Edited by
Anna Cabigiosu · Pietro Lanzini

The Green Transition of the Automotive Industry

From Technological Sustainable Innovation to Mobility Servitization

palgrave
macmillan

The Green Transition of the Automotive Industry

Anna Cabigiosu • Pietro Lanzini
Editors

The Green Transition of the Automotive Industry

From Technological Sustainable Innovation to Mobility Servitization

palgrave
macmillan

Editors
Anna Cabigiosu
Department of Management-Venice
School of Management
Ca' Foscari University of Venice
Venice, Italy

Pietro Lanzini
Department of Management-Venice
School of Management
Ca' Foscari University of Venice
Venice, Italy

ISBN 978-3-031-37199-8 ISBN 978-3-031-37200-1 (eBook)
https://doi.org/10.1007/978-3-031-37200-1

© The Editor(s) (if applicable) and The Author(s), under exclusive licence to Springer Nature Switzerland AG 2023
This work is subject to copyright. All rights are solely and exclusively licensed by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.
The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.
The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Palgrave Macmillan imprint is published by the registered company Springer Nature Switzerland AG.
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Paper in this product is recyclable.

Contents

Notes on Contributors

Lisa Balzarin is a post-doctoral researcher at Ca' Foscari University of Venice, where she completed a PhD in Management. Her research focuses on organizational routines, agency and structure, coordination and organizational change. Lisa is a qualitative researcher. She is specialized in conducting interviews and observations and in carrying out ethnographic work in different industries.

Davide Bubbico is Associate Professor of Economic Sociology and Labour Processes at the Department of Political and Social Studies at the University of Salerno where he teaches Economic Sociology and Sociology of Firm and Industrial Relations. He is a member of the Center for Automotive and Mobility Innovation (CAMI) of Ca' Foscari University of Venice, component of scientific committee of the Observatory on the Transformations of the Automotive Ecosystem and of the recent national Observatory Automotive.

Leonardo Buzzavo holds a PhD in Management and is Associate Professor at the Department of Management of Ca' Foscari University of Venice in Italy. His main areas of interest involve strategy innovation and marketing with specific focus on automotive distribution architectures. His research into automotive distribution dates back to 1994 when he held active roles in the ICDP—International Car Distribution Programme network for over two decades. He has been Scientific Director of the

Automotive Dealer Day content programme since 2003, also being invited as speaker at over 250 automotive events in 20 countries.

Anna Cabigiosu is Associate Professor of Strategy and Innovation Management at the Department of Management, Ca' Foscari University of Venice. She is the Director of the Master in Mobility and Innovation Management of Ca' Foscari where she is also a member of the Steering Committee of the Center for Automotive and Mobility Innovation.

Valentina Fava is Assistant Professor of Economic History and Business History at the Department of Management of Ca' Foscari University of Venice. She received a PhD in Economic and Social History from Bocconi University in Milan (2004) and was Max Weber Post-Doctoral Fellow at the European University Institute in Fiesole (2006–2008). She held research and teaching positions at the University of Helsinki, Technical University of Berlin and the Institute of Contemporary History of the Academy of Sciences of the Czech Republic. Her publications focus on the history of the European automotive industry and of mobility and transport technologies in the twentieth century.

Giovanni Favero is Full Professor of Economic History and Business History in the Venice School of Management of the Ca' Foscari University. He received his PhD in Urban History at the University of Perugia in 1999. His main research interests concern organizational history and the history of quantification. He was Thomas K. McCraw Visiting Fellow in US Business History at Harvard Business School.

Flavia Furegato is a marketing manager at SEAT CUPRA dealer located in Italy and she previously worked as a social media manager, project manager, quality control and communication manager in SMEs located in Italy. She studied at Ca' Foscari University of Venice where she obtained a Bachelor's degree in Economics & Management and a Master's degree in Communication & Marketing. Her Master's thesis was focused on European public mobility platforms.

Pietro Lanzini is Associate Professor of Consumer Behavior at the Department of Management and a member of the Steering Committee of the Center for Automotive and Mobility Innovation at Ca' Foscari

University in Venice. Pietro's research interests include behaviours in the field of sustainability, with a focus on mobility and on the food sector.

Andrea Stocchetti, (PhD) is tenured Associate Professor of Strategic Analysis at the Department of Management of Ca' Foscari University of Venice. He has over 25 years of experience in academic teaching, mentoring and scientific research in the fields of automotive industry, sustainable mobility, sustainability management and competitive analysis. He is co-founder and member of the scientific committee of CAMI—Center for Automotive and Mobility Innovation. He has been scientific coordinator and member of the steering committee in several projects funded by external organizations, including VI EU Framework, EU INTERREG and Italian Ministry of Research National Program.

Francesco Zirpoli is Professor at the Department of Management, coordinator of the PhD in Management, scientific director of CAMI—Center for Automotive and Mobility Innovation and Director of National Observatory on the Transformation of the Automotive Ecosystem. Francesco is research associate of the Program on Vehicle and Mobility Innovation, Mack Institute for Innovation Management at the Wharton School of the University of Pennsylvania, USA. He received his PhD from the Judge Business School of the University of Cambridge and his doctorate from the University of Naples "Federico II." His research interests include organizational routines, network governance, organization boundary decisions and the organization of innovation processes.

Abbreviations

ABC	Attitude-Behaviour-Context
ADAS	Advanced Driver-Assistance Systems
AI	Artificial Intelligence
AIF	Alliance Industrie du Futur
BAC	British Automotive Council
BEV	Battery Electric Vehicle
CADM	Comprehensive Action Determination Model
CARB	California Air Resources Board
CAV	Connected and Autonomous Vehicles
CEO	chief executive officer
CSI	Customer Satisfaction Index
DOS	Directly operated stores
EEC	European Economic Community
EP	Electrified Powertrain
EV	Electric Vehicle
FCV	Fuel-Cell Vehicle
GDP	Gross Domestic Product
HEV	Hybrid Electric Vehicle
IAC	Italian Automotive Council
ICE	Internal Combustion Engine
ICT	Information and communication technologies
MaaS	Mobility as a Service
NPS	Net Promoter Score

OEM	Original Equipment Manufacturer
OTA	Over The Air
PBC	Perceived Behavioral Control
PFA	Plateforme de la Filière Automobile
PHEV	Plug-In Hybrid Electric Vehicle
R&D	Research and Development
SUMP	Sustainable Urban Mobility Plan
SUV	Sports Utility Vehicle
TPB	Theory of Planned Behaviour
TPS	Toyota Production System
V2X	Vehicle-to-Everything
WTP	Willingness to Pay
WWI	World War One
WWII	World War Two

List of Figures

List of Tables

1

Introduction

Anna Cabigiosu and Pietro Lanzini

The automotive and mobility industries are facing years of turbulence and transformation driven by the concurrent effects of the perfect storm of new technologies, new legislation that in many States support sales of greener vehicles, new players entering the industry, and an increased social consciousness of cars' impact on the environment (Borgstedt et al., 2017; Teece, 2018). Particularly, electric motorizations provide means to reduce transportation-related air pollution and emissions that lead to climate change. Such green transition imposes a technological shift, which had to overcome carmaker incumbents' initial barriers (Steinhilber et al., 2013), as incumbent carmakers and public mobility vehicles producers traditionally have core competences in the design and production of Internal Combustion Engines (ICEs) while they lack specific competences in the design of electric batteries and consequently never produced them in large quantities (Borgstedt et al., 2017). Electric batteries are the

---

A. Cabigiosu (✉) • P. Lanzini (✉)
Department of Management-Venice School of Management,
Ca' Foscari University of Venice, Venice, Italy
e-mail: anna.cabigiosu@unive.it; pietro.lanzini@unive.it

A. Cabigiosu, P. Lanzini (eds.), *The Green Transition of the Automotive Industry*,
https://doi.org/10.1007/978-3-031-37200-1_1

most distinctive component of BEVs (Battery Electric Vehicles) and are the key performance variable affecting BEV performance. Furthermore, only recently these vehicles appear to be a real alternative to ICE (Internal Combustion Engines) counterparts in the wake of rapidly increasing sales, but they are still less rewarding and incumbents try to maximize the earnings derived from electric vehicles by enlarging mobility services provided by means of such vehicles and coherently with clients' increased interest in Mobility as a Service (MaaS). In this setting, while most strategy scholars have so far considered the automotive industry protected by almost insurmountable barriers to entry, Tesla's success opened a heated debate on the urgency of controlling EV technology (Teece, 2018). Upon these premises, the automotive and mobility industries represent a unique setting to study how incumbent firms can adapt their competences, resources, and strategies to survive in turbulent times. Scholars and practitioners are now investigating how incumbent firms could face competence-destroying technologies that are changing the rules of the game and rethink their business models coherently with the direction set by such perfect storm.

In such setting, the book is the first to provide an in-depth overview on the strategic and managerial implications of this fluid scenario for automotive and mobility incumbents, by describing how sustainable technologies have been changing over time, which are the challenges of the shift imposed by the new competitive environment and which are the implications on incumbents' competences and sources of competitive advantage. All this to identify the new drivers of growth and profitability such as open and collaborative innovation, or the so-called servitization of the industry. This book is coauthored by scholars of CAMI,[1] Center for Automotive and Mobility Innovation of Ca' Foscari University (Venice), which is a research center of academics and experts with years of experience in the fields of automotive industry and/or sustainable mobility, whose mission is to provide advances in basic and applied scientific research and to disseminate the new knowledge among stakeholders.

The volume is divided in two sections. In the former, Chap. 2 (by Leonardo Buzzavo, Giovanni Favero, and Francesco Zirpoli) provides a

---

[1] https://www.unive.it/pag/40244/.

synthesis of the main forces that cause the fluidity in the automotive and mobility industry that will then be discussed more in depth in the book. The chapter describes how the automotive industry has been going through different stages across its lifetime, with specific demand/supply combinations, technologies, and organizational forms for the whole supply chain (Holweg, 2008). From its invention through stages featuring relevant elements such as mass production, market expansion, lean organization, and globalization, it is currently experiencing a stage where the drivers of value creation and value appropriation are being profoundly modified by a set of overlapping and intertwined transformational elements. These include digitalization (with a growing importance of software vs. hardware), servitization (service vs. product), electrification (from ICE to BEV), and sustainability (with new requirements and metrics). As competences shift and learning capabilities become paramount, ambidexterity must be in place (Becker & Zirpoli, 2017). The interplay of these changes is likely to shape the automotive industry into a new mobility ecosystem for a long time, where a logic of one-best-way choices may leave the ground to an age of profound variety and experimentation.

Then, Chap. 3 (by Valentina Fava and Giovanni Favero) provides a description of the emergence of automotive sustainable alternative technologies in Europe, and of the main forces that shaped this process, from the oil shocks to the EU integration process. The chapter offers an interesting perspective on the intertwining of political, economic, and cultural variables influencing sectoral technological trajectories in Europe. While historical literature on the diffusion of sustainable automotive technologies has grown exponentially in the last two decades, it still focuses mainly on the American, British, and German cases while for instance there are only few historical studies concerning the impact of the automobility practices and automotive industry on the Italian environment and society on the long term (Paolini, 2007). The chapter provides an in-depth study of the Italian public debate on sustainable technologies in the automotive industry from the 1950s to the recent call for an energetic transition, passing through the 1970s oil shocks, the emergence of ecological movements, and the EU integration. The study will pay specific attention to the contribution of relevant experts' communities and their connection with the political decision-making process, interpreting at once the shifting positions of the multiple voices in the debate on technological options in the light of both industrial policy options and the peculiar geopolitical situation of Italy (Calabrese, 2016).

We then discuss in Chap. 4 (by Andrea Stocchetti) the challenges specifically related to greening the car and the pro and cons of the almost exclusive focus on new electric motorizations, while a broader approach to sustainability would be advisable. While sustainability is a mantra for carmakers (Richter & Haas, 2020), greening efforts focus almost exclusively on powertrain technologies. On the one hand, technology and strategies seem to be increasingly oriented toward reducing environmental impacts; yet, on the other hand competitive dynamics leave no room for innovation formulas that would kick-start a real ecological transition, much broader than that merely linked to powertrain technologies. To satisfy a demand which is mostly uninterested in environmental issues, carmakers are producing heavier and more powerful cars. As a consequence, while improved engine technology means greater relative efficiency (and potentially lower fuel consumption and less pollution), such improvement is largely canceled out by the constant increase in the weight and power of new vehicles. Policies toward the sector have objective responsibilities in this respect. As purchase incentives raise the affordability of cars, customers prefer to buy bigger and more powerful cars at the same expense. The stated aim of the incentives is to bring cleaner cars onto the market and take older and more polluting cars off the road, but has the effect of pushing increased performance rather than encouraging a shift toward more sustainable vehicles such as lighter, less powerful, and fast cars. It would be more effective, and fair, instead, to introduce disincentives for the most polluting cars. But in fact, incentives are often adopted with the actual purpose of supporting the national car industry (Pichler et al., 2021).

Finally, Chap. 5 (by Lisa Balzarin and Francesco Zirpoli) represents the conclusion of the first section of the book, discussing the impact that technological changes have on incumbents' competences, and specifically how the latter are approaching the diffusion of new electric motorizations and the development of new mobility services (Wells et al., 2020) triggered by information and communication technology and new consumer behaviors. The story of the automotive industry is marked by recurrent technological shifts, one of which is happening nowadays. Firms that operate in this industry are required to update their competences and products in the light of the diffusion of new power-train technology, that is, electrification (Thomas & Maine, 2019), and the development of new mobility services triggered by information and communication technology and new consumer behaviors. Such a change is not confined within the boundaries of automotive firms and might trigger a transition toward a new business ecosystem. The chapter aims at providing more understandings about the peculiar phase of transition that the automotive industry is experiencing and its impact on automotive firms' competence and identity. The chapter sheds light on the nature and effects of the current shift toward the electrification of the drive-train and the related new mobility services and discusses to what extent the current transition might threaten incumbents' position. It will do so by analyzing if and how the transition will also require a fundamental renewal of automotive firms' competence and identity and assess if current incumbents have the capabilities to navigate the new ecosystem.

In the second section of the book, we provide guidance about how incumbents can surf this turbulent landscape along their value chain. More in detail in Chap. 6, by Pietro Lanzini, offers further insights on the demand side and by shedding light on the behavioral and psychological determinants of individual choices in the domain of mobility, which is a pre-requisite for the implementation of new and effective strategies (Lanzini & Khan, 2017). The automotive industry and the mobility sector are experiencing turbulent times, where the intertwining effects of both endogenous and exogenous phenomena are swiftly changing the rules of the game. The rise of innovative technologies and business models, the shift from the concept of ownership to that of use, and an unprecedented awareness of sustainability-related issues are all dimensions that are likely to change the way individuals conceive mobility and choose between different options available. Now more than ever, it is crucial for automakers willing to get an edge over competitors (both inside and outside the car industry) to gain further insights on the demand side (Lanzini, 2018). That is, shedding light on the behavioral and psychological determinants of individual choices in the domain of mobility, this being a pre-requisite for the implementation of effective corporate strategies. The chapter illustrates the role that variables such as attitudes, values, or habits play in shaping individual behaviors, and illustrate the results of an empirical investigation on the topic, performed by means of an online survey on commuters and travelers.

Chapter 7, by Anna Cabigiosu, discusses how incumbents can face emerging challenges by relying on open innovation for the development of new technologies and by providing several examples describing how carmakers approached and developed new and competence-destroying technologies such as electric motorizations (Bohnsack et al., 2020). Given that entire industries face sustainability challenges, it is important to understand the dynamics that lead incumbents to develop competence-destroying sustainable product innovations. This chapter discusses the implication of the sustainable transition on carmakers' core competences and discusses how carmakers relied on open innovation during the era of shift from Internal Combustion Engines to electric vehicles by describing the process through which they leveraged open innovation for the provision and development of electric batteries, the most distinct component of electric vehicles (Bohnsack et al., 2020). The chapter adopts a processual view and provides multiple cases and examples that describe carmaker incumbents' vertical and horizontal partnerships and discusses a path-based open innovation framework for green technology characterized by an inverse U-shaped breadth and depth of partnerships correlated to different levels of technological uncertainty until carmakers start moving from market to hierarchy by producing in-house electric batteries (Laursen & Salter, 2006). The chapter also provides managerial implication and discusses how policy makers can help the sustainable transition.

Then, Chap. 8 (by Leonardo Buzzavo) provides further insights on how distribution and retail services are changing in the automotive industry due to the new digital technologies, and which alternative business models are emerging for distributors (Kim et al., 2021). The automotive industry has been long adopting a selective scheme in sales and service featuring an architecture of vertical quasi-integration. The growing degree of competition, oversupply, and the need for efficiencies have gradually triggered a process of downstream consolidation, while digitalization has been impacting retail by enabling new forms of coordination. On top of this, a gradual acceptance of new mobility packages, favoring use over ownership, has opened the way for new business models and selling practices—that is subscription—within a servitization trend. While OEMs are tempted by restructuring distribution in ways that could revamp profitability and control customer data (i.e., agency models), retailers are aiming for scale, multi-branding, and greater shares of customer wallet. The emerging scenario is likely to feature a variety of approaches where incumbents and entrants, as well as premium and volume players, will strive to gain or defend competitive positions (Candelo et al., 2021; Kim et al., 2021).

Chapter 9, by Anna Cabigiosu, analyzes the travel preferences of citizens in the main European capitals, highlighting, on the one hand, the strong use of the private car as a means of transport and, on the other hand, the willingness of public transport companies to discourage its use in favor of greater environmental and social sustainability promoted by public transport, micro mobility, and shared mobility (Browne et al., 2012). In particular, within this setting, the chapter analyzes and compares open public mobility platforms in Europe and the main sustainable mobility projects developed by local public transport operators with a focus on the electrification of bus fleets and discussion of the case of Venice. This analysis aims to identify the main trajectories of changes in public transport in Europe that are driving green transitions, their challenges, and the results obtained so far, to disentangle future avenues of change (Alochet et al., 2021; Shah et al., 2021).

Finally, Chap. 10 (by Davide Bubbico) offers an overview of the actions that governments (Germany, France, Italy, Spain, and England) are promoting for the automotive sector. As such, the objective is to consider what are the policies in direct support of car makers and the auto parts manufacturers: both in support of infrastructures (electric mobility) and in support of public and private research (Pichler et al., 2021; Griffiths et al., 2021). The adoption of regulatory measures and tax incentives for the purchase of alternatively powered cars seems to be the most obvious facts, but what roles are European governments playing in supporting their respective automakers, local production systems, and the ability of automakers and their suppliers to do sustainable product innovation (Pichler et al., 2021)? The aim of this contribution is to provide an overview of the actions that governments of Germany, France, Italy, Spain, and England are taking to support the green transition in the automotive sector. In this direction, the objective of this chapter is to consider which policies are in support of car manufacturers and their suppliers; those in support of infrastructure (electric mobility), and those in support of public and private research.

Further, the main take-aways of the two sections of the book are discussed in the Synthesis section where authors dialogue to help readers in grasping the key aspects emerging in each contribution, and how different lenses can be applied to the same topic to gain better insights. Overall, the book provides a comprehensive description of how the greening of automotive and mobility industries is affecting incumbents' sources of competitive advantage and business models. In doing so the book answers to the needs of a broad community of researchers and industry experts that are looking for a deeper understanding of the implications that the green transition is likely to have on our firms' source of competitive advantage and business models.

References

Alochet, M., Midler, C., Shou, Y., & Wang, X. (2021). The road to autonomous mobility services: Who drives the transition, where, and how? *International Journal of Automotive Technology and Management, 21*(4), 343–364.

Becker, M. C., & Zirpoli, F. (2017). How to avoid innovation competence loss in R&D outsourcing. *California Management Review, 59*(2), 24–44.

Bohnsack, R., Kolk, A., Pinkse, J., & Bidmon, C. M. (2020). Driving the electric bandwagon: The dynamics of incumbents' sustainable innovation. *Business Strategy and the Environment, 29*(2), 727.

Borgstedt, P., Neyer, B., & Schewe, G. (2017). Paving the road to electric vehicles – A patent analysis of the automotive supply industry. *Journal of Cleaner Production, 167*, 75–87.

Browne, D., O'Mahony, M., & Caulfield, B. (2012). How should barriers to alternative fuels and vehicles be classified and potential policies to promote innovative technologies be evaluated? *Journal of Cleaner Production, 35*, 140–151.

Calabrese, G. (Ed.). (2016). *The greening of the automotive industry*. Springer.

Candelo, E., Troise, C., Matricano, D., Lepore, A., & Sorrentino, M. (2021). The evolution of the pathways of innovation strategies in the automotive industry. The case of Fiat Chrysler Automobiles. *European Journal of Innovation Management, 25*(5), 1368–1387.

Griffiths, S., Del Rio, D. F., & Sovacool, B. (2021). Policy mixes to achieve sustainable mobility after the COVID-19 crisis. *Renewable and Sustainable Energy Reviews, 143*, 110919.

Holweg, M. (2008). The evolution of competition in the automotive industry. In *Build to order* (pp. 13–34). Springer.

Kim, S., Connerton, T. P., & Park, C. (2021). Exploring the impact of technological disruptions in the automotive retail: A futures studies and systems thinking approach based on causal layered analysis and causal loop diagram. *Technological Forecasting and Social Change, 172*, 121024.

Lanzini, P. (2018). The automotive industry and the increasing relevance of a consumer perspective: A research agenda. *International Journal of Automotive Technology and Management, 18*(1), 46–58.

Lanzini, P., & Khan, S. A. (2017). Shedding light on the psychological and behavioral determinants of travel mode choice: A meta-analysis. *Transportation Research Part F: Traffic Psychology and Behaviour, 48*, 13–27.

Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal, 27*(2), 131–150.

Paolini, F. (2007). *Storia sociale dell'automobile in Italia*. Carocci.

Pichler, M., Krenmayr, N., Schneider, E., & Brand, U. (2021). EU industrial policy: Between modernization and transformation of the automotive industry. *Environmental Innovation and Societal Transitions, 38*, 140–152.

Richter, I., & Haas, T. (2020). Greening the car? Conflict dynamics within the German platform for electric mobility. *Sustainability, 12*(19), 8043.

Shah, K. J., Pan, S. Y., Lee, I., Kim, H., You, Z., Zheng, J. M., & Chiang, P. C. (2021). Green transportation for sustainability: Review of current barriers, strategies, and innovative technologies. *Journal of Cleaner Production, 326*, 129392.

Steinhilber, S., Wells, P., & Thankappan, S. (2013). Socio-technical inertia: Understanding the barriers to electric vehicles. *Energy Policy, 60*, 531–539.

Teece, D. J. (2018). Tesla and the reshaping of the auto industry. *Management and Organization Review, 14*(3), 501–512.

Thomas, V. J., & Maine, E. (2019). Market entry strategies for electric vehicle start-ups in the automotive industry – Lessons from Tesla Motors. *Journal of Cleaner Production, 235*, 653–663.

Wells, P., Wang, X., Wang, L., Liu, H., & Orsato, R. (2020). More friends than foes? The impact of automobility-as-a-service on the incumbent automotive industry. *Technological Forecasting and Social Change, 154*, 119975.

Part I

2

Reshaping the Auto Industry Through Unconventional Challenges

Leonardo Buzzavo, Giovanni Favero, and Francesco Zirpoli

2.1 The Automotive Industry Entering a New Stage

2.1.1 A Relentless Evolution Shaping New Strategies and New Industry Architectures

Industries evolve over time, and the automotive industry is no exception. New technologies that are invented and new organisational forms that get experimented act as the basis for new forms of value creation and value appropriation, triggering new strategies for incumbents or for new entrants. On top of this, changes in the competitive landscape take place both gradually and in shorter lead times, such as for example

---

This chapter is a joint endeavour. The listing of author names is alphabetical. Credits authors: Buzzavo wrote Section 2.1, Favero wrote Section 2.2, Zirpoli wrote Section 2.3.

L. Buzzavo (✉) • G. Favero • F. Zirpoli
Department of Management-Venice School of Management,
Ca' Foscari University of Venice, Venice, Italy
e-mail: buzzavo@unive.it; gfavero@unive.it; francesco.zirpoli@unive.it

A. Cabigiosu, P. Lanzini (eds.), *The Green Transition of the Automotive Industry*,
https://doi.org/10.1007/978-3-031-37200-1_2

globalisation and the path towards sustainability. They bring along a blend of pressures and opportunities that each firm can subjectively interpret and translate into a unique competitive trajectory.

It may often appear superficial to label a given industry as mature, while in reality a constant interplay of forces actually determines a rejuvenation towards new strategic conducts (Baden-Fuller & Stopford, 1992; Volpato, 1983). The world of biology is sometimes an inspiration while looking at evolutionary life cycles of industries, meaning the rate at which new products, processes and organisational structures are introduced. Such *clockspeed* (Fine, 1999) relates to how well, and how rapidly, a company manages and therefore adjusts the dynamic web of relationships that run throughout its chain of suppliers, distributors and alliance partners. Industry architectures evolve over time: while at one given stage vertical integration may represent the optimal route for maximising competitiveness, at a different stage architectural advantages may be obtained without the need to engage in vertical integration, by leveraging factors such as complementarity, mobility and capabilities (Teece, 1986; Jacobides et al., 2006). The strategic pendulum of the auto industry has been featuring fascinating oscillations throughout its history: while early automotive producers were not integrated, Ford's mass production approach brought a very high level of integration, then gradually the benefits of de-integration and of refocusing on core competences triggered the global transformation of supply chains with automakers as system architects. But to keep the story interesting and dynamic, in more recent times the drive towards electrification has been generating a trend towards upstream integration in areas such as battery production or even mining for battery inputs such as lithium. At the same time some automakers are implementing a more direct role in distribution activities—mainly with an agency model, discussed in Chap. 8 of this book. Tesla represents a young entrant versus established automakers dating back a century or so, and its strategy of marked integration, both upwards and downwards in the chain, is inevitably under the spotlight when aiming to understand where the industry may be going in the near future.

2.1.2 Globalisation Trends vs. Regional Differences

Besides the peculiar traits of industry architectures that vary over time and may understandably feature differences among brands that are related to individual strategies, it is interesting to note that globalisation also appears as a sort of pendulum, with stages of intense acceleration in globalisation—such as for example the two decades starting in the 1990s after the fall of the Berlin wall—followed by a window of deep question marks over the political, economic and strategic implications of globalisation induced by unexpected events such as the global pandemic that originated in 2020 and the Russian-Ukrainian conflict that originated in 2021, all with their monumental consequences on society, economies, markets and supply chains.

All this considered, the history of the automotive industry, and more particularly of its industry architecture, appears hardly linear (Chandler, 1962; Volpato, 1983; Maxton & Wormald, 2004; Stocchetti et al., 2013). Moreover, in a world featuring a high degree of specificities in continents, regions and markets there are factors that make it challenging to draw an aggregate picture (Freyssenet et al., 2003). The massive development and market growth of the auto industry that took place in the US market between the two world wars, for example, took something like three decades to manifest in Europe, while other emerging economies went through their own growth cycles. The automotive industry world is therefore far from being flat, and regional difference also contributed to shape different evolutionary paths. For example, the large growth in the US market was fuelled by the magnitude of its consumer market that created optimal conditions for a mass production model, while in a place like Japan some specific traits were fertile conditions for the establishment of the lean production model, an approach that then spread onto automotive architectures and strategies world-wide only later. Markets feature specific conditions linked to their economies and geographies making it impossible to draw a common picture: consider for example Brazil with its context rich in alcohol as a fuel and the implications on powertrains, China with its heavy political steering of the economy and business landscape, and other regions such as India and Africa with even more specific traits as far as motor vehicles are concerned. We could argue that over time, the macro-lens of most management practitioners and academic scholars shifted across regions in order to interpret and understand the leading innovations in architectures and competitive strategies. So, while the US market can be undoubtedly considered the privileged locus of analysis for the debut of mass production circa 1920s, Europe then provides an interesting context for looking at innovation trajectories starting around mid-century, then Japan stands out as the cradle of the lean production model that originated in the 1980s. In more recent times attention is probably more scattered, with a US-originated brand like Tesla on the one hand, China making itself heard with its powerful—albeit slowing—economic arm, and other innovators in the ecosystem showing sparks of dynamism also in other areas of the world.

2.1.3 Attempting a Sketch of Architectural Evolution

As discussed, the automotive industry shows an evolutionary path that is not linear and not flat. We anyway embrace the challenge to draw a simplified framework of analysis that tries to grasp the key features of the industry, at least those that are believed to be most representative of its value chain architecture and its main competitive drivers, over time. The underlying idea is to draw the attention towards how the main drivers of competitiveness, and therefore the explaining factor for performance differentials, have evolved over time and are still evolving, facing the relevant dimensions of transformations that are in place. It goes without saying that this task clearly becomes even more challenging as we approach current times, both because true history is likely to appear clearer and more readable only in the future, and because the combination of disruptive events in recent years determines a spike in uncertainty and volatility, with an even greater challenge when looking at the future. We however believe that an attempt to map the evolution towards the present, albeit with an inevitably imperfect and partial approach, can contribute to the debate of interpreting the directions of change and the implications for industry architecture, its competitive strategies and perhaps also the very important public policy implications.

1st stage: origin of industry (late nineteenth century):

Albeit vehicles had been existing for some time, the actual turning point that constituted the recognised landmark for the birth of the automotive industry was the invention and subsequent affirmation of the gasoline engine by Karl Benz in the late nineteenth century. Vehicles existing before the establishment of gasoline power as the key technology featured a co-existence of propulsion systems being steam, gasoline and electricity. But while steam engines were expensive to build and quite difficult to maintain, battery capacity remained a big constraint that did not allow electric vehicles to take off. Most automobile manufacturers were small workshops adopting hand-made production, in typical craftmanship style. Interestingly, large companies operating in adjacent industries (e.g., railway, steel) did not see the profit opportunities that were lying in the car business in early times, and when they got involved, they did it without a strong commitment, often exiting the business just later. This caused a general underestimation of the expansion of the auto industry that was rather commonplace before World War One (Volpato, 1983).

Many producers were born—with a strong lead in the USA—focusing on chassis design and parts assembly, while parts and sometimes the engine were sourced elsewhere. This situation was quite different from what one can typically see today in automotive manufacturing: at that time the car company was a small player, relying on its suppliers' strength both on the financial and on the technological standpoint. By selling cars first to an elite market, and paying suppliers only later, they enjoyed a financial advantage, making market entry rather easy. This relative absence of barriers to entry created a wave of activity: it is estimated that in the USA a total of approximately 1500 firms entered the market in the first half of the twentieth century, albeit just a few managed to achieve stability in the market. The situation in Europe was quite different, with car purchases limited only to elites—the market was mainly focused on sports competition for wealthy buyers—and therefore much smaller conditions for the growth of a given industry model.

2nd stage: mass production emerges (circa 1920s):

The stage that christened the auto industry's dominance as a strategic paradigm spanning across industries was the adoption of full-scale mass production. It was a process that introduced peculiar elements within a craftmanship-based context: standardisation, interchangeability, synchronisation and continuity constituted the mutually reinforcing elements. The system was put in practice by Henry Ford who placed—and won—a massive bet over the market elasticity of demand. Ford's bet consisted in the following: if one could achieve a significant cost reduction allowing cheaper prices in the market, demand would take off. Such bet paid off and it is no surprise that such approach was also dubbed the American System, since the car as a commercial product as an industry is a typical American fact. In order to grasp the magnitude of such phenomenon, one may consider that the price of the Model T touring car, the iconic vehicle associated with the adoption of the mass production system, dropped from $950 in 1909 to $360 in 1916 and still lowered to an incredible $290 in 1926, a time when Ford was producing half of all the motor vehicles in the world.

Mass production implied mass sourcing and mass distribution, hence an architecture of marked vertical integration, spanning from the making of rubber tires (e.g., Ford owned permanent rubber plantations) to the provision of sales activities downstream. The so-called Big Three (Ford, Chrysler, GM) were born in the USA during this stage, while other manufacturers destined to play a prolonged role were also born elsewhere, for example Peugeot, Renault and Citroën in France, with European market starting to grow after World War One but with levels that were much more modest than the USA. All this happened certainly not without ups and downs that included also the 1929 stock market crash and depression.

3rd stage: world expansion and differentiation (circa 1950s):

After World War Two there was a striking expansion of motor vehicle production, with a manifold increase of the world output. It is estimated that during a 35-year period the total world output increased almost 10-fold, and most of the increase occurring outside the USA. Europe began reducing its divide with the USA, achieving scale economies and carrying out a rationalisation of production that made industry architecture more similar to the US context. It was a stage where supply led with strong demand, constituting what can be defined a seller's market. While the scheme adopted by Ford circa 1920s looked after scale that required integration, during this stage the need for scale drove a stage of intense concentration (Chandler, 1962; Sloan, 1963). In Europe a brand like Volkswagen managed to embark on a prolonged growth in Germany after the ashes of war, while in other markets national champions were strengthening (i.e., Fiat in Italy), laying the basis for later international expansion. The growth in the market unfolded along with growing differentiation as the industry must gradually cater to more segmented and more sophisticated needs, spanning for private and business usage, metropolitan and peripheral usage and so on.

4th stage: globalisation and lean production (circa 1980s):

In the 1970s one could say that the evolution of the automotive industry could be taking place a relative degree of continuity, or so it may seem at the time: there were prospects of further expansion in established markets plus gradual expansion in developing countries with the establishment of local plants mainly due to tariffs rather than an actual strategy. No one could expect the abrupt shock that took place in 1973 with the oil crisis and skyrocketing fuel prices and the necessary rationing that cast a serious cloud of scepticism over the auto industry's ability to withstand that major blow. According to many, the only viable solution was to transfer production to emerging countries in order to lower costs, converting industrial activities into more rewarding domains. Another similar shock came a few years later in 1979: the crisis made a stronger call for achieving large efficiency gains and started shifting consumer preferences away from larger cars—that were a typical feature in US production—towards smaller and more fuel-efficient ones.

Typical strategies adopted by auto manufacturers involved automation and shared purchasing in order to reduce costs, to partly offset rising costs induced by widening the offering to deal with a different market. The market in fact had started becoming a substitution market hence evolving from a seller's market to a buyer's market: the need for customisation to specific needs (e.g., city or periphery, family or individual transportation, leisure or work and so on) had become a ground for competitive battles, including the critical need to shorten product development cycles from conception to production.

This was the point in time when Japan started coming into the spotlight in an industry that saw the US context as the initiator and Europe as the main follower. Starting in the 1950s, Japan had evolved from a market open to foreign companies to heavy protectionism triggering a virtuous circle between domestic industry and demand, fostered by governmental support. After World War Two Japan was in a quite peculiar situation: while the US market was experiencing continuous growth and Europe lay the foundations for a leap in motorisation levels and market sophistication, Japan's economic and industrial might was devastated by the war. The focus on smaller batches and the need for flexibility, the innate focus on quality, the high level of commitment and employee involvement in the production process, the extreme degree of focus on customer value that shifted most attention from the scale of operations to the continuous improvement of product and process design, with high attention to the shortening of product development cycles as a competitive lever were among the factors that led to the emergence of a new organisational approach to vehicle manufacturing. The seeds of this approach were described in earlier literature, but it was Krafcik (1988) in a landmark article who captured the essence of the new production system inaugurated by Toyota, since then christened "lean production", but also known as TPS—Toyota Production System. The landmark book by Womack et al. (1990) had the merit of boosting world-wide popularity of such approach, proving capable of integrating efficiency, quality and flexibility in a way that was not feasible for Fordism to reach, at least not for the mature mass production system that most car companies adopted over the course of the decades. After an era when standardisation and industrial scale made the industry take off circa 1920s, through the world-wide expansion of manufacturing featuring increasing differentiation that took place circa 1950s, the 1980s then marked the unstoppable ascent of lean production as the new "one best way" that drew attention from the whole world. It was a European premium automaker, on the verge of economic collapse in the early 1990s due to troubles in efficiency and quality plus lagging demand due to unfavourable market conditions, to firmly commit to a profound restructuring that embraced significant elements of the lean production model. We could say that Wendelin Wiedeking, Porsche's CEO at that time, switched on the lean production light that then led Porsche not just to survive, but to dramatically boost efficiency and quality in a way that would represent a comeback also laying the basis for future success that lasted up to the present day. Porsche managed to interrupt a series of failures in product line expansion by hitting success with the Boxster model in 1996. And this game played out so well that Porsche then kept on building on range expansion and astonishing volume growth enjoying high margins, by gradually adding the Cayenne SUV, the Panamera saloon, the bestseller Macan to the electric-powered Taycan. Porsche represents just one of the most vivid examples of introduction of lean principles in manufacturing, something that affected more and more automakers around the world in Europe and elsewhere.

5th stage: digitalisation and sustainability (circa 2010s):

As said, when lean production became a key paradigm, all major automakers in the world adopted the new model with varying degrees of sophistication and/or specific adaptations. But while the combination of efficiency, quality and flexibility became more and more important as a competitive lever in the global scale, other innovative ingredients started to become ever more important. Technological innovations, particularly in the field of connectivity, internet and digitalisation of processes started exerting more profound pressures, both enabling new forms and architectures, and disrupting traditional and consolidated ways. The explosive growth of the digital elements in a car, the growing degree of connectivity between the car, the automaker and other parts of the ecosystem, the possibility to take advantage of new forms of customer relationship and distribution architecture made possible by digital channels, paved the way for an industry outsider to being a dynamic streak of successes starting with an all-electric model. Elon Musk with Tesla started recording a gradual growth in public awareness, sales volumes and most particularly staggering financial valuations that were hard to envision. Tesla began with the Roadster in 2008 basically adding an electric motor to an existing Lotus shell. But while this was a sort of experiment, it was the introduction of the Model S and other models—such as Model X and most importantly the more accessible Model 3—proving that the competitive challenge was quite serious, and its impact would have been stretching far.

Tesla can be seen as a sort of "unicorn" in the automotive industry, having been able to achieve, over a relatively short time frame, a strong presence that encompasses consumer awareness, attention by the media, sustained growth in sales volumes, financial valuation, with the latter being at the top spot among all automakers, at least while these lines are being written. The company certainly holds some peculiar traits, starting from a "green-field" approach that could begin from scratch the design of its industrial model, capitalising on lessons from incumbents and making choices more in line with the context. The flamboyant personality of its founder Elon Musk, often comparted to the leading character in the successful Iron Man movies—also due to his successful ventures in the space economy—provided a great jumpstart in awareness, allowing Tesla to basically spend no money into advertising, contrary to typical automakers who spend heavy sums in advertising. Tesla could also enjoy income from regulatory credits, by selling CO2 certificates to other players (e.g., FCA), consisting of many hundreds of millions of dollars over a given time frame. According to industry observers, the company managed to achieve a competitive price-performance ratio in its engine, but it is in the battery production side that it seems to hold an interesting basis of advantage, by exploiting scale and learning economies in an era of growing interest towards electric vehicles induced by governmentally mandated decarbonisation efforts. Besides all these factors, each playing some kind of role towards the final outcome, we would like to single out perhaps the most peculiar and striking component of Tesla's strategy being its overall approach that resembles more that of a software company than a traditional car company. Tesla vehicles, often referred to as "smartphones on wheels", are featuring a dominant attention on software vs. hardware, with aspects such as technological advances in AI (Artificial Intelligence) and autonomous driving features, combined with OTA (literally "over the air") updating of vehicle systems, being a common feature and an intrinsic part of its overall strategic approach. We would then argue that Tesla embodies the main features of the era in which the auto industry has entered over the last decade, being the age of digitalisation within a context of growing attention to sustainability. Besides its software-oriented strategy, Tesla entered the automotive industry scene with the peculiar advantage of creating a *lovebrand* in line with a renewed attention to the environment and to reducing greenhouse emissions to contrast global warming and its dire consequences for humanity. As a matter of fact, while attention to ESG elements—Environment Society Governance—considered as key aspects involved in any context of socio-economic growth had been gradually building over time, it is only in most recent years that they surged to global imperatives putting governments, institutions and firms on a path towards a carbon-neutral society in the course of a few decades, with the need for automotive players to play a responsible role.

