gothenburg are not the only institutions the company has to deal with. The Swedish Government endorses the Drive Me project and the idea of the development of a self-driving car, while other international kinds of institutions[14] have regular contacts with Volvo Cars. As in the previous paragraph, however, it is possible to integrate the analysis of all these actors, given the similarity of the relationships.

What emerges from the empirics is that institutions do have the interest in the success of the self-driving car as a standard in the market. In fact, it is possible to argue that the mission of the company, even in relation to this specific product (namely, improving transportation's sustainability, quality and safety) corresponds to the ones of several institutional entities.
At a municipality level, the diffusion of a self-driving car, in fact, would perfectly match with the Development Strategy Plan for 2035, aimed at implementing safety, liveability and mobility in the city. Hence, taking into account the company's target of environmental sustainability and security guaranteed by its vehicles, the self-driving car can be considered as a contribution to the institutions' goal.
At a national level, Trafikverket and Transport Styrelsen need to know and understand how to deal with this radical revolution in the transportation industry, even since the trials of the prototype and the development phase. Provided that street administration and regulations will need to be adapted to this change, considering that the final features of the technology are still unknown but that a body of norms needs to start being developed, and taking into account that the diffusion of the product will sooner or later involve Sweden, as other companies are also trying to develop this product, trying to understand how this product will look like is in the interest of the authorities. Collaborating through dialogues and consultancies is therefore the way those institutions chose to interact with Volvo Cars.

This is demonstrated by their participation in the Drive Me project which, for this reason, appears to be, as just stated, a dialogue, rather than a pure hierarchical relationship (which, of course, does not necessarily mean that the institutions will passively accomplish the industry's trend). This statement is justified by the empirical evidence concerning the importance that the company has within Sweden (and abroad) at employment and innovative level which, in a sense, gives Volvo some bargaining power derived from economic and reputational relevance. Being Volvo Cars a successful incumbent in the global car manufacturing industry with a consolidated reputation for quality, operating it on a worldwide level, and being it owned by Geely Holding, it seems legitimate to hypothesize that the

[14] SAE, ISO, UNECE.

company does have an even minimum influence over international institutions such as SAE, ISO, UNECE[15], which was also confirmed by the interviews.

Since the authorities themselves are willing to take into account Volvo's opinion when shaping a regulatory framework, it is assumable that the company is in the position of undertaking a manipulative rather than an avoiding strategy. On the other hand, there is no bright evidence that the firm has developed an exact strategy to be used with the goal of directly influencing governmental and regulatory bodies other than creating occasions of dialogue to show the results and the forecasted trajectories of the research and development activities. Nevertheless, assuming that the firm has the willingness of making the authorities approve its project, it is possible to speculate on the fact that, during those consultation sessions, it might potentially try to establish its point of view, making it look like a set of optimal decisions suitable to be taken as a basis for the development of regulations. During the pre-market phase, this might be further enhanced by the approval of the other respectable and competent members of the Drive Me agreement (Autoliv, Lindholmen, Chalmers). This is exactly on the track of what Ahuja and Yayavaram define as Co-optation and Capture (Ahuja, Yayavaram, 2011). Consequently, this not only seems to be the most efficient choice for Volvo, but it also partially meets the recommendations provided by the theory, as this same mode was assumed to be the most suitable for the technical feasibility phase, merged in the Volvo Cars-tailored framework with the R&D build up stage.
Moreover, this solution can fit both the dominance battle at international, national and municipal level for the aforementioned reasons. Furthermore, this is seen to be particularly true for Gothenburg's market, given the deep and historical relation between the firm and the city.
It is again worth it to clarify that this does not have to be seen as a negative or criminal activity, as it is done for goals that lie within the limits of legality, respect for individuals, their safety and competition dynamics. Also, the constraints that the authorities would set, namely sustainability and safety, do correspond to the company's ones, as mentioned several times above.

The *conditio sine qua non* allowing a co-optation strategy was the close collaborative relationship with institutions, endorsed by other authoritative agents within Drive Me. As a consequence, in a post-Drive Me scenario, namely from commercialization on, this combination might not hold, if not at municipal level, still in force of the nature of the relationship between Volvo and the Municipality of Gothenburg. Not having particular empirical evidence, it is therefore only possible to assume that after the introduction of the driverless car in the market, the company's influence will be smaller and, for this reason, it is arguable that avoidance strategies will be more likely to be undertaken. Given the commitment for continuous research and the creation of Zenuity, it looks reasonable to

[15] Although, of course, the influence that Volvo Cars can have over Swedish institutions is much higher for historical, geographical and socio-political reasons.

assume that delaying strategies might be required, in order to try to exploit as long as possible the newly shaped legal conditions as well as the resource allocation plans on which future R&D schedules will be based on. It is however extremely hard to predict what strategy will be used, especially in light of the still inexistent regulatory frameworks and markets of the product.

However, following this line of thoughts and assuming this to be realistic, it is possible to conclude that Volvo does not follow the guidelines provided by the theory for phases 3, 4 and 5. Delaying might indeed be the chosen relationship mode, with the addition of a possible Co-optation and Capture strategies for the local market in the Swedish city of Gothenburg, where it has a bigger influence. According to the upcoming developments, the theoretical framework might be met only in this last scenario, in case the company will be able and will find convenient to adopt Subversion strategies.

These findings are summarised in the table below.

Phase	Theory	Empirics	Match
R&D build-up / Technological feasibility (Pre-market phase)	Delaying / Co-optation and Capture	Co-optation and Capture	Yes, partially
Creating the market	Subversion	Delaying	No
Decisive battle	Subversion	Delaying	No
Post-dominance	Subversion	Delaying	No

Figure 27. Theory - Empirics comparison: Institutions

5.2.2 Zenuity

The joint venture, which has not started operating as an autonomous company yet[16], will become the driver for the commercialization of the product in the future, once it will be fully developed. From the empirical findings, in fact, it seems that this new company has not contributed actively to the development of the driverless car and that, instead, it will take advantages to the companies (and will consequently be more important) only in a successive stage. A demonstration of that, according to the researcher of the present study, is the fact that Autoliv currently contributes to the R&D process

[16] Last update on April 26th, 2017.

by participating in the Drive Me project, being it one of the partners.

It is therefore clear that the companies chose this joint venture as the way (or one of the ways) to face the industry in the mid-long term, namely, during phases 3, 4 and 5. Nevertheless, it is appears necessary to clarify several aspects.

Firstly, the fact that this company will compete on the market of the self-driving cars, still being owned for half of its shares by Volvo Cars, does not mean that the Swedish manufacturer will have no other relationship with other agents in the industry.
Secondly, considering that in the mid-long term, namely when the new company will be fully operative, Volvo Cars will source from Zenuity and, taking into account that it will have no exclusivity towards its competitors, it seems legitimate to consider this relation as an outsourcing contract. Indeed, regardless the equity share[17] owned by Volvo Cars, the manufacturer will get software from the joint venture and, as Mr Rothoff declared, will source other components by the most efficient partners it will be able to source in the global market. These two sources, together with its own capabilities and internal research, which will still be done, will allow to achieve high quality, possibly at relatively low costs (assuming that outsourcing contracts will be held with suppliers producing at the lowest costs possible for the highest quality possible).

Finally, defining Zenuity as a joint venture with "outsourcing" features does match the theoretical findings that suggested "Outsourcing" and "Joint ventures and alliances" as ideal relationship modes, for the go-to market and post-dominance steps of the dominance battle, respectively. This is in line with Mr. Rothoff's words, according to which, excluding the joint venture, outsourcing is going to be the main contractual typology, although the uncertainty caused by legal frameworks might play a crucial role in the future. The relationship will consequently be a mixed and hybrid form in between outsourcing and joint venture.
Nevertheless, there is no evidence that the firm's strategy will match, in the decisive battle phase, the theoretical suggestion of using licensing strategies.
These findings are summarised in the table below.

[17] The equity share retained by Volvo Cars is currently 50%, but it is not possible to know if this is going to change in the future, nor whether there already is an agreement about this. For the sake of simplicity, here we assume that this variable will be constant. However, it is possible to assume that, given the non-exclusivity clause for sourcing from Zenuity, this variable is not relevant to the purposes of the present study.