Whatever the future outcomes for Tesla, we would argue that some of its innovative aspects will be looked at in retrospective as important seeds of change.

2.1.4 A Look Over Time

Table 2.1 is an attempt to sketch these major stages of transformation, reinstating the fact that much more complexity lies behind the simplification, given the variation by geography and individual automakers, the oscillations in market and industry conditions and so on. All this considered, this is intended to be a sketch, more intended to help us frame questions rather than to provide answers. Also, each line between stages should be seen as a dotted and fuzzy line, also open to a different and more complete interpretation as time evolves, when things appear more readable, particularly for the times in which the observer is immersed into.

As highlighted earlier, cars were already existing, but it was Karl Benz's invention of an efficient version of the gasoline engine to mark the birth of the auto industry towards the end of the nineteenth century, with the Motorwagen representing the emblem of such stage. It was a stage where craftmanship made the very young auto industry a context for art as the primary industry lever. Ford's development of the mass production

Table 2.1 Attempting a visual recap

Time (circa)	Relevant triggers and features	Industry drivers
Late nineteenth century	Invention of gasoline-powered engine; birth of many producers; elite market	INVENTION, CRAFTMANSHIP
1920s–	Advent of mass production: Standardisation of products and tools, efficiency	INTEGRATION, SCALE
1950s–	Post-war market expansion world-wide; automotive-shaped society and gradual demand differentiation	CONSOLIDATION, DIFFERENTIATION
1980s–	Oil shocks; lean production (efficiency + quality + rapid product development); waves of globalisation	GLOBALISATION, INNOVATION (LEAN)
2010s–	Global financial crisis; urge for decarbonisation; software economy and hyper-connectivity (smartphones)	DIGITALISATION, SUSTAINABILITY

Source: Own elaboration

system, with the Model T being at the heart of the scene, had represented the entrepreneurial innovation that combined some scientific management principles with a massive bet on elasticity of demand. The basic assumption was that cheaper cars, made possible by achieving large production volumes through the standardisation of product and processes, would trigger market demand to unprecedented levels, fostering a virtuous circle. All this would constitute a clockwork-like factory operating best when integrating as many activities as possible, in order to make such standardisation happen, and control lead times and flows. With Ford, science took over art as the main thrust behind value creation in automobiles. Once this blend of integration and scale proved a winning formula allowing the advent of mass motorisation in a market exclusively aimed at a few elites, over the course of a few decades demand started expressing growing degrees of patterns, of sophistication, of segmented modules, also across different geographies. The gradual differentiation in demand, with varying needs for vehicles catering to specific mobility requirements, led automakers to greater segmentation. Scale however remained quite an important factor involved in shaping the architecture of value creation, and consolidation processes became common. These inaugurated an era—destined to last for long, encompassing the present day—where automakers appeared as corporate architectures with more than one brand/division, with General Motors and its many brands in its portfolio being some sort of the archetypal example. In this stage it became much more important for each brand within a corporate architecture to have its own character facing the market, its own story. This was the situation when cars should not all be black—referring to Ford's widely known metaphor for standardisation—but rather cater to individual dreams and desires, each with its own story and marketing proposition in a world where brands and their languages become more and more important. If we had to pick a representative vehicle for this stage, featuring brands focusing more on a segmented offering for an evolving and ever more differentiated market, we may pick a European representative vehicle as the iconic Citroën DS.

While the post-war growth led to a growing importance of marketing as a discipline involved in value creation for automakers pursuing evolving needs, the oil shocks in the 1970s were the major trigger to rapidly put Japan on the map with the astonishing success of small Japanese compact cars in the US market in the 1980s, and elsewhere later on. This success put lean production at the top of the podium, strong of its ability to shorten product development cycles and to provide flexible responses to a more volatile market. We may pick the Toyota Corolla as one of the most representative vehicles of this stage: although it was introduced earlier in the 1960s, it was towards the end of the twentieth century that it became one of the most popular vehicles in the world. The reduction in time to market made speed as one of the most important drivers of competition in a globalised world.

The technological advances of most recent decades—in particular digitalisation—and the hyperbolic acceleration of the importance of sustainability—in particular decarbonisation—as a contextual imperative, led Tesla to draw more and more attention from the financial community, marking astonishing financial valuation records. The Model 3 in Tesla's product line represents a vehicle targeting not just high-end early adopters, as it happened with the Model S and its price tag beyond the USD/EUR 100,000 mark, but also environmentally conscious consumers with

Table 2.2 Traits of automotive industry stages: metaphors and most representative vehicles

Time (circa)	Industry drivers	Visual metaphor	Most representative vehicle
Late nineteenth century	INVENTION, CRAFTMANSHIP	Art	Benz Motorwagen
1920s–	INTEGRATION, SCALE	Science	Ford Model T
1950s–	CONSOLIDATION, DIFFERENTIATION	Story	Citroën DS
1980s–	GLOBALISATION, INNOVATION (LEAN)	Speed	Toyota Corolla
2010s–	DIGITALISATION, SUSTAINABILITY	Space mission	Tesla Model 3

Source: Own elaboration

a passion for innovative technology, deciding to buy a Model 3 instead for example of a similarly priced C-class Mercedes, 3-series BMW or A4 Audi. In recent times Tesla has lowered its prices so to make its products even more accessible to broader segments of consumers. We could pick a space mission as a visual metaphor for Tesla's success: strong determination for ambitious goals, relentless experiments and patience, experimentation and testing of frontier technologies such as electric powertrain, connectivity, AI and autonomous driving.

Table 2.2 provides an attempt to capture the above-mentioned set of stages associated with a representative vehicle and a visual metaphor.

2.1.5 What's Next?

What lies ahead for the future of the automotive industry? It is quite a challenging question, considering that high volatility and global disruptions have massive impact on industry architectures, often with unexpected consequences. Just as a factual example, who would have thought that the typical stock-push context of an automotive industry would rapidly turn into customer pull in the years 2021 and 2022? The high degree of competitiveness among automotive manufacturers has generated a seller's market where vehicle stocks, customer rebates and price-competition play a major role: however, disruptions induced by the global pandemic included major bottlenecks in the availability of microchips, with a wave of effects over supply chains around the globe. For the first time in decades, in many markets the industry saw a situation of demand exceeding supply, with customer pull, long waiting times and transaction prices nearing list prices that had not been seen in decades, unless for high-end luxury brands.

When assessing the prospect for evolution of the automotive industry, a few key elements often draw much attention, being: connected vehicles, shared vehicles, autonomous vehicles, electric vehicles intended as major transformative trends. We have already mentioned, albeit briefly, the first and last items in the list: connectivity and digitalisation are not just enabling new products and processes (e.g., Tesla), but also enabling new forms of intermediation and customer relationship. E-commerce-based direct-to-consumer models for example create pressures to change on distribution networks, as discussed in Chap. 7 of this book. Connectivity enables links and intelligence among OEM, suppliers, customers, third parties, paving the way for more frequent and deeper interactions with organisational and business implications.

Electrification is determining a massive shift in the technology portfolio lying around the design, development and manufacturing of a new vehicle, with huge impact on the types of modules involved and the inevitable reshaping of the supply chain both upwards related to powertrains (i.e., batteries, engine production), downwards (i.e., energy provision for mobility) and on the overall need for life-cycle coordination.

Shared vehicles are relating to a consumer trend privileging access over ownership, that in many industries have produced significant changes. It is an intricate territory for debate, since there are different levels of solutions with varying degree of success. For example, mobility tools like Uber have gained much visibility, however such ride-hailing services while they may undoubtedly reduce the need for car ownership in metropolitan contexts, can be seen more as an upgraded stage for the taxi business rather than a new paradigm for the car industry in itself. Provision of shared services has so far seen mixed results, with most experiences still far from proving to be solid enough in terms of business models, both by entrants and by incumbents. There is no doubt that there is a growing focus over the service dimension rather than over the product dimension (Rifkin, 2000), visible in the ever more common concept of mobility-as-a-service (MAAS), something that we could read by using the servitisation codeword. This calls incumbents to rethink their own practices: more attention to the provision of mobility means that rather than purchasing a vehicle, portions of consumers may be interested in solutions satisfying their specific mobility need in time and space (Genzlinger et al., 2020). In other words, while an owned car is available in principle 100% of the time in a consumer's garage, this consumer may actually need a car—any car, not necessarily her or his own—only for some occasions, for example in weekends for leisure while commuting to work is done through public transport. It is interesting to see a well-established player such as Toyota to launch its global brand for mobility services (Kinto) as a context for experimenting in that direction, more recently followed by the Renault Group with Mobilize, while more and more players are broadening their provision of subscription models in more sophisticated ways. Insurance companies, for example, have started offering private customers the possibility to flexibly switch policies on and off according to their needs. It should also be said that the rising costs of vehicles induced by expensive battery packs may contribute to couple with consumer attitudes moving away from ownership—a feature more common in younger generational cohorts across many industries—hence favouring the diffusion of mobility solutions, subscriptions and so on. This may be in line with the growing attention by automakers to extract revenues and therefore margins not just on the sale and the provision of typical maintenance and repair but also on added value services associated with location-based services, in-car entertainment, other safety and comfort features and so on.

Finally, autonomous driving, a feature already present in cars with varying and evolving levels of driver assistance, may induce a major disruption when such functionality goes full mode, but this is likely to take some time.

On the whole, it is interesting to note that serious disruption may stem from the combined effect of some of these transformations, for example when full autonomous driving gets combined with sharing and mobility-as-a-service elements, so to open up unexpected possibilities and fundamentally alter the traditional equilibrium.

What next then? It is quite hard to say. Globalisation that has long been a key feature of the car industry has run out of speed making room for de-globalisation trends. The gradual de-integration of automotive architectures sees new interest for integration upwards (i.e., batteries) or downwards (i.e., more direct control of distribution via agency). Digital technologies keep on accelerating their transformative effects, while the path to electrification may see varying speed due to the volatility in energy prices. Within this picture servitisation is an interesting and far-ranging concept however it poses serious challenges to overcome as it also implies a major shift in approach including systems and culture (Siagri, 2021).

To what extent automakers will be able to keep the reins as system architects will have to be seen, in the ever-interesting evolutionary path of this paradigmatic industry.

2.2 Fluidity Rules: How Turbulence Shakes History

As of today, the automotive industry is in a highly fluid state, and it is far from easy to identify drivers of performance differentials and/or see the emergence of a new dominant design. This condition of uncertainty was the same more than one century ago, when the now dominant design was emerging, and is probably inherent to all industries following a non-linear evolutionary path.

The present-day architecture of the automotive industry is in fact the outcome of a development that only in part resulted from the successful strategies of entrepreneurial actors imagining the future of the car (as it was Ford, for instance) and, more often than not, from the interference with contextual transformations affecting, quite unexpectedly, mobility options and their logics. These complex processes insist on contingent conditions implying unpredictable consequences and some path dependency.

Looking back at the origin of the different components of today's dominant design in the industry, it is also evident that their emergence pattern during the first half of the twentieth century displays some complementarities, but also some independent contextual causes. Such elements include different levels: (1) the adoption of the internal combustion engine (ICE) as the powertrain of choice and the related construction and management of a complex logistics for the distribution of oil derivatives as fuel; (2) a mobility model based on the private ownership of means of transportation that became affordable thanks to their mass production by OEMs; (3) the construction of an efficient infrastructure, together with the implementation of a series of regulations concerning traffic, safety and driving licences and schools, with specific legal, insurance and tax obligations.

It can be interesting here to briefly highlight the different retrospective histories that result from a focus on each of these levels, in order to understand which conditions could partially unlock the evolutionary path of the industry.

2.2.1 Contingent Technological Alternatives

If the invention of the ICE was made possible by the technical advancements of the Second Industrial Revolution, its dominance as powertrain solution was not established until World War One and became clear only during the 1930s. Ford's mass production of ICE-based models, together with the introduction in 1913 of the cracking process in oil refining, which made gasoline available in larger quantities and cheaper, contributed to exclude the electric alternative that during the *belle époque* still appeared viable.

The lack of technical solutions allowing to overcome issues related to the weight of batteries, affecting velocity and autonomy, is usually mentioned as the main factor hindering the development of the electric car in the early twentieth century. However, similar technological gaps were also affecting the ICE technology in the same years, and new solutions were elaborated following huge investments in R&D that made the mass production of ICE automotive possible. This shift happened in the USA during the early years of the twentieth century and was mostly due to cultural factors that conditioned the imagined future of mobility (Hadjilambrinos, 2021). Further contextual elements, as the immaturity of the electric industry in that crucial time window, implying a limited access to power outside of cities, and entrepreneurial failures concerning the speculative nature of most of the involved companies, contribute to the failure of the electric car in the USA (Kirsch, 2000), which became definitive also in Europe in the exceptional context of World War One (Mom, 2013, pp. 196–201). The electrical alternative was then pushed almost completely out of market with the Great Depression of the 1930s.

As it happened in many other industries, the acceleration in the development of technological innovations that war necessities imposed on the industrial systems of the belligerent countries, along with those of their suppliers, created completely new conditions that were unpredictable before the war. In particular, the choice to organise the supply logistics around oil and its derivatives allowed the automotive industry to experiment with a whole set of new military means of transportation. The subsequent reconversion and obsolescence of earlier models created the occasion for the development of new product lines during the interwar period, laying down the conditions for multi-divisional product differentiation insisting on the same technological core.

2.2.2 Varieties of Industry Architecture

Technical and industrial developments intertwined with a parallel evolution of the mobility ecosystem that goes often forgotten but is crucial to understand the radical novelty of the automotive industry in the twentieth century. In the turn of a few decades, the car changed its status from that of a luxury toy to that of a mass necessity (Pantzar, 1997), before in the USA and then in all industrialised countries. Such an evolution was not obvious neither predictable at all following the technological emergence of the ICE as the dominant powertrain. The two issues appear largely independent, even if they have obvious interferences. In the *belle époque* the future of road transport was expected to include fuel trucks for goods and fuel buses for passengers who would move along the fixed routes of collective mobility. The ownership of a private means of transportation, as it happened in the ancient regime with carriages, would remain a privilege of the few. Ford's mass-produced models changed the same nature of the car for good, creating the demand conditions for the development of services and infrastructures fitting private mobility.

Other new industries in the same decades were facing a similar alternative between selling the service or the means to produce it to the final customer, turning out with opposite solutions, which in turn are however identified with modernity. The electric industry in the USA was suspended for long between the sale of ICE power-generating equipment to households, farms and factories, on the one hand, and the provision of electricity directly from power stations over long distances, on the other one. The adoption of the second alternative went together with the emergence as system integrators of large-scale holding companies taking care of the generation, transmission and distribution of electricity, but not producing the generating equipment (Granovetter & McGuire, 1998). However, during the critical period, the lack of access to power networks in US rural areas favoured a preference for the ICE car (the model T in particular) as "a general source of power", and not only as a "transportation device" (Kline & Pinch, 1996, p. 772).

Closer to automotive is the airline industry, which however never adopted the model of the private ownership of individual means of transportation. Private airplanes remain luxury toys, and air travel is a matter of collective transportation for the wider public. There was, however, a relevant competition between two alternative technological solutions in the emerging aviation industry: lighter-than-air vs. heavier-than-air. Despite their sophisticated technology and the availability of technical solutions to fill safety gaps, the airships disappeared as an alternative to the airplane following the famous accident of the Luftschiffbau Zeppelin 129 Hindenburg in 1937, and the rising political tensions between the USA and Nazi Germany. It was however the higher costs and slower scaling up of the infrastructural network of dedicated airfields and services that made it economically less viable (Braun, 2009). Network- and service-related costs, including hiring pilots, may also explain the failure to develop a mass market for flying machines, shedding light on the constraints deriving from the complex nature of the large socio-technical systems that underpin the development of the new industries of the twentieth century, including the automotive (Mayntz & Hughes, 1988).

2.2.3 A Complex Socio-Technical System

The rise of the car as a mass private means of transportation implied the construction of a whole set of infrastructures, services and regulations making road mobility possible, comfortable and safe. This included the creation of extensive networks of gas stations and repair shops, with effects on related industries. Major oil companies built their distribution systems in direct relationship with the development of car mobility and of a dedicated road infrastructure, substituting with gasoline fuel the declining demand for kerosene for lighting (Williamson et al., 1963).

Safety issues did also arise as car traffic increased. Historically, the focus gradually shifted from a more general concern for road conditions to the driver's competences and responsibility, and finally to the vehicle itself. The main actors in the implementation of modern traffic signs during the *belle époque* were Touring organisations (mostly focusing on cycling) in Europe and the American Automobile Association in the USA. Driver's licences were introduced in the early years of the twentieth century as an instrument to control the number of circulating vehicles and identify them. A driving test was introduced in Germany and some American states before World War One, but only through the subsequent conventions of Paris 1926, Geneva 1949 and Vienna 1968 it became the subject of international agreements. The business of drivers' education emerged gradually during this period, together with motor vehicle liability insurance. The generalisation of the latter displays the same timing of similar institutional innovations concerning traffic and mobility: first introduced in some countries (UK in 1930 and Germany in 1939) and in some American states (Massachusetts in 1925) during the interwar years, it was gradually extended only after World War Two.

The safety of the vehicle design and specifications was an issue pertaining to OEMs and only in 1958 the United Nations' Forum for the harmonisation of vehicle regulations established general safety standards concerning seat belts, roll cage and other safety innovations, which were gradually brought to market by OEMs and slowly introduced in national regulations in the following decades. Even then, however, regulation efforts were hindered by the idea of "personal freedom and mobility provided by the automotive", pushing OEMs to adopt tactics intended to delay the implementation and enforcement of stricter standards and justifying a cost/benefit approach to vehicle safety (Lee, 1998, p. 400).

The interaction of regulatory and technological constraints, a cluster of consecutive innovations and changing consumer preferences entails an increasing complexity of the socio-technical system in which the automotive industry is embedded. And the most complex a system is, the most its evolution can't be predicted from each of its components and depends on a sequence of irreversible and unexpected events, which may unexpectedly trigger radical change (Bar-Yam, 2002; Buchanan, 2000). It is then worth asking if such a change may affect the main common feature holding together the technological trajectory of the ICE, that is, an industry architecture focused on the car as a privileged means of transportation, and a socio-technical system built around private mobility, both of which underpin the role of OEMs as dominant players.

2.3 The End of OEMs' Dominance?

In a recent paper Schulze, MacDuffie and Taube acknowledge that this is a turbulent time for the automotive industry (Schulze et al., 2015). Sections 2.1 and 2.2 in this chapter put in perspective such elements of turbulence as well as eventual similarities with past moments of change. Recently, Jacobides, MacDuffie and Tae showed that, despite such turbulence, there is little evidence that current players (OEMs) are destined to decline and a major shakeout in the industry is coming (Jacobides et al., 2016). This section tries to discuss the variables that will play a major role in reshaping the automotive industry and will re-assess—after some years of major changes—Jacobides et al.'s intuition about industry dominance.[1]

---

[1] In mid-2010s, in fact, there were no signs of a change in the power equilibrium within global value chains (see for example the chip shortage crisis), of a major shift in the supply-demand dynamics (see for example the recent phenomenon of demand exceeding supply) and, at least in EU and in the USA, a dramatic acceleration of the transition towards zero-emission vehicles.

2.3.1 The Rules of the Game and the Primacy of Incumbents

Since Henry Ford's revolutionary innovation transformed automobile engineering and production, turning the car into a mass-produced product, the automotive industry has gone through many transformations. Such transformations have brought changes in technology, markets, production and new product development practices, and a consistent pattern of mergers and acquisitions, leading to strong concentration in the industry. However, such changes have never threatened incumbents' dominance. Tesla, itself, as a new entrant looks like an exception rather than the norm (MacDuffie, 2018).

An industry that doesn't change its major players over 100 years can be hardly defined as dynamic. However, a growing number of commentators believe that the trends highlighted above will indeed change the industry. Why, this time, should it be different, that is, will the industry architecture change?

It would be just impossible to address this question here, not only for reasons of space available, but because of the complexity of the industry. Many variables are at stake and too many sources of uncertainty make the picture instable and in many respects its evolution unpredictable. In what follows, instead, we try to sketch the "rules of the game" as they are now and provide the elements that might contribute to change them.

In an article titled "Why Dinosaurs Will Keep Ruling the Auto Industry", MacDuffie and Fujimoto (2010) show that OEMs are and will be difficult to substitute by new entrants due to their unique capability to orchestrate a complex set of actors and technologies by controlling the product architecture and playing, at the same time, the role of the helmsmen of their value chains from customers (downward the value chain) to suppliers (upward the value chain). In other words, playing the role of system integrator (Cabigiosu et al., 2013; Zirpoli & Camuffo, 2009) would require competences that are difficult to imitate and replicate.

A second argument refers to the cost structure of the industry that requires great investments and production volumes to be profitable. This has driven OEMs (1) to elaborate complex product development strategies premised on the sharing of product platforms and components (see for example the VW approach to product platforms) and (2) to a series of mergers and acquisitions to leverage synergies in R&D and production costs.

According to the literature, competence and cost structure reasons would explain why the dominant position by OEMs has not been eroded so far neither by suppliers (even mega suppliers such as Bosch or ZF) nor by new entrants. The first would have the scale and the competence to technically make a car but lack competences in developing products that customers want to buy as they miss key knowledge concerning how to turn customers' needs into engineering specifications. The second, would be blocked by the industry entry barriers. Tesla, a rare case of a successful new entrant, benefited from a positioning in the high-end market segment where economies of scale are less relevant. But it is now having some major difficulties in scaling up (MacDuffie, 2018). Other new entrants, especially Chinese manufacturers, are benefitting from the specific political and market conditions in China that have allowed them to grow both system integration competences (through "forced" alliances with more experienced Western partners) and scale (due to a fast-growing Chinese economy).

Consequently, despite the many windows of opportunity created by continuous technological change and other organisational and market-related innovations we have not observed in the industry anything comparable to what has happened to the computer industry (where an initially uncontested market leader, IBM, ended up selling its computer division to Lenovo) or the mobile phone industry (where companies such as Nokia or Motorola left their dominant position to companies such as Apple, Google or Samsung). All in all, previous studies suggest that a combination of difficult-to-imitate competences and industry structural features makes the automotive industry different from other high-tech industries. Such unique blend would make OEMs' dominant position difficult to erode.

2.3.2 A New Dominant Design?

Practitioners and consultants are less conservative than scholars in envisioning a different future for the industry. They observe that the industry is in an era of turbulence and that a new dominant design might emerge. This in turn would potentially lead to an industry shakeout.

One argument is that the industry for the first time is switching from an internal combustion engine drive train technology to a zero-emission drive train, be it based on batteries or fuel cells. This might favour companies like Tesla and encourage entry. Moreover, the simplification of the product architecture and manufacturing might lower the barrier to entry in the industry. Indeed, this is what is easing access into new markets, like the European one, of Chinese manufacturers. On the other hand, OEMs are not new to incorporate new technologies into their products. In this respect, there is no reason to believe that BMW, Hyundai or Toyota is less equipped than Tesla or potential new entrants in developing a new generation of zero-emission vehicles or novel product types. A related argument regards the fact that the new power train also brings the need for new recharging/refuelling infrastructures. This is a major determinant of the speed at which the substitution of ICE cars with battery electric of fuel cell cars will happen. Tesla had to build its proprietary charging infrastructure because it was a necessary condition to introduce its battery vehicles. But such a first mover position does not seem to be a major determinant of success at the moment as other OEMs are building capillary recharging infrastructures. All in all, a change in the drive train does not seem to have the strength of upsetting the rule of the game up to threaten the current dominance of OEMs.

A companion argument is that electrification is sided by digitalisation. The latter would, on the one hand, push OEMs to develop new skills and competences, mainly related to software development, in new product development and manufacturing. On the other hand, it would upset the relationship between the manufacturer and the consumer. Both consequences of digitalisation are not trivial. The first will require OEMs to change most of their innovation routines. This would probably lead to a change in their technological identity and threaten coordination in innovation activities (see Balzarin and Zirpoli in this book for a discussion of such transition). OEMs consider themselves as mechanical companies that learnt how to deal with electronics and software. The turn towards digitalisation might reverse the relevance of such technological combination, so contributing to make OEMs software companies, with some electro-mechanical competences. The second change is related to the first: as most software companies do, also car makers will have to release updates of the software running on their cars and deal with customers in different ways. There is no doubt that companies such as Tesla are better equipped to deal with digitalisation, and the following interactions with customers. OEMs, in this respect, might suffer from "core rigidities" (Leonard-Barton, 1992). Recent evidence, however, shows that OEMs are rapidly filling this gap and internalising (i.e., vertically integrating) software development and learning how to behave in the new digital landscape.

A second and probably more relevant argument to claim a change in the dominant design in the industry evokes the effects that electrification and digitalisation will have not only on car makers competences (and their knowledge base) (Perri et al., 2020, 2022) but on the broadening of products and services that will fall within the boundaries of the automotive industry. This change would be triggered by a combination of different factors. First, the need to reduce the environmental impact of car use and congestion in towns and cities (e.g., leading to the ban of private cars from cities and the growth of micro mobility). Second, changed consumer attitudes towards mobility services, including cars, that is bringing a weakening of the value of car "possession" in favour of the concept of "use-fruition" (e.g., see the flourishing of car-sharing and other service-based offerings). Finally, regulators show a renewed interest in the design of new mobility systems leading to major integration of different means of transportation (e.g., see the development of platform to offer integrated mobility services).

In such a context, digitalising the car might be the way ahead to accelerate the offering of new services through the car and, at least potentially, turn mobility demand from mainly led by the need of purchasing a product to a demand for services. Indeed, from car-sharing to robotaxi, digitalisation enables the use of vehicles in ways that are multiple and still to be explored. Such a turn towards "servitisation" is likely to push the automotive industry to develop horizontal (with complementors) rather than just vertical (with buyer, distributors and suppliers) relationships. This, as highlighted above and in other chapters of this book, could lead to the development of technological platforms offering mobility services and to the following development of new business ecosystem (for a discussion on the concept of business ecosystem and the role of platforms see Jacobides et al., 2018). In such new business ecosystems, the car as a product would be embedded in a net of services and service providers. As it happens with smartphones, both software apps and services will be channelled to customers through the car. Consequently, the value creation (and the customers' experience) will probably depend on new factors, some of which will be related to the services that a car would be compatible with (just as it happens now with smartphones, whose value depends more on the apps that run on them rather than on the object per se). Automotive pundits would observe that moving people from one place to another, as talking on the phone, will be "one" of the many functions that a car will perform.

Such a shift, in our view, is by far more likely to bring changes than the mere introduction of electrification and digitalisation technologies and the related need for car makers to change their knowledge base. In other terms, the main reason to believe that the dominant position of car makers could be threatened by new entrants is that "servitisation" would alter the value creation and value appropriation dynamics in the industry (see also Jacobides et al., 2006).

However, the parallel with the mobile phone industry, or other industries such as the gaming industry or the computer industry is not as fruitful as many commentators believe. In fact, there are three features of the automotive industry that are likely to affect the "fate" of current incumbents and make it different from business ecosystems that were shaped by technological platform dynamics.

The first is that the vehicle on which passengers move, differently from a mobile phone, a game console, or a computer, is an electro-mechanical product that must guarantee safety and emission standards. At the moment, the only player that is responsible (and liable) for such standards is the OEM. Whether alternative players are willing or will be capable of taking such responsibility is still to be verified. The second is that while technology-driven platforms have been developing thanks to the development of global standards and have leveraged huge network externalities, mobility needs are very local and idiosyncratic. Not only can cars be used for a higher variety of purposes but the physical places (and the related available services) in which they operate might be very different from place to place. For example, the needs of a farmer in a rural area, of a van-lifer travelling the world, a student or a manager living in a city, a commuter, etc. are different and placed in very heterogeneous physical spaces. Such variety poses a question of scale and profitability of mobility services. On the contrary, such questions have been resolved by "winner takes all" dynamics in other business ecosystems where consumers benefit from using, for example, the same operating system for their smartphone, game console or personal computer.

The third is that, despite the many services that a car might offer, mobility will probably remain the main reason why people use a car. This is not what we observe in the case of the evolution of the mobile phone industry where most customers rarely use the handset to call people. The prevalence of one function over the others is a further obstacle for the development of additional/complementary services. This might change in the future, for example with the introduction of robotaxi, but it is likely that entering a robotaxi will be motivated from moving from A to B.

References

Baden-Fuller, C., & Stopford, J. M. (1992). *Rejuvenating the mature business*. Routledge.

Bar-Yam, Y. (2002). General features of complex systems. In *Knowledge management, organizational intelligence and learning, and complexity* (Encyclopedia of life support systems) (Vol. Vol. 1). EOLSS Publications.

Braun, H. (2009). Lighter-than-air vs. heavier-than-air: How can network effects explain the failure of airship-technology? *The Journal of European Economic History, 38*(2), 369–391.

Buchanan, M. (2000). *Ubiquity: Why catastrophes happen*. Three Rivers Press.

Cabigiosu, A., Zirpoli, F., & Camuffo, A. (2013). Modularity, interfaces definition and the integration of external sources of innovation in the automotive industry. *Research Policy, 42*(3), 662. https://doi.org/10.1016/j.respol.2012.09.002

Chandler, A. D. (1962). *Strategy and structure: Chapters in the history of the industrial empire*. MIT Press.

Fine, C. (1999). *Clockspeed: Winning industry control in the age of temporary advantage*. Basic Books.

Freyssenet M., Shimizu K., Volpato G. (2003), Globalization or regionalization of the European car industry?., Palgrave-Macmillan.

Genzlinger, F., Zejnilovic, L., & Bustinza, O. F. (2020). Servitization in the automotive industry: How car manufacturers become mobility service providers. *Strategic Change, 29*, 215–226.

Granovetter, M., & McGuire, P. (1998). The making of an industry: Electricity in the United States. *The Sociological Review, 46*(S1), 147–173.

Hadjilambrinos, C. (2021). Re-examining the automobile's past: What were the critical factors that determined the emergence of the internal combustion engine as the dominant automotive technology? *Bulletin of Science, Technology & Society, 41*(2–3), 58–71.

Jacobides, M. G., Cennamo, C., & Gawer, A. (2018). Towards a theory of ecosystems. *Strategic Management Journal, 39*(8), 2255–2276. https://doi.org/10.1002/smj.2904

Jacobides, M. G., MacDuffie, J. P., & Tae, C. J. (2016). Agency, structure, and the dominance of OEMs: Change and stability in the automotive sector. *Strategic Management Journal, 37*(9), 1942–1967. https://doi.org/10.1002/smj.2426

Jacobides, M. G., Knudsen, T., & Augier, M. (2006). Benefiting from innovation: Value creation, value appropriation and the role of industry architectures. *Research Policy, 35*, 1200–1221.

Kirsch, D. A. (2000). *The electric vehicle and the burden of history*. Rutgers University Press.

Kline, R., & Pinch, T. (1996). Users as agents of technological change: The social construction of the automobile in the rural United States. *Technology and Culture, 37*(4), 763–795.

Krafcik, J. F. (1988). Triumph of the lean production system. *Sloan Management Review, 30*(1), 41–52.

Lee, M. T. (1998). The Ford Pinto case and the development of auto safety regulations, 1893–1978. *Business and Economic History, 27*(2), 390–401.

Leonard-Barton, D. (1992). Core capabilities and core rigidities: A paradox in managing new product development. *Strategic Management Journal, 13*, 111–125.

MacDuffie, J. P. (2018). Response to Perkins and Murmann: Pay attention to what is and isn't unique about Tesla. *Management and Organization Review, 14*(3), 481–489. https://doi.org/10.1017/mor.2018.32

MacDuffie, J. P., & Fujimoto, T. (2010). *Why dinosaurs will keep ruling the auto industry*.

Maxton, G. P., & Wormald, J. (2004). *Time for a model change: Re-engineering the global automotive industry*. Cambridge University Press.

Mayntz, R., & Hughes, T. P. (Eds.). (1988). *The development of large technical systems*. Schriften des Max-Planck-Instituts für Gesellschaftsforschung Köln.

Mom, G. (2013). *The electric vehicle: Technology and expectations in the automobile age*. Johns Hopkins University Press.

Pantzar, M. (1997). Domestication of everyday life technology: Dynamic views on the social histories of artifacts. *Design Issues, 13*(3), 62–95.

Perri, A., Silvestri, D., & Zirpoli, F. (2020). Change and stability in the automotive industry: A patent analysis. *SSRN*. https://doi.org/10.2139/ssrn.3703548

Perri, A., Silvestri, D., & Zirpoli, F. (2022). Technological change, knowledge base, and industry dynamics: Theory, methods, and the case of the automotive industry. In *The Oxford handbook of industry dynamics*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190933463.013.39

Rifkin, J. (2000). *The age of access: The new culture of hypercapitalism*. J.P. Tarcher/Putnam.

Schulze, A., MacDuffie, J. P., & Täube, F. A. (2015). Introduction: Knowledge generation and innovation diffusion in the global automotive industry-change and stability during turbulent times. *Industrial and Corporate Change, 24*(3), 603–611. https://doi.org/10.1093/icc/dtv015

Siagri, R. (2021). *La servitizzazione. Dal prodotto al servizio. Per un futuro sostenibile senza limiti alla crescita*. Edizioni Angelo Guerini e Associati.

Sloan, A. (1963). *My years at General Motors*. Currency.

Stocchetti, A., Trombini, A., & Zirpoli, F. (Eds.). (2013). *Automotive in transition. Challenges for strategy and policy*. Ca' Foscari. Digital Editions.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research Policy, 15*, 285–305.

Volpato, G. (1983). *L'industria automobilistica internazionale: espansione, crisi e riorganizzazione*. Cedam.

Williamson, H. F., Andreano, R. L., Daum, A. R., & Klose, G. C. (1963). *The American petroleum industry, part 2: The age of energy 1899–1959*. Northwestern University Press.

Womack J.P., Jones D.T., & Roos D. (1990). The machine that changed the world., Rawson Associates.

Zirpoli, F., & Camuffo, A. (2009). Product architecture, inter-firm vertical coordination and knowledge partitioning in the auto industry. *European Management Review, 6*(4), 250. https://doi.org/10.1057/emr.2009.25

3

From Transport History to History of Sustainable Mobility

Valentina Fava and Giovanni Favero

3.1 From Transport History to History of Mobility: De-structuring the Main Narrative on the History of the Automobile

In the last two decades, the field of transport history has undergone a veritable revolution in its methods and theoretical perspectives. The mobility turn has affected the way historians explain both the resilience of the gasoline engine and the emergence of alternative propulsion technologies. In particular, mobility historians have targeted as deterministic the production and supply-centered narrative which has, for a long time, dominated literature on the automobile industry. The acknowledgment of the cultural component of the automobility system as well as the relevance of "cultural ambience" in determining the adoption of

---

V. Fava (✉) • G. Favero
Department of Management-Venice School of Management,
Ca' Foscari University of Venice, Venice, Italy
e-mail: valentina.fava@unive.it; gfavero@unive.it

A. Cabigiosu, P. Lanzini (eds.), *The Green Transition of the Automotive Industry*,
https://doi.org/10.1007/978-3-031-37200-1_3

technological systems have greatly enriched the historical understanding of the inertia which has characterised twentieth-century mobility practices and delayed the adoption of more sustainable alternative propulsion technologies. A process of re-writing significant parts of the history of both mobility practices and the automotive industry is currently in progress: in this chapter, we explain the recent change in the research field, transport history, and present some innovative contributions which focus on both electrical vehicles and emission standards' regulations and adopt a socio-technical constructivist perspective. Contrary to other, more elusive, cultural histories of technologies, the cosen sample of works keeps track of four elements (networks and organizations, users' everyday routines, public acceptance, and laws) which proved to be key determinants in allowing the transition from a technological system based on electrical propulsion to the gasoline engine at the beginning of the twentieth century. These works seem to suggest a viable frame to make sense also of the more recent resistance and inertia in moving toward more sustainable mobility practices.

Under the influence of the cultural and mobility turn, some historians have asked themselves new questions which go well beyond the "supply side of the transport service" (Mom, 2003, 131) and its economic and productive dimension (Sheller & Urry, 2006; Kaufmann, 2009). At first, they questioned whether transport could actually be investigated only as a "physical-cum-functional process," without paying attention to its "social-cum-cultural meaning" or to human practices of transport (Divall & Revill, 2005, 145). Later, the original focus—the historical evolution of transport modes and technology—left space for the study of "the movement of people and goods, which has, over the course of the last century, become a purpose in itself, not governed primarily by economic or even rational motives" (Mom, 2003, 132).

Movement appears to themas a "purposeful, meaningful – and thus cultural – act" which is determined and framed by specific material circumstances and has important consequences on social and political structures (Divall & Revill, 2005, 102). The need to answer the question of "why people and things move" (more than the question of how they do it) led historians to study transport artifacts and technologies in their interaction with human subjectivities, social and individual identities as well as narratives and representations (Divall & Revill, 2005; Clarsen, 2010; Revill, 2014).

To underline the change and relevance of the research focus—the "multiple, diverse and intersecting forms of mobilities" and the technical systems allowing them (Sheller & Urry, 2006)—the definition of the field has changed, and the more encompassing term of "mobility history" is often used as a substitute for "transport history," considered by many historians to be too limited in scope (Mom et al., 2009). In the words of Sheller and Urry (2006, 208), "the 'new mobilities' paradigm is not a grand narrative but a set of questions, theories and methodologies" which suggests using "mobilities" as analytical lenses through which to examine any social sciences' and humanities' research objects. In this view, the evolutionary grand narrative—implying an evolutive succession of transport modes, from horse, to bicycle, to steam powered and later internal combustion vehicle—has been deconstructed and torn to pieces under the influence of a set of new questions and "conceptual transfers" aimed at "decentering traditional transport history" (Mom et al., 2011) and overcoming the scholarly biases that originated from an excessive emphasis on the economic significance of transport. The idea that the fittest technology wins and the less fitted fades away seems Darwinist and determinist, and what is more, unable to answer many of the questions which historians had about technology and its diffusion. For example, mobility historians accuse historians of transport to have only focused on specific means of transportation, the ones they identified with industrial "modernity" and progress, at first the railway, the symbol of industrializing Britain, and later on the mass-produced gasoline-propelled automobile, the icon of twentieth-century America. In doing so, they ended up neglecting other transport modes, considered more backwards and less efficient, "forgetting that the majority of humankind still travels on foot, or on bicycle, or rickshaw, and may continue to do so for the coming generations" (Mom et al., 2011, 1, 2). And in fact, these "traditional" transport modes, including walking, have preserved a key role and significance for their communities, sometimes coexisting and integrating themselves with the more "modern" ones. Some of these alternative mobility practices, as the rickshaw or the collective taxi, have been recently rediscovered as more sustainable forms of mobility which were largely diffused in history and seem to have a role in future (Norton, 2009; Tao, 2013; Cox, 2013; Steele & Lin, 2014). Another bias of traditional transport history is "Western exceptionalism." The plea, thus, is "to look at the Rest rather than the West," and re-think or "decenter" the concept of modernity in mobility, as something that does not necessarily equate with "carriage and speed" (Steele & Lin, 2014, 44; Mom, 2003; Mom, 2015).

Beyond definitions, it is the research agenda that has changed and mobilized theoretical and methodological resources coming from disciplines other than history, such as geography, cultural studies, intellectual history. The aim seems to be to offer a set of global narratives of the way in which humans, animals and things moved in history and still do.

Transport artifacts, and the car more than any other, are charged with human emotions: they embody social and individual identities, and, in history, they have often been modified in reality or in imagination by individuals and communities to satisfy ideas or specific needs. In this sense, mobility historians are primarily interested in the systems of knowledge and representations enabled by transport technologies (Clarsen, 2015).