Phase	Theory	Empirics	Match
Creating the market	Outsourcing	Hybrid: Joint Venture / Outsourcing	Yes
Decisive battle	Licensing	Hybrid: Joint Venture / Outsourcing	No
Post-dominance	Joint Ventures & Strategic Alliances	Hybrid: Joint Venture / Outsourcing	Yes

Figure 28. Theory - Empirics comparison: Industry, phases III, IV, V

5.2.3 Partnership with Uber

Despite one of the assumptions of the present research was to focus the analysis of the private market, it is worth to spend some words on this partnership and to make considerations about the potential importance this relation might have for the company in the future. In fact, considering the popularity Uber has in several countries around the globe, it might be possible to state that the adoption of this product by such a company would benefit Volvo, as it would be an indirect advertisement of the driverless car. However, this assumption would only hold if the cars themselves would be Volvo branded, as this is what is directly seen by customers. Nevertheless, being the agreement focussed on the development of the software, it is possible to exclude this pillar from the evaluation of the ways Volvo Cars can use to impose the driverless car as a standard[18].

Nevertheless, the connection with Uber might be used in the future in order to expand the business to new markets, or simply for marketing purposes. It is arguable that, in every phase of the dominance battle, the settlement of a new contract with this firm might potentially lead to different kinds of advantages.

In the pre-market face, that temporarily corresponds to the development of the software for the Californian company, as well as in the commercialization stages, it could give the firms the possibility to advertise their offer and their brand. From Volvo Cars' perspective, being chosen as partner by a firm operating at worldwide level can be considered as a confirmation of its reputation and its quality standards. It would be easy, in other words, to leverage on credibility.

Moreover, disclosing Uber's adoption of this technology might help the company in establishing the driverless car within customers' habits. It is in fact arguable that potential adopters could be

[18] This is assumable from a pure managerial point of view not considering marketing strategies by the companies.

persuaded by the safety and quality of this new typology of car, when this is adopted by another globally diffused firm with safety and reputation as core strategic elements.

Last but not least, if well promoted, a transportation service provided with a driverless car by a Uber-Volvo Cars partnership might be wanted by the Municipality of Gothenburg itself. Within the framework of the Development Plan for 2035, this kind of solution might help reducing even more the usage of private cars and would help boosting safety and sustainability.

Nevertheless, from the interviews and from the data collected for this research, there is no evidence allowing to state that Volvo Cars is planning to deepen the relationship with Uber after the expiration of this research contract.

5.3 Theory and findings: a short summary

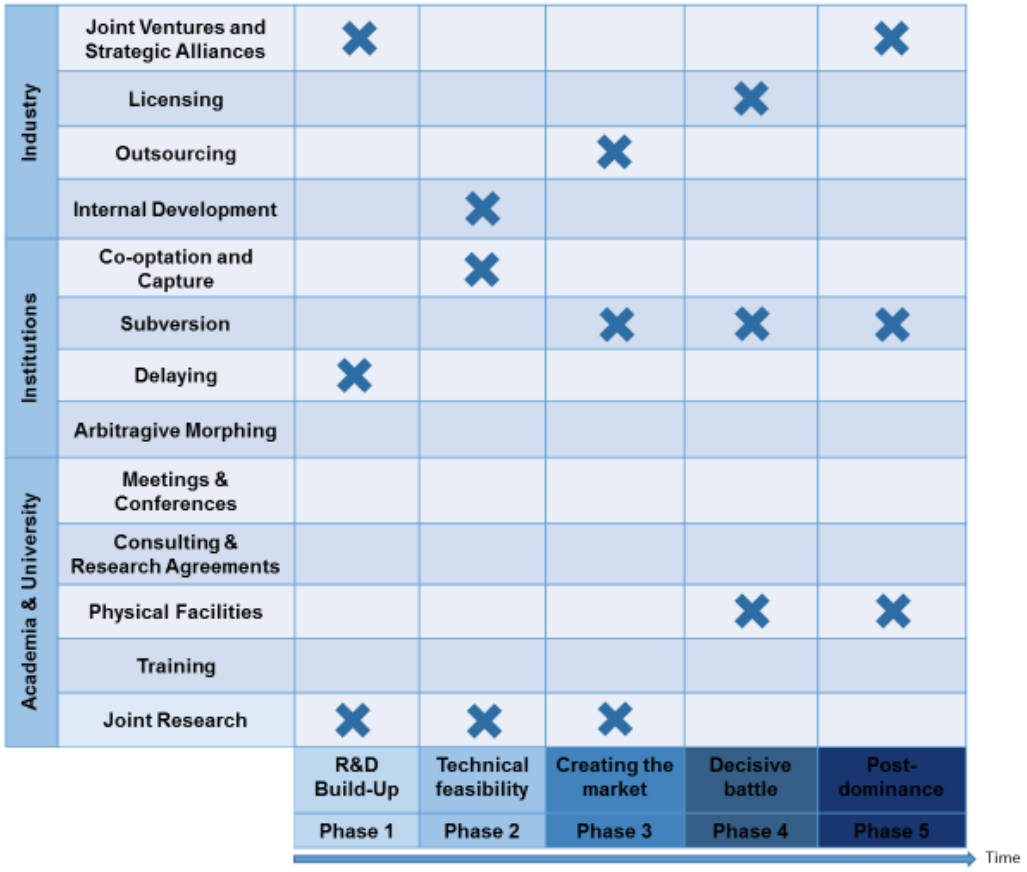
This research has tried to address the problem of incumbents operating in innovative industries and trying to retain competitive advantage by shaping emerging technological trajectories (Klepper, 1997; Dosi, 1982). When a new technology, embodied in a product or a service, is introduced into the market, some particular features can in fact emerge as dominant paradigms, leading to the imposition of an industry standard, here considered as an emerged dominant trajectory (Suarez, 2004).

Among the models suggested by the literature, the *ex-ante* approach used by Suarez (2004) has been thought to be the most complete to be used to study what elements an incumbent should leverage on throughout all the phases of the dominance struggle. On the basis of the Triple Helix model (Etzkowitz, Leydesdorff, 2000), this has been integrated with some of the strategies suggested by Ahuja and Yayavaram (2011) to manage the relationships with institutional actors and with D'Este and Patel's categorization (2007) of firm-university collaborations, in order to study, with a relational approach, what are the optimal relationships in every step of the dominance battle an incumbent should have with industry, institutions, academia and universities, in order to impose its product as a standard.
This has been studied through the creation of a matrix, reported again below, which has been thought to be a tool to address the research questions, as it integrates the time-based *ex-ante* perspective with different relational key strategies suited for the imposition and control of a standard.

This has been applied to Volvo Cars in relation to the development of its self-driving car, actually still in a pre-market phase. The aim was to provide the company with tailored managerial suggestions and recommendations.
Empirical evidence has shown that three pillars lay at the basis of the development of this new technology, namely the Drive Me project, Zenuity -a new joint venture founded together with Autoliv,

and a partnership with Uber which, however, represents a market different from the private ownership one studied by this thesis.
Drive Me, undertaken with actors from industry, institutions as well as academia, is an alliance within which different projects are implemented in parallel: they will converge towards the final product, which is implemented iteratively with a trial and error R&D process, ameliorated by the presence of industrial and academic partner providing knowledge and capabilities. Institutions are involved for the development of a legal framework and for the pilot on-road trials.
Zenuity, majorly important for the market phases, will on the other hand constitute the cornerstone around which part of the R&D and the outsourcing activities for the production will take place.

The theoretical findings slightly differ from the empirical ones. Both are reported below and the comparison between the two will help in generating managerial recommendations tailored for the specific situation and context Volvo Cars operates in.