The concept of socio-techncal system—which includes material components and human actors—is central in connecting the manifold and overlapping dimensions of mobility ("representational, material and experiential"). Helmuth Trischler defines transport artifacts as "visible nodes in the seamless and often immaterial networks that provide mobility for goods, innovation and people. These nodes materialize as means of transport […] they are coded components of complex systems" (Trischler & Zeilinger, 2003, 1).

In this light, the automobile is a technical artifact resulting from a process of social construction involving not only manufacturers and designers, but also users, institutional actors, and other relevant social groups whose lives have been affected by the specific characteristics of the socio technical system originating from the use of the gasoline car (Hughes, Pinch, 1986).

According to David Nye, the twentieth-century "automobility system" rests on two pillars: the individual use of car and the gasoline engine; the system stabilized itself at the end of the 1910s, as Fordist model of production, and resisted until the end of the century (and further); any attempts at decoupling the two main components of the system, gasoline engine and individual use of car, proved to be difficult because, as Nye explained, the "mutual interactions of many human and non-human components as cars, drivers, passengers, infrastructures as roads and gas stations, oil suppliers and car manufacturers, driving rules and signs" had the power to 'lock in' social life into the modes of mobility that automobility generates and presupposes" (Nye, 2013).

It seems that the duty of the historian of mobility is to decodify and disentangle the components of the system\network and bring the system\network and its historical evolution to the surface, making it visible and intelligible.

In this view, the evolutionary grand narrative—implying an evolutive succession of transport modes, from horse, to bicycle, to steam powered and later internal combustion vehicle—has been deconstructed and torn to pieces under the influence of a set of new questions and "conceptual transfers" aimed at "decentering traditional transport history" (Mom et al., 2011) and overcoming the scholarly biases that originated from an excessive emphasis on the economic significance of transport. The idea that the fittest technology wins and the less fitted fades away seems Darwinist and determinist, and what is more, unable to answer many of the questions which historians had about technology and its diffusion. For example, mobility historians accused historians of transport to have only focused on specific means of transportation, the ones they identified with industrial "modernity" and progress, at first the railway, the symbol of industrializing Britain, and later on the mass produced gasoline propelled automobile, the icon of twentieth-century America. In doing so, they ended up neglecting other transport modes, considered more backwards and less efficient, "forgetting that the majority of humankind still travels on foot, or on bicycle, or rickshaw, and may continue to do so for the coming generations" (Mom et al., 2011, 1, 2). And in fact, these "traditional" transport modes, including walking, have preserved a key role and significance for their communities, sometimes coexisting and integrating themselves with the more "modern" ones. Some of these alternative mobility practices, as the rickshaw or the collective taxi, have been recently rediscovered as more sustainable forms of mobility which were largely diffused in history and seem to have a role in future (Norton, 2009; Tao, 2013; Cox, 2013; Steele & Lin, 2014). Another bias of traditional transport history is "Western exceptionalism." The plea, thus, is "to look at the Rest rather than the West," and re-think or "decenter" the concept of modernity in mobility, as something that does not necessarily equate with "carriage and speed" (Steele & Lin, 2014, 44; Mom, 2003; Mom, 2015).

3.2 From the History of Fordism to the History of the EV and the Emission Standards

This change of perspective or, according to some, the methodological "revolution" had clear consequences on the way in which historians made sense of the dominance of the gasoline engine and the delayed emergence of alternative forms of propulsion. On this basis, mobility historians, partially, "re-wrote" the history of two key moments in the automobile's techncal development—the golden years of the electric vehicle (1890–1912) when a mobility system based on EVs and public transport seemed close to prevailing over the private use of oil propelled cars; and the last two decades of the twentieth century, when, on the one side, the EV returned at the forefront of the designers' agenda and, on the other, the political pressure for a regulation of the emissions standards became stronger.

In both cases, the idea of the prevailing of a superior—more efficient—technology is the object of contending. According to mobility historians, the prevalence of a technology over another does not depend (only or always) on technical factors but on systemic interactions and culture. The success of a technical artifact over another is thus the *explanandum* and not the *explanans*, and historians can learn more from failures than from successes.

To understand the origins and motives of the inertia and resistance to change, so evident in the history of the EV and of the automobility, historians reconstructed the microphysics of the development, diffusion and use of the EV, as well as the multilayered decision-making leading to the definition of European and national emission standards—as a form of co-construction between experts and civil society (Klebaner & Ramirez Perez, 2019).

In this view, users count as much as designers and manufacturers in shaping the trajectory of the artifact or the regulation. And the idea that potential users have of the artifact\regulation shapes its development until stabilization. Interpretative flexibility is also determined by the economic and organizational networks in which relevant social groups are embedded. A thorough study would also need to shed light on the process of co-evolution of the artifact and its user culture (Mom, 2004 and 2014).

Knie and Hård borrowed the concept of “cultural ambience” (Staudenmaier, 1984) which appears particularly useful to make sense of the rise and fall of some alternative automobile projects. Cultural ambience refers to “the atmosphere which permeates a technology and without which it cannot survive. If an artefact or a technological system is to function properly, then it has to find for itself a space within this ambience” (Knie & Hård, 2001, 92; 2010) which means that it has to fit in to or be able to modify\reorganize the “ambience.” They focus on four dimensions: “organizations and networks, routines and daily practices, meaning and discourse as well as law and politics” which need to be aligned for an artifact to be adopted.

If transport historians have for a long time insisted on the “hardware” and the “supply side”- focusing on technology, manufacturing firms, supply chain, work organization—to explain and justify the success of the gasoline engine; mobility historians urge instead to discuss the “software”—the meaning given to the artifact by its users, the way in which it becomes part of everyday routines, the level of public acceptance—to explain toward change, moving the focus from the assembly line to the narrative and discursive level. A third relevant perspective is one of legal historians and historians of European integration who have instead focused on experts’ negotiations and on the definition of laws and policies on a national and international level.

Scholarly revolutions leave, however, the readers with a comprehensive approach but no unique study able to encompass the four dimensions which constitute the "cultural ambience."

Historical literature on technical alternatives clusters around two main themes: the Golden Ages of the EV (1900–1912) and the political economy of the emission standards.

For a long time, historians of technology attributed the disappearance of the electrical engine to its technical flaws, limited speed cruise, and battery range. Some recent studies, however, challenged the production centered vision, suggesting a complementary explanation based on a micro-level historical analysis of the development and diffusion of the two competing technologies in the US and Europe at the beginning of the twentieth century.

In the first decade of the twentieth century, electric automobiles circulated in both American and European cities as private cars and public transport and service—taxi cabs, delivery vans, urban trucks, and fire engines. Historians of automobilism refer to the years between 1900 and 1912 as the Golden Age of the electric car. EVs were praised because they were not as noisy and smelly as the gasoline propelled cars, and they were easier to drive. Research on batteries was steadily progressing. In some cities, legislation favored them and power companies were very active in improving their performance and diffusion. Electric taxicab companies prospered and their large fleets were intensively used; on the contrary, the unreliability of the first internal combustion engines made them less idoneous for public transport. Mom argues that in fact electric propulsion was "technologically and economically superior" at least until 1914. This was probably even true for private motorists because the limits of the battery range and life were not unsurmountable for the wealthy part of the population who could afford a car.

Yet EV succumbed in front of the relentless diffusion of the combustion engine at the eve of the First World War and, for more than 40 years, any alternative to propulsion engine disappeared not only from public debate but also from industrial design. According to Mom and Kirsch, the reason for the success of the internal combustion engine vs its electrical alternative has to be sought not in the technical flaws of the EV—mainly because limited speed cruise and battery range did not matter in the urban context where EV circulated as public transport. It was rather the result of the interaction of diverse societal and cultural factors, among them a crucial role was played by the users' culture (Kirsch & Mom, 2002).

Kirsch and Mom's history of the Electric Vehicle Company, a urban electric taxi cab company active in late nineteenth-century New York, shows that the cause of its failure was not the choice of the inferior electrical technology, as many had pointed out, but it was the decision to focus on "selling motor vehicles service instead of selling motor vehicles." The problem was not technology per se but the business concept, a "centralized transport service" vs a "decentralized pattern of privately owned and operated internal combustion automobile." The gasoline engine prevailed in the 1910s because of its functional flexibility but also because of other non-rational reasons closely dependent on the culture of the first users. Gasoline engine guaranteed higher speed, the possibility of touring outside the cities and to be park cars at home and not in a public garage.

Gasoline propelled automobiles were born as "individual adventure machines" under the motto "racing, touring and dirty hands." Their design was functional to the expectations for speed, risk, driving virtuosity, and freedom of the first intended users. Through a broader investigation of early American car culture, based on archives and trade journals, Mom argued that at the basis of the diffusion of gasoline engine there was the first drivers' need for adventure. In fact, the decline of the first electric engines, quite early relegated to urban collective transport, was the result of the mismatch between the expectations of the first motorists and car owners and the characteristics of the electric engine. The dangerless, clean, quiet and lady-like electrical engine did not nourish the car enthusiasm as much as the faults of the first gasoline engines, which were dirty, noisy, technical unreliable, and ultimately dangerous (Mom, 2004). In the 1920s cultural ambience, there was clearly no "space" for the EV in the everyday routines of individuals who could afford a car, despite rather favorable regulations and manufacturers active in research.

The EV was thus discharged quite early in the history of automobilism, relegated to public transport and urban context and associated with a feminine attitude. This stigma shaped also the future perceptions of the electric vehicle for many years to come.

From the 1960s onward interest in electric cars began to appear again, prototypes and a few electric variants converted from gasoline models—but only in the 1980s governments destined some funds for electric vehicles programs. It was only when CARB (California Air Resources Board) announced a zero-emission vehicle mandate that electric car development returned high in the agenda of car manufacturers. Or so it appeared. General Motors (GM) did in fact manage to mass produce the EV1 in 1997 but the attitude of the giant car maker was at least ambivalent. EV1 had futuristic design and could be only leased, in this sense, it was very innovative and, for the first time, broke the symbiosis between individual use and gasoline propeller. However, none of the classical GM brands marketed the EV1, which was in fact distributed by GM's Saturn dealers; the distribution and assistance network was active only in Arizona and California, and EV was the object of a specific marketing strategy targeting "trendy forward looking man," downsizing the scope and relevance of the artifact. Knie and Hard recall how the EV1—which presented some problems with cold temperature—was named "sunny-side" or "sunny-boy."

The EV1 would have required a "new cultural ambience" and, in particular, would have required everyday drivers to be convinced that the vehicle fitted their needs but, unsurprisingly, GM did not make serious efforts to do so, and only 1000 leasing contracts were signed (Knie & Hård, 1999; 2001, 97). Rules and laws were thus in place, however, Eisler shows even more clearly how manufacturers responded by lobbying against the mandate, adopting innovation initiatives in R&D to mitigate the risks, but somehow boycotting the manufacturing and commercialization of their own products (Eisler, 2020, 781). According to Eisler, GM embarked in the Impact experiment partnering with Ovonic Battery Company (an R&D enterprise dominating the intellectual property of nickel metal hybrid battery) to monopolize the use of Ovonic batteries—preventing the Japanese Toyota to adopt them—and produce a small number of "sophisticated but costly all battery electric cars as a way of demonstrating to regulators the intractability of the durability dilemma" (Eisler, 2020, 782). Toyota, as a reaction, managed to turn US environmental regulation into a commercial advantage, showing that if the zero-emission vehicle was not sustainable, its hybrid car, Prius, would instead guarantee lower emissions, neutralizing the durability dilemma of batteries, and become the first electric car for the masses (Eisler, 2020, 800).

In this case, the cultural ambience, specifically the regulation on zero-emission vehicle, was at first undermined and reinterpreted by GM and Toyota to annihilate the space for the zero-emission vehicle—stigmatized as a "sunny" and "funny" light car—and by Toyota to create a favorable cultural environment for its hybrid vehicle.

Unfortunately, historical research on the alternative propulsion systems in the automotive industry is limited by the availability of archival documentation and lack of willingness of car manufacturers to share their experience and material. However, another important, although indirect, source to study for the emergence and adoption of alternative propulsion systems is the documentation referring to the negotiations on emission standards on an European level and the role of some governments in influencing them. These studies explore the reaction of national actors, firms and governments, to EEC (European Economic Community) emission rules and eventually their repercussions on national automotive industries and the dynamics of competition; or discuss governmental answers to EU soft laws and the coherence of national environmental policies in a still limited number of European states (Germany, Switzerland, Sweden) (Näsman & Pitteloud, 2022, 5).

What emerges from these first works is that the adoption of clean technologies has been the result of the negotiation among different stakeholders, European institutions, firms\national champions, national governments, but also users and consumers.

The history of the regulations of emissions is interpreted as a form of technopolitics and an important page of the history of the "hidden" integration of Europe made at first by practices and infrastructures, circulation and appropriation of knowledge more than by formal rules (Kaijser & Schot, 2014; Kohlrausch & Trischler, 2014; Vinsel, 2019). The most original and recent articulation of this debate concerns the idea that the public acceptance of the alternative technologies was severely curtailed by the car makers' attitude not to spread information on them, preventing consumers and their associations to become aware about technical opportunities and possibilities, and to actively discuss and take a stance on the theme. It clearly emerges from these researches that in the majority of

European countries (with some significant exception as Sweden), while government and car makers were lobbying at the EEC level, the large audience was not informed about existing technical alternatives.

3.3 Italian Environmental Debate and the Public Debate on Car Emissions and Alternative Technologies

The Italian case has been particularly neglected by historians. Only a few studies focus on the history of Italian motorization and present data on environmental impact of car-related emissions (Paolini, 2007, 2011; Maggi, 2011). At the European level, Italy was a late comer and a follower which mainly reacted to input from EEC (European Economic Community). According to Henning Arp, who wrote his PhD dissertation on Italian environmental policies, the country's weakness depended on the fragmentation of the administrative system which made enforcement and controls difficult, not only on a blatant disregard. For a long time, air pollution remained a local problem concerning human health hazards environment (Arp Henning, 1995, 167). In fact, the first environmental law tackling the problem of air pollution was the 1966 Legge Anti-Smog (Anti-Smog Law) which in fact did not concern car emissions—it was strictly related to industrial plants and to the country's areas where the plants were concentrated.

A key year in Italian environmental history was 1986, when the national Ministry of the Environment was created. This was the first sign of political awareness of the relevance and need for a national environmental policy; the creation of the Ministry centralized competencies previously dispersed in other ministries. This followed a general tendency by political parties to "green" their programs and answer rising environmental problems. Some opinion polls made in 1986 show that there was awareness and concern about the problem of noxious car exhaust gases and regulation of emissions among the Italian population as it was the case in other European states (Ramirez Perez, 2010; 2020; Näsman & Pitteloud, 2022; Bergquist, A., & Näsman, M. 2023 for the Swedish and

Swiss cases, and Klebaner & Ramírez Pérez, 2019 for the German case; Kajiser, 2013). Yet in Italy this concern did not make it to the political arena, where debate on nuclear energy was indeed very intense and led to the 1987 referendum on nuclear energy (Arp, 1995).

As a matter of fact, as far as car emissions were concerned, at the level of EEC, in the 1980s, the Italian government strongly resisted an early move to US 1983 standards. It gave up only in the 1989 when the European Council adopted the Small Car Directive; as a result the Italian government's opposition to the mandatory application of the three-way catalyst was finally abandoned.

In his study, Arp has argued that behind the reluctance of the Italian government in supporting stricter emission regulation there was the business interest of the Italian national champion, Fiat. Fiat specialized in small cars whose cost would be seriously affected by the introduction of catalyst converters; in addition, Fiat did not export toward countries where rules on emissions were stricter, such as the US (McCarthy, 2007); futhermore, Fiat depended on Bosch ignition systems. In this perspective, the Italian government had to resist more stringent regulations on emissions to provide Fiat with the opportunity and time to have Magneti Marelli and Weber to produce ignition systems for catalytic cars. In addition, the Italian government did not face a specific social pressure to "green" the automobile industry (differently from Germany or Sweden; Näsman, M. 2021).

In the early 1990s both in terms of regulations and organization and network, according to the few studies we have at our disposal, the interest towards alternative propulsion technologies in the Italian cultural ambience was lmited. This becomes even more clear in the publications of both ACI (Italian Automobil Club) and the periodical magazine *Quattroruote* which targeted a larger audience.

At the beginning of the 1970s, some documents produced by ACI showed that the problem of pollution and car emissions was not extraneous to the Italian public debate but overtones demonstrated that ACI experts considered alternative propulsion technologies as coming from a (non-desirable) science fiction novel. In an article titled "Without Revolution the Car Future" published on *Autoclub e* via (1, 1970, 18) the author was reassuring the readers that despite the "wonders that the futurologists promise us, we will continue for a long time to use the car as we know it, albeit continuously improved" and that since no radical changes were at sight "coexistence on the roads will depend mostly on our common sense." For many years, he argued, the automotive industry had used its traditional cars with their performance, safety, and comfort. Futurologists imagined automated highways on which cars, controlled by electronic brains, could run faster and faster; they were dreaming about trains that would carry the cargos and rushing individuals at extraordinary speed; they saw roads populated by electric or steam-powered cars that, along with silence, respected the environment of megacities but he claimed that changing the automotive industry was not a priority on the agenda and, in any case, it would not happen overnight. He noticed that economic development did not run as fast as the imagination of these "inventors" of ideas. He bragged that despite the extraordinary technical inventions of the twentieth century, the old combustion engine, the four wheels, and the steering gear were still there, and would have remained there for a while. Of course, he recognized: "In the near future, therefore, one thing above all will be important: to use the automobile with an awareness of the limits, physical and psychological, that the environment imposes on us. We will live quieter and longer." He staggered common sense sentences with strong calls to the conservatism of ACI associates, reassuring them on the immutability of their routines.

The idea of a new, more comfortable, more environmentally friendly electrically propelled car seemed utopian: the echoes of the renewed interest toward EV reached Italian motorists, particularly scared by the increase in the cost of oil. In 1973, not surprisingly an article titled "The Car that goes without gasoline," (Autoclub e via 14–15, 1973, 28–29) discarded plans for electric, turbine, and hot-air powered car as destined to failure. Atomic power seemed to be the future, yet how was it possible to apply it to motor vehicles? And what about the synthetic fuels which Germans had used during the Second World War? The "cars of the future" seemed bizarre, odd, unrealistic proposals and no solution was envisioned to the rising cost of fuels. The ACI newsletter dealt with the future of the automobile with a simplicity close to shallowness; the articles reflect a substantial lack of expertise and absence of interest in promoting a public debate based on data and expert knowledge; not only it did not take seriously the alternative propulsion technologies, dubbed as utopian and unrealistic, and the emergence of car-related environmental problems, which could be solved with common sense, but it also pretended to ignore the pressing increase of the cost of oil. The binomial- individual use of the car and internal combustion engine—was the stone on which the habits of early 1970s Italian motorists peacefully rested.

The magazine *Quattroruote* dealt with the resurgence of the interest toward the EV and alternative propulsion technologies with more responsibility, at first providing its readers with a large range of information, which was often based on available expert knowledge.

At the end of the 1960s, interest toward electric vehicles increased, although it remained quite marginal. *Quattroruote* published several articles on car makers investment in R&D and prototypes quoting the GM and Fiat experiments with Electrovair II and Electrovan. Nonetheless, authors remained skeptical toward the potential of the electric propulsion. Technical flaws and infrastructural needs—limited range and the need for an extensive charging infrastructure—seemed unsurmountable.

The interest for alternative sources of fuel skyrocketed during the Yom-Kippur war and the subsequent rise in price of oil, discussions about potential alternatives to oil surfaced from the pages of *Quattroruote*.

The high price of oil acted as a catalyst for the debate but soon the discussion broadened and also tackled the problem of car-related air pollution, traffic and noise. Some authors feared that, at that rate of consumption, oil supplies would have decreased substantially, and they began considering a change in propulsion both possible and desirable in the near future. Others viewed the oil crisis almost positively, since they believe that it could smooth consumption and make oil stocks last longer, allowing for technical progress in the field. Documenting the Dutch decision to ban vehicles on Sundays, *Quattroruote* stated: “Dutch Sundays are like this, the same could happen all over the world, because of the oil crisis: cars parked, as well as other vehicles with an engine, and streets will find their ancient calm again.”

Exploiting energy coming from the sun was one of the most talked about alternatives. It was not considered as a power source for cars, but for other types of industries, leaving more supply of oil for cars themselves, and thus, reducing general consumption. Multiple articles were published on *Quattroruote*, still possibilities seemed limited by the Italian resource endowment: "Capturing sun energy and transforming it into usable energy is not a fantasy, but a reality. It is done by Japan, Israel, Australia and Germany […] Unfortunately the technology to do so is still insufficient in Italy."

Other authors pushed for atomic energy. Some highlighted the great potential while others feared it, because of its use to end the Second World War and its aftermath, which was still very vivid in everyone's minds. The "atomic" car entered the public debate, still with futurologist overtones. Responding to a letter, Steno Siccoli, popular author on *Quattroruote* wrote: "The time we are living may push some scientist to find a definitive solution to the energy issue, so as to free us from such condition of dependence that we have been living for at least the last ten years […] People against nuclear power are afraid since the word 'nucleus,' or 'atom,' evokes the frightening memory of the atomic bomb. […] Others suggest, in order to avoid nuclear power, to exploit natural gases and methane gas, obtained by the distillation of organic waste, which is positively viewed by ecologists, since it is a nonpolluting resource […] In conclusion, it is important to remember that we all should do the best to save energy: either by using the car only when necessary or building less energy-demanding vehicles."

Such thesis was further proposed in other articles as well. The main aim was not to decrease oil consumption directly from transport, since an alternative to oil was extremely hard to find, but reduce the consumption of other industries and use nuclear power as a source for electricity.

"Savings need to be done in those areas where oil can be easily replaced. It cannot be replaced in the transport sector; however, it can be done in other sectors: industries, production of electric energy and heating […] A whole structural change of the traffic needs to take place, and, in particular, we needs to radically change the car […] Solar energy is still far away, wind and geothermal power are insufficient: in order to satisfy the needs we must resort to nuclear energy."

Starting from the 1970s, diesel engines captured the attention of the readers of *Quattroruote* which devoted significant space to it. Diesel was cheaper but many car enthusiasts highlighted its poor performance, when compared to the traditional ICE car. Moreover, through the years, diesel prices increased, especially due to state-imposed excise on diesel cars, the highly criticized “supertax.” Nonetheless, buying a diesel car remained convenient, especially because diesel technology was used for lorries, and the State decided to keep diesel prices constant, in order not to damage the logistic sector. In 1984, diesel cars represented 34% of the total matriculations for the year, with peaks of 50–60% in some regions. This number was one of the highest, if not the highest in Europe. It is not surprising that starting from the second half of the 1970s, the number of diesel car reviews published by *Quattroruote* constantly increased.

Sporadically some articles on alternative sources to produce propelling energy to substitute oil, from ethanol or methanol were also published. More continuous was the attention given to the EV. Quattro Ruote published extensively on the Autoshow dedicated to EVs in Philadelphia. Most of the vehicles presented were still prototypes, but the Autoshow signaled a change in the public debate and perception of the EV.

An Italian brand was present too: PGE collaborated with ENEL and presented its model Van 8. There were other Italian prototypes, as Zele Zagato, Fiat Xi 23, a van developed both by Fiat and ENEL. *Quattroruote* greeted the news nicely, highlighting the benefits of EVs over traditional ICE vehicles: EVs were less polluting, less noisy, and easier to drive, important characteristics especially in the city centers, where pollution and congestion were dangerous and fastidious. An article published in July 1980 quoted a study forecasting that by 2000 the number of circulating EVs would have reached 10 million units, with an enormous increase compared to the 1700 circulating in 1980.

The number of articles dedicated to the electric technology increased especially from the beginning of the 1980s. This was probably the effect of the two major oil crisis which made oil price skyrocket, of fears regarding energetic dependence as well as increasing apprehension about the effects of air pollution on human health. Despite the increasing curiosity surrounding the EV, *Quattroruote* presented them as prototypes with many problems underlining the lack of charging infrastructure and considering the technology as utterly unattainable.

Finally, the magazine also discussed the option of biogas, made mainly by methane, derived from processing organic waste. At the time, it was extremely expensive, even though it represented an efficient way to recycle waste. In a few occasions, *Quattroruote* expressed some concerns for the lack of political action connected with the search for alternative energy sources.

"To govern is to forecast, everybody knows it, except for our politicians, which are not capable of taking specific measures to face the energy issue. They only talk about those measures: mention great projects which are never followed by action." The article went on listing all the potential energy sources which could have helped in decreasing such energy dependence, also comparing Italy with other countries, and highlighting the fact that progress in Italy was extremely slow. The magazine denounced he immobility of the Italian government when it came finding new alternative power sources. Since the early 1980s, something changed in the editorial policy of the magazine: it reduced the pages devoted to discuss socially and politically relevant themes, while an increasing number of articles were dedicated to the actual cars. The magazine decided to publish a higher number of articles about car reviews and more in general, minor technical innovations. Still, in some issues, articles appeared expressing environmental concerns, nonetheless their frequency decreased and their tones were significantly lighter compared to the ones of articles published a decade before. The reasons for such change could be various. Since the first edition, *Quattroruote* had uncovered and discussed many of the car-related problems that could have an impact on both automobilists and society. Many of them exacerbated during the 1970s and 1980s, as traffic jam. Environmentalist feelings and movements grew during the 1970s. The editorial line of the magazine seemed to go against the tide. It should be noted that Gianni Mazzochi, first director of the magazine, passed away in 1984. It was the decision of the new director, Raffaele Mastrostefano, to focus on car enthusiasts, less concerned with the social and cultural dimensions of the automobility and more interested toward vehicles themselves.

The Italian legislative immobilism may have exhausted the authors, or simply the editorial board might have decided not to offer the space for attacking the automobile industry.

For sure, paradoxically enough, the more the social and environmental issues became relevant from a political perspective, the less the magazine discussed them. This applies, in particular, to European regulations: there is no sign on *Quattroruote* of European initiatives, as the one signed on June 27th, 1990, the "Green Paper on the Urban Environment" or the rich documentation produced and discussed at the European level as "For a European Union Energy Policy in 1995," "The Impact of Transport on the Environment" in 1992, "European Transport policy for 2010: Time to Decide."

A comprehensive and systematic analysis of the articles published on *Quattroruote* and on ACI publications is still not available and needs to be filled. However, a first overview of the contents and overtones of articles in the Italian specialistic press, destined to a larger audience, shows a particular lack of information and a quite significant "attachment" to the private use of the automobile coupled with a specific preference to internal combustion engine. *Quattroruote* and ACI discussed alternative technologies as matter of science fiction, downplayed them as utopic projects; they presented environmental concerns as insignificant or unjustified fears which were not supposed to change old habits and routines. At least until the late 1990s, the Italian cultural ambience was not ready to make space for sustainable mobility: all the relevant actors, from firms to consumers and policy makers, seemed not to perceive the need for a change, strenuously opposing it.

References

Bergquist, A., & Näsman, M. (2023). Safe before Green! The Greening of Volvo Cars in the 1970s–1990s. *Enterprise & Society, 24*(1), 59–89.

Clarsen, G. (2010). Automobility south of the west. Towards a global conversation. In *Mobility in history: Themes in transport: T2M yearbook 2011* (pp. 265–274). Editions Alphil.

Clarsen, G. (2015). Ideas in Motion. Frontiers of Mobility Studies. *Transfers 5*(1), 114–121.

Cox, P. (2013). The future of rickshaws: Concluding thoughts and wider issues. *Transfers, 3*(3), 119–123.

Divall, C., & Revill, G. (2005). Cultures of transport: Representation, practice and technology. *The Journal of Transport History, 26*(1), 99–111.

Eisler, M. (2020). Public policy, industrial innovation, and the zero-emission vehicle. *Business History Review, 94*(4), 779–802.

Henning, H. A. (1995). Multiple actors and arenas. European Community regulation in a polycentric system: A case study on car emission policy. EUI PhD theses; Department of Political and Social Sciences.

Hughes, T. P., & Pinch, T. J. (Eds.) (1986). *The social construction of technological systems. New directions in the social studies of technology*. MIT Press.

Kaijser, A. (2013). Under a common acid sky: Negotiating transboundary air pollution in Europe. In N. Disco & E. Kranakis (Eds.), *Cosmopolitan commons: Sharing resources and risks across borders*. MIT Press.

Kaiser, W., & Schot, J. (2014). *Writing the rules for Europe: Experts, cartels, and international organizations*. Palgrave Macmillan.

Kaufmann, V. (2009). Mobility: Trajectory of a concept in the social sciences. In G. Mom, G. Pirie, & L. Tissot (Eds.), *Mobility in history: The state of the art in the history of transport, traffic and mobility*. Editions Alphil.

Kirsch, D., & Mom, G. (2002). Visions of transportation: The EVC and the transition from service- to product-based mobility. *Business History Review, 76*(1), 75–110.

Klebaner, S., & Ramírez Pérez, S. (2019). Managing technical changes from the scales of legal regulation: German clean cars against the European pollutant emissions regulations in the 1980s. *Management & Organizational History, 14*(4), 442–468.

Knie, A., & Hård, M. (2010). Innovation – The endless frontier: Historical modes of engineering science. *Technology Analysis & Strategic Management, 22*(4), 433–445.

Knie, A., & Hård, M. (2001). The cultural dimension of technology management: Lessons from the history of the automobile. *Technology Analysis & Strategic Management, 13*(1), 91–103.

Knie, A., & Hård, M. (1999). The grammar of technology. German and French diesel engineering, 1920–1940. *Technology and Culture, 40*(1), 26–46.

Kohlrausch, M., & Trischler, H. (2014). *Building Europe on expertise: Innovators, organizers, networkers*. Palgrave Macmillan..

McCarthy, T. (2007). *Auto mania: Cars, consumers, and the environment*. Yale University Press.

Maggi, S. (2011). *Politica e economia dei trasporti (XIX- XX secolo)*. Una storia della modernizzazione italiana.

Mom, G. (2003). What kind of transport history did we get? Half a century of JTH and the future of the field. *The Journal of Transport History, 24*(2), 121–138.

Mom, G. (2004). *The electric vehicle; technology and expectations in the automobile age*. Johns Hopkins University Press.

Mom, G. P. A. (2007). Diffusion and technological change: Culture, technology and the emergence of a 'European car'. In J. Baten, & J. Ehmer (Eds.), *Verkehrsgeschichte auf neuen Wegen* (pp. 67–82). (Jahrbuch für Wirtschaftsgeschichte = Economic History Yearbook 2007; Vol. 48,1). Akademie Verlag.

Mom, G. P. A. (2014). Atlantic automobilism: Emergence and persistence of the car, 1895–1940. *Explorations in mobility*, Vol. 1. Berghahn Books Inc.

Mom, G. (2015). The crisis of transport history: A critique, and a vista. *Mobility in History, 6*(1), 7–19.

Mom, G. P. A. (2020). Trending Transfers: A Decade of New Mobility Studies through the Lens of Transmodality, Transnationalism, and Transdisciplinarity. *Transfers: Interdisciplinary Journal of Mobility Studies, 10*(1), 2–19.

Mom, G. P. A., Divall, C., & Lyth, P. (2009). Towards a paradigm shift?: A decade of transport and mobility history. In *Mobility in history: The state of the art in the history of transport, traffic and mobility* (pp. 13–40). Editions Alphil.

Mom, G., Clarsen, G., Kim, N., Seiler, C., Möser, K., Müller, D., & Volti, R. (2011). Hop on the bus, gus. *Transfers, 1*(1), 1–13.

Näsman, M. (2021). *The Political Economy of Emission Standards. Politics, Business and the Making of Vehicle Emission Regulations in Sweden and Europe, 1960–1980s*, PhD thesis, Economic History Unit, Umea University.

Näsman, M., & Pitteloud, S. (2022). The power and limits of expertise: Swiss–Swedish linking of vehicle emission standards in the 1970s and 1980s. *Business and Politics, 24*(3), 241–260.

Norton, P. (2009). Urban mobility without wheels: A historiographical review of pedestrianism. In *Mobility in history: The state of the art in the history of transport, traffic and mobility* (pp. 111–115). Editions Alphil.

Nye D. E. (2013). *America's Assembly Line*. MIT Press.

Paolini, F. (2007). *Storia sociale dell'automobile in Italia*. Carocci.

Paolini, F. (2011). Trasporti e ambiente nell'Italia del Novecento (1950–2001). *Ricerche Storiche, 41*(3), 565–587.

Ramírez Pérez, S. (2010). Automobile standardisation in Europe between technological choices and NeoProtectionism. In C. Bouneau, D. Burigana, &

A. Varsori (Eds.), *Les Trajectoires de l'innovation technologique et la construction européenne* (pp. 187–204). Peter Lang.

Ramírez, P. S. (2020). Embedding the market during times of crisis: The European automobile cartel during a decade of crisis (1973–1985). *Business History, 62*(5), 815–836.

Revill, G. (2014). Reflections on rails and the city. *Transfers, 4*(2), 124–130.

Sheller, M., & Urry, J. (2006). The new mobilities paradigm. *Environment and Planning A, 38*(2), 207–226.

Staudenmaier, J. M. (1984). What SHOT hath wrought and what SHOT hath not: Reflections on twenty-five years of the history of technology. *Technology and Culture, 25*(4), 707–730.

Steele, M. W., & Lin, W. (2014). History, historiography, and be (com) ing on the move: Introduction to the special section. *Transfers, 4*(3), 43–48.

Tao, X. (2013). Making a living: Bicycle-related professions in Shanghai, 1897–1949. *Transfers, 3*(3), 6–26.

Trischler, H., & Zeilinger, S. (Eds.). (2003). *Tackling transport* (Artifacts Series: Studies in the History of Science and Technology). Science Museum.

Vinsel, L. (2019). *Moving violations: Automobiles, experts, and regulations in the United States*. Johns Hopkins University Press.

4

Greening the Car—Mission Impossible or Not Pursued?

Andrea Stocchetti

4.1 Introduction: Looking Beyond the Tailpipe Emissions

The automotive industry is undergoing a vast process of innovation, in which several technological trajectories concur to shape what many observers believe will be a new paradigm, hopefully more sustainable than the present one. The main fields of innovation driving such processes are the gradual shift from conventional internal combustion engines (ICEs) in favour of electrified powertrains (EPs), the development of advanced driver-assistance systems (ADAS), the implementation of connectivity technologies (V2X), plus the set of practices broadly referred to as sustainable product design and manufacturing. All these technological trends have a high potential in reducing the overall environmental impact of cars.

A. Stocchetti (✉)
Department of Management-Venice School of Management,
Ca' Foscari University of Venice, Venice, Italy
e-mail: stocchetti@unive.it

A. Cabigiosu, P. Lanzini (eds.), *The Green Transition of the Automotive Industry*,
https://doi.org/10.1007/978-3-031-37200-1_4

Carmakers are credited with a natural tendency to transfer the most innovative technologies to the market.

In this historical phase when the critical emergency of climate change hogged the concerns of the public, the business ecosystem is so sympathetic towards technological innovations as to be uncritical to their side effects, in particular their external costs.

Not only has the focus on pollutant emissions overshadowed other important aspects of car unsustainability, but it has somehow helped to legitimize the one-best-way from the technological point of view, rather than opening the doors to wider systemic solutions. Two current examples are the electric car, which eliminates exhaust pollution, and autonomous driving, which is supposed to reduce accidents to zero. However, both these technologies raise other problems and, above all, do not solve many other socio-economic problems associated with car use, particularly in urban contexts.

Indeed, a significant part of car-related sustainability issues comes from aspects other than emissions and in fact, despite the technological progress constantly being made, policies and market mechanisms still hold back a potential of the car concept that could be an all-round socio-ecological transition. Moreover, despite the self-image advocated by carmakers of sustainability-oriented companies, even the achievements related to emissions are the result of external pressure rather than of companies' spontaneous effort. Improvements in emissions have always been driven by a tug-of-war with the authorities, willing to limit the environmental damages of cars. As well, the current phase of progressive transition from internal combustion engine technology to battery-powered electric motors, the so-called zero-emission vehicles, is undertaken only as long as it is profitable for carmakers, at the cost of huge subsidies justified by the promise that battery electric vehicles (BEVs) and fuel cells vehicles (FCVs) will zero tailpipe emissions. In this process, the need to use public money to reduce car emissions is never questioned, while other measures that also reduce car emissions to zero (traffic restrictions, the exclusion of cars from cities, speed limits, weights and power limits, etc.), are systematically challenged and pointed out as limitations to individual and market freedom. Besides, should the full achievement of BEVs and ADAS result in more intensive car use, cities will not be more sustainable.

In other words: not only the technology of cars should be innovated, but also its concept and its role in the overall mobility system, especially in cities.

In this chapter we will see how the road to so-called zero emissions has been traced by regulatory interventions and competitive issues rather than by the innovative will of carmakers. At least until the focus of electrified powertrains, on which there was an unprecedented convergence of purpose by policy makers and manufacturers.

4.2 The Route to the "Zero Emission"

Today's cars pollute very little compared to those of the late twentieth century, and immensely less than those of the 1970s.[1] Cars with high tailpipe emissions are being increasingly banned and many cities, states and the entire European Union have set deadlines beyond which only "zero-emission" cars can be sold. Such an achievement, far from being the result of the initiative of carmakers, was triggered by drastic and widely opposed legislative measures, and by contingencies that forced carmakers to innovate.

The rapid growth of motorization in the post-war period was seen as a process of democratization of mobility but had as a direct consequence a dramatic increase in urban pollution. Around the mid-1960s, urban pollution reached unbearable levels (Goldstein & Howard, 1980; Gonzalez, 2002; Melosi, 2004). In California incidents of perceptible health damage occurred as early as the 1940s and got progressively worse until the 1950s. However, car manufacturers strongly rejected the idea that such problems were due to car pollution (Gonzalez, 2002; Penna & Geels, 2012), at least until it became glaringly obvious, which prompted the authorities to take urgent measures.

---

[1] EPA (2020). History of Reducing Air Pollution from Transportation in the United States. https://www.epa.gov/transportation-air-pollution-and-climate-change/history-reducing-air-pollution-transportation.

The European Economic Community (EEC) promulgated its first directive[2] on the topic in 1970. In the United States the early version of a federal law, known as "Clean Air Act",[3] in 1963 lays the groundwork for the setting up of environmental legislation, funding research and authorizing the federal government to enforce regulations on emissions. This step and the one that followed, with the amendment of the Act in 1970, were particularly complex processes, marked by high levels of conflict between regulators and carmakers (Orford, 2021).

The refractoriness of carmakers to any attempt to reduce emissions was already evident when, despite the 1963 "Clean Air Act" and the declared cooperative efforts to implement emission reduction devices, American carmakers produced no tangible results. In 1969 the US Department of Justice opened an antitrust suit against the carmakers (Goldstein & Howard, 1980), accusing them of "using the cover of a joint research venture to suppress the development and diffusion of pollution control technologies" (Gerard & Lave, 2005, 766). The common feeling about the problem of car emissions was changing and a year later, in 1970, the "Clean Air Act" was significantly amended, with an unprecedented measure that imposed a 90% reduction target on carmakers within five years.

The 1970 "Clean Air Act" was seen as forcing (Gerard & Lave, 2005) and US lawyers argued that it was not a matter for a federal law since pollution was concentrated in cities and, therefore, it was a "local" problem (Orford, 2021).

Nowadays, it is widely (but not universally) agreed that when faced with an obvious pollution problem, the authorities can intervene with draconian measures. In the mood of the time, instead, it was not to be taken for granted that a measure designed to improve air quality would be considered less of a priority than aspects such as company profits and cost of vehicles. The political priorities and the shared principles

---

[2] The European Economic Community (EEC), precursor of the European Union, promulgated in 1970 a directive (Council Directive 20 March 1970, 70/220/EEC) that, referring to earlier French and German regulations, imposed limits of carbon monoxide and hydrocarbon emissions to the member states.

[3] The "Clean Air Act" (42 U.S.C. 7401 et seq.) was promulgated in 1963 and then amended in 1970, 1977 and 1990. The 1970 Act imposed a 90% reduction in various cars pollutants within five years and, of course, was aggressively hampered by US carmakers (Kaiser, 2003).

regarding areas of legislative intervention were such that it was questionable whether public health came before economic interests or before the legislative competences of the various bodies.

In the press, as well as in the courtrooms where the cases brought against the "Clean Air Act" were debated, carmakers and their spokesmen feared the negative consequences of the new regulation. Among these were job losses, unsustainable costs of new cars, exit from the market of smaller competitors, abandonment of investments in alternative technologies such as the electric engine, and the growth of concentration of the market, tending towards oligopoly (Flint, 1971).

The case of the "Clean Air Act" of 1970 and the intense media campaign against it that followed has somehow set the standard in showing the potential of regulations in defending public health reasons against corporations, more inclined to spend on court cases than to invest in innovation.

> For a considerable period of time American carmakers simply ignored emission control legislation. Subsequently both state and federal emission regulations were fought by aggressive lobbying (…) It is obvious that the American automobile industry became entangled in a situation in which it was less expensive to take legal action than to strive for new technological solutions. (Kaiser, 2003, 33)

Only a few years after the "Clean Air Act" and EC Directive 70/220, extraordinary external events strengthened the conditions for carmakers to invest in more efficient engines. It is the case of the two waves of the oil shock, the first one in 1973–74, the second in the early 80s. In both cases, a sudden increase in global oil prices occurred, due to a number of factors[4] that caused the disruption of oil supplies from the Middle East. Oil prices rose dramatically: the price of oil in 1982 is ten times that of

---

[4] The first oil shock was due to the decision by the Organization of Petroleum Exporting Countries (OPEC) to raise the price of oil. The most relevant causes of the second one were the Iranian Revolution and the Iran-Iraq War. Between 1973 and 1974 the annual average price of oil quadrupled from around $4 to almost $13 per barrel. It grew only slightly until 1979 when the second oil crisis began, between 78 and 79 and reached over 33 dollars in 1982. Source: https://www.eia.gov/outlooks/steo/realprices/.

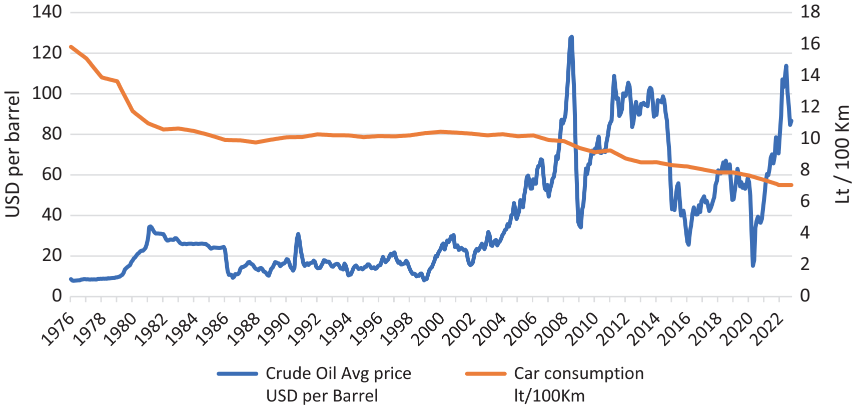


Fig. 4.1 Crude oil price and average car consumption, 1976–2022*. *The 2022 data is preliminary. Crude oil average monthly price, yearly average consumption of models produced in the year. Source: Elaboration on data from US Environmental Protection Agency (2022) *EPA Automotive Trends Report*. Data available at www.epa.gov/automotive-trends/explore-automotive-trends-data; oil data available at https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=f000000__3&f=m Accessed 20/01/2023

1972, and fuel consumption has suddenly become one of the most relevant factors when choosing a car.

Long story short, this is why between the 70s and until 1982 there has been the most significant improvement in car efficiency (i.e. decrease in fuel consumption). Innovating to survive, a strategy that would not have been undertaken without the two above mentioned disruptive factors, namely the "Clean Air Act" in the United States, whose European equivalent is the Directive 70/220/EEC, and the oil shocks (1973–74 and 1979–82) (Fig. 4.1).

Between 1976 and 1982, in the midst of the effects of both oil crisis and the new anti-pollution legislation, carmakers reduced on average car consumption by the same percentage as they would have done in the following 40 years, between 1983 and 2022 (respectively 33% from 1976 to 1982 and 34% from 1983 to 2022). In addition, it is significant that between 1982 and 2006 the average consumption level remained substantially unchanged (−7%), while after 2006 it started to fall again with some intensity (−22% between 2006 and 2022), as a result of the progressive spread of hybrid vehicles first and electric vehicles later.

In the perspective that only regulation and market pressures can push car manufacturers to make substantial improvements in technology, the European Union approved in 2022 a preliminary document on a Europe-wide ban on ICE cars from 2035, with a set of regulations known as "Fit for 55".[5] As far as we know, such a political decision to ban polluting cars on such a wide scale is unprecedented. The process of final enactment of the law was subsequently halted in the face of opposition from three states, namely Germany, Poland, and Italy, that were united in their intent to protect the more traditional part of the domestic automotive sector. On the negotiating table with the EU Germany and Italy have placed the recognition of "alternative" liquid fuels that are either plant-derived or obtained through synthetic chemical processes using mainly hydrogen, water and CO2.

Moreover, there are several reasons to believe that this negotiation was pushed more by the automotive supply chain than by carmakers themselves. The latter, while they have already largely announced that they are moving away from thermal engines, have more advantages than disadvantages from the electrification process, as we shall see later.

The "Fit for 55" story has many similarities with that of the American "Clean Air Act" in the '70s. Indeed, in the narrative used by those who oppose the measure, we find the same elements as in the past: the denial of the responsibilities of internal combustion engines in causing pollution; the technological "non-neutrality" of the decision, and the abandonment of investment in alternative technologies; the increase in production costs; and the disruption of competition. In addition, various arguments regarding the technical unfeasibility of the solution.

Although the "Fit for 55" might seem a far more radical action than the "Clean Air Act", the technological transition involved in the EU directive is less problematic for car manufacturers than the drastic reduction imposed by the "Clean Air Act", considering the technologies of the

---

[5] The European regulation banning the sale of ICE cars in Europe from 2035 (COM(2021) 556 final, + Annex) has been approved by the EU Parliament in 2022. It is part of a wide legislative package known as "Fit for 55", which set a series of climate-related actions in several industries, with the aim of achieving the goals set by the "Green Deal" (COM(2019) 640 final + Annex), that is the document presenting the EU strategy and roadmap to reach climate neutrality within 2050.

time. Moreover, the "Fit for 55" finds a socio-economic ecosystem certainly more inclined to such a change, for at least two reasons.

First: the "Fit for 55", voted by the European Parliament in June 2022 and amended in September 2022, came after extensive consultations and analyses whose results had already been published by the European Commission in September 2020.[6] Likely, for those who gravitate in various ways in the field of transport sustainability, the measures contained in the "Fit for 55" were not as unexpected as one would like to believe and the hypotheses of a deadline for the elimination of polluting vehicles were already circulating since 2018.

Second: as will be better explained later, there is data to show that the transition to electrified powertrain to date seems to be a more interesting opportunity for carmakers, and this is precisely why the major carmakers made themselves ready for the transition well before the deadline set by the European directive.

In addition to these two facilitating factors, there is the fact that the costs of further marginal improvements to internal combustion engines would have been probably higher than those of switching to new technologies, if significant improvements are still possible. In fact, it is not clear whether it would be possible to reduce emissions from ICE cars beyond a given limit, which may already be close to being reached.

We have previously seen that the consumption per km of passenger cars decreased over time in response to legislative and market pressures also induced by oil price oscillation (Fig. 4.1). Cars have been more and more efficient, and of course the increase in efficiency led to a decrease in emissions. The greater efficiency was a compulsory route both to comply with legal limits that have become increasingly stringent over time,[7] and to challenge the increasing costs of fuel. As a result, also the CO2 emissions decreased in the same way, since the amount of CO2 emitted per litre of fuel is a constant (Fig. 4.2).

---

[6] Commission Staff Working Document Impact Assessment (...) "Stepping up Europe's 2030 climate ambition" (...) SWD/2020/176 finalSWD(2020) 176 final.

[7] In fact, both European countries and the United States originally devoted their emissions regulations to curbing the most harmful pollutants, namely carbon monoxide, nitrogen oxides, hydrocarbons and particulate matter. CO2 reduction has gained attention more recently, following the spread of the global warming awareness.

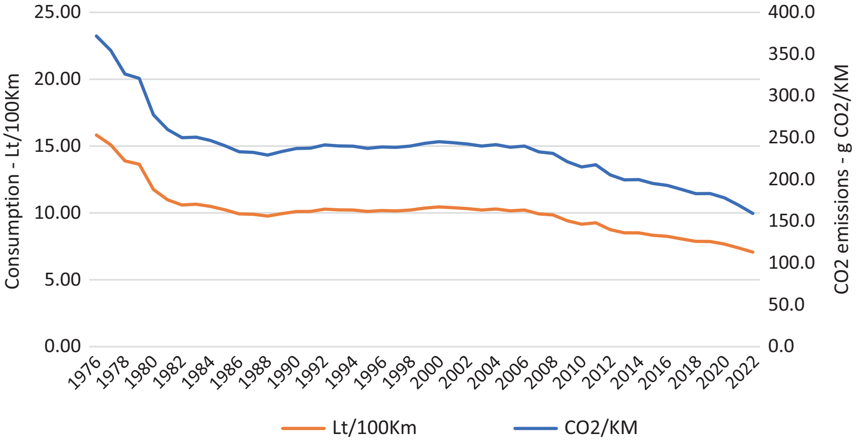


Fig. 4.2 Average car consumption and emission, 1976–2022*. * The 2022 data is preliminary. Source: Elaboration on data from US Environmental Protection Agency (2022) *EPA Automotive Trends Report*. Data available at www.epa.gov/automotive-trends/explore-automotive-trends-data. Accessed 20/01/2023

The key point is that with the ICE technology the improvement of CO2 emission depends only on the lower consumptions. This can be seen dividing the average car consumption with average car emissions over time. Figure 4.3 shows the amount of CO2 emitted per litre of fuel consumed. From 1976 to 2020 it remains virtually constant, varying by about 1%, and only begins to decrease significantly after 2018, when the share of electric and hybrid cars placed on the market becomes relevant. In other words, the capability of ICEs to deliver energy for the same amount of fuel has improved greatly over time, but the carbon efficiency of ICE using traditional fuels is essentially the same over time.

As for the carbon footprint, therefore, the only way to reduce the CO2 is to reduce the fossil fuel consumption per km. To further reduce fuel consumption, various way can be pursued, first and foremost by reducing the weight and the power of the car. But in the last 40 years the market (i.e. carmakers, but also buyers) has taken an opposite decision. Figure 4.4 shows the trend in the average weight and power of models released between 1976 and 2022. As can be seen, growth has been uninterrupted since 1982. The effects of electrification can also be seen here, with a surge in weight and especially power since 2018.

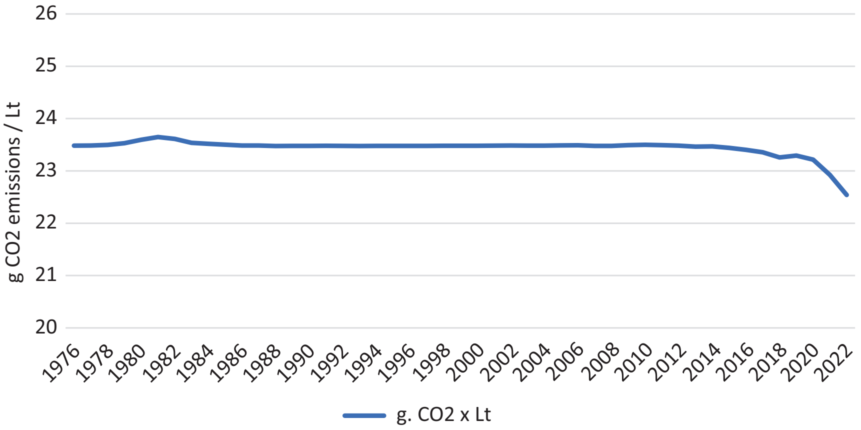


Fig. 4.3 CO2 emissions per litre of fuel, 1976–2022*. *The 2022 data is preliminary. Source: Elaboration on data from US Environmental Protection Agency (2022) *EPA Automotive Trends Report*. Data available at www.epa.gov/automotive-trends/explore-automotive-trends-data. Accessed 20/01/2023

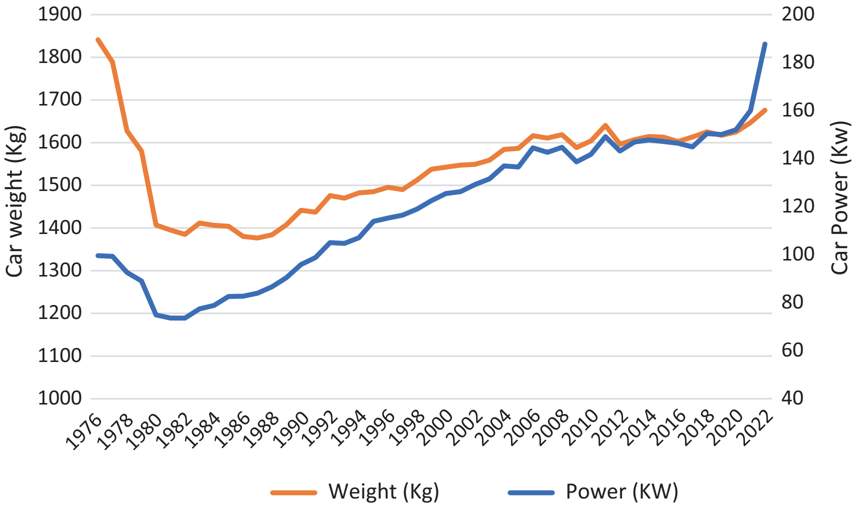


Fig. 4.4 Evolution of car average weight and power, 1976–2022*. *The 2022 data is preliminary. Source: Elaboration on data from US Environmental Protection Agency (2022) *EPA Automotive Trends Report*. Data available at www.epa.gov/automotive-trends/explore-automotive-trends-data. Accessed 20/01/2023

The demand for ever bigger and more powerful cars is not only responsibility of buyers. They are also induced to focus their preferences in this direction by incentive policies and payment instalment mechanisms that make feature upgrades more attractive (Pardi, 2022). But of course, this is at the expense of unquantified but visible social costs, which translate into a race to the top in prices and thus in a reduced affordability of the car, or at least in its greater weight on family budgets.

The comforting side is that in this long period of increasing weight and power, fuel consumption and emissions have fallen (today's cars emit less than 1% of the pollutants of a car of the 1970s). However, one wonders how much more they would have fallen if carmakers would have pursued the way of lighter and less powerful cars.

In our opinion, however, if today's cars pollute much less than those of many years ago it is a consequence of laws and to some extent of demand preferences, rather than a deliberate willingness to reduce pollution. Progress has been made to achieve legal compliance with standards and regulations or even to increase competitiveness pandering demand preferences, while carmakers' effort in this regard has nothing to do with the quest for sustainability.

If there was any doubt about the fact that, despite the common narrative, carmakers have not been cooperative in reducing environmental impact, the "Dieselgate" stands as powerful.

The "Dieselgate", also known as "Volkswagen scandal", was a major scandal that came to light in the United States in 2015, when the United States Environmental Protection Agency (EPA) issued a notice of violation to VW for violating the "Clean Air Act" (Mansouri, 2016; Mujkic & Klingner, 2019). In a nutshell, VW installed software in its diesel vehicles designed to detect when a car was being tested for emissions and would activate emissions control systems to reduce pollutants. When the cars were driven on the road, the software would turn off emission controls, allowing cars to improve performance at the cost of emitting nitrogen oxides (NOx) at levels up to 40 times higher than the legal limit in the United States. VW initially denied the allegations but later admitted instalment of the device in millions of vehicles worldwide.

The scandal had major financial and legal repercussions for VW, including billions of dollars in fines and settlements, a significant drop in its stock price and the resignation of its CEO. The scandal also sparked a broader investigation into diesel emissions cheating by other automakers, leading to further fines and recalls with different carmakers being caught in similar situations. In 2017, Fiat Chrysler agreed to pay a $515 million settlement to the US government and California regulators for allegedly installing software in its diesel vehicles that allowed them to emit excess pollutants. In 2019, Daimler was found to have installed defeat devices in some of its diesel vehicles and was fined nearly $1 billion by German authorities for selling diesel cars that did not comply with emissions standards. Other automakers, including Renault and Opel, have also faced investigations and fines for emissions cheating in Europe.

In all this, there has been no shortage of voices defending VW, arguing in various ways and with various rhetoric for the theory of the legitimate need to violate an unfair law (Bovens, 2016; Rhodes, 2016).

Studies on the conduct of carmakers about environmental policy disclosure noted a tendency to neutralize the issue rather than to acknowledge it.

> In response to the pressures linked to the scandal, manufacturers adopted various neutralization techniques aimed at using apparently socially acceptable arguments to justify the integrity of their company and the legitimacy of their practices (…) Most of the time, these expressions tend to minimize the scale and seriousness of the ongoing scandal, reducing it to an essentially technical problem: 'the diesel emissions issue' (…), 'the diesel issue' (…), the 'emissions testing issue' (..), the 'diesel debate' (..), the 'alleged failure [of] emission control calibration' (.), the 'alleged misreporting [of] diesel emissions' (…), and so on. (Boiral et al., 2022, 184)

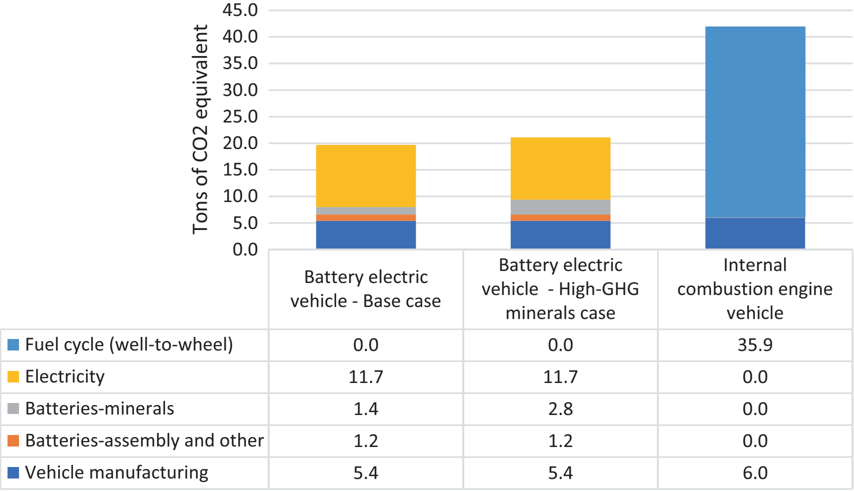
The "Dieselgate" has been studied from all possible perspectives, many things have been said, and among them it clearly emerges that it was not a random incident, but the result of a widespread corporate culture (Aurand et al., 2018) which has had consequences on many fronts, including that of demand. Until 2014, diesel cars dominated the European market with a sales share higher than 50%. Then an inexorable decline began for diesel engines, leading to 15% of the market in 2022 (and still decreasing). This is unlikely to be a coincidence; rather, it is likely that among the many lessons provided by the "Dieselgate", it might be inferred that investing in innovation is more cost-effective than protecting the existing at all costs. If this is true, the "zero-emission" car could overcome the reluctance of carmakers and also help improve the environment, being above all a good deal.

4.3 The Promised Land of Powertrain Electrification

Much has been said about electric cars polluting upstream, having batteries that pollute, and so many other things that somehow call into question the environmental benefit of replacing the ICE fleet with a BEV. The issue is complex indeed, since looking beyond exhaust emissions (on which BEV obviously wins hands down), the two supply chains have different criticalities and the comparison is complex. In the current state of knowledge, the International Energy Agency (IEA) has measured and compared the life-cycle emissions of greenhouse gases of a mid-size BEV vehicle with that of a mid-size ICE. The results are shown in Fig. 4.5. According to the IEA analysis, the impact of ICE cars remains far worse than that of BEV cars, and the difference lies in the fuel supply chain. Conventional fuels have a far worse carbon footprint than batteries, at least in Europe, where, moreover, the CO2 density of electricity production has been steadily declining for many years and is expected to decline further in the future (Fig. 4.6).

To our knowledge, the electrification will provide environmental benefits, and the trend of sales provides optimistic impressions about this.

Talking about Europe, electric cars demand took about ten years to increase from 0% to 1% of overall car demand, and only three years (from 2018 to 2021) to get from 1% to 10%. The long introduction was due to the underperforming features, in particular the distrust of demand driven by the lack of charging points, the long charging times, the actual driving range and (last but certainly not least) the higher purchasing prices. In 2022, BEVs reached the all-time record of 14% of total demand and hybrid cars (HEV) reached a share of 32% (Fig. 4.7).



	Battery electric vehicle - Base case	Battery electric vehicle - High-GHG minerals case	Internal combustion engine vehicle
Fuel cycle (well-to-wheel)	0.0	0.0	35.9
Electricity	11.7	11.7	0.0
Batteries-minerals	1.4	2.8	0.0
Batteries-assembly and other	1.2	1.2	0.0
Vehicle manufacturing	5.4	5.4	6.0

Fig. 4.5 Comparative life-cycle greenhouse gas emissions of a mid-size BEV and ICE vehicle. Source: IEA, *Comparative life-cycle greenhouse gas emissions of a mid-size BEV and ICE vehicle*, IEA, Paris https://www.iea.org/data-and-statistics/charts/comparative-life-cycle-greenhouse-gas-emissions-of-a-mid-size-bev-and-ice-vehicle, IEA. Licence: CC BY 4.0

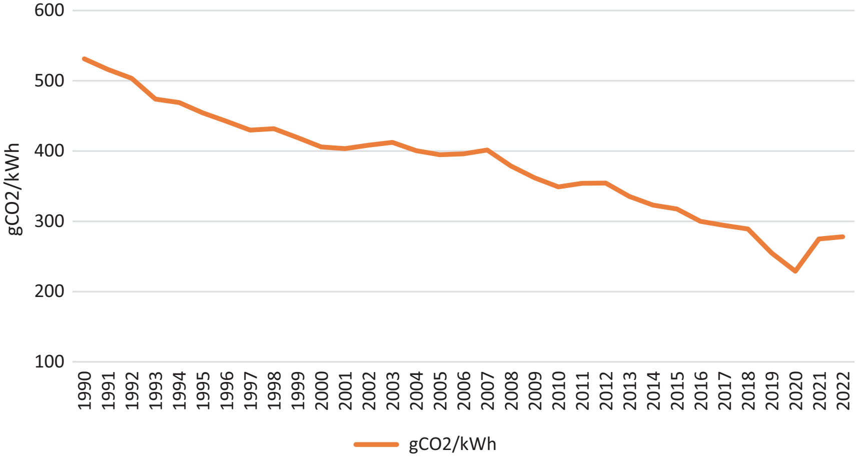


Fig. 4.6 CO2 intensity of electricity generation in Europe (EU27). Sources: EEA—European Environmental Agency, Our World in Data (for 2022)

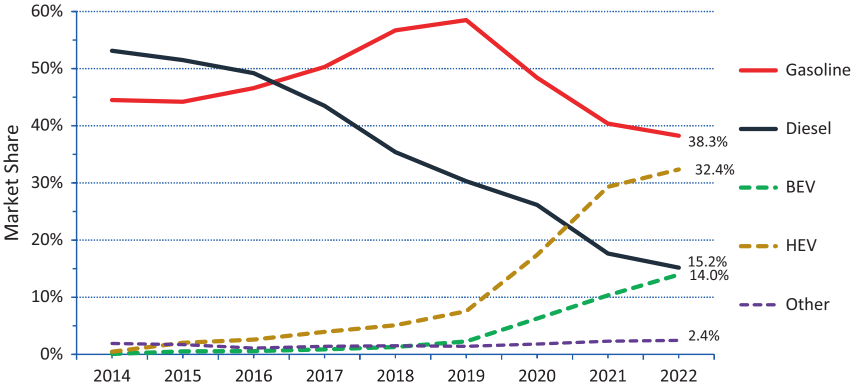


Fig. 4.7 Market share trend of passenger cars in Europe by engine, 2014–2022. ** BEV: Battery Electric Vehicles, HEV: Hybrid Electric Vehicles. Source: Elaboration on ACEA data

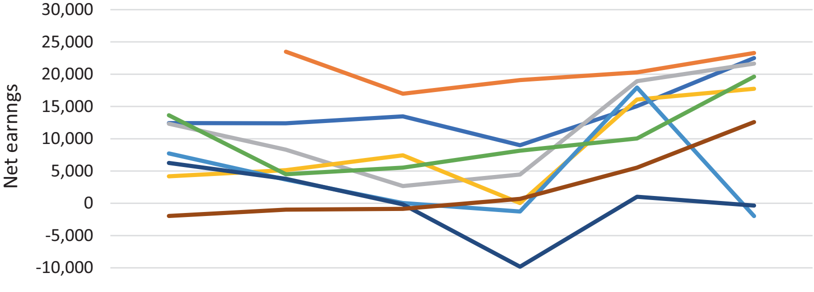
While in the past the spread of conventional cars had occurred thanks to the investments of car and fuel manufacturers, the electric car probably would not be even close to today's shares without the enormous public policy spending to support such technology in the form of tax benefits, purchase incentives or incentives for the installation of charging points.

Indeed, between 2020 and 2022 unprecedented incentives have been granted in most European countries for the purchase of low-emission cars. According to a report by the International Energy Agency,[8] in 2021 global public spending on incentives and subsidies to electric cars was almost 30 billion dollars (26.5 billion euros), twice the previous year. It can be estimated that in 2022 alone the total direct incentive allocated in Europe for the purchase of BEVs to individuals and businesses is no less than 4.2–4.5 billion euros,[9] a figure to which we must add the investments for the development of charging infrastructure and the tax benefits, not easily quantifiable. In a nutshell, the effort in favour of the electric was unprecedented.

---

[8] "Global EV Outlook 2022", IEA.

[9] This estimate was made by calculating the minimum incentive provided by the main EU countries for the purchase of electric cars, multiplied by the number of cars registered in each country in the same year.



	2017	2018	2019	2020	2021	2022
Volkswagen	12,428	12,395	13,474	8,997	15,045	22,500
Toyota		23,486	16,975	19,100	20,282	23,285
Mercedes-Benz*	12,326	8,300	2,670	4,451	18,923	21,640
Stellantis N.V.**	4,187	5,131	7,439	36	16,083	17,740
Ford	7,731	3,677	47	-1,279	17,937	-1,981
BMW	13,643	4,499	5,522	8,149	10,035	19,620
Renault	6,251	3,781	-158	-9,827	1,006	-361
Tesla	-1,962	-976	-870	690	5,524	12,583

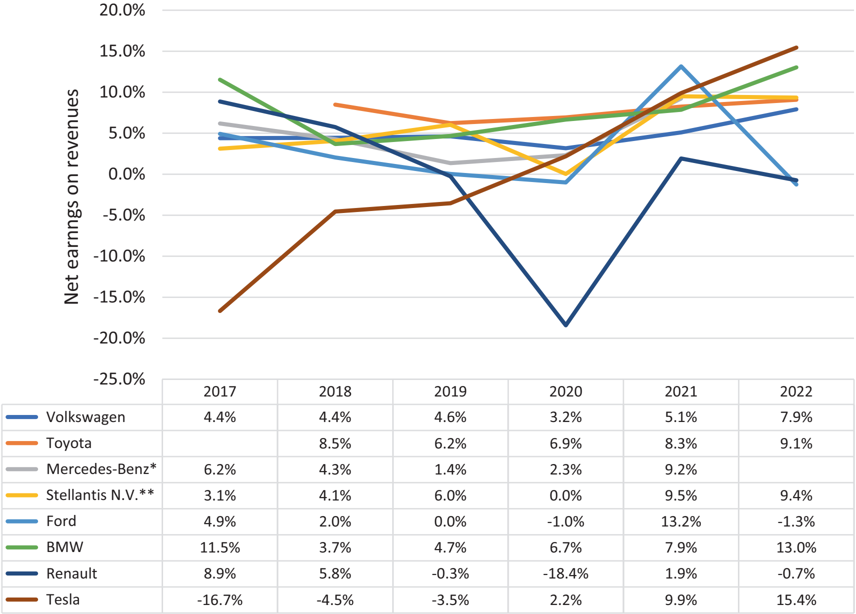
Fig. 4.8 Net profit performance of the top seven automotive groups by production value operating in Europe (2017–2021, for Toyota 2018–2022. Data in thousands of US dollars). * Daimler AG until 01/02/2022. ** Fiat Chrysler Automobiles N.V: until 18/01/2021. Net profit for 2020 was substantially wiped out by the allocation of €3.3 billion to dividends. Sources: Orbis-BVD data base, Reuters, investors relations of the automotive groups

And it is also thanks to public incentives that the electrification has perhaps represented the most interesting opportunity that carmakers have had in many years to revitalize their business.

In this regard, for the majority of main automotive groups, the growth in the share of electrified cars coincides with large increases in net profit (Fig. 4.8).

Data show that the main automotive groups (except Ford and Renault) earned net profits equal to or above pre-Covid levels, showing that the ability to generate profits by the main carmakers is resilient even to crisis factors such as those that have occurred in recent years, from epidemics to the scarcity of electronic components and, of course, to the transition to electric.

Not only earnings grew in absolute terms, but also the overall profitability increased, as shown by the trend of the ratio between net profits and total revenues. Apart from Renault, the other groups have a ratio of



	2017	2018	2019	2020	2021	2022
Volkswagen	4.4%	4.4%	4.6%	3.2%	5.1%	7.9%
Toyota		8.5%	6.2%	6.9%	8.3%	9.1%
Mercedes-Benz*	6.2%	4.3%	1.4%	2.3%	9.2%	
Stellantis N.V.**	3.1%	4.1%	6.0%	0.0%	9.5%	9.4%
Ford	4.9%	2.0%	0.0%	-1.0%	13.2%	-1.3%
BMW	11.5%	3.7%	4.7%	6.7%	7.9%	13.0%
Renault	8.9%	5.8%	-0.3%	-18.4%	1.9%	-0.7%
Tesla	-16.7%	-4.5%	-3.5%	2.2%	9.9%	15.4%

Fig. 4.9 Trend in the ratio of net profit to production value of the top seven automotive groups by production value operating in Europe (2017–2021, for Toyota 2018–2022). * Daimler AG until 01/02/2022. ** Fiat Chrysler Automobiles. Sources: Orbis-BVD data base, Reuters, investors relations of the automotive groups

net profit to production value of between 5 and 14 percentage points, higher than pre-Covid levels (Fig. 4.9).

Seemingly, financial data show that the increase in the share of electrified (hybrid and electric) cars at the expense of ICEs has positive effects on the profitability of carmakers. While these profits are certainly (also) the result of public spending that stimulated and subsidized the spread of electric cars, it is very difficult to measure the relevance of such interventions. Assuming that this is the road to have only "zero-emission" cars on the road, bartering public money for public health sounds a proper strategy.

Unfortunately, electric or not, the excessive use of cars in urban areas does have negative impacts on the environment and public health. Even

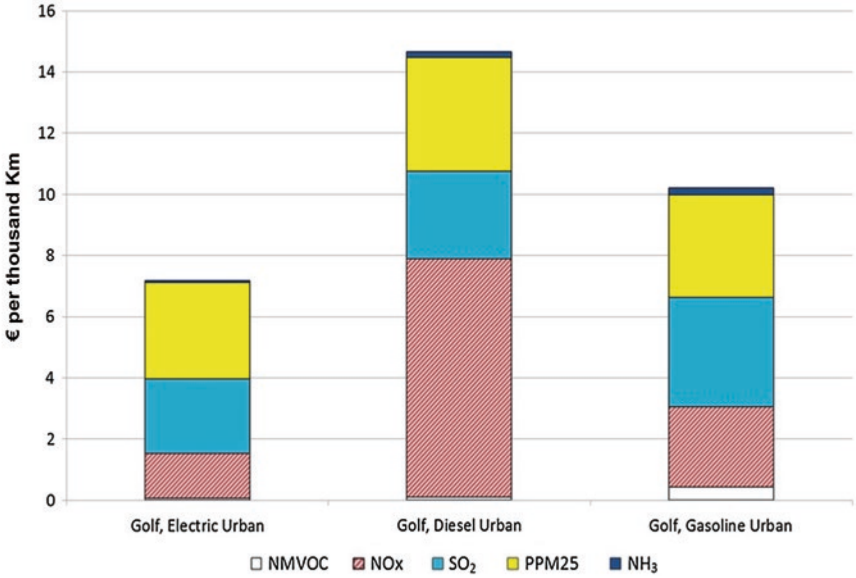


Fig. 4.10 External costs of cars' air pollution. Source: Girardi et al. (2020), 146

electric cars emit pollutants, mainly from tyres and brakes, and do not solve the issue of traffic congestion, which is a major cause of increased stress and decreased quality of life for residents. Although BEVs perform far better than traditional ICEs as for the life-cycle emissions, their external costs still are higher than necessary (Fig. 4.10) (Girardi et al., 2020).

In sum, on the one hand the perspective of electrification could for once bring carmakers and the environment together. On the other hand, the real goal should be to reduce the number of (at least private) cars on the road, and where possible to eliminate them. This can hardly be done in areas with limited public transportation options, but in an urban context, the need for the car is increasingly questioned and the reduction of car dependence is the ultimate goal of sustainable mobility policies.

4.4 The Car and the City: A Controversial Liaison

Often, what is viewed negatively today had a positive connotation in the past. Mass motorization has shaped the vision of future cities for decades (Dunn et al., 2014) and car has been considered an achievement, and still is in fact for a large share of demand. The environmental issues that (already in the '50s) affected some US cities only temporarily changed the generally positive view of mass motorization, as the new and less polluting cars have returned somewhat better air to cities. But pollution is only a part of the overall unsustainability of car dependence, which significantly affects the quality of urban life far beyond the environmental issue (Newman & Kenworthy, 1999). From the point of view of actual liveability, in particular, what was supposed to be a feature to make citizens more mobile has sometimes become a segregating factor (Sheller & Urry, 2000).

A number of additional problems other than pollution arise from excessive car use in the urban environment:

(a) traffic congestion: deteriorates the quality of life due to longer commutes, wasted time, and stress associated with waiting and the sense of insecurity generated by heavy traffic.
(b) Land use: cars subtract physical spaces from urban social life and can lead to social isolation, to the extent that in a car-friendly city people are less likely to interact with their neighbours or engage in physical activity.
(c) Sprawl and loss of green space: cars often encourage urban sprawl, or the spread of urbanization standards into rural areas. This can lead to the loss of green areas at increasing distance from the urban centre, thus providing the fragmentation of habitats for wildlife.
(d) Social inequality, related to both car affordability and urban segregation of city areas induced by car-related infrastructures.
(e) Public and social costs, related to infrastructures building and maintenance, subtracting budget that could be used in other possible investments.

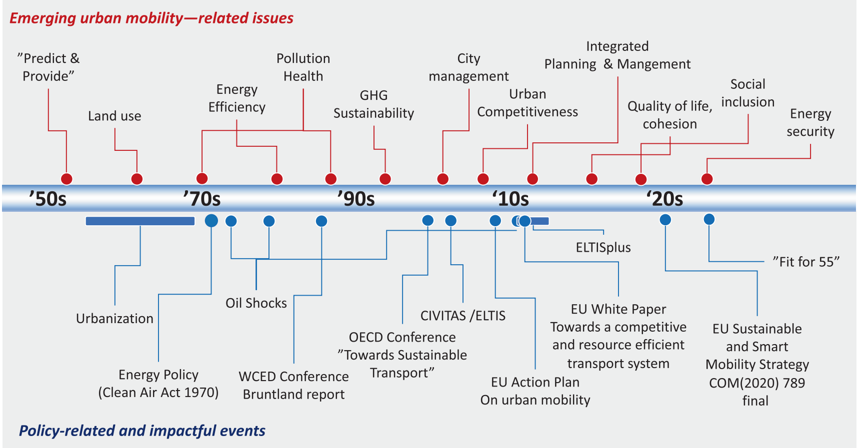


Fig. 4.11 Main issues and main events over time that have shaped the contemporary concept of urban sustainable mobility

The sources of unsustainability listed above, in addition to safety and environmental concerns, may seem obvious. Instead, they are the result of an evolving awareness that (at least in Europe) has matured over the years as a result of the emergence of a number of priorities that guided the evolution of the principles underlying sustainable mobility policies (Fig. 4.11).

In the post-war period, the basic principle, known as "predict & provide", was merely concerned with ensuring adequate infrastructure for automobiles and operated by building new roads according to predicted traffic growth. Soon the problems of uncontrolled traffic growth emerged, as such an approach was at the root of a vicious cycle that took resources away from alternative transportation policies. Meanwhile, urbanization was growing, which gave greater emphasis to pollution problems.

From the 1990s onwards, initiatives to reduce car pollution intensified, and the concept of "car-free cities" began to spread (Nieuwenhuijsen & Khreis, 2016), initially synonymous with partial closure to traffic, later to be articulated as semi-closure, zero emissions only, and similar.

From a policy perspective, managing traffic congestion and car dependence in urban centres is an even more complex problem than the one leading to the Clean Air Act amendment of the 1970s. At that time the public basically agreed on the need to reduce pollution. Instead, it is much more complex to manage the set of trade-offs that arise from other sources of unsustainability, given that citizens' opinion is divided between the benefits of freedom of car use and the benefits of no traffic. In this sense, what has led to today's conception of sustainable mobility is a mixture of both political and cultural initiatives that, perhaps for the first time in history, has partly thwarted the widespread rhetoric of the car as synonymous with freedom and well-being (Topp & Pharoah, 1994; Baehler & Rérat, 2022). Over time, the principles of sustainable mobility have evolved from a focus on technical and environmental aspects to an increasing emphasis on social aspects (Lanzini & Stocchetti, 2021). The transition to "zero emissions" doesn't untangle the complex relationship that exists between the car and urban life, and this is why the presence of the car in the city is likely to regress, and it's not a matter of technology.

There is a strong link between urban spaces, the way they are lived and social cohesion (Forrest & Kearns, 2001). The main competitor of the car in the urban environment is the search for a neighbourhood dimension in social relations, which fosters new conceptions of how to design urban spaces and mobility. This implies a paradigmatic change in the vision of how a city should be, whose end point stands in eliminating the need for vehicles. The state of the art of this vision is the "15-minute city" (Khavarian-Garmsir et al., 2023), a proximity-based approach in urban planning aiming at making it possible for people to reach frequently used places in such a short time (e.g. 15 minutes of walking or cycling) that they do not need to use motor vehicles. While such a concept goes beyond the idea of addressing decarbonization through steep technological climbs and infrastructure revolutions, it proposes a return to origin without degrowth but, on the contrary, with attractive outlooks in terms of sustainability, quality of life and health (Allam et al., 2022).

The concept of the "15-minute city" seems to have all the makings of a desirable ideal in every respect. Nevertheless, even such an appealing and promising idea is not feasible without the active participation of individual citizens. Strange as it may seem, this is the "mission impossible" on the road to zero emissions: neither the technology nor the design, but the persistence of a culture that considers the car as something beyond a mere functional tool for transportation.