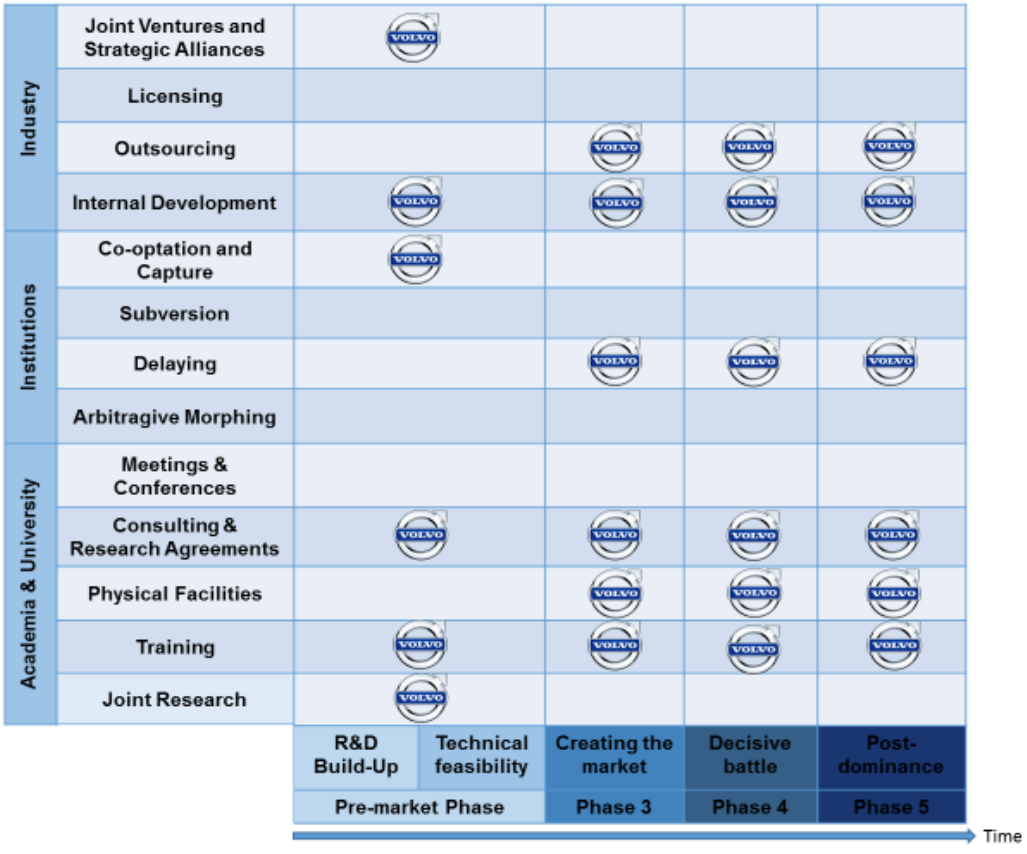


Figure 29. Relational matrix, theoretical and empirical results (the former above, the latter below) (Tushman, Anderson, 1986; Shapiro, Varian, 1999; Suarez, 2004; Schilling, 2005; D'Este, Patel, 2007; Hill, 2007; Ahuja, Yayavaram, 2011; Grant, 2016)

Conclusions

This last part of the thesis is dedicated to addressing the research questions presented in the introduction. What is more, the main findings and the relevance of this study are here presented, together with some managerial recommendations. Last but not least, the limitations of the study and some suggestions for future research are provided.

The present research is aimed at trying to develop a theoretical model that can be used by incumbent firms as a managerial tool in the process of imposing a new product as a standard in the market. In particular, the target of this study are all those companies that, as dominant actors already retaining bargaining power within a market do have a minimum extent of reputation in it and that have to deal with different external agents, namely institutions, actors operating in the industry, universities and academia when facing the emergence and the development of a new technological wave. In this scenario, it is fundamental to try to keep being as innovative as possible, in order not to be evened by competitors or new entrants in terms of innovative offer to the customers and, in general, to the market.

As a single case study, this research's aim was to perform a research tailored for Volvo Cars and, in particular, for the development of its driverless technology. From its headquarters in Gothenburg, Sweden, the company has indeed started extensive research and development activities to foster the technological advancements regarding this product and it has established several diversified and strategic relationships with different agents at national and international level. The research question this thesis wants to address is:

"What is the best set of external relationships Volvo Cars can have to impose its autonomous driving technology as a market standard?"

However, given the location of the company's headquarters, the historical and consolidated relationship between the company, the local universities and institutions and taking into account the mobility plan launched by the Municipality of Gothenburg were, in the mean time, the on-road pilots have been started, introducing the following sub-research question was considered to be pertinent:

"*What is the best set of external relationships Volvo Cars can have to impose its autonomous driving technology as a standard in the market of Gothenburg?".*

Although the imposition of market and industry standards is a hardly debated issue in academic and managerial literature, the academia has not provided a model that supports innovative firms in achieving this result, especially under a relational point of view, leaving a grey area to be filled by

future research.
Most of the studies have an *ex post* approach (Suarez, 2004) and suggest key resources (Shapiro, Varian, 1999) companies should leverage on, or single commercialization strategies (Hill, 1997; Schilling 2205) that might help the process of standard imposition. Some researches do consider extensively the influence that socio-political factors have on this process, giving importance to the social, human aspects of it and therefore to its dynamism, even in light of political driving forces (Dosi, 1982; Clark, 1985; Tushman and Anderson, 1986).

Therefore, in order to try to partially fill this academic gap, an analytical model with an *ex ante* approach has been created. After an extensive literature review, taking into account the exuberant coexistence of any firm with its industry, with institutions and with academic agents accordingly to the Triple Helix paradigm (Etzkowitz, 2008), and considering the diversity between the different steps of a product's life, this research has tried to develop a framework to provide a theoretically optimal set or relationships that are considered to be more likely to lead to the imposition of the new technology as a standard. In other words, each of the five different phases of the dominance battle defined by Suarez (2004), from the beginning of the research and development activities to a situation where the company has the dominance over the market and has imposed its product, is matched with a set of three categories of external relationship modes. These latter were selected among the plethora suggested by the literature after an extensive review of the different theories. Grant (2016), Schilling (2005), Tidd and Bessant (2013) were the most authoritative sources that provided the possible relationships with industry, while Ahuja and Yayavaram (2011) were considered to be the milestones for the institutional links. Last but not least, D'Este's and Patel's studies (2007) constituted the basis for the categorization of industry-academy relations.
The theoretical model and, most of all, its outcomes were compared to the empirical findings gathered with primary and secondary researches on Volvo Cars. The former were collected through three interviews to managers from the company, while the latter through the consultancy of websites and journals.

Main findings

The research has shown that Volvo Cars' actual and planned strategies partially match with what is suggested by academic literature.
Starting from the relationships with the industry, the model here presented recommends the implementation of joint ventures and strategic alliances, to be held in parallel with internal development activities as most suitable and efficient relationship modes at the current pre-market phase of the dominance battle. The market-based steps see different solutions suggested as optimal by the framework, as outsourcing is considered to be the most suitable mode during the creation of the market, while licensing emerges as the best for the decisive battle. Last but not least, according to this thesis' model, an incumbent should leverage on joint ventures and strategic alliances to

maintain the dominance, in the long term.
In the current phase, therefore, Volvo Cars should leverage on the strategic alliance with Autoliv through the Drive Me project and it should maintain its internal researches running. On the other hand, the company should keep on searching and establishing outsourcing relationships to exploit when it will create the market of the product. Consequently Zenuity, the joint venture with Autoliv, should mainly be exploited for its outsourcing-hybrid features at that stage, while its proper joint venture characteristics should be strengthened again in the long term, for the maintenance of an adequate level of pace and quality in R&D.
What does not seem to be in the plans of the company, however, is a licensing strategy. The findings of this research lead to suggest a complementary adoption of this mode as soon as there will be evidence that the product will be able to generate some inertia of adoption, namely in phase 4. At this stage, the need to capture market shares by diffusing the company's design, making it definitive in the markets and therefore locking competitors out, leads to consider licensing as the most suitable strategy Volvo Cars will need to undertake to enlarge its installed base and to gain the shares of sceptical and late adopters.