4.5 The Shortest Path to Zero Emissions

When thinking of a car-free city, anyone would probably think of Venice, the world’s only fully pedestrian city. Usually, one might believe that the uniqueness of the lagoon city in this regard is the result of a historical condition that has prevented cars from spreading. In truth, things could have been different, and Venice, too, could have become an automotive city.

Not far from Venice, overlooking the same lagoon, there is a small city that is extremely similar to Venice in terms of architecture and urban structure, but nevertheless is crossed by cars far and wide. Chioggia is about seven times smaller than Venice (0.80 Sq. km against 5.65 Sq. Km for Venice), little more than half of the island of Murano (1.45 Sq. km) (Fig. 4.12). In fact, it is an island about 1 km long and, on average, less than 600 m wide: that is, two-thirds the length of Terminal 2 of Paris Airport “Charles De Gaulle” and a little larger. In spite of this, the city is constantly clogged with cars (Fig. 4.13).

Chioggia is an actual “15-minute city” in its own right, but despite representing an ideal case for traffic closure, attempts to remove cars have always foundered amid protests from residents.

When culture and habits override functional rationality, technology is a palliative that solves problems only in part. Chioggia could easily replicate the Venetian quality of life, while it will not be more liveable once all cars are electric.

Fig. 4.12 Venice and Murano (car-free) compared at equal size with Chioggia (car congested)

Fig. 4.13 Roads congested by car in Chioggia. Source: Google Street View, ©2023, accessed March 16th 2023

Chioggia is not an uncommon case but it has its own particularity in the extreme similarity and geographical proximity to Venice. It was presented here to emphasize, with the reality of the facts, that making the car environmentally friendly is a cultural rather than a technological issue.

The long and hard road to zero emissions is to leave the car in the garage whenever possible, and building car-free cities is a feasible mission and is the subject of increasing studies and projects.

Building a widespread car-free mentality, on the other hand, is the more difficult mission; it is a cultural project that will take time and require the participation of a large group of stakeholders, many of whom, however, have quite different goals.

References

Allam, Z., Nieuwenhuijsen, M., Chabaud, D., & Moreno, C. (2022). The 15-minute city offers a new framework for sustainability, liveability, and health. *The Lancet Planetary Health, 6*(3), e181–e183.

Aurand, T. W., Finley, W., Krishnan, V., Sullivan, U. Y., Abresch, J., Bowen, J., et al. (2018). The VW diesel scandal: A case of corporate commissioned greenwashing. *Journal of Organizational Psychology, 18*(1).

Baehler, D., & Rérat, P. (2022). Beyond the car. Car-free housing as a laboratory to overcome the "system of automobility". *Applied Mobilities, 7*(3), 280–297.

Boiral, O., Brotherton, M. C., Yuriev, A., & Talbot, D. (2022). Through the smokescreen of the Dieselgate disclosure: Neutralizing the impacts of a major sustainability scandal. *Organization & Environment, 35*(2), 175–201.

Bovens, L. (2016). The ethics of Dieselgate. *Midwest Studies in Philosophy, 40*, 262–283.

Girardi, P., Brambilla, C., & Mela, G. (2020). Life cycle air emissions external costs assessment for comparing electric and traditional passenger cars. *Integrated Environmental Assessment and Management, 16*(1), 140–150.

Dunn, N., Cureton, P., & Pollastri, S. (2014). A visual history of the future. In *Future of cities: Working paper*. Foresight, Government Office for Science.

Flint, J. M. (1971, June 1). Clean air and autos: Industry is troubled by antitrust rules. *New York Times*.

Forrest, R., & Kearns, A. (2001). Social cohesion, social capital and the neighbourhood. *Urban Studies, 38*(12), 2125–2143.

Gerard, D., & Lave, L. B. (2005). Implementing technology-forcing policies: The 1970 Clean Air Act Amendments and the introduction of advanced automotive emissions controls in the United States. *Technological Forecasting and Social Change, 72*(7), 761–778.

Goldstein, B. H., & Howard, H. H. (1980). Antitrust law and the control of auto pollution: Rethinking the Alliance between competition and technical progress. *Environmental Law, 10*, 517.

Gonzalez, G. A. (2002). Local growth coalitions and air pollution controls: The ecological modernization of the US in historical perspective. *Environmental Politics, 11*(3), 121–144.

Kaiser, W. (2003). Clean air act and American automobile industry. *Icon, 9*, 31–43.

Khavarian-Garmsir, A. R., Sharifi, A., & Sadeghi, A. (2023). The 15-minute city: Urban planning and design efforts toward creating sustainable neighborhoods. *Cities, 132*, 104101.

Mansouri, N. (2016). A case study of Volkswagen unethical practice in diesel emission test. *International Journal of Science and Engineering Applications, 5*(4), 211–216.

Melosi, M. (2004). *The automobile and the environment in American history*. Online*:* http://www.autolife.umd.umich.edu/Environment/E_Overview/E_Overview1.htm

Mujkic, E., & Klingner, D. (2019). Dieselgate: How hubris and bad leadership caused the biggest scandal in automotive history. *Public integrity, 21*(4), 365–377.

Lanzini, P., & Stocchetti, A. (2021). From techno-centrism to socio-centrism: The evolution of principles for urban sustainable mobility. *International Journal of Sustainable Transportation, 15*(11), 815–825.

Newman, P., & Kenworthy, J. (1999). Costs of automobile dependence: Global survey of cities. *Transportation Research Record, 1670*(1), 17–26.

Nieuwenhuijsen, M. J., & Khreis, H. (2016). Car free cities: Pathway to healthy urban living. *Environment International, 94*, 251–262.

Orford, A. D. (2021). The Clean Air Act of 1963: Postwar environmental politics and the debate over Federal power. *Hastings Environmental Law Journal, 27*, 1.

Pardi, T. (2022). Heavier, faster and less affordable cars: The consequence of EU regulations for car emissions. *ETUI Research Paper-Report*, 7.

Penna, C. C., & Geels, F. W. (2012). Multi-dimensional struggles in the greening of industry: A dialectic issue lifecycle model and case study. *Technological Forecasting and Social Change, 79*(6), 999–1020.

Rhodes, C. (2016). Democratic business ethics: Volkswagen's emissions scandal and the disruption of corporate sovereignty. *Organization Studies, 37*(10), 1501–1518.

Sheller, M., & Urry, J. (2000). The city and the car. *International Journal of Urban and Regional Research, 24*(4), 737–757.

Topp, H., & Pharoah, T. (1994). Car-free city centres. *Transportation, 21*, 231–247.

US Environmental Protection Agency. (2022). *EPA automotive trends report.*

5

The Transition of the Automotive Industry from an Identity Perspective

Lisa Balzarin and Francesco Zirpoli

5.1 Introduction

Changing and innovating have always been in the DNA of the automotive industry (Maxton & Wormald, 2004). However, the transition that this sector is currently facing looks unprecedented (Schulze et al., 2015). Current studies and reports usually tackle the transition from several points of view. The first is the technological one: identifying and classifying the technological challenges that the automotive industry faces—connectivity, electrification, climate neutral energy sources, autonomous driving, more inclusion of software (Bertoncello et al., 2021; Burkacky

---

This chapter is a joint endeavour. The listing of author names is alphabetical. Credits authors: Balzarin wrote Section 5.2, Zirpoli wrote Section 5.4, Sections 5.1, 5.3, and 5.5 have been jointly written.

L. Balzarin • F. Zirpoli (✉)
Department of Management-Venice School of Management,
Ca' Foscari University of Venice, Venice, Italy
e-mail: lisa.balzarin@unive.it; francesco.zirpoli@unive.it

A. Cabigiosu, P. Lanzini (eds.), *The Green Transition of the Automotive Industry*,
https://doi.org/10.1007/978-3-031-37200-1_5

et al., 2021; Kuhlmann et al., 2021). The second point of view is the organizational one: many studies evaluate whether organizations have the necessary resources and capabilities to face the above-mentioned technological challenges and how they may acquire them (Jacobides et al., 2016). The third point relates to employee's skills: some studies are particularly concerned with the consequences that the current transition has and will have in the next future for the professionals who operate in the automotive industry (Kuhlmann et al., 2021). Finally, another angle from which understanding the transition is the regulatory one: current research aims at providing directives to support policy makers in regulating the shift in an effective way that encounters the need of the organizations that operate in this sector and those of citizens (Pardi, 2022).

These studies raise relevant issues and add useful knowledge to guide stakeholders, carmakers and their suppliers, towards the possible future opportunities and challenges. However, they miss to reflect on the impact that the current transition is having on the "identity" of the automotive industry and the organizations that operate in it. An industry identity refers to the collective understanding of which are the central enduring and distinctive principles, systems and practices of an industry (Dhalla & Oliver, 2013; Stigliani & Elsbach, 2018; Hoffman & Ocasio, 2001). Such sharing of beliefs and rules of the game provides some advantages. For example, it enables coordination. Hence, when the identity of an industry is changing, coordination may be upset as the common ground that the identity provides to agents is destabilized, and thus agents run out of those shared guidelines that align their actions.

In the case of a complex industry such as the automotive one, coordination at the industry level is considered particularly relevant to address the challenges that stand in front of the industry. This is due to both the complexity of the challenges to be addressed and the fact that most innovation and production activities in the industry are carried out through networks of organizations.[1] As identity matters in terms of coordination and shapes the strategic behaviour of organizations (addressing if and to what extent current changes in the automotive industry are bringing an

---

[1] In its website, Eucar (European Council for Automotive and R&D), for example, collects the projects that results from a joint effort to find solutions to contemporary challenges.

identity change looks relevant to understand the likely evolution of the industry, that is its composition and the sources of competitive advantage of its players. In the reminder of the chapter, we try to address two questions: is the current transition changing the automotive industry identity? If so, what are the likely consequences for its major players?

In what follows, we start from reviewing how management literature defines an industry identity and which are the likely effects on the industry's players of its change. Then, we discuss if and to what extent the automotive industry is transforming its identity and the likely implications. We conclude with some reflections about the future of the automotive industry.

5.2 The Identity of an Industry

The industry identity refers to the collective understanding of which are the central enduring and distinctive principles, systems and practices of an industry, that is the set of beliefs that are shared in the industry and what the industry does (Dhalla & Oliver, 2013; Stigliani & Elsbach, 2018; Hoffman & Ocasio, 2001). The industry identity mirrors the commonalities that characterize all the organizations that belong to that industry (Irwin et al., 2018; Stigliani & Elsbach, 2018), and it defines which are its boundaries (Hoffman & Ocasio, 2001).

The identity of an industry impacts on the dynamics of that industry and of the organizations that operate in that industry. The industry identity may cut out some opportunities of business. Tripsas (2009), for example, shows that in the digital photography industry "[b]ecause the industry and technological context were viewed through the lens of the digital photography identity, Linco employees' ability to see other technical opportunities was limited" (p. 451). The industry identity can affect how the organizations that belong to that industry face and react to institutional pressures and the performance of the organizations that operate in it (Dhalla & Oliver, 2013). The industry identity can be used as a tool to decrease the cost of transactions and coordination (Dhalla & Oliver, 2013). Additionally, the industry identity serves to interpret and put into practice those top-down actions that support the organization in sustaining its legitimate position in the network of the organizations that compose that industry (Irwin et al., 2018).

5.3 The Impact of Technological Trends on the Automotive Industry

Scholars and practitioners' accounts of the current technological transition show that there are reasons to believe that digitalization and electrification might generate unprecedented changes for the industry and its major players, that is OEMs (see also Chap. 1 of this book). In fact, the technological transition that the automotive industry is facing concerns the inclusion of technologies that require competences somehow different from those that have traditionally characterized the automotive industry. These technologies would also be at the basis of a major change of the industry business ecosystem.

From a merely technological point of view the turn towards the electrification of vehicles changes the architecture of the product and the related knowledge base. In particular, OEMs are developing new skills and competences, mainly related to software development in new product development and manufacturing (Burkacky et al., 2018; Burkacky et al., 2021).

This has generated a reduction in the workforce of mechanic engineers and an increase of experts specialized in electric engineering and software development. A recent report of the Boston Consulting Group (Kuhlmann et al., 2021) states that "the core automotive industry will certainly suffer significant job losses" (Kuhlmann et al., 2021, p. 1). The same study, however, predicts that "the shift to EV will have only a minor net impact on jobs, leaving the total number of jobs in the affected industries largely unchanged in 2030 compared with 2019" (Kuhlmann et al., 2021, p. 6). This would be mainly due to a "substitution" of old jobs with new ones related to electrification and digitalization. Similarly, a McKinsey & Company article by Conzade et al. (2021, p. 12) reports: "according to the Institute for Economic Research (Ifo) in Munich, more than 100,000 jobs will change in the German automotive industry by 2030. That is roughly five to ten times the scale of jobs compared with the phaseout of coal power that Germany announced for 2038".

As far as the development of a new mobility ecosystem, another tenet of pundits of electrification and digitalization is that these technologies are fostering a major shift towards *servitization* (Genzlinger et al., 2020). Carmakers are now focusing more on the customers' needs and their experience rather than on the mere technological performance of the vehicle. Similarly, the focus is shifting from how people drive to how people move. If before we stressed the fact that the knowledge base that characterizes the automotive industry is changing, these latter features suggest that also the broader role of the carmaker within the business ecosystem and the related competences required to successfully navigate the automotive industry are changing. As a matter of fact, the boundaries that separate and distinguish the automotive industry from the mobility service and transportation industry are blurring (see Chap. 1 in this book).

5.4 Is the Automotive Industry's Identity Changing?

The automotive industry is not new to the need of broadening and mastering the evolution of its knowledge base (see for an overview Perri et al., 2020). Since the early eighties from a predominantly mechanical-based industry, it started incorporating new technological domains, such as electronics, new materials, digital technologies, mechatronics, software, etc. (Lee & Berente, 2012; Maxton & Wormald, 2004). The industry has also led the development and adoption of new manufacturing and product development processes (Womack et al., 1990) and design and engineering tools, such as virtual development and simulation techniques (Becker et al., 2005).

Why this time there is ample consensus that the change will be disruptive? Leading, for example, McKinsey & Company to state that the increase of software presence in the car is causing a "reprogramming of the automotive industry" (Burkacky et al., 2021, p. 2)?

The identity literature helps in addressing these questions, giving value and examining some key points that risk otherwise to be underestimated or only partially taken in consideration. So far, the automotive industry has considered itself as characterized by a mechanical core. The main organizational actors operating within it identified with such a knowledge base and acted accordingly. Nowadays, the overwhelming advance of electrification and digitalization is shaking the centrality of mechanical engineering, with consequences in different characterizing dimensions of the automotive industry.

This turn has an impact in terms of those procedures and practices that have made the automotive industry a leading arena of managerial innovation (see for example Womack et al., 1990 and the following diffusion of lean manufacturing and lean product development practices). The switch from developing mechanical components to generating and integrating software systems and parts is disruptive mainly because of three reasons. At first, software components, *vis a vis* mechanical one, have a shorter shelf life and a higher pace of development, leading to shorter new product development cycles. Secondly, software development is less capital intensive. Finally, software development continues during the whole "shelf life" of the product. One of the main consequences is an upsetting of the usual pace of innovation and manufacturing activities that, as a matter of fact, is turning OEMs into software companies with some electro-mechanical competences.[2]

The technological turn is also jeopardizing the traditional centrality of the product—the car—in the logics and dynamics that have usually defined the automotive industry. This change has the potential to profoundly alter the industry architecture transforming the relationship between carmakers and their customers. As most software companies do, also carmakers will have to release updates of the software running on their cars, opening up new opportunities for channelling further services together with software updates.

---

[2] Electrification is also leading to a simplification of the product architecture. Product complexity has traditionally been a key determinant of the industry dominance of OEMs as system integrators (see MacDuffie (2013) and Zirpoli and Camuffo (2009)) (see Buzzavo, Favero and Zirpoli in this book). Product simplification might represent another driver of identity change in the industry.

Put in this light, the growing centrality of electric and electronic engineers and the entry of new professionals—such as software developers—, highlighted by the BCG and McKinsey & Co reports, appear to be more impactful than the previous waves of new engineers entering the carmakers and suppliers R&D labs.

These observations at the industry identity level lead to reflect on the critical situation of the OEMs. First, following Tripsas (2009), carmakers and their suppliers might experience problems with their ability to see opportunities, both technological and market related. Tesla is an example of how a new entrant can be better equipped in the face of the new software-related competences and needs to interact with customers in different ways. Secondly, organizations that belong to that industry might change their way of reacting to institutional pressures, so generating performance differential between organizations that operate in it (Dhalla & Oliver, 2013). With the development of the EV technology, for example, carmakers have reversed their attitude towards massive outsourcing of innovation and are re-internalizing development and manufacturing activities. This is inevitably changing the relationship in their vertical value chain and impacting their relationship with first tier suppliers. Finally, the new business ecosystem might profoundly alter the economic behaviour and the capabilities of the economic agents that operate in the industry, and the rules that govern the relationships among these economic actors (see Buzzavo in this book).

5.5 Conclusions

This book chapter aims at understanding if and to what extent the profound technological change that is impacting the automotive industry is also affecting its identity, and discusses the implications of the industry identity change.

The technological transition is disrupting those shared beliefs and understandings that have traditionally characterized the automotive industry and governed the inter and intra organizational dynamics of the actors operating within it. What is the new frontier of the automotive industry identity is still evolving even if the focus on certain technological opportunities is driving the sector in pursuing some directions while inevitably abandoning others.

It is a fact that the identity of this industry has hitherto been built on the development of excellent technical competences and the enhancement of the focal technological product—the car. Nowadays, these paradigms are generating a conundrum: to be loyal to such an identity nature, the automotive industry is facing a (r)evolution precisely of its identity.

What happens at the industry level affects the organizational dynamics, so that the transformation at macro level (e.g. the distinctive technology knowledge base) might lead to changes at micro levels (e.g. new product development practices), with the result of upsetting what is currently central, enduring and distinctive about organizations—their organizational identity (Albert & Whetten, 1985; Gioia et al., 2000; Whetten, 2006). As a consequence, we expect an impact on many dimensions of the organizations actually dominating the industry, from their strategy (Ravasi et al., 2020) to their coordination (Kogut & Zander, 1996), from their knowledge base (Nag et al., 2007) to their daily practices (Bojovic et al., 2020; Feldman & Rafaeli, 2002; Oliver & Vough, 2020). Such an impact will be successful only if organizations will manage to find a new equilibrium around new processes and routines.

Carmakers are thus confronting with the development of new business models that increase the complexity of the multilevel transformation that is hitting the automotive industry. From this point of view, actual players might find it difficult to establish new connections with new business partners or to adapt current relationships with established collaborators without the shared understanding about the identity of the industry to which they belong. Acknowledging that carmakers will have to navigate a new ecosystem implies that they are facing the twofold need of fine-tuning relationships with new and existent partners—that is the logic according to which they choose the right partners, how to negotiate with them, and how to reach smoothly the predefined objectives—while making sense of the new identity of the industry in which they operate. The common values, behavioural guidelines, and taken-for-granted practices that govern the industry dynamics are no longer a certainty to count on. Organizations have thus to explore, negotiate and formulate which are those elements that are needed to favour a promising collaboration.

Overall, our analysis brings us to conclude that as the current technological change is simultaneously (1) modifying the industry knowledge base, (2) opening new business opportunities through servitization and, as a consequence, (3) fostering the adoption of new organizational and business practices by carmakers and their suppliers is likely to produce a significant change in the industry identity. This, the literature predicts, might produce major adaptation challenges, somehow unprecedented, for the automotive industry incumbents and how they collaborate to face the new innovation challenges.

References

Albert, S., & Whetten, D. A. (1985). Organizational identity. *Research in Organizational Behavior, 7*, 263–295.

Becker, M. C., Salvatore, P., & Zirpoli, F. (2005). The impact of virtual simulation tools on problem-solving and new product development organization. *Research Policy, 34*(9), 1305–1321.

Bertoncello, M., Martens, C., Möller, T., & Schneiderbauer, T. (2021). *Unlocking the full life-cycle value from connected-car data*. McKinsey & Company.

Bojovic, N., Sabatier, V., & Coblence, E. (2020). Becoming through doing: How experimental spaces enable organizational identity work. *Strategic Organization, 18*(1), 20–49.

Burkacky, O., Deichmann, J., Doll, G., & Knochenhauer, C. (2018, February). *Rethinking car software and electronics architecture*. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/rethinking-car-software-and-electronics-architecture

Burkacky, O., Deichmann, J., Frank, S., Hepp, D., & Rocha, A. (2021). *When code is king: Mastering automotive software excellence*. McKinsey & Company. https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/when-code-isking-mastering-automotive-software-excellence

Conzade, J., Cornet, A., Hertzke, P., Hensley, R., Heuss, R., Möller, T., Schaufuss, P., Schenk, S., Tschiesner, A., & von Laufenberg, K. (2021). *Why the automotive future is electric*. McKinsey & Company.

Dhalla, R., & Oliver, C. (2013). Industry identity in an oligopolistic market and firms' responses to institutional pressures. *Organization Studies, 34*(12), 1803–1834.

Feldman, M. S., & Rafaeli, A. (2002). Organizational routines as sources of connections and understandings. *Journal of Management Studies, 39*(3), 309–331.

Genzlinger, F., Zejnilovic, L., & Bustinza, O. F. (2020). Servitization in the automotive industry: How car manufacturers become mobility service providers. *Strategic Change, 29*(2), 215–226.

Gioia, D. A., Schultz, M., & Corley, K. G. (2000). Organizational identity, image, and adaptive instability. *The Academy of Management Review, 25*(1), 63–81.

Hoffman, A. J., & Ocasio, W. (2001). Not all events are attended equally: Toward a middle-range theory of industry attention to external events. *Organization Science, 12*(4), 414–434.

Irwin, J., Lahneman, B., & Parmigiani, A. (2018). Nested identities as cognitive drivers of strategy. *Strategic Management Journal, 39*(2), 269–294. Scopus.

Jacobides, M. G., Knudsen, T., & Augier, M. (2006). Benefiting from innovation: Value creation, value appropriation and the role of industry architectures. *Research Policy, 35*(8), 1200–1221.

Jacobides, M. G., MacDuffie, J. P., & Tae, C. J. (2016). Agency, structure, and the dominance of OEMs: Change and stability in the automotive sector. *Strategic Management Journal, 37*(9), 1942–1967.

Kogut, B., & Zander, U. (1996). What firms do? Coordination, identity, and learning. *Organization Science, 7*(5), 502–518.

Kuhlmann, K., Küpper, D., Schmidt, M., Wree, K., Strack, R., & Kolo, P. (2021). Is E-mobility a green boost for European automotive jobs? *Boston Consulting Group*. https://www.bcg.com/it-it/is-e-mobility-a-green-boost-for-european-automotive-jobs

Lee, J., & Berente, N. (2012). Digital innovation and the division of innovative labor: Digital controls in the automotive industry. *Organization Science, 23*(5), 1428–1447.

MacDuffie, J. P. (2013). Modularity-as-property, modularization-as-process, and 'modularity'-as-frame: Lessons from product architecture initiatives in the global automotive industry. *Global Strategy Journal, 3*(1), 8–40.

Maxton, G. P., & Wormald, J. (2004). *Time for a model change: Re-engineering the global automotive industry*. Cambridge University Press.

Nag, R., Corley, K. G., & Gioia, D. A. (2007). The intersection of organizational identity, knowledge, and practice: Attempting strategic change via knowledge grafting. *The Academy of Management Journal, 50*(4), 821–847.

Oliver, D., & Vough, H. C. (2020). Practicing identity in emergent firms: How practices shape founders' organizational identity claims. *Strategic Organization, 18*(1), 75–105.

Pardi, T. (2022). *Heavier, faster and less affordable cars. The consequence of EU regulations for car emissions*. Report 2022.07. European Trade Union Institute.

Perri, A., Silvestri, D., & Zirpoli, F. (2020). *Change and stability in the automotive industry: A patent analysis* (SSRN Scholarly Paper No. 3703548).

Ravasi, D., Tripsas, M., & Langley, A. (2020). Exploring the strategy-identity nexus. *Strategic Organization, 18*(1), 5–19.

Schulze, A., Paul MacDuffie, J., & Täube, F. A. (2015). Introduction: Knowledge generation and innovation diffusion in the global automotive industry—Change and stability during turbulent times. *Industrial and Corporate Change, 24*(3), 603–611.

Stigliani, I., & Elsbach, K. D. (2018). Identity co-formation in an emerging industry: Forging organizational distinctiveness and industry coherence through sensemaking and sensegiving. *Journal of Management Studies, 55*(8), 1323–1355.

Tripsas, M. (2009). Technology, identity, and inertia through the lens of "the digital photography company". *Organization Science, 20*(2), 441–460.

Whetten, D. A. (2006). Albert and Whetten revisited: Strengthening the concept of organizational identity. *Journal of Management Inquiry, 15*, 219–234.

Womack, J. P., Jones, D. T., & Roos, D. (1990). The machine that changed the world. .

Zirpoli, F., & Camuffo, A. (2009). Product architecture, inter-firm vertical coordination and knowledge partitioning in the auto industry. *European Management Review, 6*(4), 250–264.

Dialogue between authors

Dialogue Between Authors

In the first part of the volume each author has offered a view of the evolution of the auto industry from a different perspective. The feeling from reading it could be that of authors with different ideas and attention to different aspects, but this is not the case. The overall view of the automotive sector, its problems, and the importance of its role, are widely shared among the authors. But unlike painting, in which a single author can apply a Picasso-like deconstruction to account for the whole subject, in the case of writing, themes must be separated because, unlike the image, the written word is a sequential transmission of information and therefore takes on meaning based on what precedes and what follows.

There are balances that are the result of architectures that are stable, durable and resilient to any backlash or external pressure. This is not the case in the auto industry. Its equilibrium, assuming it exists, is always unstable, the result of backlash and the harbinger of economic, environmental and social damage that is always less talked about than it should be. To account for this in a single chapter would risk creating an even more distressing painting than Guernica, and that is not the authors' intention. Instead, the common goal was to provide the reader with tools for his or her own evaluation, respecting everyone's sensibilities. Thus, information and a historical perspective are, more or less accentuated in the various chapters depending on the temperament of the authors, with at most the hooking, here and there, to anecdotes that should give pause for thought.

The evolution outlined in Chap. 2 appears to be a phenomenon with natural dynamics, almost shaped by Darwinian forces. In the chapters that follow, the hand of man is more evident, but not so much (or not only) the one with an Enlightenment spirit that shines through in the chapter by Buzzavo et al. Rather, it is a hand that is aware of the serious and growing problems that counterbalance the benefits of the car, and seeks environmentally and economically reasonable alternatives. In both Chaps. 2 and 3 we read about the better intentions of innovators, so that we have to get to Chap. 4 to grasp the essence of more than half a century-long tug-of-war between the interests of the environment and those of car manufacturers. Stocchetti's chapter shows that the processes of the first two chapters are not simple evolutionary dynamics taken for granted, but the result of unstable balances between political and economic forces, with customers acting as the needle of the scales in both directions, demanding clean air and bigger and more powerful cars at the same time.

These three different perspectives focus on material features and prelude to the analysis of the identity aspects of the car industry, the topic which is addressed in the fourth chapter. Here Balzarin and Zirpoli discuss a fourth evolutionary movement, mimetic and profound to the point of being almost unnoticed, but crucial to framing many aspects that emerge from the first three chapters. The automotive industry, which was clearly identified by its end product and industry players, now is dissolving into a larger entity, the mobility ecosystem, where the car is no more the unique mean ensuring free and flexible mobility.

This chapter, which closes the first part of the volume, completes that deconstruction that joins concepts that were separated in the perspectives of the previous chapters. The car is a technological, social and emotional construction for which every change raises both anxieties and hopes.

Between the lines of the first part of the book emerges the will to see the car evolving and not become extinct. Of course, hope arises that it be environmentally friendly, but this is not enough. Its fate is always in the balance between the enlightened reason of a technology that aims for ever safer and more environmentally friendly cars, and the unmentionable and perverse side that brings together carmakers and drivers, beguiled by features that enhance road bullying. Making the former prevail is not easy. There are contexts, such as the urban context, in which the car is more harmful than useful. Above all, this doesn't contribute to make mobility a right that does not override others, which, unfortunately, the immoderate use of cars systematically does, since it takes away economic resources, health and space at the expense of quality of life. The transformation in a socio-centric sense that emerges in the evolutionary traits outlined in Part I either preludes a segregation of the car or its technical and identity renewal, or both. The best way to think about the car is to go back to the basics, thinking of it in terms of well-being and sustainability, both goals with which, over time, the car has come into conflict. However, automotive is among the most innovative industries, it just needs to continue this way.

Part II

6

Mobility and Individual Choices in Turbulent Times—An Overview

Pietro Lanzini

6.1 An Evolving Scenario and the Relevance of a Consumer-Based Perspective

The mobility sector is experiencing turbulent times, with a *perfect storm* of disruptive changes affecting at an unprecedented pace the automotive industry and the heterogeneous set of connected players. Technological innovations such as Advanced Driver-Assistance Systems (ADAS) and especially powertrain electrification are bound to heavily affect carmakers' strategies, with policies in different geographical contexts that are supporting the phasing out of traditional, Internal Combustion Engine (ICE) vehicles. The EU is for instance supporting the so-called Fit for 55 package, envisaging the ban on the sale of gasoline and diesel vehicles in 2035 (see Chap. 9 for an overview on EU industrial policy for the

---

P. Lanzini (✉)
Department of Management-Venice School of Management,
Ca' Foscari University of Venice, Venice, Italy
e-mail: pietro.lanzini@unive.it

A. Cabigiosu, P. Lanzini (eds.), *The Green Transition of the Automotive Industry*,
https://doi.org/10.1007/978-3-031-37200-1_6

automotive sector). Its effective implementation is however questioned by a strong opposition, based on concerns ranging from job loss and industrial desertification to geopolitical consequences, or even to demand doubts about driving range, charging infrastructures or skyrocketing electricity prices, as in the 2022–23 energy crisis. The envisaged re-organization of entire supply chains is also affecting value creation and distribution, with electrification having an impact both upstream with reference to powertrains and downstream as regards energy distribution (see Chap. 1 for a detailed overview on the topic).

Further, sociological dynamics are changing the attitudes of citizens towards different travel mode alternatives. On the one hand, an unprecedented environmental awareness in growing shares of commuters and travellers, so that sustainability-related variables enter in the equation when it comes to decide which type of vehicle or transport mode to purchase and/or use; on the other hand, the shift from the concept of *possession* (of private cars) to that of *use*, with the subsequent development of sharing services.

Last but not least, exogenous shocks such as the SARS-CoV-2 pandemic, which upset deeply rooted patterns and modified the perceptions about mobility alternatives. For instance, while public transportation has long been considered as a *sustainable* alternative, the need to maintain social distancing highlighted the social dimension of sustainability, so that environmental and social drivers operate in different directions. While lots has been done to curb the drawbacks of sharing common spaces (e.g., some trains introduced an innovative ventilation system as to minimize the risk of virus transmission), at the time of writing many individuals (especially in the fragile categories) still perceive public transportation as a risky alternative thus opting for private mobility, with all the problems connected to pollution and congestion it entails.

Stemming from the acknowledgement of such complexity, the chapter focuses on the need to investigate in detail the *demand* side, which has long been overshadowed by an approach privileging an analysis of infrastructural policies on the one hand and industry structure and strategies on the other. Further, not only is it vital to have a clear picture of *what* commuters and travellers do, but even more so *why* they choose a specific option. In other words, an inferential approach is needed as a pre-requisite for the implementation of sound public policies and effective corporate strategies: only a deep understanding of the motives behind modal as well as purchasing choices provides businesses and policy makers with a solid background enabling them to understand on which levers to act in order to achieve envisaged goals.

Behavioural research in the field of mobility is vast, encompassing different and heterogeneous literatures, though most of the relevant theories have their roots in social psychology. Traditionally, most empirical investigations focused on the dichotomy between private vehicles and alternative means of transportation, with the former being considered the unsustainable option (although in recent years the automotive industry experienced extraordinary technological advancements, so that new models of ICE vehicles are much less polluting than older models). Current research is challenged by multiple layers of complexity, as even in the domain of cars there are competing technologies (ICE vs electric) and new ways of conceiving the product (from ownership to use, as in the world of sharing mobility).

Section 6.2 focuses on the first aspect, pertaining to modal choice (what are the factors that trigger our decision to choose either using cars or alternative transport modes?), while the empirical appendix of Sect. 6.3 delves into the second aspect, which has been long overlooked yet is bound to become extremely relevant in years to come (what is the point of view of demand on electrification? Which are the main concerns of drivers as regards purchase and use of innovative technologies such as electric vehicles?). This will guide the reader through a stepwise journey where cars, like in a funnel approach, become the specific object of analysis from a consumer perspective. First, an analysis of whether we opt for cars or for available alternatives; then, a focus on cars with an analysis of the key elements that we ponder in choosing a specific technology.

6.2 Across Rationality, Habits and Values: An Overview of the Main Determinants of Travel Mode Choice

While a complete overview of different frameworks on modal choice clearly exceeds the scope of the present section, it is useful to provide a broad overview of the main models that are adopted as to gain further insights on the drivers of behavioural choices.

It is possible to identify two main branches which focus on rationality and habits, respectively.

According to the so-called rationalistic perspective, commuters and travellers choose to use specific means of transportation after a rational, cognitive evaluation of different alternatives, elaborating available information and then developing specific intentions which, as long as no hindering factors emerge, develop into actual behaviours (so-called attitude-behaviour research). The key theoretical foundations are represented by the Theory of Reasoned Action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) and the Theory of Planned Behaviour (Ajzen, 1991), with later developments that added further elements to increase its predictive capability (Conner & Armitage, 1998). According to this perspective, people consider the pros and cons (e.g., price, comfort, travel time and so on) of different alternatives in terms of routes, travel mode or vehicles (looking for further information if they feel they need to get a clearer picture of available options) and based on this rational process they develop the intention to choose a specific option (e.g., driving a private vehicle, sharing a car, taking the bus, etc.).

Indeed, these theories have their roots in acknowledging the attitude-behaviour gap, which has a long track of evidence in literature and suggests that intentions are the closest predictor of actual behaviours. In other words, we do something because we develop the intention to do so: we take our private car to go on a trip because, after examining the alternatives at hand, we develop the intention to do so. Of course, although intentions and behaviours are closely interrelated constructs, they should not be considered as synonyms, as there might be hindering factors (both contextual and subjective) preventing the adoption of the behaviour, regardless of the previously developed intentions: for instance, I might intend to go to work by bike, but suddenly weather forecasts change and, consequently, I have to change plans and drive my car.

A further step is represented by the analysis of what, in turn, predicts intentions. According to the Theory of Reasoned Action, social pressure and attitudes frame our behavioural intentions. Attitudes reflect the generic (positive or negative) predisposition that we have towards a specific activity (e.g., I enjoy riding the bus to my office). They reflect beliefs towards an outcome and the evaluation of whether such outcome is desirable or not: in other words, attitudes are the combination of beliefs and evaluations. Based on the information at hand, *how do I believe would it be to take a bus to get from home to my workplace* (belief)? *Is this something that I consider as positive and enjoyable, or not* (evaluation)? Subjective norms, on the other hand, reflect social pressure and how an individual perceives that his/her relevant ones would approve or disapprove a specific activity. For instance, *would my friends appreciate if they knew I go on holiday only using sustainable transport modes*?

The theory clearly represents an oversimplification of the complexity of factors leading to a specific behaviour, like travel mode choice. The most important limitation of the model is represented by the fact that it assumes all behaviours being under volitional control: if *I want* to do something, *I am able* to actually do it. However, let's consider the example of a young couple willing to visit friends living 600 miles away. They are willing to travel as quickly as possible from their hometown to their final destination, so that airplane would be the better option they would go for. The original formulation of the Theory of Reasoned Action would suggest that this is what the couple would actually do. However, many times there are subjective or contextual hindering factors so that it is not possible to act according to our own positive attitudes and subjective norms. For instance, the flights are fully booked, or the prices, given the high season, are extremely expensive so that the couple actually *cannot* opt for the airplane alternative. In other words, although holding positive attitudes towards taking a flying (positive attitudes) and having family and friends approve it as the best choice (positive social pressure and subjective norms), they would have to reach the destination by means of other travel modes such as for instance train or private car.

To overcome such limitation of the theory and fine-tune the predictive capability of the model, the Theory of Planned Behaviour (TPB) extends Theory of Reasoned Action adding perceived behavioural control as a further predictor of behavioural intentions. Perceived behavioural control (PBC) represents how easy or difficult we perceive a specific task is: how easy would it be to go visit friends by plane, for the young couple? It is important to stress the *perception* element: an activity could be inherently easy to be performed, yet if it is not perceived as such by the agents, most likely this will represent a formidable hindering factor.

The model has arguably become one of the most popular frameworks for investigating a large set of behaviours including those related to mobility, and its predictive capability proved to be very good, over a high number of empirical investigations that adopted it (either in the original formulation or in extended versions) for the analyses. Indeed, there are attempts at integrating further variables in the planned behaviour framework, as to provide a more accurate description of the elements underpinning individual choices: "albeit planned-behaviour frameworks do not represent a novelty in consumer behaviour studies, they act as a living organism, as current research is still working on the original formulation, adding variables capable of fine-tuning the model and increasing its predictive capability. Some of such variables are particularly relevant in sustainability-sensible domains. For instance, activities such as commuting or recycling are carried out repetitively in stable settings: I go to work every day at the same time, on the same route, and so on. The repetition of an activity makes it habitudinal, so that an automatic response at the subconscious level is triggered (Ouellette & Wood, 1998). […] [habits] have been incorporated by many studies within the Theory of Planned Behaviour framework, and integrated as an extension of the original formulation" (Lanzini, 2018a, page 23).

While Reasoned Action and Planned Behaviour have their roots in personal utility maximization that could be labelled as *egoistic*, there are on the other hand rationalistic models that build on *altruistic* drivers of individuals. The Norm-Activation-Model (Schwartz, 1977; Schwartz & Howard, 1981) posits that personal norms represent the key factor orienting our behaviour. Personal Norms can be described as "feelings of moral obligation to perform or refrain from specific actions" (Schwartz &

Howard, 1981, page 191), insofar as people tend to act socially and environmentally friendly, once they are aware of which are the consequences of their behaviours on the social/natural environment. The theory derives its name from the assumption that there are specific factors capable of *activating* personal norms: these factors are *problem awareness* and *ascription of responsibility*. Problem awareness refers to the extent to which people are aware of the consequences of not acting sustainably (e.g., awareness on the fact that commuting to work by private car instead of by bus implies much higher polluting emissions and footprint); ascription of responsibility on the other hand reflects personal feelings of responsibility for the same consequences (e.g., *is it up to me to reduce those emissions, or is it the responsibility of other actors to provide better alternatives*?).

As far as the relationship between awareness of consequences and ascription of responsibility is concerned, while some experts suggest that the former is an antecedent of the latter (and they both predict personal norms and behaviours), others propose an interpretation according to which both constructs operate at the same level, as personal norms predictors (De Groot & Steg, 2009). Like Theory of Planned Behaviour, also Norm Activation Model is supported by a vast body of empirical evidence, with many studies confirming its validity.

The models that have been briefly illustrated have in common their roots in a so-called rationalistic perspective, which means that the activities we perform and the choices we make are basically the result of an elaborated cognitive process. However, human beings are individuals of habits: many times we do something not because of a rational evaluation of pros and cons of alternatives at hand, but simply because *we are used to*, we have done it for a long time. There is growing evidence supporting the hypothesis that Habits represent a crucial predictor of behavioural patterns, especially in specific contexts such as that of mobility: habits are indeed a formidable behavioural determinant, capable of hindering an aware evaluation of alternatives, so that the cognition-led intention to opt for a specific mode is substituted by an automatic choice. Habits represent, along with intentions and partially in alternative to them, the closest predictor of behaviours, whose relevance in determining behavioural patterns could not be overemphasized.

Although the term habit is often used in everyday life, it is no easy task to provide a correct definition and its operationalization. In literature different definitions can be found. According to Aarts and Dijksterhuis (2000), habits represent "A form of a goal-directed automatic behaviour. Habits are represented as links between a goal and actions that are instrumental in attaining this goal. The strength of such link is dependent on frequent co-activation of the goal and the relevant action in the past. The more often the activation of a goal leads to the performance of the same action under the same circumstances, the stronger the habit". For Verplanken and Aarts (1999) they are "Learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states" and Verplanken himself later elaborates the concept synthesizing habits as "Repeated behaviours that have become automatic responses in recurrent and stable contexts" (2011).

There are indeed three elements that characterize a genuine habit: (i) frequency of past behaviours, (ii) stability of the context and (iii) automaticity. The mere (although frequent) repetition of a specific activity is not considered as a sufficient condition for a habit to emerge. On the contrary, it represents a necessary yet not sufficient condition, which needs to be coupled with the other two elements. Automaticity can be problematic if policy makers (or other actors such as companies) are willing to change individual behaviours. Indeed, whenever automaticity becomes salient and a habit emerges, the aware cognitive decisional process gets deactivated. As a consequence, individuals do not seek or even process the information that they receive or that they are exposed to, like in presence of an invisible communicational barrier where messages and inducements bounce back, prior to reaching the target.

Mobility is one of the behavioural domains where stronger is the possibility of developing habits, especially in daily commutes. Indeed, typically commuters travel on the same route (e.g., from home to the office, and back), more or less at the same time (i.e., with stable traffic conditions) so that a specific modal choice becomes the automatic alternative. Commuters that have driven a private car for years to go to work might not consider the possible advantages of a new alternative, such for instance a new subway line that would make the trip quicker and more convenient. Rationally, they are aware of the existence of the alternative, but out of habits they keep behaving as they have been doing for a long time.

Given the relevance they assume in shaping behaviours, it is crucial to find an adequate measurement of habits. The Self-Reported Habit Index (Verplanken & Orbell, 2003) represents a well-established tool (extensively adopted in modal choice research), based on a validated scale where (in its original formulation) respondents express their agreement (Likert scale) on a battery on 12 statements focusing on repetition, automaticity and identity.

Another tool that is often used in behavioural analyses is represented by the Oreg Resistance to Change scale (Oreg, 2003), where once again respondents are asked to express their agreement on a battery of statement, delving into aspects such as routine seeking, emotional reaction, short-term thinking and cognitive rigidity.

The crucial difference between the two scales is that while the Self-Reported Habit Index is about a specific behaviour or activity, the Oreg Resistance to Change scale does not refer to any specific behaviour: on the contrary, it is about subjective traits of personality that make an individual either prone to developing stable behaviours (and thus habits) or seeking change and different activities.

Most daily behaviours (including mobility) are, indeed, the outcome of a process where both elaborated cognitive processes and habits play a role, which prominence may vary according to the specific individual or the context. Consistently, many models are bridging the different perspectives (rationality vs automaticity) as to encompass different behavioural drivers: in other words, attempts of merging in a single behavioural model both a rationalistic perspective and the acknowledgement of the role exerted by habits (Ajzen himself admits that habits can be integrated in the Planned Behaviour framework, though with a marginal role).

The Attitude-Behaviour-Context (ABC) model (Guagnano et al., 1995; Stern, 2000) is based on the dichotomy between attitudinal and contextual factors, and assumes that stronger impacts of contextual factors will lead to a weaker attitude-behaviour link. The four variables encompassed by ABC are attitudinal factors (e.g., values, norms etc.), contextual forces (e.g., incentives, external influences etc.), personal capabilities, and habits. According to the specificity of the case object of analysis, the relative relevance of each variable in guiding responsible behaviours can vary: for instance, travel mode choice is influenced more by policies and habits, while green purchasing is mainly influenced by factors such as knowledge or skills.

Also the Comprehensive Action Determination Model (CADM, Klöckner & Blöbaum, 2010) advocates the integration of different approaches, since sustainable behaviour can be influenced by intentional, habitual, and situational sources; according to CADM, moreover, intentional and habitual determinants can in turn be influenced by normative processes such as social or norms.

The question that arises hence is how to disrupt habits that are deeply rooted and not consistent with the envisaged goal. The problematic aspect is that people with deeply rooted habits erect a sort of subconscious invisible barrier, so that information about alternatives bounces back, without reaching them. If a commuter is used to do a specific trip for a long time and a habit emerges, she will not be processing information about alternative options that might be even more comfortable, cheaper and, in one word, better. There are however theories that suggest when to act in order to disrupt old habits. According to the Habit Discontinuity Hypothesis (Verplanken et al., 2008), commercial inducements and policy interventions should be deployed when so-called windows of opportunity open up. These windows can be represented by big disruptions in the business-as-usual scenario. In other words, interventions to change behaviours can be more effective as long as they are deployed in the context of life course changes or disruptions in the relevant context (e.g., closure of bridges and streets for roadworks). It is indeed in such windows that individuals are more willing to search for further information about alternative courses of action, and are more open to change: when these discontinuities take place, individuals are somehow spurred to reconsider the way they do things, and willing to look for information about the alternative opportunities. It is hence when these windows of opportunity open that agents interested in framing new behavioural patterns should deploy interventions.

The aforementioned theories have been adopted by the majority of studies on the determinants of modal choice (sometimes in their original formulation, sometimes with later developments or in combination of one with another). Empirical investigations however reached heterogeneous and at times inconsistent results, so that it is no easy to *draw a line* on why commuters and travellers adopt specific behavioural patterns.

In the case of modal choice research, for instance, we might have some empirical studies suggesting that environmental values are very important predictors of behaviour, other evidence suggesting they have little impact, and even analyses according to which environmental values are irrelevant. How can we identify the most robust conclusions? Meta-analyses represent a secondary statistical research tool, that synthesizes evidence coming from a number of primary studies. Such methodology has been adopted by Lanzini and Khan (2017) to shed light on the psychological and behavioural determinants of modal choice, whose results are synthesized in Tables 6.1 and 6.2.

The findings include important suggestions for policy makers and businesses in the automotive and mobility sector:

- The high heterogeneity between studies can be explained, according to the moderator analysis, mostly by methodological aspects (e.g., typical vs actual behaviours) rather than by aspects such as location, trip purpose or specific population.
- Intentions and behaviours are not the same. Although intentions represent the closest predictor of behaviours, there is a relevant gap between the two (consistently with TPB), so that more analytical

Table 6.1 Car use intention

Variables	K	Sample	$\hat{r}$	Z-value	95% CI		I^2
ATT (car)	7	2906	0.563	5.916***	0.402	0.690	96.832
INJ. N. (car)	7	2906	0.424	7.749***	0.326	0.513	89.066
DES. N. (car)	6	2706	0.272	1.968**	0.001	0.506	98.048
PER. N. (car)	3	1665	0.394	16.953***	0.353	0.434	0.000
PBC (car)	7	2906	0.322	3.088***	0.121	0.498	96.867
ENV. CONC.	3	1103	−0.259	−8.434***	−0.315	−0.201	0.000
HABIT (car)	7	4068	0.472	7.195***	0.357	0.573	94.612
Past car use	4	1584	0.739	3.471***	0.391	0.902	98.762

Source: Adapted from Lanzini and Khan (2017)

Table 6.2 Sustainable transportation intention

Variables	K	Sample	$\hat{r}$	Z-value	95% CI		I^2
ATT (green)	23	17,824	0.467	11.086***	0.394	0.534	97.064
INJ. N. (green)	20	16,770	0.410	12.819***	0.353	0.464	94.061
DES. N. (green)	7	3272	0.347	5.280***	0.224	0.459	93.095
PER. N. (green)	13	8968	0.508	9.925***	0.421	0.585	95.996
PBC (green)	23	15,355	0.526	9.579***	0.434	0.607	98.083
AWAR. CONS.	4	1684	0.236	3.213***	0.094	0.369	89.019
PROB. AWAR.	14	13,213	0.315	10.307***	0.258	0.370	91.603
ASC. RESP.	7	2614	0.344	7.014***	0.253	0.429	84.746
ENV. CONC.	14	5518	0.225	7.756***	0.170	0.280	72.609
HABIT (green)	4	1438	0.554	3.454***	0.264	0.752	97.144
Past non-car use	6	3077	0.731	8.891***	0.620	0.813	95.686
ENV. VAL.	9	7547	0.153	4.407***	0.086	0.220	88.016

Source: Adapted from Lanzini and Khan (2017)

emphasis should be put on the subjective and contextual factors that widen the intention-behaviour gap.

- The role played by habits is more prominent than expected, as it outperforms constructs such as attitudes and behavioural control, which have been long considered as the key feature to monitor. Businesses and policy makers should exploit windows of opportunities to reach the target of awareness or communicational campaigns, and focus efforts and investments in such specific time-frames.
- Environmental values affect intentions, but are surprisingly weak in predicting actual behaviours: in other words, intentions and behaviours have different sets of predictors. This implies, for instance, that focusing communication on environmentalism is not effective in shaping behaviours, while it would be better to focus on disrupting habits or increasing perceived control, and introducing sustainability as a (relevant) added value rather than the key-point of the campaign.

As anticipated in the introduction, the automotive sector and mobility in general are facing a *perfect storm*, with unprecedented shocks after decades of slow and incremental changes that only marginally modified the predominant paradigm, based on ICE powertrains. Such shocks are not limited to technological revolutions: at the time of writing, for instance, the world is slowly coming out of the SARS-CoV-2 pandemic, which heavily affected transport and mobility as an obvious consequence on lockdowns or restrictive measures aimed at limiting (that is) the mobility of people and hence the chances of virus transmission. The pandemic clearly represented a striking example of a disruption that forced people to reconsider the way they travel or commute, and to process information about alternative choices (a *window of opportunity*, in the words of Verplanken). The implications are relevant for operators and policy makers, insofar in the aftermath of the pandemic there is a limited amount of time where travellers have the cognitive window open and might be more receptive to inducements and messages aimed at changing their travelling behaviours in terms of routes and modal choice. Even once restrictions are lifted, the experience of the pandemic might have changed well-established habits and attitudes towards different means of transportation so that the persistence of the effects has the potential to shape behavioural patterns also in years to come. A broad literature analysed the effects of the pandemic on behavioural change, mostly suggesting that fear of contagion lead to a decrease in the use of public transport and a shift to private vehicles, with the magnitude of the changes that has been depending both on health-related and socio-economic factors: fragile individuals have been keener on abandoning public transport, while poor people had less opportunities to change personal behaviours (Parker et al., 2021).

6.3 Are We Ready Today for the Mobility of Tomorrow? An Empirical Investigation on Commuters' Attitudes Towards Electrification

In years to come, however, arguably the most important disruption that the automotive industry is bound to face is *electrification*. A first caveat to the reader is represented by a specification regarding the term electrification itself. While sometimes in common parlance people refer to generic electric vehicles, these indeed represent a broad and heterogeneous category ranging from HEVs (Hybrid Electric Vehicles, powered by a combination of ICE with electric motors) to PHEVs (Plug-In Hybrid Electric Vehicles, powered by batteries yet relying also on a small ICE to recharge batteries) or even BEVs (Battery Electric Vehicles, or "full electric"): in the remaining of the section, the term "electric vehicles" will refer to full electric unless otherwise specified.

Focusing on the EU market it can be observed that on the one hand there has been at institutional level a strong commitment to implement the legislative framework for the phasing out of ICE powertrains, with the enticing vision of curbing pollution on the path to decarbonization. It is worth stressing how the overall *sustainability* of a given vehicle (or transport mode) is extremely complex. In the case of electric vehicles, for instance, although there are no tailpipe emissions it is important also to understand whether electricity is produced from renewable sources or not; further, emissions represent only one aspect on which the assessment should be made (see Chap. 3 for an overview of how further variables other than powertrain emissions should be considered as to improve the overall sustainability of vehicles). On the other hand, however, concerns were raised about the possible consequences of such a strong change of direction. It is the case for instance of fears that EU countries will be overly dependent on foreign players as regards raw materials and key components such as rare earths and batteries, or even that the shift might lead to job losses if part of the workforce will not be absorbed by the new production processes (the production of electric vehicles requires less manpower at the assembly line).

Once again, a crucial aspect which is sometimes overlooked in public discourses is the point of view of demand, with people that are disoriented by the changes lingering on the horizon and that fear electrification might entail not only higher purchasing costs (as of today e-vehicles are considerably more expensive that ICE counterparts), but also other drawbacks. This clearly represents a setback for the diffusion on electric vehicles, mirrored by the majority of purchasers that still opt for ICE vehicles. For instance, the issue of driving autonomy: *how many kilometres can I drive before having to stop and charge batteries*? According to the US Environmental Protection Agency, EVs have an average autonomy of 377 km against 648 km of gasoline vehicles (EPA, 2021). A second aspect pertains to the availability of infrastructures: *how easy is it going to be to* *charge my batteries while I am far from home? How long is it going to take every time?* In Italy, for instance, there are over 32,000[1] charging points but the time needed for battery charge ranges from 30 minutes (43-50 kW charging points) to hours: while this could be acceptable for drivers charging their vehicles at home, it can be problematic for travellers that need to stop at charging stations during long trips. A third hindering factor is represented by uncertainties on future electricity costs: in 2022 the energy crisis (triggered by international instability, higher demand by emerging economies and speculation) had an obvious impact on charging costs, so that the economic convenience (in terms of cost per km) of electric vehicles over traditional ones is shrinking (especially if batteries get charged at public stations rather than at home).

Practitioners might answer to such concerns stressing how the time-span to 2035 should be enough to cope with the electrification shift, with innovative technologies capable of improving battery efficiency and capillary of charging infrastructures as to support a steady increase in the circulating fleet of electric vehicles. Yet, “consumers” still have many uncertainties about this future change: the empirical appendix of the chapter illustrates the results of a survey investigating the point of view of commuters and travellers.

The survey is based on a sample of 568 respondents from northern Italy, with data collected via an online questionnaire in the fall of 2022, a period when the Fit For 55 package was making the headlines. The target of the survey is represented by younger generations: the mean age of the sample is 29.5 y.o. and 53% is represented by males. A preliminary question investigated the type of vehicles owned by respondents: answers confirmed that electrification still represents a niche of the market, with 1.7% of respondents owning a full electric and 4.8% owning a hybrid vehicle.

First, the survey investigated the key constructs of TPB: that is, the intention to purchase electric vehicles and the role played by attitudes (*do I like electric vehicles?*), subjective norms (*what is the opinion of my relevant ones on the topic?*) and perceived behavioural control (*would it be easy for me to switch to electric?*). Intentions have been analysed with reference to

---

[1] Data retrieved from motus-e.org, as of September 2022.

both hybrid and full electric vehicles. Not surprisingly, consumers are more willing to purchase hybrid vehicles (3.14 on a 1 to 5 scale) compared to full electric (2.79). As regards the latter option, respondents seemingly have positive attitudes (3.55) and perceive adequate social pressure (3.58), while perceived behavioural control is lower (3.29), as many fear they might not be able to purchase and use such innovative product. A first obvious concern is represented by the cost of purchase. As a consequence, one question focused on the Willingness to Pay (WTP) of consumers: that is, given a specific category of cars how much they believe they would be willing to pay more, if it was (full) electric. Almost one fifth of respondents (18%) is not willing to pay any premium price in order to purchase an electric vehicle, where a further 38% of respondents is willing to pay only a small premium price (no more than 10%), 30% of the sample would be willing to pay up to 20% more, while only the remaining 15% is apparently ready to sustain even a bigger premium price. This is consistent with the current scenario where full electric vehicles still represent a niche for wealthy segments of the market: however, prices of new models seem to be more affordable, and this trend is likely to continue in years to come. However, price (which is also heavily affected by available public subsides) is not the only problem that lingers on the future of electric vehicle market. The survey investigated how issues like driving range, availability of charging infrastructures, charging time, aversion of new technologies and high charging costs affect the intention of respondents to consider electric vehicles for their next purchase.

Figure 6.1 illustrates the results of the survey as regards the relevance of specific concerns, with respondents asked to express on a scale of 1 to 5 how each issue is important in limiting the willingness to consider electric vehicles for the next car purchase:

The only aspect which is not considered as a relevant setback is represented by the need to adopt a new technology (1.58): indeed, while it might be speculated that some commuters/travellers might be resistant to change and, having deeply rooted habits, could be unwilling to change product technology (*will I be able to drive easily such an innovative type of vehicle? Is it going to be easy to learn how to charge batteries?*), the results of the survey seemingly do not confirm this. A possible explanation could

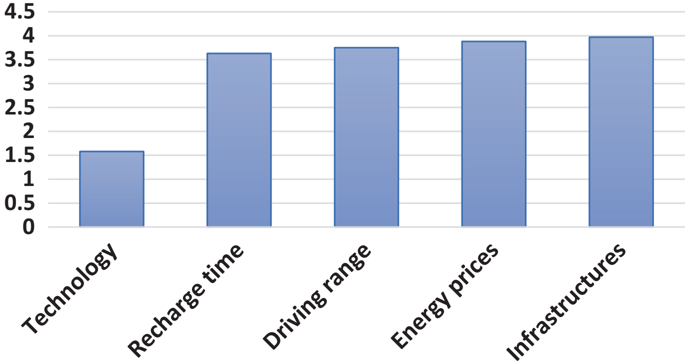


Fig. 6.1 Electric vehicles purchase concerns. Average scores on a 1 (not relevant at all) to 5 (extremely relevant) scale

be represented by the young age of the sample: younger individuals on average are more willing to experiment new products and technologies, while for older generations of drivers concerns of having to change product technology might play a bigger role.

Respondents are sensibly more concerned by charging time (3.63), driving range (3.75) or even skyrocketing energy prices (3.88). While the increase of prices at charging stations is out of the hands of carmakers, charging time and driving range are object of heavy R&D investments, as to achieve technological improvements capable of smoothing current bottlenecks. However, the factor representing the key concern of individuals is represented by the perception of inadequate availability of infrastructures (3.97). Electric vehicles can be indeed charged both "at home" or in dedicated stations distributed on the territory. Many travellers, especially in the case of longer trips, fear that they might have problems finding available charging stations. Charging infrastructures represent a formidable bottleneck for the diffusion of electric mobility, and all involved actors should invest not only in the actual infrastructure (which clearly represents a key pre-requisite), but also in informational campaigns spreading the message that widespread coverage of the territory and availability of charging stations will not be an issue.

Lastly, it is worth stressing how according to mainstream literature environmental awareness (which represents one of the key features of contemporary consumers) is not a key element in orienting actual behaviours (Lanzini & Khan, 2017): awareness about the (un)sustainability of current mobility paradigms is considered by many as an important aspect capable of shaping our intentions, but when it comes to turning intentions into behaviours, other factors (economic, performance-related and so on) play a much bigger role. The majority of respondents consider electric vehicles more sustainable than ICE counterparts: yet, the average score of agreement with the statement "Electric cars are less polluting than internal combustion ones" (3.43 on a 1 to 5 scale) is not as high as it could be expected, given that (full) electric vehicles do not emit CO2 while in use. The explanation lies in the fact that, on the one hand, people are aware that it all depends on how electricity is actually produced: if the energy to charge batteries is produced from fossil fuels, we are not solving a problem but merely transferring it from one place to another. On the other hand, there is widespread awareness of how emissions represent only one aspect of the sustainability of vehicles, so that other variables (such as battery disposal) need to be taken into consideration.

6.4 Conclusions

Sustainability, digitalization, servitization and electrification are keywords that are bound to shape the mobility of (today and) tomorrow. Stemming from such assumption, the present chapter has its roots in the acknowledgement that, regardless of legislative initiatives that might in years to come speed up the process towards more sustainable mobility paradigms, demand will represent a key actor, so that the relevance of a demand-based perspective could not be overemphasized. Consistently, the *take home message* is that behavioural research should trespass the boundaries of academia and inform the decisional process of public and private actors involved in the changing landscape of mobility in general and of the automotive industry in particular, providing a sound informational background on which to frame policies and strategies (Lanzini, 2018b). This is becoming even more important in turbulent times when the boundaries between alternatives are more blurred than in the past, with new technologies and sociological trends changing long-established perceptions and rules of the game: for instance, sharing services encompass both features of traditional car use (the vehicle itself, which can be typically ICE powered) yet can be labelled as a sustainable alternative to private ownership (in line with the emerging trend of use over possession). This multi-layer complexity has automotive industry enter uncharted territory, so that now more than ever it is crucial to shed light on the behavioural and psychological determinants of mobility behaviours, consistently with the famous Drucker's motto "You cannot manage what you cannot measure".

References

Aarts, H., & Dijksterhuis, A. (2000). Habits as knowledge structures: Automaticity in goal-directed behaviour. *Journal of Personality and Social Psychology, 78*(1), 53.

Ajzen, I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes, 50*(2), 179–211.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behaviour*. Prentice-Hall.

Conner, M., & Armitage, C. J. (1998). Extending the theory of planned behaviour: A review and avenues for further research. *Journal of Applied Social Psychology, 28*(15), 1429–1464.

De Groot, J. I., & Steg, L. (2009). Morality and prosocial behaviour: The role of awareness, responsibility, and norms in the norm activation model. *The Journal of Social Psychology, 149*(4), 425–449.

EPA. (2021). *U.S. Department of Energy and U.S. Environmental Protection Agency*. Fueleconomy.gov website.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behaviour: An introduction to theory and research*. Addison-Wesley.

Guagnano, G. A., Stern, P. C., & Dietz, T. (1995). Influences on attitude-behaviour relationships: A natural experiment with curbside recycling. *Environment and Behaviour, 27*(5), 699–718.

Klöckner, C. A., & Blöbaum, A. (2010). A comprehensive action determination model: Toward a broader understanding of ecological behaviour using the example of travel mode choice. *Journal of Environmental Psychology, 30*(4), 574–586.

Lanzini, P. (2018a). *Responsible citizens and sustainable consumer behaviour: New interpretative frameworks*. Routledge.

Lanzini, P. (2018b). The automotive industry and the increasing relevance of a consumer perspective: A research agenda. *International Journal of Automotive Technology and Management, 18*(1), 46–58.

Lanzini, P., & Khan, S. A. (2017). Shedding light on the psychological and behavioural determinants of travel mode choice: A meta-analysis. *Transportation Research Part F: Traffic Psychology and Behaviour, 48*, 13–27.

Oreg, S. (2003). Resistance to change: Developing an individual differences measure. *Journal of Applied Psychology, 88*(4), 680–693.

Ouellette, J. A., & Wood, W. (1998). Habit and intention in everyday life: The multiple processes by which past behaviour predicts future behaviour. *Psychological Bulletin, 124*(1), 54.

Parker, M. E., Li, M., Bouzaghrane, M. A., Obeid, H., Hayes, D., Frick, K. T., Rodrìguez, D. A., Sengupta, R., Walker, J., & Chatman, D. G. (2021). Public transit use in the United States in the era of COVID-19: Transit riders' travel behaviour in the COVID-19 impact and recovery period. *Transport Policy, 111*, 53–62.

Schwartz, S. H. (1977). Normative influences on altruism. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 10, pp. 221–279). Academic Press.

Schwartz, S. H., & Howard, J. A. (1981). A normative decision-making model of altruism. *Altruism and Helping Behaviour*, 189–211.

Stern, P. C. (2000). New environmental theories: Toward a coherent theory of environmentally significant behaviour. *Journal of Social Issues, 56*(3), 407–424.

Verplanken, B. (2011). Old habits and new routes to sustainable behaviour. In *Engaging the public with climate change: Behaviour change and communication* (pp. 17–30). Routledge.

Verplanken, B., & Aarts, H. (1999). Habit, attitude, and planned behaviour: Is habit an empty construct or an interesting case of goal-directed automaticity? *European Review of Social Psychology, 10*(1), 101–134.

Verplanken, B., & Orbell, S. (2003). Reflections on past behaviour: A self-report index of habit strength. *Journal of Applied Social Psychology, 33*(6), 1313–1330.

Verplanken, B., Walker, I., Davis, A., & Jurasek, M. (2008). Context change and travel mode choice: Combining the habit discontinuity and self-activation hypotheses. *Journal of Environmental Psychology, 28*(2), 121–127.

7

Open and Collaborative Innovation in the Automotive Industry

Anna Cabigiosu

7.1 The Role of Collaborative and Open Innovation as a Driver of Value Creation for Competence Destroying Innovations

The study of innovation hardly needs justification as innovation is a primary source of growth and firms' competitive advantage (Damanpour et al., 2009). The innovation literature has vastly analyzed the determinants of innovation and among them has emphasized the importance of open innovation, which is the use of collaborations with external parties to share knowledge and develop innovations (Chesbrough, 2003). This peculiar stream looks at how firms collaborate, the performance implications of collaboration with different partners, the categories of innovations that benefit the most from collaboration, and also the potential drawbacks of collaboration (Laursen & Salter, 2006).

A. Cabigiosu (✉)
Department of Management-Venice School of Management,
Ca' Foscari University of Venice, Venice, Italy
e-mail: anna.cabigiosu@unive.it

A. Cabigiosu, P. Lanzini (eds.), *The Green Transition of the Automotive Industry*,
https://doi.org/10.1007/978-3-031-37200-1_7

Even though the literature on technological change discusses the role of open innovation, we still know little about how firms rely over time on open innovation in an era of rapid and radical technological evolution. Openness to external knowledge can reduce the risk of a sector getting "locked-in" to undesirable technological trajectories and it becomes crucial to understand how established firms manage the challenges posed by competence destroying innovations and technologies (Nair et al., 2016) both in manufacturing and in services (Cabigiosu, 2019).

Incumbent carmakers traditionally have core competences in the design and production of internal combustion engines (ICEs), while they do not have specific competences in the design of electric batteries, which are the most distinctive component of EVs and have the most impact on the many EV performance variables (Borgstedt et al., 2017). Furthermore, only recently have sales numbers positioned these vehicles as a real alternative to ICE vehicles. Despite the fact that strategy scholars have so far considered the automotive industry to be protected by almost insurmountable barriers to entry, Tesla's success has opened a vivid debate on the urgency of controlling EV technology (Teece, 2018). The same urgency emerges from the ever more restrict governmental regulations on emissions.

In this setting, incumbent carmakers face high levels of technological and market uncertainty and their competitive advantage may be threatened because new technologies make existing competences (at least partially) obsolete (Tushman & Anderson, 1986). Understanding the process through which incumbent carmakers can cope with these technological discontinuities by leveraging an open innovation strategy can provide valuable insights to technology and innovation management literature.

Technological discontinuities are major technological changes resulting in the creation of a new technology that requires new competences and knowledge in both the development and production of the product (Tushman & Anderson, 1986). Technological discontinuities can lead to intensified competition and to a period of uncertainty related to new technologies and market leaders (Abernathy & Clark, 1985; Anderson & Tushman, 1990).

Incumbents are particularly challenged when innovations are competencedestroying and they are thus burdened with core rigidities and the legacy of old technology (Leonard-Barton, 1992; Tushman & Anderson, 1986). This was the case with the carmakers and the design and production of electric batteries for EVs (Teece, 2018).

Scholars have suggested that incumbents can use alliances, joint ventures, supply relationships, and other types of collaborations to learn from external partners and acquire the competences necessary to endure in the new technological landscape (Lee et al., 2010; Hamel, 1991; Kogut, 1988; Khanna et al., 1998). In particular, the resource dependence theory argues that the more a firm needs specific resources for its competitive advantage, the more the firm will prefer those partnerships that ensure long-lasting and tighter relationships, such as joint ventures or merger and acquisitions, that stabilize their relationships and align incentives (Eisenhardt & Schoonhoven, 1996; Paulraj & Chen, 2007). The open innovation literature defines the external search depth as the level of collaborative involvement of the external sources with the firm and suggests that the depth of an open innovation strategy captures how heavily a firm invests in its relationships in order to build absorptive capacity to facilitate learning from others and to engage partners in an intense knowledge and information sharing (Lee et al., 2010; Cohen & Levinthal, 1990; Lauresn & Salter, 2006). The open innovation literature also suggests that a firm's external strategy has a breadth dimension, defined as the number of external source domains that a firm relies upon in their research and development activities. Firms with multiple partnerships will have access to a wider set of resources, a better understanding of a new technology and what other firms are doing, and have more chances to develop new technologies (Dyer & Nobeoka, 2000; Dyer & Singh, 1998; Grant & Baden-Fuller, 2004).

While the open innovation literature agrees in emphasizing the performance implications of an open innovation strategy, this stream also warns that too many partners may generate over-searching and the inability to fully exploit the external knowledge acquired, as well as an over-dependence on eternal partners: the firm external search breadth and depth are curvilinearly (take an inverted U-shape) related to innovative performance (Laursen & Salter, 2006; Csaszar & Siggelkow, 2010). Furthermore, we still need studies that analyze in a process view how incumbents rely on an open innovation strategy to cope with discontinuous technologies and how they vary in time the depth and breadth of their open innovation strategy.

Open innovation is crucial in the automotive industry because carmakers buy several components and subsystems from external suppliers that are pivotal partners for the development of new car models and component technologies (Goffin et al., 1997; Zirpoli & Becker, 2011) as well as for the development of EVs (Sierzchula et al., 2015; Cano-Kollmann et al., 2018). How did carmakers incumbent rely on open innovation to cope with the emergence of a greener but competence destroying technology?

In the next section I provide a synthesis of the life-cycle model of open innovation (Cabigiosu, 2022), which provides a framework to analyze how open innovation changes in time with a technological discontinuity and then I apply the model to the leading incumbents in the automotive industry until 2016: Toyota, General Motors (GM), and VW (Volkswagen). The discussion and conclusions section provides the main theoretical and managerial implications of this study.

7.2 The Life-Cycle Model of Open Innovation in the Automotive Industry

One of the most cited frameworks depicting the dynamic pattern of technological innovation is the Abernathy-Utterback life-cycle model (Abernathy & Utterback, 1978) where industries face cycles of technological discontinuities characterized by a period of ferment and rivalry among technological variations that eventually leads to the selection of a dominant design. This cycle can also be represented as an inverted U-shape where the rate of major technological change decreases in time when a dominant design emerges (Murmann & Frenken, 2006). Once a dominant design is selected, the focus of competition shifts from product to process innovations. Abernathy and Utterback (1978) and Anderson and Tushman (1990) define dominant design as a single architecture that dominates a product category, with a market share higher than 50%. Dominant designs matter because firms that adopt the dominant design architecture and technology will be less likely to exit and are more likely to survive (Suarez & Utterback, 1995).

In the automotive industry the dominant design is constituted by the 1908 Ford Model T (Fujimoto, 2014). Afterward, the automotive industry has been characterized by high frequency of product and process innovations in the first part of the twentieth century, while in the second half we observed long-term incremental improvement of core technologies, with carmakers substantially maintaining conventional motorizations. This is called the long-tail of the automotive industry (Fujimoto, 2014). In such mature industries innovation is typically incremental, and process innovation is as important as product innovation and correlated to higher barriers to entry due to cost to build competitive manufacturing plants regarding their scale and technological endowment (Cano-Kollmann et al., 2018).

This pattern changed during the '90s, when new stringent legislations, higher fuel prices, the availability of new technologies, and the higher attention of many stakeholders to environmental issues started generating increasing pressures over incumbents for the development of EVs, which constitute a technological discontinuity (Bergek et al., 2013).

EVs constitute a competence destroying technological discontinuity in that electric-car batteries start playing a significant role in determining multiple performance of EVs as compared to ICEVs, such as safety, life span, specific energy or costs (Cano et al., 2018). An era of ferment started, and multiple competing chemistries were used to produce electric batteries. The nickel technology was initially safer and cheaper, but lithium batteries are lighter and smaller and have a higher recharge density, a lower energy dissipation rate, and can be recharged multiple times (Lu et al., 2013; Herrmann & Rothfuss, 2015; Schott et al., 2015). From 2006, EVs experience a new revival thanks to a mixture of fiscal incentives and industrial policies (Kolk & Tsang, 2017). In 2006, was also presented the prototype of the Tesla Roadster, the first full-electric car to use lithium-ion batteries. Around 2011 data show that carmakers heavily converged on lithium chemistries that start dominating the industry, and an increase in the number of EVs models and of patents granted in EVs technologies (Wang et al., 2016; Sierzchula et al., 2012; Borgstedt et al., 2017).

In this setting incumbent carmakers started multiple collaborations with suppliers, competitors, and research centers to approach the electric batteries technology. The process of opening their innovation boundaries could be particularly challenging for incumbents and capital-intensive industries like automotive that are more rigid in changing their internal innovation processes. Furthermore, we observe an increasing range of knowledge from several and distant scientific fields that incumbents need to control, combine and integrate, such as chemistry for the electric batteries or consumer electronics for infotainments. The increased newness and complexity of knowledge bases to be controlled, has been pushing carmakers to search and obtain innovations from outside their own boundaries and that of their traditional supply chain. In this setting it becomes crucial to understand how carmakers changed in time their open innovation strategy (Wilhelm & Dolfsma, 2018).

The automotive industry is an R&D intense industry where innovation is mainly prompted by carmakers and selected first-tier suppliers, such as Denso, Bosch, or Valeo. But while incumbents are experienced in managing their supply chain and relationships, experience with other partners and with external actors outside the industry is at a more nascent stage (Helper & Sako, 2010).

Cabigiosu (2022) describes the process through which incumbent carmakers managed their open innovation strategy for the supply of electric batteries along the breadth and depth dimensions. This process is called the life-cycle model of open innovation and is graphically illustrated as a hilly curve representing the process through which the breadth and depth of incumbents' open innovation strategies change over time with the level of technological uncertainty in a scenario of radical and competence destroying innovation (see Fig. 7.1).

Radical and competence destroying innovations produce a period of technological uncertainty. Incumbents start exploring the new landscape with the help of external partners and combine understanding, absorption, evaluation, and use of external knowledge. During this phase (see the left side of Fig. 7.1), firms still prudentially explore the new technology and the external search breadth and depth are comparatively lower. Incumbents need to create absorptive capacity with a few partners and do so by relying on their traditional supplier relationship strategy: they

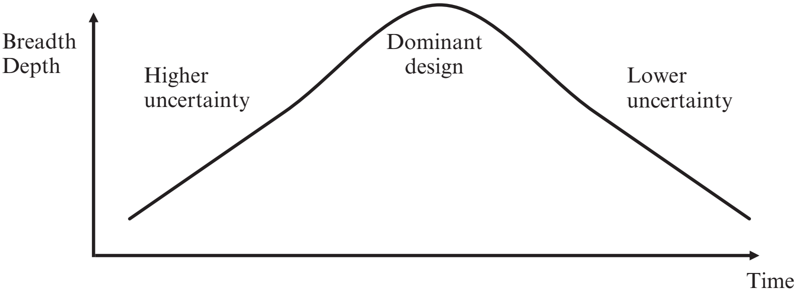


Fig. 7.1 The life-cycle model of open innovation. Source: Cabigiosu (2022)

engage first-tier suppliers in collaborative relationships and share technological and component specific knowledge with them to create new shared knowledge bases that constitute crucial coordination mechanisms for the development of such complex products (Cabigiosu et al., 2013).

Second, when absorptive capacity is built incumbents have the convenience and are able to manage and engage a higher number of partners in hand-in-glove relationships through which to further explore the technological landscape and increase the control over relevant bodies of knowledge and control external resources (Dyer & Singh, 1998; Eisenhardt & Schoonhoven, 1996). This exploration phase is correlated to higher levels of external search breadth and depth, until the emergence of a dominant design reduces the technological uncertainty and the market rush to identify the most performing technology (see the hill in Fig. 7.1). During this phase higher levels of depth are relevant to favor partners' co-design of complex products. In the case of automotive industry, automakers are highly involved in the design of electric batteries to assure complete integration between the battery pack and the vehicle and the development of performing green vehicles (Cabigiosu, 2013; Furlan et al., 2014). Interestingly enough, the exploration phase may eventually open the incumbents' boundaries to collaborations behind their supply chain and competitors may become coopetitors, suggesting that these relationships are viable in specific environmental contexts (Dyer & Singh, 1998).

Finally, the third phase signals the (eventual) reduction in the technological uncertainty if a dominant design emerges. Incumbents cut the overall number of collaborations because the need to explore and monitor the environment is comparatively lower (the right side of Fig. 7.1) (Park et al., 2018). During this third phase it is more likely that incumbents move from market to hierarchy because they are able and find it economically convenient to start in-house production. In the third phase, incumbents have accumulated the required competences and technological uncertainty has been reduced. Also, concurrent sourcing may offer increased learning by combining internal and external knowledge streams, and firms facing variable volumes of sales may adapt their own production capacities which may improve suppliers' benchmarking or generate production economies (Parmigiani, 2007).

In the next sections I use the above-presented life-cycle model of open innovation to describe in detail and compare the Toyota, GM, and VW open innovation strategies from the '90s to 2016 to increase our understanding of how incumbent carmakers approached electric batteries technology by relying on open innovation. I selected Toyota, GM, and VW because all are incumbents that entered the automotive industry before the 2000 with competencies related to the combustion engine and started commercialized EVs before 2012. I set as a threshold for the year 2012 because I wanted to analyze the open innovation strategy of those incumbents that entered before lithium-ion technology became dominant and for which the analysis of the evolution of the open innovation strategy is more meaningful. Before 2012, EVs' market was still living an era of ferment and fluidity, representing about 0.5% of the overall vehicles sold worldwide (Sierzchula et al., 2015). Also Toyota, VW, and GM were incumbents with the highest market share in the USA, Europe, and Japan until 2016 (Toyota, GM, and VW).[1]

Building on Cabigiosu (2022) I analyzed the news on multiple agreements (supply relationships, strategic alliances, joint ventures, research contracts, licensing, merger and acquisitions) and for the development/provision of electric batteries (or battery packs or cells) that appeared on Business Source Complete (BSC), LexisNexis, and all hits on EV manufacturer and their partners web-sites.

---

[1] GM had higher revenue than Ford till 2016 before the decision to sell the Opel/Vauxhall Business (https://www.forbes.com/sites/greatspeculations/2019/12/23/how-does-ford-and-gms-revenue-compare/).

I used the life-cycle model for sourcing strategies (Cabigiosu, 2022) in which the x-axis represents the time and the y-axis represents the sum of incumbents' new external partnerships signed each year (the breadth). The same analysis was used for the depth: the x-axis represents the time and the y-axis represents the number of new partnerships signed each year that are classified as being adapt to prompt knowledge sharing between partners (alliances, joint venture, strategic alliances, and research projects) distinguished from traditional supply relationships (Schilling, 1999). These types of partnerships generate an advantage in accessing and applying knowledge because let carmakers better explore and access additional and new complementary competences, and contribute not only to the acquisition of new knowledge but also to the application of knowledge (Kogut, 1988). The model is represented in Fig. 7.1.

7.3 Findings

7.3.1 Toyota

Toyota Motor Corporation (henceforth Toyota) is a Japanese carmaker. In 2021, global sales of the Toyota Group reached nearly 10.5 million vehicles and $276.57 billion sales making, numbers that make Toyota the world's largest carmaker.[2]

Toyota's attention toward hybrid cars started during the 90s. In 1997 Toyota and Matsushita Electric Industrial founded Panasonic EV Energy Co (Toyota, 1997). This joint venture, owned by Matsushita Electric Industrial for 60% and by Toyota for 40%, invested in R&D activities and produced nickel metal-hydrate (Ni-Mh) batteries. At the end of 1997 Toyota launched the first hybrid model, the first generation of Toyota Prius, which sold about 160 million vehicles all around the world and Toyota became a significant mass producer of electric motors and engaged in intimate collaboration with its supplier of electric vehicle batteries, Panasonic, to develop hybrid-electric battery systems to be

---

[2] https://global.toyota/en/company/profile/production-sales-figures/202112.html.

integrated in the hybrid power train. The companies formed a joint venture and during the development project Toyota located a significant number of vehicle engineers at Panasonic. At a later stage, Toyota acquired a controlling interest in this joint venture (Green Car Congress, 2007). In 2003 Toyota launched the second generation of Prius. Technological improvements allowed increasing the size of Prius and its autonomy and efficiency. The batteries were still produced by Panasonic EV Energy.