What is more, among the complex and thick set or relationships Volvo has with universities and academia, it should endorse some rather than others, according to the stage of the dominance battle. At the current status, according to the framework here developed, it should favour the collaborative research with Chalmers. Moreover, differently from what results to be the planned strategy (specifically for the driverless car) it should maintain privileging this mode even during the creation of the market. Only when the product will give signals of creating inertia in adoption, the focus will have to be switched to physical facilities, namely toward the collaboration with Lindholmen. Thus, in the long term, a focus on this latter relation seems to be strongly recommendable even if, of course, maintaining in parallel all the other different relationships might help in integrating smoothly Volvo's short, mid and long term strategies, allowing it to seek dominance and business sustainability in the mean time, as discussed in the Analysis.

Last but not least, the imposition of the self-driving car as a standard in the market might be fostered by a strategic planning of the firm-institutions relationships. It is now worth to state again that this does not need to be seen as the scheduling of illicit activities but, instead, as the strategic definition of the approach the firm shall have to gain the most out of this unavoidable and necessary kind of relation. Keeping all the assumptions used during the research, in order to try to define the uncertain and blurred features of the present and intended future strategies of the company, the theoretical framework defined in this research suggests the suitability of the co-optative strategy currently adopted for the pre-market strategies. However, it also leads to suggest a combination of it with a delaying strategy, which would be aimed at trying to avoid sharp and relatively sudden changes of the legal scenario and therefore of the most basic feasibility requirements in a product-development phase. Holding the assumed presumptions, on the other hand, the company should try to undertake

subversion strategies from the commercialization of the driverless car on. Those might, in fact, provide more chances and possibilities to use institutions to expand into other markets or to solve emergent dynamics in the future.

When referring to the single market of Gothenburg, the results slightly change, by virtue of the particular relationship existing between Volvo, Lindholmen, Chalmers and the Municipality itself, that allows to consider the city as a geographical cluster. From an industry-firm point of view, the presence of the Science Park, in fact, should be exploited to find and develop new partnerships or collaborative agreements (which are especially relevant in the post-dominance phase) with local companies or actors for projects focussed on the area of the city, to enlarge the customer base and to boost the creation of complementary products or services both in the long and in the short term. The biggest differences from the global scenario, however, can be found in the connections with universities and institutions.

The closeness to the academia can allow the company to maintain a pure joint research collaboration during the creation of the market, allowing the company to stick to what is recommended by the model here proposed. Also, Trainings, Meetings, Conferences and Consultancy, which do never emerge as fundamental in our theoretical framework, can be here strategically used to work on phase-specific variables, such as credibility for phase 1 and 4, exploiting the reputation and networks.

The biggest implication, however, concerns the relationships with local institutions. Considering the deep relation between Volvo and the Municipality, particularly endorsed -for what concerns this study, by the recent Developed Plan for 2035 and by the sustainability and safety issues tackled by the institution, the company will be likely capable of undertaking a manipulative strategy, recommended by this research, even for the commercialization stages. Hence, is seems a safe option to recommend the adoption of a perpetual manipulative and, in particular, co-optative supplementary kind of approach for the management of the market in Gothenburg.

Relevance of the research and managerial implications

The findings of the present thesis do have relevance at an academic as well as at a firm level.

The model developed and implemented in this research provides a framework that studies how Volvo Cars and other incumbent companies, especially in an incumbent position, can practically try to impose a new product as a standard in the market, by managing and leveraging on external relationships. This represents a contribution to the academic previous art, as it covers a grey area that was previously unexplored, providing practical suggestions with an *ex-ante* perspective, accordingly to Suarez' theories (2004). This means that this model can be potentially applied to any

firm with the same characteristics and used by it as an instrument in any step of the dominance battle.

What is more, the approach used in this study envisages an analytical study of how the three actors involved in what Etzkowitz calls Triple Helix (2008) dynamic need to be involved and managed by a firm in every single and different step, from the initiation of the research and development activities, to a long term and post-dominance scenario. This approach differs from the existent literature, as it takes into account the interconnectedness between social and political actors throughout different moments and it frames and depicts different optimal strategies integrating them with a temporal variable.

Additionally, through the application of the developed model to Volvo Car's case and, in particular, through the analysed implications that the Drive Me project has on the dominance battle, this study confirms Narayanan's and Chen's (2012) vision of how standards can emerge from the interaction of different social actors as a collective choice.
This analysis of Drive Me can also be considered as an empirical test of Tushman and Anderson's theories, according to which the power that a dominant producer has in the market, together with the creation of an intra-industry committee -as well as an alliance, can be a fundamental element a firm can leverage on when trying to impose a standard, especially when it is supported by the government (Tushman, Anderson 1986).

The research has different implications at firm level as well. As a single case study, in fact, it was tailored for Volvo Cars and it provides the company with a model that can assist its managerial choices with consequences on the short, mid and long term.
The managers of the firm can, in fact, take the theoretical outputs of the model as a confirmation of the validity of the strategies that are being implemented at the moment, during the pre-market phase. Moreover, in a mid and long term perspective, the company has the possibility to reconsider the planned strategies according to the suggestions presented by this thesis. This might therefore help the company in gaining a dominance position in the global and local market of the self-driving car and can therefore lead to higher profits in the future, while bearing the diffusion of a technology whose basic features of security and sustainability do endorse the mission of the company itself.

In general, the paradigm here presented can be used in the future by Volvo for the launch of other products in different markets, as well as by other companies with similar characteristics.

Limitations and suggestion for future research

The theoretical framework that has been developed in this thesis was tailored for studying a firm in a mature stage of its life cycle, with established relationships with industry, academia and institutions and, most of all, with a certain degree of reputation, at least in its field of expertise. This clearly

represents a limit of the model itself, as it cannot be applied to any company which does not match with the aforementioned characteristics, as the validity of the basic assumptions here set would collapse. The model, indeed, is based on academic articles and pieces of literature which are focussed on this category of firms. Hence, the adaptation of this approach to a universally applicable paradigm is left to the future researches. Analogously, coming studies might fascinatingly try to convert this model into a small and medium enterprise-focussed theory.

A second limit of this thesis involves the *social* feature of the topic. The model sharply divides the time horizon of the dominance battle in several phases. However, it is arguable that a manager might not be able to exactly recognise the moment of shift from one stage to the following, as this kind of analysis concerns a social phenomenon with uncountable and uncontrollable exogenous variables, as well as unknown underlying dynamics, which make these sharp categorizations fade.
Nevertheless, this can be considered as a prompt for future studies, which might focus on developing a framework or some criteria to assess with certainty the verification of the transition from one phase of the dominance battle to the following.

A third relevant limit of this study derives from one of its main advantages. It was in fact stated that this framework can be used in any moment of the product's life cycle in order to increase the possibilities to impose it as a standard. However, this might imply the necessity to completely change the firm's strategy, which might be unfeasible for contractual or strategic reasons, for instance. Hence, in light of this consideration, the applicability of this study is partially hampered. So, in the context of a future case study using this same approach, it could be interesting to study how it is possible to arrange and modify the current constrained relationships to shape them over the ideal ones suggested by the matrix.

An additional consideration concerns the competitive environment within which Volvo Cars operates. It has been said that the company is a hub at the centre of a network of relationships, where any output from any actor affects the inputs arriving to the other(s). The present research, however, does not consider any relationship among the three agents that does not concern the development of the self-driving car, nor exogenous competitive forces which might bias the scenario.

Last but not least, despite the relationships with institutions are studied on the base of assumptions made on theoretical backgrounds, a legal framework does not exist yet. This means that, especially in the mid and long term, some considerations might not hold anymore, depending on how the context represented by the car manufacturing industry will evolve.

References

Bibliography

Aaker, David A. *Strategic market management*. John Wiley & Sons, 2008.

Ahuja, Gautam, and Sai Yayavaram. "Perspective—Explaining influence rents: The case for an institutions-based view of strategy." *Organization Science* 22.6 (2011): 1631-1652.

Anderson, Philip, and Michael L. Tushman. "Technological discontinuities and dominant designs: A cyclical model of technological change." *Administrative science quarterly* (1990): 604-633.

Bell, Elizabeth RJ. "Some current issues in technology transfer and academic-industrial relations: a review: Practitioners' forum." *Technology Analysis & Strategic Management* 5.3 (1993): 307-322.

Brannock, Jean C., and Amanda M. Denny. "Basic guidelines for university-industry research relationships." *SRA Journal* 30.1/2 (1998): 57.

Bryman, Alan, and Emma Bell. *Business research methods*. Oxford University Press, USA, 2015.

Burnham, James B. "Evaluating industry/university research linkages." *Research-Technology Management* 40.1 (1997): 52-55.

Chesbrough, Henry W. "Why companies should have open business models." *MIT Sloan management review* 48.2 (2007): 22.

Clark, Kim B. "The interaction of design hierarchies and market concepts in technological evolution." *Research policy* 14.5 (1985): 235-251.

Cyert, Richard M., and Paul S. Goodman. "Creating effective university-industry alliances: An organizational learning perspective." *Organizational dynamics* 25.4 (1997): 45-57.

David, Paul A. "Clio and the Economics of QWERTY." *The American economic review* 75.2 (1985): 332-337.

Deeds, David L., and Charles WL Hill. "Strategic alliances and the rate of new product development: an empirical study of entrepreneurial biotechnology firms." *Journal of Business Venturing* 11.1 (1996): 41-55.

D'Este, Pablo, and Pari Patel. "University–industry linkages in the UK: What are the factors underlying the variety of interactions with industry?." *Research policy* 36.9 (2007): 1295-1313.

D'este, Pablo, and Markus Perkmann. "Why do academics engage with industry? The entrepreneurial university and individual motivations." *The Journal of Technology Transfer* 36.3 (2011): 316-339.

Dosi, Giovanni. "Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change." *Research policy* 11.3 (1982): 147-162.

Etzkowitz, Henry. *The triple helix: university-industry-government innovation in action*. Routledge, 2008.

Etzkowitz, Henry, and Loet Leydesdorff. "The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university–industry–government relations." *Research policy* 29.2 (2000): 109-123.

Etzkowitz, Henry, et al. "The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm." *Research policy* 29.2 (2000): 313-330.

Farrell, Joseph, and Garth Saloner. "Installed base and compatibility: Innovation, product preannouncements, and predation." *The American economic review* (1986): 940-955.

Funk, Jeffrey L. "Standards, dominant designs and preferential acquisition of complementary assets through slight information advantages." *Research Policy* 32.8 (2003): 1325-1341.

Gallagher, Scott. "The complementary role of dominant designs and industry standards." *IEEE Transactions on Engineering Management* 54.2 (2007): 371-379.

George, Gerard, Shaker A. Zahra, and D. Robley Wood. "The effects of business–university alliances on innovative output and financial performance: a study of publicly traded biotechnology companies." *Journal of Business Venturing* 17.6 (2002): 577-609.

Gluck, Michael E., David Blumenthal, and Michael A. Stoto. "University-industry relationships in the life sciences: Implications for students and post-doctoral fellows." *Research policy* 16.6 (1987): 327-336.

Grant, Robert M. *Contemporary strategy analysis: Text and cases edition*. John Wiley & Sons, 2016.

Hill, Charles WL. "Establishing a standard: Competitive strategy and technological standards in winner-take-all industries." *The Academy of Management Executive* 11.2 (1997): 7-25.

Hisrich, Robert D., and Raymond W. Smilor. "The university and business incubation: Technology transfer through entrepreneurial development." *The Journal of Technology Transfer* 13.1 (1988): 14-19.

Kenworthy, Jeffrey R. "The eco-city: ten key transport and planning dimensions for sustainable city development." *Environment and urbanization* 18.1 (2006): 67-85.

Klepper, Steven. "Industry life cycles." *Industrial and corporate change* 6.1 (1997): 145-182.

Leydesdorff, Loet, and Mark Deakin. "The triple-helix model of smart cities: A neo-evolutionary perspective." *Journal of Urban Technology* 18.2 (2011): 53-63.

Leydesdorff, Loet, and Martin Meyer. "Triple Helix indicators of knowledge-based innovation systems: Introduction to the special issue." *Research policy* 35.10 (2006): 1441-1449.

McKelvey, Maureen, and Sharmistha Bagchi-Sen, eds. *Innovation Spaces in Asia: Entrepreneurs, Multinational Enterprises and Policy*. Edward Elgar Publishing, 2015.

Moore, James F. "Predators and prey: a new ecology of competition." *Harvard business review* 71.3 (1993): 75-83.

Narayanan, V. K., and Tianxu Chen. "Research on technology standards: Accomplishment and challenges." *Research Policy* 41.8 (2012): 1375-1406.

Peltoniemi, Mirva. "Preliminary theoretical framework for the study of business ecosystems." *EMERGENCE-MAHWAH-LAWRENCE ERLBAUM*- 8.1 (2006): 10.

Perkmann, Markus, and Kathryn Walsh. "Engaging the scholar: Three types of academic consulting and their impact on universities and industry." *Research Policy* 37.10 (2008): 1884-1891.

Perkmann, Markus, and Kathryn Walsh. "University–industry relationships and open innovation: Towards a research agenda." *International Journal of Management Reviews* 9.4 (2007): 259-280.

Peter, Newman, Kenworthy Jeffrey, and Glazebrook Garry. "Peak car use and the rise of global rail: why this is happening and what it means for large and small cities." *Journal of Transportation Technologies* 2013 (2013).

Porter, Michael E., and Claas Van der Linde. "Toward a new conception of the environment-competitiveness relationship." *The journal of economic perspectives* 9.4 (1995): 97-118.

Rosenbloom, Richard S., and Michael A. Cusumano. "Technological pioneering and competitive advantage: the birth of the VCR industry." *California management review* 29.4 (1987): 51-76.

Schilling, Melissa A. *Strategic management of technological innovation*. Tata McGraw-Hill Education, 2005.

Shane, Scott, and Toby Stuart. "Organizational endowments and the performance of university start-ups." *Management science* 48.1 (2002): 154-170.

Shapiro, Carl. "Navigating the patent thicket: Cross licenses, patent pools, and standard setting." *Innovation policy and the economy* 1 (2000): 119-150.

Shapiro, Carl, and Hal R. Varian. "The art of standards wars." *California management review* 41.2 (1999): 8-32.

Srinivasan, Raji, Gary L. Lilien, and Arvind Rangaswamt. "The emergence of dominant designs." *Journal of Marketing* 70.2 (2006): 1-17.

Suarez, Fernando F. "Battles for technological dominance: an integrative framework." *Research Policy* 33.2 (2004): 271-286.

Tidd, Joseph, John R. Bessant. *Managing innovation: integrating technological, market and organizational change*. Wiley, 2013.

Tushman, Michael L., and Philip Anderson. "Technological discontinuities and organizational environments." *Administrative science quarterly* (1986): 439-465.

Zhang, Jing, and Xiong-Jian Liang. "Business ecosystem strategies of mobile network operators in the 3G era: The case of China Mobile." *Telecommunications policy* 35.2 (2011): 156-171.

Sitography

Autoevolution. (2017). *Volvo Models & History*. [online] Available at: https://www.autoevolution.com/volvo/ [Accessed 7 Mar. 2017].

Autoliv.com. (2017). *Autoliv in Brief*. [online] Available at: https://www.autoliv.com/AboutUs/Pages/InBrief/default.aspx [Accessed 30 Apr. 2017]

Autoliv.com. (2017). *Mission Vision and Business idea*. [online] Available at: https://www.autoliv.com/AboutUs/Pages/Business%20model/MissionVisionandBusinessidea.aspx [Accessed 30 Apr. 2017].

Chalmers.se. (2017). *About Chalmers | Chalmers*. [online] Available at: http://www.chalmers.se/en/about-chalmers/Pages/default.aspx [Accessed 30 Apr. 2017].

First To Know Scandinavia AB (2017). The ( ) Space: Process, Platform, Network & Hubs. [online] Available at: http://www.firsttoknow.se/the-space.html [Accessed 30 Apr. 2017]

För Liv och Rörelse. (2016). *About this page | För Liv & Rörelse*. [online] Available at: http://forlivochrorelse.se/en/about-this-page/ [Accessed 12 Mar. 2017].