In 2004 Toyota started a partnership with Ford which started using the Toyota hybrid technology (Zaun, 2004) and in 2005 Toyota increased its participation in Panasonic EV Energy till buying the 80.5% of shares. Toyota heavily invested in Panasonic EV Energy and triplicated the production capacity of the Miyagi plant investing about 300 million dollars. These investments were necessary to cope with the market success of the Prius.[3] In 2007 Toyota and Matsushita Electric Industrial reinforced their partnership: Toyota acquired 20.7 million shares in Matsushita (Industry week, 2007). In 2008 Matsushita Electric Industrial changed its name to Panasonic (Panasonic, 2008). In 2009 Toyota decided to switch from a single sourcing strategy to a double sourcing strategy starting a new supply relationship with Sanyo for the supply of lithium batteries. At the end of 2009 Panasonic completed a 400-billion-yen acquisition of a 50.2% stake in Sanyo, making Sanyo a subsidiary of Panasonic. In 2010, Panasonic announced that they would acquire the remaining shares of Sanyo (Fallah, 2010).

In 2009 Nissan used via licenses Toyota's hybrid drive system in the Altima. Licensing technology from Toyota was a means to getting a production vehicle on the road sooner, saving a high amount of R&D time and cost and reducing the production development time, thanks to the availability of component parts and batteries from Toyota's suppliers (Carley, 2009).

In 2010 Toyota bought 3% of Tesla Motors, sold in 2014, to combine the Tesla knowledge of electric car technology with the Toyota production and distribution capacity for the RAV4 model (Tesla, 2010). In 2011 Toyota invested other 60 million dollars in the relationship with Tesla; the agreement was to jointly develop the RAV4, a plug-in electric

---

[3] http://www.greencarcongress.com/2010/03/tmc-20100330.html.

vehicle. For Toyota this is the first full electric vehicle. The project combines the Tesla knowledge of electric cars technology with the Toyota production and distribution capacity. But in 2014 Toyota, after three years and several million dollars invested, decided to end this partnership. Several may be the causes of this decision: the RAV4 failure, Toyota's focus on hybrid and hydrogen cars, or the Tesla strategy aimed at opening its technology (Tabuchi, 2014).

In 2012 Toyota and BMW signed a "memorandum of understanding" to jointly develop the next generation of electric lithium batteries. The technologies jointly developed have been applied in BMW in the models i3 and i8, while Toyota is going to use them for the Prius. These new batteries have a longer duration and a higher power than the nickel metal-hydrate (Ni-Mh) batteries. In 2014 Primearth (the new name of Panasonic EV from 2010) increased the production of nickel metal-hydrate (Ni-Mh) batteries to satisfy the demand of Toyota hybrid cars. The Miyagi plant will be expanded to supply 500 million cars a year, 200 million more than the cars today produced (Shepard, 2013).

Overall, Toyota experimented multiple partnerships, especially with competitors, and maintained in time two first-tier suppliers, Primearth and Sony, both controlled by Toyota.

7.3.2 General Motors

General Motors (GM) is a US firm whose headquarter is in Detroit (Michigan). GM's global revenue in 2021 was $127 billion and GM sold just under 6.3 million vehicles.[4]

In 1994 GM acquired Ovonics, which produces batteries and it is owned by Ovshinsky the inventor of the modern nickel-methanol hydrate battery (Ni-Mh). GM and Ovonics founded the joint venture GM Ovonic (Wald, 1994). The original aim of this acquisition was to control the development of the Ni-Mh technology for the first GM electric car, the EV1 BEV. Nevertheless, GM had to face the action of the US Auto Battery Consortium (USABC), which was willing to pursue the interest

---

[4] https://investor.gm.com/news-releases/news-release-details/gm-reports-2021-full-year-and-fourth-quarter-results-including/.

of the carmakers belonging to the consortium by limiting the development of the Ni-Mh technology. Indeed, GM decided to renounce to his project and in 2001 the oil company Texaco acquired the GM's share of Ovonics (Wald, 1994).

In 1996 Delphi started supplying the lead acid batteries for the first release of the EV1 model. Delphi Energy System Engineers developed batteries that were expected to give customers the ability to use at 85% of the battery pack's charge on a daily basis without damaging the batteries or decreasing the life of the battery (Wayne Dobson, 2000).

In 1999 GM started buying lead-acid battery packs from Panasonic and from 2005 also nickel batteries (Mendoza & Argueta, 2000).

In 2007 GM started producing the Chevrolet Malibu hybrid, which embodies the batteries produced by Cobasys (Abuelsamid, 2007).

In 2008, GM and Hitachi, a Japanese firm leader in the electronic and electric industry, signed an agreement for the supply of lithium batteries to be installed on more than 100,000 cars produced by GM (Hitachi, 2008).

In 2009 GM announces a project with LG Chem to develop long-lasting lithium batteries. In 2011, GM enlarged its partnership with LG for the design and production of a large set of components for electric vehicles and they realize the new structure of the cathode of the Li-ion battery (Soyoung, 2009).

In 2011 GM invested more than 17 million dollars in Envia Systems, with the aim of reducing of about one-third the final cost of the electric vehicles and to create batteries able to supply 400 watt-hour per kilo (the Tesla batteries supplied a maximum of 130 watt-hour per kilo) (Ingram, 2013). Also, in 2011 GM enlarged its partnership with LG to the design and production of a large set of components for electric vehicles and they realized the new structure of the cathode of the Li-ion battery.[5] The same year GM presented two new car models that rely on the Li-Ion batteries supplied by Hitachi: the hybrid model Buick LaCrosse and the electric model Chevrolet Volt. The Chevrolet Volt has the motor, invert and batteries all supplied by Hitachi (Greimel, 2011). In 2011, GM starts a

---

[5] http://www.greencarcongress.com/2011/08/gmlg-20110825.html.

partnership with A123 System, which is a chemical firm founded within the MIT. The partnership is mainly focused on the co-developed of the software to control the batteries (Cobb, 2012). In 2012 the new Buick Regal embodies the Hitachi Li-Ion batteries. This will be the last model produced with the Hitachi technology. The main reason of this departure is the Hitachi strategy: the firm aims at becoming a global supplier without having close relationships with specific carmakers. During the same year GM ended also the collaboration with A123 System, which will be acquired by the Chinese Auto Industry Wanxiang Group. In 2013 GM launched the EV Spark with the Nanophospate Li-Ion batteries developed with A123. In 2013 GM ended its partnership with Envia that was not able to meet the GM's expectations (Ingram, 2013). In 2013 also GM presented the new Volt with LG batteries (http://cleantechnica.com/2013/08/09/lg-chem-plant-to-make-american-batteries-for-chevy-volt/).

In 2016 Honda and General Motors started working together on plug-in hybrid cars. By partnering, both GM and Honda can cut costs by sharing technology (saving time and money), sourcing parts in bulk, and economies of scale (Edelstein, 2016).

Indeed, GM is investing in lithium batteries and in an exclusive partnership with LG Chem. But in 2014 GM announced that General Motors Co. is moving production of the battery pack for its all-electric model of the Chevrolet Spark minicar in-house at the company's battery assembly plant in Detroit (Naughton, 2014). The pack was previously supplied by A123 Systems. GM is going to invest $65 million to expand the production of lithium-ion batteries. Larry Nitz, executive director of GM global transmission and electrification engineering, explained that, "Using our in-house engineering and manufacturing expertise enabled us to deliver a battery system that is more efficient and lighter" (http://www.plasticsnews.com/article/20140515/NEWS/140519948/gm-bringing-more-lithium-ion-battery-production-in-house). In 2014 LG Chem announced that they would supply also VW and the Audi brand (http://www.greencarreports.com/news/1085827_battery-maker-lg-chem-biggest-electric-car-winner-of-all).

Overall, GM entered into multiple supply relationships, more or less tighten, with a number of first tiers and one component supplier. At the end of 2014, GM relied on lithium technology, one first-tier supplier and on a concurrent sourcing strategy.

7.3.3 Volkswagen

Volkswagen Group (henceforth VW) is controlled by the holding Volkswagen AG, whose headquarters is in Wolfsburg (Germany). VW is the main European carmaker and in 2021 VW sold worldwide 8.6 million vehicles and recorded a revenue of 271.2 billion dollars.[6]

VW started investing in the electric/hybrid niche only in 2006 with a partnership with Sanyo to develop nickel batteries. This partnership ended in 2010 when Sanyo entered the Toyota-Panasonic relationship (Green Car Congress, 2008).

In 2007, VW participated in an R&D project named LIB 2015 (Lithium Ion Battery) sponsored by the government and aimed at increasing the performance and sustainability of lithium batteries. The project involves several firms such as BASF, Bosch, Evonic Deguessa, and Li-Tec. The hybrid model Audi A1 presented in 2007 embodies the technologies developed during this project (Sauer et al., 2017).

In 2009 VW empowered its relationships with the suppliers of batteries. VW signed a letter of intents with Toshiba to join their technologies to develop more efficient electric propulsions and batteries with a higher energy density (Williams, 2009). The same year VW and the Chinese BYD Auto signed an agreement for the co-development of hybrid and electric cars with a Li-Ion technology. The BYD Auto is a subsidiary of the BYD group, which is the global leader of the production of Ni-Cd batteries and of mobile batteries. The partnership was supposed to improve VW knowledge of batteries and to help in BYD entering the automotive industry as carmaker (Green Car Congress, 2009). In 2009 VW also signed a partnership with Varta Microbattery: Varta would have shared its know-how about batteries and accumulators with VW with the

---

[6] https://www.volkswagenag.com/en/news/2022/03/volkswagen-group-achieves-solid-results-in-2021-and-drives-forwa.html#.

aim of increasing batteries performance and VW would have ensured a large purchase of batteries (Reuters, 2009). But VW went on searching for further partners and monitoring the market. For example VW shared information with Bosch-Samsung JV and LG Chem (Dumitrache, 2010).

In 2010 VW presented the first model of a hybrid SUV, the Tuareg Hybrid, for the European market. The batteries are Ni-Mh batteries produced by Bosch (Dumitrache, 2010).

In 2012 China BAK Battery announced it supplies lithium-ion batteries to FAW-Volkswagen Automotive Co., a joint-venture of FAW Group Corporation and Volkswagen AG (China BAK Battery Inc, 2012).

In 2013 VW presented two new electric models: the e-Up! and the e-Golf. Both models have lithium batteries. The motor, gear, and batteries are all developed and produced in-house. Furthermore, VW announced that it is going to increase investments in electrified motorizations and also in the battery's technology (Green Car Congress, 2013).

In 2015 VW announced that LG Chem and Samsung SDI will supply Audi with batteries produced at their European plants. The South Korean tech companies will also invest in cell technology in Europe (Korosec, 2015).

Overall, VW experimented with multiple partnerships mainly with electric batteries suppliers, to then starting its in-house production.

7.3.4 Analysis

Toyota always maintained a relationship with Primearth (previously Panasonic) its main first-tier supplier and followed its traditional strategy characterized by few selected first tiers, Primearth and Sanyo, controlled via the acquisition of majority shares. This basic strategy was then adapted and stretched in time: the breadth of Toyota partnerships was limited from late '90s till 2009 and then increased in between 2009 and 2012 to finally decrease when lithium became dominant.

Also, GM entered in the '90s and maintained a relevant supplier, LG, as first-tier supplier with whom to have a long-lasting and collaborative relationship. In 2014 GM also started producing batteries in-house.

VW is comparatively a late entrant who, starting from 2006, signed multiple partnerships with a variety of first tiers, also Chinese suppliers, till initiating its own in-house production in 2013.

Table 7.1 synthesizes the timetable of the main partnerships signed by GM, Toyota, and VW.

Figures 7.2 and 7.3 apply the life-cycle model of open innovation to GM, Toyota and VW and show how the breadth and depth of the three carmakers changed in time. The life-cycle model of open innovation suggests that the three carmakers followed an open innovation strategy characterized by three steps and an inverted U-shaped path of breadth and depth.

First, before when 2006 technological uncertainty was still high because multiple battery chemistries were competing, Toyota and GM gradually opened their boundaries to external collaborations and started building a knowledge base and their own absorptive capacity about battery technologies. Toyota and GM bought electric batteries from a few selected first-tier suppliers with which they still have collaborative relationships, and they essentially replicate their traditional sourcing strategy where few first-tier suppliers are engaged in innovative and collaborative activities. This step is labeled prudential exploration and the open innovation breadth and depth are comparatively lower. VW waited until 2006 before starting new collaborations for the development of electric batteries and then more rapidly increased its partnerships.

Second, in between 2006 and 2012, the three carmakers analyzed increased the breadth and depth of their open innovation strategies: technology uncertainty was reduced, lithium acquired a dominant position, and incumbents were managing multiple partnerships to enhance their opportunities to develop performing EVs. Particularly VW experienced the highest number of new partnerships with multiple first-tier suppliers from Sanyo to LG.

Finally, after 2012, the three carmakers analyzed to reduce the breadth and depth of their open innovation strategy, especially Toyota and GM retained few selected global mega suppliers of batteries. The breadth of VW's open innovation search displays a right-long tail.

All three carmakers move to in-house production of batteries via green field investments or acquisitions (Kalaitzi et al., 2019).

Table 7.1 Timetable of the main partnerships signed by GM, Toyota, and VW from the 1990s till 2016

	1994	1997	1999	2004	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
GM	GM acquired Ovonics, which produces nickel-methanol hydrate battery (Ni-Mh) and founded the joint venture GM Ovonic	Delphi starts supplying lead acid batteries	GM starts buying lead-acid battery packs from Panasonic and from 2005 also nickel batteries			GM uses lithium batteries produced by Cobasys and Hitachi	GM and Hitachi sign an agreement for the supply of lithium batteries which ends in 2012	GM announces a project with LG Chem to develop long-lasting lithium batteries		Partnerships with Envia Systems and A123			In-house production	
Toyota		Toyota and Matsushita Electric Industrial founded the joint venture Panasonic EV Energy Co.		In 2004 Toyota starts a partnership with Ford				Supply relationship with Sanyo for the supply of lithium batteries. Licensing out to Nissan	Toyota buys 3% of Tesla Motors		Toyota and BMW jointly develop the next generation of electric lithium batteries			
VW					Partnership with Sanyo to develop nickel batteries	VW participated in an R&D project named LIB 215 (Lithium Ion Battery)		VW signs an agreement with Toshiba, with Chinese BYD Auto, and with Varta Micro battery	VW has a supplier Bosch		In 2012 China BAK Battery announced it supplies Volkswagen	In-house production		LG Chem and Samsung become supplier

Source: Own elaboration

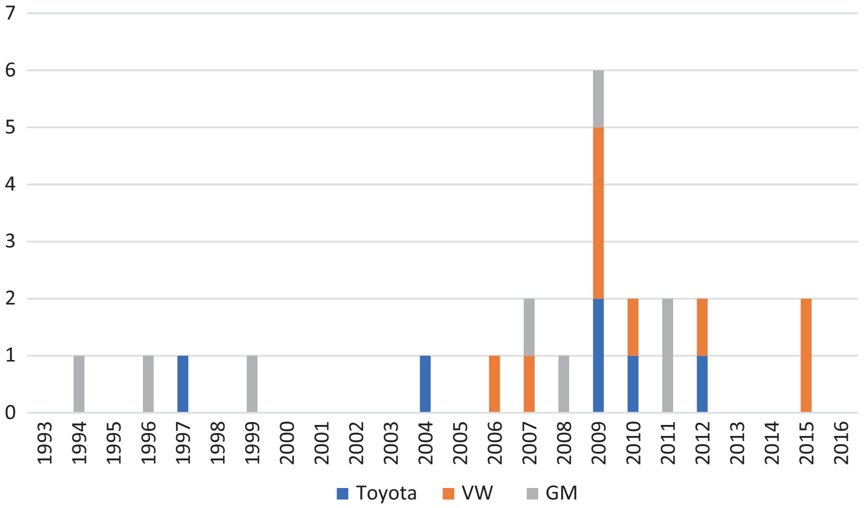


Fig. 7.2 The breadth of Toyota, GM, and VW's open innovation strategies measured as the cumulative number of partnerships signed each year. Source: Own elaboration

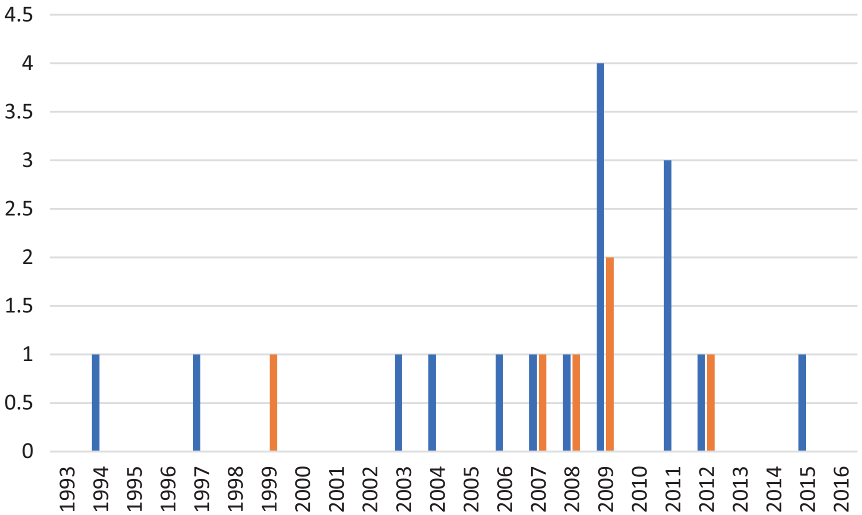


Fig. 7.3 The depth of Toyota, GM, and VW's open innovation strategies measured as the number of new partnerships signed each year that are classified as being adapt to prompt knowledge sharing between partners (alliances, joint venture, strategic alliances, and research projects) distinguished from traditional supply relationships (Schilling, 1999). Source: Own elaboration

7.4 Discussion and Conclusions

The life-cycle model of open innovation suggests that during the era of ferment a la Abernathy and Utterback (1978) incumbents prudentially open their boundaries to external collaborations to combine the evaluation of new technologies and start the absorption of distant knowledge. The first movers, such as Toyota and GM experiment before 2006 a longer prudential phase to explore the new technology and to integrate it within the car architecture and do so by relying on few partners and traditional supplier relationship strategy. VW decided to boost its open innovation strategy later and experimented a shorter exploration phase selecting an expert partner, namely Sanyo. Data show that after 2006 all carmakers increased their partnerships and technological uncertainty decreases, while the urgency for a technological transition arose (Dyer & Singh, 1998; Eisenhardt & Schoonhoven, 1996). Automakers also increased their external search depth to achieve a richer exchange of data, information, and knowledge with suppliers (Cabigiosu, 2013; Furlan et al., 2014). Finally, after 2012, once a dominant design emerged carmakers reduced the breadth and depth of collaborations because the need to explore and monitor the environment was comparatively lower. In this phase Toyota, GM, and VW went back to their traditional supply relationship mode where few selected suppliers are retained (Park et al., 2018) and decided to start in-house production of electric batteries, to combine internal and external knowledge streams, to have their production capacity and improve suppliers' benchmarking (Parmigiani, 2007).

This analysis contributes to the understanding of how incumbents can rely in time on an open innovation strategy to approach a competence destroying innovation. First, while the open innovation literature has so far mainly discussed the optimal level of external search breadth and depth at the firm level and in a static view (Randhawa et al., 2016) and demonstrated that external search breadth and depth have an inverted-U-shaped relationship with innovation performance (Laursen & Salter, 2006), in a processual view the inverted U-shaped open innovation model describes the strategy adopted by carmakers incumbents when they need to rely on external partners to cope with a competence destroying technology. This chapter describes the learning process through which incumbent carmakers created a new knowledge base, explored the environment, shared knowledge with partners, and acquired control over external resources until technological uncertainty was reduced and a dominant design emerged, thus reducing the need for monitoring and learning from the outside. While the open innovation literature employs a static view and claims that at the firm level the external search breadth and depth have an optimal level (Lu & Chesbrough, 2021), I add that in a processual view the optimal open innovation strategy is contingent on variables such as the level of technological uncertainty and the emergence of a dominant design (Randhawa et al., 2016) and that we need a more in-depth understanding of how incumbents use open innovation when dealing with a competence destroying innovation over time (Geels, 2018), of how this strategy change in time (Moreno-Mondéjar et al., 2020; Nair et al., 2016) and how an open innovation strategy can involve both vertical and horizontal partners and create coopetitive relationships for the development of new industry standards (Cainelli et al., 2015; Melander, 2017).

Second, this analysis shows that the three carmakers intensified their open innovation search slightly before the emergence of a dominant design but with a different timing. Consequently, the pattern described by the open innovation life-cycle model can present three stages characterized by different lengths depending on firms' timing of entry and strategy, and suggests that firms entering later face by definition lower levels of uncertainty and can find more competent suppliers, but may also find it harder to establish with them more exclusive partnerships and may need to engage in a more intense open search to bridge the gap with first movers, as exemplified by the VW case. These firms may present a stepper curve of open innovation with a long right tail.

Third, this chapter also contributes to supply chain management literature by showing how the carmakers incumbents' sourcing strategy has been stretched and adapted in time to allow firms to face a competence-destroying transition. The analyzed carmakers moved from few relationships with selected first-tier suppliers to a sourcing strategy in which more and different partners are added to acquire new and distant knowledge and explore the new technology (Park et al., 2018; Dyer & Singh, 1998).

Then, when technological uncertainty decreases and carmakers incumbent had acquired the new technological knowledge, they went back to their traditional supply chain strategy and started moving from market to hierarchy to produce in-house the new technology and to retain a higher control over a pivotal production (Parmigiani, 2007).

Fourth, in the analyzed cases we observed higher levels of vertical integration immediately after, and not before, the emergence of a dominant design. Scholars suggested that vertical integration is necessary to allow firms controlling and handling all the technologies required to bring a new product to the market (Baldwin & Clark, 2000), while they do not need to overcome the inertia of external suppliers that are locked into established technologies and avoid the related transaction costs (Helfat & Campo-Rembado, 2016). But in the analyzed context, vertical integration is not pivotal because incumbents started approaching the basics of electric batteries with few first-tier suppliers by relying on their traditional and collaborative sourcing strategy (Cabigiosu et al., 2013). These results may be influenced by the R&D intensity and higher risks facing by incumbents and by the availability of global suppliers with relevant production economies and less resistance to exploring how to applicate electric batteries in the automotive industry.

Overall, this chapter emphasizes how open innovation is multifaced and when dealing with transitions requires a processual view: cars are complex products, made of multiple and distant technologies handled by different specialized firms. Thus, this setting highlights the relevance of managing external partnerships to survive in a technologically turbulent environment. In this chapter I provide guidance to managers willing to understand how to engage in an open innovation strategy, with whom and the timing till start producing in-house greener technologies. On one side the development of complex products requires both breadth and depth in the underlying knowledge base, on the other higher breadth and depth increase the costs correlated to build external partnerships for innovation: to foresee firms' open innovation strategy in a turbulent landscape is crucial to cope with this trade-off (Bergek et al., 2013; Prencipe, 2000; Cabigiosu et al., 2012). This chapter uses the Totyota, VW, and GM cases and suggests how to manage this trade-off in a processual view, how to manage in time a portfolio of partners and how to conciliate the need for stable, cooperative, and selected supply relationships, with a call for a broader open innovation strategy (Dyer & Nobeoka, 2000).

Also, this study has policy implications and suggests when and how governments should sustain more open innovative efforts: incentives are crucial in more mature industries and they can be placed on open innovation practices, especially when technology uncertainty is still high and products are complex, incentives may be relevant to favor vertical and horizontal networks of firms with complementary knowledge bases.

Even though this contribution has the merit of extending existing knowledge about automotive incumbents' sourcing strategies during technological discontinuities, future studies may deepen our understanding of how incumbent carmakers' timing of entry and different product strategies affected the life-cycle model presented and collect primary sources.

References

Abernathy, W. J., & Clark, K. B. (1985). Innovation: Mapping the winds of creative destruction. *Research Policy, 14*, 3–22.

Abernathy, W. J., & Utterback, J. M. (1978). Patterns of industrial innovation. *Technology Review, 80*(7), 40–47.

Abuelsamid, S. (2007, May 13). Cobasis confirms they are supplying batteries for Chevy Malibu hybrid. Autoblog. https://www.autoblog.com/2007/03/13/cobasys-confirms-they-are-supplying-batteries-for-chevy-malibu-h/

Anderson, P., & Tushman, M. L. (1990). Technological discontinuities and dominant designs: A cyclical model of technological change. *Administrative Science Quarterly, 35*, 604–633.

Baldwin, C. Y., & Clark, K. B. (2000). Design Rules, The Power of Modularity. MIT Press, Cambridge.

Bergek, A., Berggren, C., Magnusson, T., & Hobday, M. (2013). Technological discontinuities and the challenge for incumbent firms: Destruction, disruption or creative accumulation? *Research Policy, 42*(6), 1210–1224.

Borgstedt, P., Neyer, B., & Schewe, G. (2017). Paving the road to electric vehicles–a patent analysis of the automotive supply industry. *Journal of Cleaner Production, 167*, 75–87.

Cabigiosu, A. (2013). The impact of electric motorizations on cars' architecture and supply chain relationships within the automotive industry. In A. Stocchetti, G. Trobini, & F. Zirpoli (Eds.), *Automotive in transition. Challenges for strategy and policy* (pp. 45–64). Edizioni Ca' Foscari.

Cabigiosu, A. (2019). *Innovation in knowledge intensive business services: The digital era*. Routledge.

Cabigiosu, A. (2022). Sustainable development and incumbents' open innovation strategies for a greener competence-destroying technology: The case of electric vehicles. *Business Strategy and the Environment, 1*, 2315–2336.

Cabigiosu, A., Campagnolo, D., Costa, G., & Furlan, A. (2012). Knowledge dynamics in third-party logistics: Balancing exploitation and exploration through service architectures. In *Exploring knowledge-intensive business services* (pp. 155–173). Palgrave Macmillan.

Cabigiosu, A., Zirpoli, F., & Camuffo, A. (2013). Modularity, interfaces definition and the integration of external sources of innovation in the automotive industry. *Research Policy, 42*(3), 662–675. https://doi.org/10.1016/j.respol.2012.09.002

Cainelli, G., De Marchi, V., & Grandinetti, R. (2015). Innovation requires different resources? Evidence from Spanish manufacturing firms. *Journal of Cleaner Production, 94*, 211–220.

Cano, Z. P., Banham, D., Ye, S., Hintennach, A., Lu, J., Fowler, M., & Chen, Z. (2018). Batteries and fuel cells for emerging electric vehicle markets. *Nature Energy, 3*, 279–289.

Cano-Kollmann, M., Awate, S., Hannigan, T. J., & Mudambi, R. (2018). Burying the hatchet for catch-up: Open innovation among industry laggards in the automotive industry. *California Management Review, 60*(2), 17–42.

Carley, L. (2009, September 2). While the Toyota Prius dominates most of the hybrid discussion, the Nissan Altima Hybrid warrants some attention, too. *Underhood Service*. https://www.underhoodservice.com/hybrid-service-nissan-altima/

Chesbrough, H. W. (2003). Open innovation: The new imperative for creating and profiting from technology. Harvard Business Press.

China BAK Battery Inc. (2012, August 23). China BAK to supply lithium-ion batteries to FAW-Volkswagen Automotive Co., Ltd. https://www.prnewswire.com/news-releases/china-bak-to-supply-lithium-ion-batteries-to-faw-volkswagen-automotive-co-ltd-167156165.html

Cobb, J. (2012). A123 systems and GM announce large but unspecified battery supply contract. *Automotive News*. http://gm-volt.com/2011/08/12/a123-systems-and-gm-announce-large-but-unspecified-battery-contract/

Cohen, N. W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*, 128–152.

Csaszar, F. A., & Siggelkow, N. (2010). How much to copy? Determinants of effective imitation breadth. *Organization Science, 21*(3), 661–676.

Damanpour, F., Walker, R. M., & Avellaneda, C. N. (2009). Combinative effects of innovation types and organizational performance: A longitudinal study of service organizations. *Journal of Management Studies, 46*(4), 650–675.

Dumitrache, A. (2010, August 4). Bosch invests EUR 400M annually in EV powertrain development. *Autoevolution*. https://www.autoevolution.com/news/bosch-invests-eur-400m-annually-in-ev-powertrain-development-23148.html

Dyer, J. H., & Nobeoka, K. (2000). Creating and managing a high-performance knowledge-sharing network: The Toyota case. *Strategic Management Journal, 21*(3), 345–367.

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review, 23*(4), 660–679.

Edelstein, S. (2016). Honda to cooperate with GM on plug-in hybrid technology? *Green car reports*. Retrieved April 11, 2022, from https://www.greencarreports.com/news/1101858_honda-to-cooperate-with-gm-on-plug-in-hybrid-technology

Eisenhardt, K. M., & Schoonhoven, C. B. (1996). Resource-based view of strategic alliance formation: Strategic and social effects in entrepreneurial firms. *Organization Science, 7*(2), 136–150.

Fallah, A. (2010). Toyota & Sanyo team up for lithium ion batteries. *Car Advice*. June 24, 2021, from http://www.caradvice.com.au/89122/toyota-sanyo-team-up-for-lithium-ion-batteries/

Fujimoto, T. (2014). The long tail of the auto industry life cycle. *Journal of Product Innovation Management, 31*(1), 8–16.

Furlan, A., Cabigiosu, A., & Camuffo, A. (2014). When the mirror gets misted up: Modularity and technological change. *Strategic Management Journal, 35*(6), 789–807.

Geels, F. W. (2018). Disruption and low-carbon system transformation: Progress and new challenges in socio-technical transitions research and the multi-level perspective. *Energy Research & Social Science, 37*, 224–231.

Goffin, K., Szwejczewski, M., & New, C. (1997). Managing suppliers: When fewer can mean more. *International Journal of Physical Distribution & Logistics Management, 27*(7), 422–436.

Grant, R. M., & Baden-Fuller, C. (2004). A knowledge accessing theory of strategic alliances. *Journal of Management Studies, 41*(1), 61–84.

Green Car Congress. (2007, June 27). Toyota and Matsushita deepen ties over hybrid batteries. https://www.greencarcongress.com/2007/06/toyota-and-mats.html

Green Car Congress. (2008, May 28). VW and Sanyo form Li-ion partnership; VW to focus on drivetrain electrification. https://www.greencarcongress.com/2008/05/vw-and-sanyo-fo.html

Green Car Congress. (2009, May 29). Volkswagen and BYD agree to explore partnership for hybrids and EVs. https://www.greencarcongress.com/2009/05/vw-byd-20090525.html

Green Car Congress. (2013). Volkswagen's first two production battery-electric vehicles debut at Frankfurt. https://www.greencarcongress.com/2013/09/20130911-vw.html

Greimel, H. (2011). Hitachi will supply LaCrosse battery pack. Automotive News. http://www.autonews.com/apps/pbcs.dll/article?AID=/20110307/OEM06/303079927/1186

Hamel, G. (1991). Competition for competence and inter-partner learning with international strategic alliances. *Strategic Management Journal, 12*(1), 83–103.

Helfat, C. E., & Campo-Rembado, M. A. (2016). Integrative capabilities, vertical integration, and innovation over successive technology lifecycles. *Organization Science, 27*(2), 249–264.

Helper, S., & Sako, M. (2010). Management innovation in supply chain: Appreciating Chandler in the twenty-first century. *Industrial and Corporate Change, 19*(2), 399–429.

Herrmann, F., & Rothfuss, F. (2015). Introduction to hybrid electric vehicles, battery electric vehicles, and off-road electric vehicles. In *Advances in battery technologies for electric vehicles* (Vol. 1, pp. 3–15). Woodhead Publishing.

Hitachi. (2008, March 04). Hitachi receives order from GM for lithium-ion battery systems for hybrid-electric vehicles. http://www.hitachi.com/New/cnews/080304.html

Industry week. (2007). Toyota boosts ties with Matsushita. Retrieved April 12, 2022, from http://www.industryweek.com/companies-amp-executives/toyota-boosts-ties-matsushita

Ingram. (2013, December). Envia's high-energy battery cell mired in dispute, GM cancels deal, green car reports. https://www.greencarreports.com/news/1088912_envias-high-energy-battery-cell-mired-in-dispute-gm-cancels-deal

Kalaitzi, D., Matopoulos, A., & Clegg, B. (2019). Managing resource dependencies in electric vehicle supply chains: a multi-tier case study. *Supply Chain Management: An International Journal*.

Khanna, T., Gulati, R., & Nohria, N. (1998). The dynamics of learning alliances: Competition, cooperation, and relative scope. *Strategic Management Journal, 19*(3), 193–210.

Kogut, B. (1988). Joint ventures: Theoretical and empirical perspectives. *Strategic Management Journal, 9*(4), 319–332.

Kolk, A., & Tsang, S. (2017). Co-evolution in relation to small cars and sustainability in China: Interactions between central and local governments, and with business. *Business & Society, 56*(4), 576–616.

Korosec, K. (2015, August 14). Audi is teaming up to build a Tesla competitor. *Fortune*. http://fortune.com/2015/08/13/audi-tesla-samsung-lg-chem

Laursen, K., & Salter, A. (2006). Open for innovation: the role of openness in explaining innovation performanceamong U.K. manufacturing firms. *Strategic Management Journal, 27*(2), 131–150.

Lee, S. C., Liang, H., & Liu, C. Y. (2010). The effects of absorptive capacity, knowledge sourcing strategy, and alliance forms on firm performance. *The Service Industries Journal, 30*(14), 2421–2440.

Leonard-Barton, D. (1992). Core capabilities and core rigidities: A paradox in managing new product development. *Strategic Management Journal, 13*(1), 111–125.

Lu, L., Han, X., Li, J., Hua, J., & Ouyang, M. (2013). A review on the key issues for lithium-ion battery management in electric vehicles. *Journal of Power Sources, 226*, 272–288.

Lu, Q., & Chesbrough, H. (2021). Measuring open innovation practices through topic modelling: Revisiting their impact on firm financial performance. *Technovation*, 102434.

Melander, L. (2017). Achieving sustainable development by collaborating in green product innovation. *Business Strategy and the Environment, 26*, 1095–1109.

Mendoza, A., & Argueta, J. (2000). Performance characterization GM EV1 Panasonic lead acid battery. Edison Company. https://avt.inl.gov/sites/default/files/pdf/fsev/2000panpbaev1report.pdf

Moreno-Mondéjar, L., Triguero, Á., & Sáez-Martínez, F. J. (2020). Successful eco-innovators: Exploring the association between open inbound knowledge strategies and the performance of eco-innovative firms. *Business Strategy and the Environment, 29*(3), 939–953.

Murmann, J. P., & Frenken, K. (2006). Toward a systematic framework for research on dominant designs, technological innovations, and industrial change. *Research Policy, 35*, 925–952.

Nair, A., Yan, T., Ro, Y. K., Oke, A., Chiles, T. H., & Lee, S. Y. (2016). How environmental innovations emerge and proliferate in supply networks: A complex adaptive systems perspective. *Journal of Supply Chain Management, 52*(2), 66–86.

Naughton, N. (2014, May 15). GM bringing more lithium-ion battery production in house. *Automotive News*. Retrieved August 06, 2021, from http://www.plasticsnews.com/article/20140515/NEWS/140519948/gm-bringing-more-lithium-ion-battery-production-in-house

Panasonic. (2008). Matsushita Electric Becomes Panasonic Corporation. https://news.panasonic.com/global/press/data/en081001-4/en081001-4.html

Park, W. Y., Ro, Y. K., & Kim, N. (2018). Architectural innovation and the emergence of a dominant design: The effects of strategic sourcing on performance. *Research Policy, 47*(1), 326–341.

Parmigiani, A. (2007). Why do firms both make and buy? An investigation of concurrent sourcing. *Strategic Management Journal, 28*, 285–311.

Paulraj, A., & Chen, I. J. (2007). Environmental uncertainty and strategic supply management: A resource dependence perspective and performance implications. *Journal of Supply Chain Management, 43*(3), 29–42.

Prencipe, A. (2000). Breadth and Depth of Technological Capabilities in CoPS: The Case of the Aircraft Engine Control System. *Research Policy, 29*(7–8), 895–911.

Randhawa, K., Wilden, R., & Hohberger, J. (2016). A bibliometric review of open innovation: Setting a research agenda. *Journal of Product Innovation Management, 33*(6), 750–772.

Reuters. (2009). VW plans Varta tie-up on electric car batteries. Retrieved April 11, 2022, from https://www.reuters.com/article/us-volkswagen-varta-idUSTRE58O2KN20090925

Sauer, A., Thielmann, A., & Isenmann, R. (2017). Modularity in roadmapping, an integrated foresight of technologies, products, applications, markets and society: The case of lithium ion battery LIB 2015. *Technological Forecasting and Social Change, 125*, 321–333.

Schilling, M. (1999). Winning the standards race: Building installed base and the availability of complementary goods. *European Management Journal, 17*(3), 265–274.

Schott, B., Puttner, A., & Muller, M. (2015). The market for battery electric vehicles. In B. Scrosati, J. Garche, & W. Tillmetz (Eds.), *Advances in battery technologies for electric vehicles* (pp. 35–54). Woodhead Publishing.

Shepard J. (2013, January 24). BMW and Toyota Pen strategic agreement for development of fuel cells and lithium-air battery tech. *EEPower*. https://eepower.com/news/bmw-and-toyota-pen-strategic-agreement-for-development-of-fuel-cells-and-lithium-air-battery-tech/#

Sierzchula, W., Bakker, S., Maat, K., & Van Wee, B. (2015). Alliance formation in the automobile sector during an era of ferment. *Creativity and Innovation Management, 24*(1), 109–122.

Sierzchula, W., Bakker, S., Maat, K., & Van Weeb, B. (2012). The competitive environment of electric vehicles: An analysis of prototype and production models. *Environmental Innovation and Societal Transitions, 2*, 49–65.

Soyoung, K. (2009). LG Chem could build battery cells in U.S., Reuters. Retrieved January 12, 2009, from https://www.reuters.com/article/us-autoshow-lgchem-idUSTRE50B4WH20090112

Suarez, F. F., & Utterback, J. M. (1995). Dominant designs and the survival of firms. *Strategic Management Journal, 16*(6), 415–430.

Tabuchi, H. (2014, May 12). Seeing future in fuel cells, Toyota ends Tesla deal. *The New York Times*. https://www.nytimes.com/2014/05/13/business/energy-environment/seeing-future-in-fuel-cells-toyota-ends-tesla-deal.html

Teece, D. J. (2018). Tesla and the reshaping of the auto industry. *Management and Organization Review, 14*(3), 501–512.

Tesla. (2010, June 30). Tesla Motors and Toyota Motor Corporation intend to work jointly on EV development, TMC to invest in Tesla. https://www.tesla.com/it_IT/blog/tesla-motors-and-toyota-motor-corporation-intend-work-jointly-ev-development-tm

Toyota. (1997, December 11). Matsushita and Toyota establish Panasonic EV Energy Co., Ltd. for Ni-MH EV batteries. https://global.toyota/en/detail/8144406; http://news.panasonic.com/press/news/official.data/data.dir/en081001-4/en081001-4.html

Tushman, M. L., & Anderson, P. (1986). Technological discontinuities and organizational environments. *Administrative Science Quarterly, 31*, 439–465.