Goteborg.se. (2017). *Traffic, streets and roads*. [online] Available at: https://goteborg.se/wps/portal/english/trafik-och-gator/ [Accessed 30 Apr. 2017].

International.goteborg. (2017). *DriveME self-driving cars for sustainable mobility*. [online] Available at: http://international.goteborg.se/smart-cities-and-sustainable-solutions/driveme-self-driving-cars-sustainable-mobility [Accessed 24 Feb. 2017].

Iso.org. (2017). About us. [online] Available at: https://www.iso.org/about-us.html [Accessed 29 Mar. 2017].

Lindholmen Science Park. (2017). *About us*. [online] Available at: http://www.lindholmen.se/en/about-us [Accessed 30 Mar. 2017].

Media.volvocars.com. (2017). *This is Volvo Car Group*. [online] Available at: https://www.media.volvocars.com/global/en-gb/corporate/this-is-volvo [Accessed 29 Mar. 2017].

Media.volvocars.com. (2017). *Volvo Cars and Autoliv announce the launch of Zenuity*. [online] Available at: https://www.media.volvocars.com/global/en-gb/media/pressreleases/202044/volvo-cars-and-autoliv-announce-the-launch-of-zenuity [Accessed 29 Mar. 2017].

Media.volvocars.com. (2017). *Volvo Cars and Autoliv to create joint venture for autonomous driving*. [online] Available at: https://www.media.volvocars.com/global/en-gb/media/pressreleases/195888/volvo-cars-and-autoliv-to-create-joint-venture-for-autonomous-driving [Accessed 29 Mar. 2017].

Sae.org. (2017). *About - SAE International*. [online] Available at: http://www.sae.org/about/ [Accessed 29 Mar. 2017].

Sartre-project.eu. (2017). Sartre project. [online] Available at: http://www.sartre-project.eu/en/about/Sidor/default.aspx [Accessed 24 Mar. 2017].

Trafikverket. (2017). Trafikverket. [online] Available at: http://www.trafikverket.se/en/startpage/about-us/Trafikverket/ [Accessed 30 Apr. 2017].

Trafikverket. (2017). *Which authority does what within transportation?*. [online] Available at: http://www.trafikverket.se/en/startpage/about-us/Trafikverket/Which-authority-does-what-within-transportation/ [Accessed 30 Apr. 2017].

Transportstyrelsen.se. (2017). *Transportstyrelsen*. [online] Available at: http://www.transportstyrelsen.se/en/About-us/ [Accessed 30 Apr. 2017].

Unece.org. (2017). *Mission*. [online] Available at: https://www.unece.org/mission.html [Accessed 27 Mar. 2017].

Volvocars.com. (2017). *This is Volvo Cars* | *Volvo Cars UK Ltd*. [online] Available at: http://www.volvocars.com/uk/about/our-company/this-is-volvo-cars [Accessed 25 Mar. 2017].

Volvocars.com. (2017). *IntelliSafe* | *Volvo Cars UK Ltd*. [online] Available at: http://www.volvocars.com/uk/about/our-innovations/intellisafe [Accessed 25 Mar. 2017]

Volvocars.com (2017). *Autonomous Driving* | Volvo Cars International. [online] Available at: http://www.volvocars.com/intl/about/our-innovation-brands/intellisafe/autonomous-driving [Accessed 2 May 2017]

Volvoclub.org (2017). History of the Volvo Car. [online] Available at: https://www.volvoclub.org.uk/history/ [Accessed 26 Mar. 2017]

APPENDIX I – Further considerations behind the selection of the optimal relationship modes

Phase 1: R&D build up

According to the model developed in this paper, the main drivers that need to be considered the most in this phase are credibility, the presence and development of complementary assets, the regime of appropriability and the characteristics of the technological field.

Industry

Regarding the industry, joint ventures and outsourcing seem to be the most suitable solutions, as they accomplish two out of the three pillars of this phase. Both of them, however, seem to lack mechanisms to protect effectively and permanently the control and the appropriability over a certain technology.

Joint ventures provide speed in research and development (Schilling, 2005), which is assumed to boost the creation of the characteristics of the technological field: in a trial and error phase such as the R&D one, having a high frequency of trials looks like a good strategy for creating an efficient solution to a market need in a (relatively) short time horizon. To the eyes of the author, this seems to be fundamental and particularly optimal if framed in a joint venture context, as it boosts the research departments' possibilities to reach agreements, cooperate and share information, possibly operating along the whole value system where the product will be inserted. If this kind of solution does allow a research centre to gain new competences and possibly complementary assets, it also leads to lower costs, it enhances flexibility and takes to the union of the markets of the different companies which might lead, in the future, to a wider installed base and consequently to the creation of positive network externalities (depending, of course, on the particular specificities of the product or service).

Outsourcing provides several relevant advantages as well, still matching, as mentioned above, two out of the three pillars enlightened by Suarez (2004): this mode facilitates the process of competence acquiring and helps reducing the necessary effort to create, find out or match complementary assets, products or resources(Schilling, 2005). Also, it stimulates the creation and definition of the characteristics of the technological field, as particular features of the product or service (as well as long lasting or temporary strategic agreements) can be developed in a relatively short term and with flexibility. However, this results in a slower process and averagely higher costs than the ones obtained with joint ventures. For this reason, it seems reasonable to select the former as the best option for the R&D build up phase, considering the necessity of having fast R&D dynamics at this stage.

Licensing does not seem to be the most efficient solution in this phase. Although it allows a firm to acquire capabilities, it is not optimal in situations of technological uncertainty (Schilling, 2005). It is therefore arguable that this mode does not allow a company to react to emerging technological dynamics and trajectories, and it might risk to bound the firm over a solution, locking it in a given path even before starting pursuing it.

Internal development is also absolutely not optimal in such a dynamic context. Provided the fact that is leads to higher costs and slower processes, it is possible to state that it does not allow the company to have a continuous interface with external agents. This might hamper the possibility of gaining strategic agreements, external inputs in research and development processes and alliances for the creation of synergies, externalities and complementarities with complementary products or services, for example.

Academia and Universities

Joint research appears to be the option that takes the highest number of advantages in a pure R&D phase as, according to the literature, it accomplishes all the three strategic variables. This agreement, in fact, provides a sound appropriability of the developed knowledge and solutions. If firms and academic centres collaborate, they can potentially match different competences, skills, functions and assets that lead not only to lower R&D costs, but also to a deeper understanding of the technology, its applications and its possible matches with other complementary products or phases along the value system. What is more, it is arguable that when the participating firm(s) and university (-ies) have a highly respectable reputation in the specific field the research is conducted about, the alliance, and therefore its outputs, do gain credibility and might represent a reference point for competitors and for customers in the commercialization phase.

Physical facilities can also lead to fast problem solving activities, shortening the time to market (Hisrich, Smilor, 1988), still keeping credibility high and creating knowledge spillovers that might potentially enhance the creation of new or complementary products from the prototyping phase. Nevertheless, the literature puts in evidence that this mode is not always responsive of short term needs (Cyert, Goodman, 1997). This does not seem to match perfectly with spot-necessities characterising a rough and always-changing step as the build-up one. It is therefore possible to state that is does not help in developing specific features of the technological field and that, in this phase, it is advisable to use this relationship mode only as a complementary one.

The same conclusion can be given for consultancy. It seems reasonable not to consider this as the best alternative for this first stage, as it presents less matchings with Suarez's pillars and it consists in a less rooted and continuous interaction. Nevertheless, it is arguable that having this kind of activity

as a non-core relationship with industry and academia can be an extremely good option, especially to be used as strategic support for specific arising problems.

The literature did not provide extensive information about meetings, conferences and training as a support in a build-up phase. The former can surely ensure control over the IPRs but, to the eyes of the author, it does not seem to provide a structured and continuously tailored support in such a delicate and always changing step. An analogous explanation can be provided regarding the latter mode, which allows firm to have focussed research: although this can help in the development of a technological pattern, it does not seem to provide sufficient stand-alone support to a complex R&D activity.

Institutions

Before analysing the different alternatives, it is again important to put in evidence that, when it comes to institution shaping, the company in question always deals with a relatively exogenous agent, which can therefore be influenced to a certain extend.

In an R&D phase, where the environment and the forecasts of its trends need to be inspected, a delaying strategy results to be the most suitable one. According to the literature (Ahuja, Yayavaram, 2011), in fact, this approach allows to monitor the institutional scenario by interfering on the introduction of new rules and, for example, minimum requirements. A company might therefore be more likely to know if something is going to change in a given field of expertise, and can consequently calibrate its research objective or schedules or, on the contrary, it might try to influence and support the implementation of a rule. This means that a firm adopting this approach is more likely to know if a given product or service with determined characteristics is going to be legal or at least accepted: having this kind of information in a preliminary phase such as the build-up one means, as a consequence, having the possibility to establish in time (and possibly as a first mover) the right characteristics of the technological field and consequent agreements, dynamics or, for instance, information-sharing practices.

Conducting an arbitragive morphing strategy at the stage, on the other hand, would also help the company in handling the legitimacy of the business, but it would seem like it would change too radically the final feature of the product.

Phase 2: Technical Feasibility

This stage sees regulation and technological superiority as fundamental variables (Suarez, 2004).

Industry

Surprisingly, internal development is the mode that, according to the consulted literature (Schilling, 2005; Grant 2016; Hill, 2007; Shapiro and Varian, 1999; Tushman and Anderson, 1986), provides

the highest probability of imposing the product in question as a standard in the market, as it allows the firm to have a stricter control over the developments of the technological wave: for this reason, the advancement of the technology can be tailored on the strengths of the firm. Considering that at this phase a prototype has already been created, it is possible to assume that at least the extremely basic features of the newly created technology have been defined: by developing internally the "secondary" traits (not necessarily in terms of importance, of course), an incumbent has the possibility to define them according to the specificities, peculiarities and resources which are typical of the firm and of its prior competitive advantage. On top of that, the internal feature of this process can ensure the appropriability of the work in such a delicate and sensitive step.

Joint ventures can also increase the degree of technological superiority, but they also imply the risk of knowledge leaks (Schilling, 2005), especially in a mid and long term time horizon. For this last reason, it looks legitimate to consider this mode as not as suitable as internal development: provided that at this stage no feature is definitive, revealing potentially winning solution at the very pre-market stage might destroy the efforts that have been put until then.
On the other hand, licensing and outsourcing do not present, according to the literature, any advantage that can nurture regulatory issues or boost technological superiority.

Academia and Universities

Joint Research is the mode that, according to the literature, best fits this second stage, as it boosts technological superiority by giving the firm the possibility to solve and implement extremely specific (and therefore potentially differentiated) features and it helps in demonstrating their viability (Cyert, Goodman, 1997). On top of that, this form of relationship foresees the involvement of the government and it is therefore supposed to be in line with the future regulations, creating the least frictions with institutions and governmental offices.

On the other hand, it is worth to mention that physical facilities can also take significant advantages, as they can help in shortening both problem solving activities and the needed time to market (Hisrich, Smilor, 1988): it is therefore assumable that this is also true for prototypes and that this might enhance strategic manoeuvring policies and technological superiority. Also, they can shape policies and practices suitable for the firm, which might help from a regulatory point of view. It is therefore a good alternative to joint research, depending on the specific situation of the firm in analysis.
Consulting might also be a valid alternative, as it can potentially boost technological superiority by helping accelerating the product definition process with technical and tailored suggestion, but it lacks the regulatory aspect.

Institutions

In this phase, regulation is particularly important (Suarez, 2004) and so, as a consequence, the relationships with institutions. Although the literature does not seem to extensively have studied this, it looks correct to assume that co-optation and capture is the most suitable approach at a technological feasibility stage. The main reason for this is that a company can try to use its influence over an institution to take a decision or a path undertaken by the technology look optimal to the institution's eyes: in this phase, in fact, the new technology needs to be approved by the authorities in order to enter a market.

Arbitragive morphing might also be considered to be a suitable strategy, as the company might want to change some of its charters in order to meet minimum requirements that are requested by the authorities. For example, a firm might want to change its juridical features to pay less taxes, or to be able to operate under given circumstances and gain in terms of technological superiority. The evidence in favour of the first mode in however stronger.

Delaying can also play an important role: this strategy can be used in order to postpone the validity of a law impeding (or allowing) the exploitation of a certain asset or resource for R&D reasons (for example for sustainability and environmental reasons): in this case, the firm might want to use it until the research process has been finished, as it might imply significant savings in terms of finances or time. This might contribute to the achievement of a higher technological superiority than competitors thank to the exploitation of the resource (sticking to the example), but it does not take to a proper approval of a product, in the sense that it might be considered as a pure postponement of the problem.

Subversion might potentially have benefits in this phase, as a company might try to use an institution to indirectly sponsor the R&D campaign of the new product, in order to get credibility and eventually network externalities and increasing its installed base. Nevertheless, there is no particular evidence for this in literature.

Phase 3: Creating the Market

For creating a market, strategic manoeuvring is assumed the be the most important variable, as it comprehends entry timing, pricing strategies, licensing policies as well as relationships with complementarities and expectation management (Suarez, 2004).

Industry

The evidence that emerged from the literature makes outsourcing look like the best alternative in this phase, as this mode allows the firm to potentially appropriate all the advantages related to the

strategic manoeuvring variable. Indeed, it allows the company to have lower costs (Schilling, 2005), which can lead to several advantages.

First, it can relieve the firm from some of the production processes, allowing it to concentrate in-house resources to the development of further innovation. This would result in a more dynamic R&D and might eventually lead to a higher degree of technological superiority or to the creation of complementary products.

Secondly, lower costs can mean lower prices and, consequently, a price strategy that can be aimed at increasing customer base and (depending on the product or service, of course) indirectly increasing network effects at a later stage.

Joint ventures can also be a solution, but they imply sharing the advantage of the product, which might hamper the technological superiority of a firm, especially if there is a disparity in reputational terms between the companies or entities participating in this collaboration. However, they can boost market pre-emption, which can be fundamental in this phase.

Academia and Universities

When it comes to relationships with academia, it is extremely difficult to pick one single interaction mode for this phase.

Joint research looks like perfect, as the literature puts in evidence its advantage of reducing R&D costs (George et al, 2002), which comes to be shared between the parties. This can allow strategic pricing strategies. What is more, it is arguable that if the parties participating in this agreement are renowned for the quality of their products or services (research and teaching from the academic side), then the collaboration might promote even further the installed base of all the companies as well as the network effects related to their offers. Also, this has the potential of boosting customer expectations (and creating possibilities for students and researchers of the university of course).

Moreover, it is possible to say that from a firm's perspective, having an academic support means receiving inputs about new technologies and therefore inputs for new R&D activities to keep the innovation level of the firm high. It is arguable that this can lead to the creation of complementary products.

Physical facilities have the advantage of lowering the price (George et al, 2002) and solving technological issues relatively fast (Hisrich, Smilor, 1988). However, they do not seem to be helpful in a stage where the product is already in production and when commercialization should be as fast and effective as possible. This is further slowed due to bureaucracy. Joint research' s reputational effects has therefore been thought to have a bigger relevance in this case.

For the sake of completeness, it is necessary to specify that consulting activities were assumed by

the author to be a mode that enhances technological superiority, as it allows tacit knowledge absorption.

Institutions

The strategy that has been thought to be the best one in this phase is subversion, as an influent firm might try to use the institution to expand the market of a new technology: to the eyes of the author, considering Suarez' framework, this advantage seems to be particularly useful at this stage. Regarding the other strategies, there in not considerable empirical evidence in literature, although it can be argued that delaying the validity of a rule hampering the diffusion of a technology can be crucial for the stability of the market creation process.

Phase 4: Decisive Battle

At this stage, what is important is credibility and complementary assets, installed base, network effects and switching costs (Suarez, 2004), as it is fundamental to gain the largest market share possible.

Industry

Licensing and joint ventures are the most suitable modes for this phase, although the former seems to present more strategic advantages than the latter, and it has therefore been chosen as the optimal one for this stage. However, it is necessary to keep in mind that, especially for an incumbent, keeping two relationships modes at the same time (or an hybrid one) can often be possible. For this reason, it is appropriate to always put in light advantages and drawbacks of different options.

Licensing allows a firm to reach new markets and hidden niches (Schilling, 2005), which means increasing the installed base and network effects. What is more, considering that with this business model the licensor diffuses a technology among other firms, it is arguable that there are more chances that a complementary product is created: it might lock the customer in a product's usage or system. This would also increase switching costs incurred to substitute products.

Last but not least, it is possible to say that when the licensing agreement is stipulated between firms renowned for high quality and high reputation in their field of expertise, the credibility of all of them is boosted. In addition to this, it is arguable that licensing is a relationship that implies less bindings than joint ventures, allow therefore a higher flexibility and more chances to change strategic directions *in itinere*.

On the other hand, Joint Ventures can boost critical mass and network effects, given the fact that two firms can collaborate for the development and diffusion of a product by "pooling" their customer bases.

Academia

Physical facilities are without any doubt the relationship mode that best fits the firm-academia dialogue in the decisive battle step. As it was noticed in the theoretical framework, indeed, it can lead to meet all the three strategic variables typical of this stage.

However, it seems reasonable to consider consulting and training as a complementary strategies, as they can boost the credibility of the firm and they can provide long and short term targeted and tailored strategies for gaining competitive advantage and market shares.

Institutions

Subversion has been thought to be the strategy a firm can gain the most from, as it can try to use an institution by exploiting its networks and connections at social levels in order to get to be known by more and more potential users. It is reasonable to assume that this can help increasing the installed base and therefore network effects. What is more, if a product is sponsored by an institution, it might gain credibility, as a customer might see this as a quality warranty. If for example, by virtue of a contract or a partnership, the government would purchase several units of a car and use it for municipal car sharing services, the product itself would indirectly be sponsored by institutions, it would be more commonly seen by potential customer which might then decide to purchase it.

Phase 5: Post-dominance

In order to maintain its superior and dominant position after imposing its product or service in the market, a company needs to put particular attention to its installed base and to the network effects created by its good, together with the switching costs related to it (Suarez, 2004).

Industry

Given the broadness of the whole set of possibilities and scenarios a firm has in the long term, it is extremely difficult to label one as the best.

Nevertheless, even if, for this phase, joint ventures have more advantages listed by theory, to the eyes of the author it looks necessary to mention licensing as a valid alternative, which might be used in parallel or as an alternative, depending on the specific situation. In fact, it gives the firm the possibility to expand to new markets and niches (Schilling, 2005), which might give the company a relevant new market share and might enable launches of the new product in a different context, for different users or customers and maybe for different uses. It is potentially possible that a new market translates into complementary products or that the licensed technology itself is used as complementary to the core good offered by the licensees. Hence, licensing can correspond to agreements and possibilities that allow to operate along different value systems, although it has the drawback of putting the company in risk of know-how leakages in the long run (Schilling, 2005).

To be thorough, it is worth to spend some words on outsourcing and internal development. In this phase, the former can boost strategic manoeuvring and strategic price policies, as it lowers costs and therefore prices, at least potentially (Grant, 2016). However, it cannot be considered as a valid strategy by its own as, if framed in a long term perspective, it does not provide extensive inputs to keep the firm innovative.

Last but not least, internal development can give the possibility of keeping innovativeness as a corporate goal, but it does need extensive resources and it does not benefit from sharing resources and networks with other firms or institutions.

Academia

Physical facilities is the relationship mode that, according to the consulted literature, frames the post-dominance stage the best. Indeed, this mode provides a stable a long term network for commercialization together with continuous research inputs that can be used by the firm for product and process innovation activities (Cyers, Goodman, 1997).

However, it is possible to consider training and consultancy as integrative modes that provide long or short term hints for strategies and innovative inputs, as they are not considered by the researcher to be constant and supporting enough relations in the long term for a firm operating in a dynamic and turbulent market.

Institutions

A priori, it is not possible to predict how the institutional scenario will be in a post-dominance phase. It is necessary to notice that if a product gets to this fifth stage, it means that it must have had a relatively high success and that, as a consequence, the producing company might be considered as relevant in the industry (provided that it was not before the launch of this good or service). For this reason, it is possible to state that in this phase, the influence that the firm has over the institution is stronger than it was before.

Therefore, given the scarce attention by academic literature on the specific topic, it seems reasonable to exclude arbitragive morphing (as the company does not need to “hide”, given the success and therefore the visibility it had in the previous stages) as a necessary strategy for surviving as an incumbent. Holding this assumption, delaying might be substituted efficiently by co-optation and capture. This last, together with subversion, remains as possible optimal alternatives. However, considering the risk of falling into incumbent inertia dynamics, namely the possibility of losing innovativeness and market shares, it seems that subversion can be labelled as a safe option for surviving in the long term as a dominant firm. In fact, it provides the possibility to exploit the institution as a mean of diffusion of the product to new markets and as a quality guarantor.

APPENDIX II - Interview guide.

Interview 1

Who	When	How Long	Where
Marcus Rothoff	February 27th, 2017	9:30 am to 10:30 am	Volvo headquarters, Gothenburg

- Introduction to the master thesis project. Asking permission to use names in the report and to record the interview
- Introduction to the product and the projects Volvo Cars is following
- Focus on the private market of the self-driving cars
- What is the main goal Volvo Cars wants to achieve in this “cultural change”?
- Who are the most important agents Volvo Cars work with and how do you deal with them?
- Do you refer to any theoretical model to deal with these agents?

Interview 2

Who	When	How Long	Where
Tord Hermansson	March, 22nd,2017	11:00 am to 11:40 am	Volvo headquarters, Gothenburg

- Introduction to the master thesis project. Asking permission to use names in the report and to record the interview
- What do you think, in general, about the network of relationships that exists between Volvo, Institutions, Industry and Academia?

- Especially concerning the Drive Me project, what is the relationship with the industry for R&D, launch and market strategies?

- Especially concerning the Drive Me project, what kind of relationships do you think it would be feasible (now and/or in the future) for Volvo Cars to have with the industry? What advantages do you see?

- What is the relationship with institutions?

- Do you think Volvo Cars is big/relevant enough to negotiate/manipulate institutions or turn their choices into an advantage for Volvo Cars itself?

- To what extent you think that, in every step of the technological battle, Volvo Cars will be able to deal with institutions?

- Especially concerning the Drive Me project, what is the relationship with universities and academia for R&D, launch strategies?

- Are there formal and/or informal relationships? If so what are the differences, what is better and when?

- What's the competent office and who is the responsible at the municipality of Gothenburg?

Interview 3

Who	When	How Long	Where
Marcus Rothoff	March, 22nd, 2017	2:00 pm to 3:10 pm	Volvo headquarters, Gothenburg

- Introduction to the status of the research. Asking permission to use names in the report and to record the interview

- Do you think this product has network externalities and compatibility?

- Could you please provide an overview of the Drive Me project? (What is it, how it works, is there a specific department within Volvo Cars?)

- Could you please provide some information about its history, about the current status of the project and its future?

- Do you see this project as a new technological trajectory? (defined as a new direction of change, namely a technological paradigm, on which a new market trajectory is grounded (Dosi, 1982))

- Do you think that being an incumbent did/does/will influence the success of the project? (in terms of internal developed resources, network, installed base, market and reputational power, for example. Is it different when it comes to Gothenburg?)

- What is the current status of the technology/product?

- Does Volvo Cars have the capabilities of developing this technology alone?

- Has Volvo Cars any relation with other firms in the industry to develop the technology and/or launch it in the market? If not, is it planning to have some in the future?

- What about the appropriability of the technology?

- Has Volvo Cars any relation with universities to develop the technology and/or launch it in the market? If not, is it planning to have some in the future?

- Has Volvo Cars any relation with institutions to develop the technology and/or launch it in the market? If not, is it planning to have some in the future?

- Timing of the project

- How will you commercialize the driverless car?