Wald, M. (1994, December 3). GM and Ovonic to make batteries for electric cars. *The New York Times*. https://www.nytimes.com/1994/12/03/business/gm-and-ovonic-to-make-batteries-for-electric-cars.html

Wang, Q., Jiang, B., Li, B., & Yan, Y. (2016). A critical review of thermal management models and solutions of lithium-ion batteries for the development of pure electric vehicles. *Renewable and Sustainable Energy Reviews, 64*, 106–128.

Wayne Dobson, M. (2000). The automotive industry development process for major radically new technologies, inception to production: A study of electric and hybrid electric vehicles. Master Degree in Science and Technology thesis. MIT. https://dspace.mit.edu/bitstream/handle/1721.1/88822/45403133-MIT.pdf?sequence=2

Wilhelm, M., & Dolfsma, W. (2018). Managing knowledge boundaries for open innovation–lessons from the automotive industry. *International Journal of Operations & Production Management, 38*(1), 230–248.

Williams, M. (2009, February 13). Toshiba, Volkswagen plan to work on electric car technology. *Network World*. https://www.networkworld.com/article/2262698/toshiba%2D%2Dvolkswagen-plan-to-work-on-electric-car-technology.html

Zaun T., (2004, March 10). Ford to use Toyota's hybrid technology. *The New York Times*. https://www.nytimes.com/2004/03/10/business/ford-to-use-toyota-s-hybrid-technology.html

Zirpoli, F., & Becker, M. C. (2011). The limits of design and engineering outsourcing: performance integration and the unfulfilled promises of modularity. *R&D Management, 41*(1), 21–43.

8

Automotive Distribution at the Gates of Change: Towards New Architectures

Leonardo Buzzavo

8.1 The Evolution of Automotive Distribution Architectures

8.1.1 The Evolution of the Franchised Dealer System

The development of market demand for automobiles in the twentieth century has led automakers to allocate a growing degree of focus to the specific organization of the distribution system. Albeit allowing for inevitable differences due to geographies and to individual brand strategies, one could say that the industry has gradually converged towards the adoption of a pattern of vertical quasi-integration (Pashigian, 1961; Volpato, 1989). This choice has implied the orchestration of a selective distribution system, where franchise standards determined the features that dealers had to possess in order to operate and satisfy demand.

L. Buzzavo (✉)
Department of Management-Venice School of Management,
Ca' Foscari University of Venice, Venice, Italy
e-mail: buzzavo@unive.it

A. Cabigiosu, P. Lanzini (eds.), *The Green Transition of the Automotive Industry*,
https://doi.org/10.1007/978-3-031-37200-1_8

Franchised dealers, intended as independent entrepreneurs who invested their own capital and focus, tended to give up much of their entrepreneurial independence by adhering to standards, accepting significant restraints existing in the franchising contract in exchange for satisfactory profitability levels.

Over time more sophistication in consumer needs called for a proliferation of products and their related service needs, thus generating more complexity. It must be pointed out that franchised dealers are not just involved in selling and in physical distribution activities but have become more and more involved in tasks involving marketing and brand support since manufacturers are highly interested in enhancing the purchase and ownership experience towards greater levels of customer loyalty. All this has led dealers to become more professional and organized in their processes, in their human resources and organization, in their portfolio of services, typically determining a gradual increase in both fixed and variable costs. In order to convince dealers to adopt more professional standards, manufacturers have gradually introduced more and more elements of variability in gross margins, including both quantitative and qualitative bonuses, mainly related to brand-specific investments and processes. Moreover, a general increase in the presence of commercial campaigns by manufacturers—on top of gross margins—to support competitiveness in an ever-crowded marketplace, has determined a greater impact of manufacturers' choices over dealer profitability. This determined an increased scope for manufacturers to control dealer through economic means. In some cases, margin schemes and campaigns have grown in complexity and bureaucracy to a level that some dealers consider quite burdensome: the risk is to take away focus from value-added activities—such as customer prospecting, customer experience and so on—and to dedicate more time and effort to complicated and bureaucratic tasks.

8.1.2 The Range of Strategic Options in Distribution

It must be noted that the presence of franchised dealers does not always allow a full market coverage for sales and/or service activities, particularly in less densely populated regions. And while the geographical distance that a consumer may be prepared to drive in order to buy a new car may be significant, for service activities this is dramatically reduced. This has led more and more brands to promote a network of service provision with the establishment of additional service outlets, either operated by franchised dealer themselves—in this case generally labelled as 'service satellites'—or operated by other subjects. These typically consist in service-only authorized players, that may or may not hold a direct link to the manufacturers depending on legal frameworks and brand choices. So, there may be first-tier service-only authorized players, holding a contractual relationship with the manufacturer, or else second-tier service-only authorized players, who hold a relationship with the local franchised dealer.

As said, the automotive distribution system is typically shaped by a logic of vertical quasi-integration, where manufacturers do not own and directly control dealers but rather tend to exert a considerable degree of control through economic means, mainly consisting in franchise standards, variable margin schemes plus commercial campaigns (Dietl et al., 2009; Jacobides et al., 2006). The option of directly owning and operating dealerships appears quite an exception on the global scene, with a few exceptions:

(a) Directly operated stores (DOS) in some metropolitan areas. While this option is legally forbidden in some geographies (e.g. many US states), it is frequent for brands to own and to operate some outlets directly. It must be said that in practice this option is quite limited to some brands and some geographies: sometimes it is a legacy from the past or, more often, it is required by the need to comply with very high representation costs in metropolitan areas. In some cases, and similar to other industries, it is seen as a laboratory for the manufacturer where to experience first-hand contact with consumers and acquire more knowledge and insights in retail, believed to be functional also to calibrate standards. When looking at Europe, where this solution is legally allowed, according to data by ECDH-ICDP approximately less than 3% of total sales outlets are falling in this category. This average relates to considerable variation among brands, with some French brands—like Renault in France for example—and German brands—like BMW in Germany—being the most representative cases. Evidence from industry sources suggests that profitability levels and customer satisfaction levels of owned-operated outlets are generally lower than for most dealers.

(b) Directly operated network in some countries. This is typically the case where a brand in a minor country has established a National Sales Company directly owning and operating dealerships. Another case is represented by Porsche Holding with some of the Volkswagen Group franchises, where a company linked to the manufacturer (albeit not the manufacturer itself) controls a sizable share of dealerships even in larger markets.

(c) Tesla. The brand has adopted a direct sales approach from its beginning in 2008, with presence focused on relatively small Tesla stores typically located in metro area shopping malls. Service activities mainly rely on mobile service provision and remote diagnosis. Presence in each country is comparatively much lighter versus traditional brands, with very lean offices and staff compared to headcount-heavy National Sales Companies owned by brands in major markets in which they operate. Albeit representing an interesting example of a direct route, often drawing attention in the industry, it must be said however that Tesla holds some peculiar features that make its imitation rather difficult. The brand could enter the market over a decade ago with a green-field approach through an electric-only product targeting early adopters and leveraging on the strong awareness revolving around the charisma of its founder Elon Musk. This choice allowed to eliminate traditional features such as the advertising budget, typically a relevant spending for brands, as well as dealership intermediaries. Interestingly, in more recent years the approach by Tesla has evolved, along with the growth in volumes in lower segments, the need to deal with increased competition in electric vehicles and the need to address consumers in other stages of the adoption curve. Small shopping mall outlets started making room for Tesla Centers, larger in size and sometimes located in former dealer premises of traditional brands.

8.2 Competitive Pressures and Enablers for Change

8.2.1 Network Concentration

Going back to the industry architecture in distribution we then observe that vertical quasi-integration through networks of independent dealers appears the default strategy for brands across the world. Two major phenomena that impact onto this framework can be highlighted and therefore discussed here. The first is the trend towards concentration that had started some time ago and is still producing its effects. The second is the growth in digital technologies and in particular consumer adoption of tools such as smartphones inducing dis-intermediation or re-intermediation that alters the traditional equilibria. Let's explore these two in sequence.

A seller's market that endured for quite some time, where demand exceeded supply, led automakers to extend their market coverage by adding more and more dealers. This has created the conditions for achieving significant commercial performances by tapping into as many areas as possible. Also, brands noting significant commercial potential in a given area, while realizing that the locally appointed dealership was not fully exploiting it, typically created the conditions for more competition, by adding another dealer representative. Broadly speaking the distribution architecture dealing with a seller's market was characterized by a two-fold feature. On the one hand there was a considerable number of dealers, causing the average sales throughput per dealership being challenged downwards when market started showing signs of retreat. On the other hand, the quest for sales volumes and local market presence induced brands to stimulate the installation of considerable retail capacity, typically translating into relatively large showrooms along with elaborate organizational structures. A common feature of these solutions was a relatively high break-even point, requiring high volume levels in order to be profitable. So, in cases of market downturn there came a double combined effect, being the reduction in average sales throughput due to the presence of too many dealers, plus a fall in profitability given that the relatively high break-even point was not suitable for lower sales volumes.

More competition, rising standards and operational costs, shrinking margins, all gradually lead to retailer concentration so that dealers not capable of coping with the new market conditions, plus those without sufficient motivation and/or succession plans, are driven to exit the market or to become the target for acquisitions by bigger players, typically those backed by more financial solidity (Buzzavo, 2008). Such concentration has been partly facilitated by manufacturers who, beginning to recognize that in some cases they had pursued strategies of territory coverage that led to too many intermediaries during stages of market growth, have started aiming at a lower number of more solid entrepreneurs with a stronger equity structure and more professional facilities and systems, capable of playing a better role as retailing partners. This trend has been unfolding with an orientation towards multi-branding—dealers representing more than one brand—exploiting some degrees of synergies and scale economies. Over time manufacturers have therefore become more open to multi-branding, realizing that stronger and more professional players, albeit not fully dedicated to their own brand at the corporate level, could be a more relevant strategic alternative to perform well in the medium-long run. It must also be noted that multi-brand dealers can also provide significant support to the brand even during times of difficulty that may be related to a specific brand or brand category, for example a time of ageing product lines waiting for fresher products or a general negative market trend towards specific segments—that is, lower propensity or more aggressive taxation towards luxury products.

When looking at dealer numbers (see Table 8.1), data from various sources across many geographies provide evidence of a process of gradual consolidation.

What are the factors driving the concentration in dealer numbers? What led an industry typically following a route of dealer coverage expansion to then feature the opposite trend? Let’s explore some of the most important ones.

As previously said, manufacturers began realizing that too many dealers competing for the same market would trigger price wars that would

Table 8.1 Network concentration

USA: the number of dealerships owned by the top largest 150 dealership companies grew by 66% from 2011 to 2021 (source: Automotive News Research & Data Center)
Europe: the number of main dealer sales outlets from 2010 to 2022 fell by 14% (source: ICDP—ECDH)
Brazil: the number of dealership companies fell by 23% between 2018 and 2022 (source: Fenabrave)
Italy: the number of dealership companies fell by 70% between 2002 and 2022 (source: Quintegia Dealer Network Study)

not only compromise sales margins, but also induce short-termism and situations of negative fallout on attention to customer satisfaction and customer experience, elements that were becoming more and more important over time in a more competitive environment looking for constant differentiation in a crowded marketplace.

Secondly, the increased sophistication in products, in managing a broader set of activities related to customer service, in adopting a deeper inclination to measurement of performance and continuous improvement, in the acquisition of new competences to master the use of digital technologies so important in retail were among the major reasons calling for a growing alignment between brand standards—intended not just as physical standards for facilities but also operational and organizational standards related to processes—and dealers themselves. In other words, manufacturers started realizing that it was more viable to promote investment, innovation and collaboration on key areas of improvement with a smaller number of dealer entrepreneurs rather than having to deal with a large number of intermediaries. Also, the lack of entrepreneurial succession in some companies, typically having a family-based nature, created a barrier towards the desired continuity that a brand would like to ensure in terms of local representation and market power.

On top of this, the increasing importance of new technologies plus challenges in overheads associated to more and more elaborate organizational structures capable of catering to evolving customer needs, determined a rise in overhead costs, automatically triggering the need to achieve scale economies, particularly in the domains of systems, administration and logistics.

Larger players could also develop a stronger managerial attitude and competence dedicating to the promotion and development of ancillary services and adjacent business areas, such as used cars and mobility services (Buzzavo, 2013).

Finally, the sophistication in retail—and the related impact on the skills and competences required—push companies towards the need to attract talents capable of evolved and more disciplined processes, a more mature managerial logic, a praxis of measurement and improvement on a constant basis. It is quite hard for a small size company to attract talents, since it has very little room to offer opportunities for career advancements. On the contrary a large firm, and even more a multi-dealership group, with more locations, a more structured set of hierarchical layers, plus more developed areas of back-office and service activities, can focus on employer branding and attract talents who can at least bet on a rewarding career inside that same company.

8.2.2 The Digital Challenge in Automotive Retail

As seen, the quest for greater efficiency and effectiveness in automotive retail has led towards a higher degree of concentration. The advent of digital technologies, and e-commerce opportunities in particular in a context where most consumers hold digital tools, has represented an important driver of transformation beginning in the last years of the twentieth century, with a major acceleration over the last decade. Digital technologies represent an enabling factor for the traditional industry challenge to evolve from a stock push model towards a customer pull logic (Holweg & Pil, 2005). While some product categories were starting to be sold and purchased over the internet a few decades ago—most notably starting with books and music CDs that sparked the early fortunes of platforms such as Amazon—players in the automotive distribution industry were starting to wonder to what extent the e-commerce route would affect the retail architecture. The early stages—towards the end of the twentieth century—were characterized by the emergence of third parties exploiting a referral scheme. They boosted their online visibility so that consumers looking for vehicles could be intercepted, and the intermediaries could then direct the lead—meaning the customer profile and contact details—to a dealer in a given region. This approach, with Autobytel being one of the most notable examples in the US market of such infomediaries, exploited the scarce attitude of existing players—both manufacturers and dealers—to grow their online presence therefore acting as a broker. This was the time when the so-called internet sales were believed to be an additional channel: franchised dealers who had begun using more than one infomediary started having separate entries in their premises to treat those 'internet customers'. While infomediaries started booming, franchised dealers and manufacturers started growing more familiarity with the internet as a marketing tool, hence enhancing their capabilities to promote greater visibility and to better manage related processes. This was the time when dealers improved their websites, started promoting more online advertising, along with manufacturers' stimulus and support. As a consequence, after what we could define as a first early stage of using the internet in automotive retail with a prominent role of third parties such as infomediaries, the industry entered a second stage with a more direct role of incumbents such as dealers and manufacturers now aware of the critical importance of stimulating and managing leads through the internet. During this second stage the internet mainly acted as a lead generator, with customer prospects then entering a sales funnel that gradually goes back to the traditional sales process, albeit with some specific measures and steps involved. After this second stage that basically injected the internet in the early stages of the shopping process—for example, digital marketing—players started moving to the next stage being the creation of actual e-commerce, albeit not completely, in the process. This third stage consisted in allowing customers to start booking a vehicle, paying a deposit, sometimes subscribing to a specific service, therefore enhancing e-commerce elements in additional steps of the customer journey. Full online transactions—that we may consider a sort of fourth stage in this sequence of situations—are a more recent phenomenon attracting growing experimentation dealing with a range of technical, regulatory and operational implications that require specific solutions and agreements. It is not hard to understand how acquiring a car involves greater complexity and risk than buying other product categories over the internet, not to mention aspects such as for example the change of title, payment, financial services, insurance and so on. But besides these barriers one should also consider the complexity associated with how an internet-driven sale might impact the existing manufacturer-dealer relationship, and this has two major implications. The first is that if customers are opting for a deeper and more frequent use of the internet in the shopping process, then the function of physical premises is diminished. This creates a potential mismatch between standards enforced by manufacturers on dealers (e.g. minimum square metres for display areas) that may result in costly investments with decreasing returns. The second implication is that manufacturers promoting a more active role in seeking direct customer contact may become potentially able to sell directly, hence bypassing the dealer who may be reduced just to a delivery point (this is an aspect that will be discussed further in the next section of this chapter).

Research being carried out by many entities in the car industry has demonstrated that customers started incorporating the internet into their shopping process as an integral element. For cars such as for many other product categories, consumers are moving across different steps of their shopping journey with a constant shifting across digital and physical components, often at the same time, for example when using digital tools inside a physical store. This implies that the internet cannot be seen as a separate channel, but it has rather become a key feature of a digitized world that is challenged not just to add one channel, but rather to integrate it with consistency into its overall retail architecture and policies, in a configuration defined 'omni-channel' (Table 8.2).

What emerges when looking at these evolutionary stages is that over time the role of the internet in automotive retail evolved from a separate standalone channel to a pervasive element affecting the whole of the company processes and its relationship with the target market. This implies that a 'silo approach' is not functional any longer and players should embrace a new logic that blends the digital landscape into the overall omni-channel architecture.

More room for e-commerce, at least in principle, inevitably acts as one of the triggers inducing some brands to take on a more active role in distribution. This leads also into a broader discussion into the trend

Table 8.2 The evolution of e-commerce in automotive distribution

Stage	Typical feature	When
1. Infomediaries	Third parties using a referral system	Late 1990s
2. Lead management	Manufacturers (OEMs) and dealers generating and managing leads via internet	Early 2000s
3. Partial e-commerce	Manufacturers (OEMs) and dealers introducing digital touchpoints in the customer journey such as booking, reserving a vehicle	2010s
4. Full e-commerce	Experimenting full purchase or subscription	2020s

Source: Own elaboration

involving automotive distribution architectures related to the agency model, that will be examined in the next section.

8.3 The Quest for Retail Coordination: Reshaping Distribution Architectures

8.3.1 Going Direct? The Agency Option

We have seen earlier in this chapter how automotive retail has seen a process of gradual concentration triggered by a set of economic and organizational reasons. This is a longer-run process that had already started decades ago, triggered by the growing intensity of competition induced by globalization and by the constant entry of new brands in the marketplace. On top of this, we have seen a medium-run phenomenon being the advent of the internet and digital communication tools becoming widespread among consumers. This has led automotive retail to cope with new dynamics and grasp new opportunities, upgrading its marketing and sales processes in a transition that it is still undergoing at present. While the internet started affecting retail in the 1990s, it is only in the 2010s that the diffusion of smartphones and the shifts in consumer behaviour have determined a stark acceleration in this transformation, triggering most experimentations in digital customer journey and a shift towards an omni-channel retail. The industry is now undergoing a shorter-run momentum that tops the above-mentioned waves of transformation with other new elements. We can identify the growing urgency to adopt electrification as one of them—a topic discussed also elsewhere in this book—and a growing interest among some manufacturers to adopt a more direct role in the architecture, mainly with an agency model. The latter will now be the focus of our analysis.

As specified early, the automotive distribution architecture has been traditionally shaped with a logic of vertical quasi-integration consisting in network of franchised dealers being independent entrepreneurs. In such way manufacturers manage the trade-off between control on the one hand and costs and risks on the other hand through a selective distribution scheme based on standards. But economics and organizational reasons lie behind a growing interest among many brands to evolve to a greater degree of control, that an agency-based approach may entail. When looking at **economic** reasons we can identify the need to:

- Improve transaction prices by limiting customer discounts often triggered by intra-brand competition. Albeit most recent times have seen shortages in product supply induced by exogenous events—that is, the pandemic, the supply chain shortages and the Russian-Ukrainian conflict—that reduced stock push and its related rebates in favour of customer pull and therefore improved margins, it is not clear to what extent the industry can operate on a customer pull mode once the context may ease.
- Cut distribution costs by internalizing the gross margin awarded to dealers, and this clearly relates to the ability to more efficiently and effectively run those portions of the chain, as it will be discussed later on.
- Generate new margins associated to other revenue streams that may stem from advances in technology and/or evolving customer needs such as in-car services, activation of vehicle features throughout the ownership process, mobility services and so on.

When looking at **organizational** reasons we may consider the need to:

- improve customer experience, particularly for premium brands who find it most important to differentiate how customers are treated along

the many steps of the customer journey and the purchase and ownership process.
- Take advantage of opportunities enabled by digital technologies towards a more direct role and relationship.

It must be highlighted that the push towards electrification that is mandated by governments, requiring manufacturers to build and sell zero-emission vehicles in a not-too-distant future, also intertwines with the elements mentioned above. On the one hand electric vehicles tend to be more expensive than their internal-combustion counterparts, mainly due to the high costs of the battery pack, and the quest to make them more accessible creates extra pressures on the total value embedded in the architecture and therefore on the distribution margins. On top of this, while internal-combustion engines determine significant service and parts revenues to brands for electric vehicles such revenues are estimated to drop given the intrinsic features of electric motors, and this drives some manufacturers to eye the business of energy provision by trying to promote partnerships or more structured initiatives (i.e. Volkswagen Group with Electrify America unfolding in a similar fashion like Tesla's Supercharger network).

So, economic and organizational elements are leading more manufacturers to consider adopting a more direct role in automotive retail, and undoubtedly the success achieved by Tesla, who adopts a wholly direct approach, also contributes to make this option worth considering—albeit as previously said this remains a peculiar case. In order to assess to what extent this seems feasible, let's examine in detail how the agency model compares with the current system based on networks of franchised dealers.

The main difference between the dealership contract and an agency model is that dealers purchase cars from the car maker and resell them to customers on their own name, making a profit from the sale, while agents act on behalf of the automaker (Young, 2021). The agent does not own the vehicles and the invoice is sent by the car maker to the customer: the agent receives sales commissions and eventually compensations for additional services carried out on behalf of the car manufacturer. In the automotive industry agency finds application mainly in new vehicles sales, but it could also be applied to used cars business, while it is not typically used in service and spare parts distribution (Table 8.3).

8.3.2 An Assessment of the Agency Route in Retail

As seen in Table 8.3, agency marks some important differences when compared to the dealership contract also with regard to the level of risks involved: in principle the pure commercial agent would risk only the time spent at the job, with all other risks being borne by the brand (the principal).

It must be said that there are variations on the basic scheme, also when considering country-based regulations that are in place with respect to commercial agency and related practices. For example, some automotive brands envision a variation on the pure agency scheme, with agents carrying out invoicing in their own name.

Without entering quite complex territories that include country variations and articulated legal nuances, that would also fall beyond the scope of this work, we would rather focus on the economic consequences impacting on the manufacturer-dealer relationship entailed by the new architecture. On the whole, the dealership would see a reduction in its

Table 8.3 Franchised dealer vs. commercial agent: key differences

	Franchised dealer	Commercial agent
Basics	Operates according to guidelines, receives margins, carries risk on investments, stock	Performs a defined task for the principal (OEM), receives a commission, carries no risk
Selling	Owns stock, sets selling price, and invoices in own name	Principal (OEM) owns stock, sets selling price and invoices in own name
Investments	Expected to make relationship-specific investments	OEM pays for (or reimburses) all relationship-specific investments
Overall approach	Independent entrepreneur—takes more risks, but potential for more rewards	Stable and predictable business for agent; agent's business is transparent to the OEM

Source: Elaboration from Young (2021)

scope of activities, as some are picked up by the manufacturer directly, and its entrepreneurial scope of action would be diminished in favour of a more structured relationship relying on the manufacturer approach. Total turnover would decrease, as invoicing commissions would inevitably be generating smaller invoices than vehicle transaction prices. Smaller headcount and smaller turnovers would also correspond to profitability levels expected to be smaller, however with a lower commercial risk. But it is on the manufacturer side that the situation appears even more challenging, with considerable impacts in terms of operational costs and all the set of processes, systems and people related to internalizing activities that were left in the dealer scope of action before.

Manufacturers who have announced the transition to agency schemes include the already mentioned Stellantis group for European markets, and include many premium brands, with Mercedes in a prominent role, having already piloted for quite some time this model in Sweden—as well as in some domestic market situations. Frictions with dealer networks are not rare if one considers that the transition to an agency model implies a thorough impact on the legacy investments carried out by dealers. In other words, a typical component of the franchised dealer architecture is the need to carry out brand-specific and therefore idiosyncratic investments, that are expected to be recovered over time through sales margins. But the shift to agency with the provision of smaller commissions put those investments under the spotlight, and networks become concerned, often generating frictions and litigations.

In order to carry out some evaluation of this trend it is useful to do so while analysing how agency might fulfil the need for some specific objectives envisioned by manufacturers.

With respect to driving motives that have previously been identified as economic drivers there was the need to control transaction prices. Asides from any comment on the sensitivity of this issue with respect to competition laws, it should be said that agency does not appear as the only strategic avenue towards that objective. As a matter of fact, the reduction of dealer networks favouring more concentration—as previously described, a common factor across many markets—plus a shift to more demand-pull rather than stock-push may move in that direction. The need to reduce costs is often referred to as a rationale driving towards agency: but shifting to agency inevitably implies higher operational costs in the early stages, so the end game would result from the ability to achieve significant economies—particularly scale economies—in a reasonable time frame, and this has to be demonstrated. Finally, the need to exploit greater revenue generation over the ownership cycle triggered by connectivity and electrification does not necessarily require agency in order to function, as customer information is already shared within the existing franchise architecture.

When looking at organizational drivers the need to improve customer experience is often heralded as a go-to for agency, since brands—in particular premium brands—often strive to steer dealers towards the desired behaviours in a consistent and constant way by dealers who are sometimes seen as non-compliant or distracted with the desired levels of service and care. However, with agency this evolves from being an indirect problem for the automaker to being its own direct problem. As a matter of fact, evidence so far has shown in general quite unsatisfactory performance in situations where automakers are directly owning and operating retail outlets, particularly with customer satisfaction and customer advocacy levels, typically recorded via CSI-Customer Satisfaction Index and NPS-Net Promoter Score studies. Also, it must be said that shifting more coordination at upper levels inevitably generates more rigidity, and this is risky in a context that is highly turbulent and customer attitudes become more differentiated. On top of this, it should be considered that internalizing some activities traditionally falling in the dealer's domain requires a considerable degree of focus and resources, not to mention the required competences involved. Finally, when the need to promote more consistency towards the value proposition in an omni-channel world is underlined as a driver towards agency, one should not forget that the blending of online activities in the customer journey—a topic that has been previously discussed as a critical element in the architecture—inevitably poses heavy challenges in any situation.

On the whole, brands who are crafting their new intended architectures towards agency models may end up realizing that the path may be on a serious upward slope and perhaps posing more problems than initially expected. Costs may be up more than expected, and not be decreasing in the longer run as expected, while revenue growth assumed through new margins and better loyalty may be overestimated. Frictions with existing network members may generate direct litigation costs plus indirect fallout in the quality of the relationship, while operational complexity, also associated with country-specific regulations, may represent a maze that is quite difficult to navigate. On the whole, the transition lead time may end up being much longer than planned, and this brings up an important fact: such an important shift in the architecture would require a solid guidance at the top, in order to resist the headwinds that may threaten it, and that lead time may fall well beyond a typical lead time in waves of strategic plans adopted by brands. Perhaps the most delicate aspect, and this may represent in our view the strongest barrier to be overcome when shifting to agency, would go back to the core competence, being the ability of the manufacturer to be more of a retailer, something that falls out of its traditional portfolio of competences (Prahalad & Hamel, 1990).

8.3.3 A Glimpse into the Future of Automotive Retail

While future outcomes are inevitably hard to envision in a complex and volatile world, we may well highlight that in many industries a mix of distribution architectures exists, with a blend of solutions. Even in brands commonly referred to as emblems of a direct route, hybrid situation is in place: Apple for example, a brand that marked a major departure from the typical value chain architecture in consumer electronics, features hybrid situations, where directly owned and operated retail stores—both physical stores most typically in metropolitan areas and an e-commerce site—co-exist with indirect distribution channels involving authorized resellers.

As discussed throughout this chapter, automotive retail has evolved for about a century now, but its basic architecture has remained rather unchanged. Globalization, competition and the advent of e-commerce have triggered some adaptations, such as network concentration and attempts for more omni-channel management, that have recorded evolution rather than revolution. The interest towards architectural change with the agency model announced by a sizable number of brands determines a significant change, probably the most radical attempt to change that has involved the industry for quite a long time, however we have laid out a set of cautionary remarks suggesting that the outcome may be a situation of hybrid approaches and co-existence. We may see some brands operating agency while other brands operate franchised networks, plus even some brands operating hybrid channel architectures featuring a bit of both. Also, hurdles on the route to agency may lead some brands to resort to an upgrade of the franchised dealer architecture promoting better alignment and cooperation. This co-existence may be a feature of the automotive retail system into a new stage, with hybrid situations involving not just economic and contractual agreements, but also the proliferation of multiple compartments requiring players to cope with greater variance. This is the case of the co-existence of the sales of internal-combustion cars along with hybrid and electric vehicles, the co-existence of an evolved mix of physical and digital touchpoints, the co-existence of ownership formulas along with subscription and shared ownership models, including access-based propositions. As a matter of fact, while the internet and digital technologies are allowing new forms of coordination and brand-customer relationships, it is undeniable that the provision of services revolving around mobility and therefore the ability to operate as a mobility hub will also require a combination of physical resources and infrastructure. In other words, both atoms and bits will be important towards satisfying consumer needs. On the whole, it seems that managing automotive retail will require greater multi-tasking abilities and the development of a more articulated portfolio of competences in order to cope with an ever-differentiating context.

References

Buzzavo, L. (2008). Business strategies and key success factors for automotive retailers: The case of dealer groups in Italy. *International Journal of Automotive Technology and Management, 8*(1), 105–119.

Buzzavo, L. (2013). Towards a new business model for automotive distribution. In A. Stocchetti et al. (Eds.), *Automotive in transition. Challenges for strategy and policy* (pp. 77–97). Ca' Foscari Digital Editions.

Dietl, H. M., Royer, S., & Stratmann, U. (2009). Value creation architectures and competitive advantage: Lessons from the European automobile industry. *California Management Review, 51*(3, Spring), 24–49.

Jacobides, M. G., Knudsen, T., & Augier, M. (2006). Benefiting from innovation: Value creation, value appropriation and the role of industry architectures. *Research Policy, 35*, 1200–1221.

Holweg, M., & Pil, F. K. (2005). *The second century: Reconnecting customer and value chain through build-to-order moving beyond mass and lean production in the auto industry*. The MIT Press.

Pashigian, B. P. (1961). *The distribution of automobiles, an economic analysis of the franchise system*. Prentice-Hall.

Prahalad, C. K., & Hamel, G. (1990, May–June). *The core competence of the corporation*. Harvard Business Review.

Volpato, G. (Ed.). (1989). *Commercializzare l'automobile*. Cedam.

Young, S. (2021). Agency. A better approach to distribution networks? *ICDP Executive Briefing*. International Car Distribution Programme No. 06/21.

9

The Role and Design of Open Territorialized Mobility Platforms for Sustainable Mobility

Flavia Furegato and Anna Cabigiosu

9.1 Urban Mobility in Europe

People mainly travel within urban areas to go to work and school rather than for pleasure (Kanger et al., 2020; Ruggieri et al., 2020). Mobility of people is at the heart of our society and economic activities. Globally, passenger travel activity increased by 74% between 2000 and 2015 and it is estimated that it will double in cities by 2050, with several negative consequences, such as congestion, air pollution, noise, and accidents (Nemoto et al., 2021).

Urban mobility platforms often include multiple services and modes of transport (by rail, road, and sea) (Mounce & Nelson, 2019). To

---

F. Furegato
Auto Po Group, Ferrara, Italy

A. Cabigiosu (✉)
Department of Management-Venice School of Management,
Ca' Foscari University of Venice, Venice, Italy
e-mail: anna.cabigiosu@unive.it

A. Cabigiosu, P. Lanzini (eds.), *The Green Transition of the Automotive Industry*,
https://doi.org/10.1007/978-3-031-37200-1_9

describe the mobility situation of a city, region, or urban area, we talk about "modal split", which is the percentage of trips that occur regularly in an area by transport system. Sustainability in transport can be achieved with sustainable modes of transport, and private car use does not usually enhance sustainability, whereas public transport and non-motorized modes, such as walking and cycling, do (Black, 2010). It is therefore important to understand what drives people towards and away from specific modal splits and the trend of those who move by choosing among the various transportation systems available, including public and private transportation, scheduled services such as buses and streetcars, dial-a-ride services such as cabs, car sharing, micro-mobility devices such as bicycles and scooters, and walking, in order to enhance transport sustainability (Santos et al., 2013).

The study of travellers' choices and definition of some emerging trends aim to improve the design and sustainability of urban transport to meet current and future passenger needs. What means of transportation do Europeans prefer to use? Table 9.1 shows the travel preferences of European citizens by percentage according to the type of transportation used, considering that most daily travel takes place for work purposes. The data presented are extracted from the EPOMM[1] dataset and the Audimob-ISFORT[2] (for Italian cities) datasets on the modal split of all trips in cities above 400,000 inhabitants. Of these, we present data for 32 European cities that are among the most representative of different geographic areas and among those with the highest population density, which are more exposed to traffic issues and are challenged by the need for more efficient public transportation systems.

Among the 32 cities selected, the percentage of trips made on foot is equal to or greater than 30% in only 13; among them, only Naples, Paris, Seville, and Valencia are small centres, less than 200 km^2, and therefore

---

[1] EPOMM is the European platform on Mobility Management (MM), formed by a network of governments in European countries, represented by the ministries that are responsible for MM in their countries. EPOMM is an international non-profit organization based in Brussels. One of the most popular tools is TEMS (The EPOMM Modal Split), a database of the modal splits of more than 380 European cities of varying sizes (largely consisting of centres with above 100,000 inhabitants).

[2] Italian High Institute for Transportation Education and Research, available at https://www.isfort.it/ricerca/audimob/.

Table 9.1 Data about modal trips in the main European cities

City	Country	Population	Area (km^2)	On foot (%)	By bicycle (%)	Private transport (%)	Public transport (%)
Amsterdam	Holland	747,093	219	20	22	38	20
Athens	Greece	3,627,500	3808	8	2	53	37
Barcelona	Spain	4,600,000	7733	46	1	35	18
Berlin	Germany	3,506,239	892	30	13	31	26
Brussels	Belgium	1,136,920	161	3	2	47	48
Bucharest	Romania	1,940,000	228	22	1	24	53
Budapest	Hungary	1,700,000	525	32	1	2 k	47
Copenhagen	Denmark	548,443	88	25	31	29	15
Genoa	Italy	583,601	243	21	0	48	31
Hamburg	Germany	1,735,663	755	28	12	42	18
Helsinki	Finland	613,100	715	32	11	23	34
Lisbon	Portugal	2,800,000	2802	16	1	48	35
London	England	7,556,900	1572	20	3	40	37
Lyon	France	1,243,000	1746	32	2	51	15
Madrid	Spain	3,260,000	606	29	0	29	42
Marseille	France	1,177,000	672	34	1	54	11
Milan	Italy	1,352,000	182	22	4	47	27
Munich	Germany	1,326,807	310	28	14	37	21
Naples	Italy	3,085,000	119	30	1	18	51
Oslo	Norway	573,185	454	34	5	36	25
Paris	France	2,211,297	105	47	3	17	33
Riga	Latvia	699,000	307	19	2	45	34
Rome	Italy	2,628,080	1285	16	0	27	57
Seville	Spain	1,450,000	141	31	2	53	14
Sofia	Bulgaria	1,600,000	1344	14	3	51	32
Stockholm	Sweden	1,889,945	6519	17	1	47	35
Tallinn	Estonia	414,752	159	30	4	26	40
Turin	Italy	886,837	130	7	1	64	28
Valencia	Spain	1,540,000	135	41	2	40	17
Vienna	Austria	1,721,573	415	28	6	29	37
Vilnius	Lithuania	554,192	401	36	1	38	25
Warsaw	Poland	1,702,000	517	21	1	24	54

Source: EPOMM-TEMS and Audimob-ISFORT

more easily traversable, while the other nine have a medium or large territorial extension. Interestingly, the citizens of Barcelona, the city with the largest land area considered in the analysis, move much more on foot (46%) than by private or public transportation. As far as bicycle travel is concerned, excluding Copenhagen and Amsterdam, there are even fewer centres with a value that can be considered significant; in fact, most are at a level below 10%.

Public transport accounts for more than 30% of trips in 56% of cities analysed, while in Marseille and Seville it does not reach 15%. The proportion of trips made by public transportation exceeds 50% in three cities: Rome (57%), Warsaw (54%), and Bucharest (53%).

Private vehicles, including cars and motorcycles, are the most frequently used and least environmentally sustainable form of modal split; the Italian city of Turin ranks first in terms of private vehicle use, with this journey type exceeding 50% of trips there and also in five other European centres.

Considering as an indicator of sustainable mobility the combination of public-transport–cycling-walking, we observe that this exceeds 70% of trips in the cities of Paris (83%), Budapest (80%), Helsinki (77%), Bucharest and Warsaw (76%), Tallinn (74%), and Copenhagen, Madrid, and Vienna (71%) (see Fig. 9.1). Among the largest cities, Helsinki has the best distribution of modal shares: low car use (23%) is matched by a 32% share of walking trips (well above the European average) and a 34%

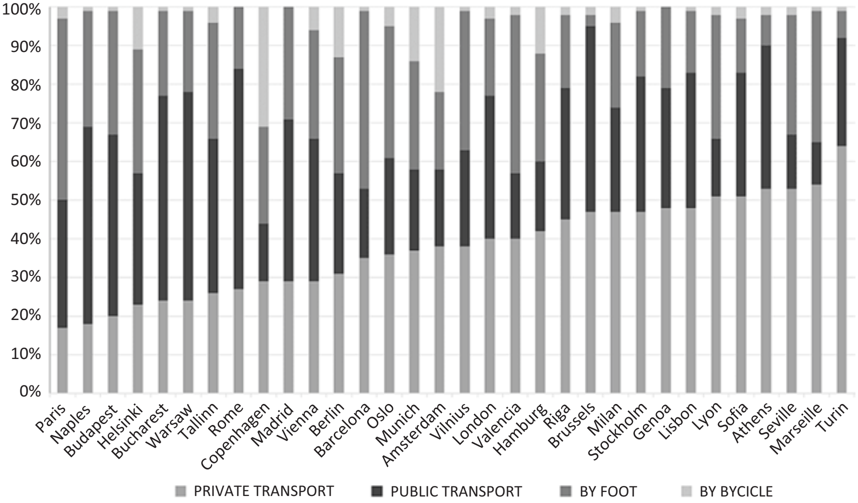


Fig. 9.1 Percentage of modal trips in the main European cities. Source: Own elaboration of EPOMM-TEMS and Audimob-ISFORT data

share of public transport; finally, it ranks among the top cities for cycling, which accounts for 11% of trips. London, historically known for its efficient public transport system, records a very low share for bicycle use (3%) and a high average for private transport (40%). On the contrary, Copenhagen has excellent values of bicycle and pedestrian mobility, at 31% and 25% respectively, higher than those of private cars and public transport, at 29% and 15% respectively. But in this case, we observe a smaller territorial extension of the city (only 88 km^2), where it is easier to move on foot or by bicycle.

Nevertheless, the environmental sustainability of public transport is also tightly related to the technology used for the motorization of transport means, such as buses and boats. In the European cities under analysis, a proportion of the vehicles still run using internal combustion engines (ICEs). The countries with the lowest number of registered gasoline vehicles are Austria, France, and Portugal (Eurostat, 2021). The environmental impact of public vehicles also depends on their age: currently in Europe most public vehicles are between 10 and 20 years old, while only 15% are less than two years old (Eurostat, 2021).

For these reasons, the next section introduces the concept of open territorialized mobility platforms and focuses on green technologies that public service providers in the main European cities are using, focusing on electric buses. Finally, Sect. 9.4 focuses on the Venice case to start discussing how historical European cities are greening their fleets and the dialogue that exists between the space of a city and the new electrified technologies.

9.2 Open Territorialized Mobility Platforms

There is increasing talk about environmentally sustainable mobility, which also involves the public transportation sector. Mobility can be environmentally sustainable when it reduces impactful effects such as air pollution, noise pollution, and emissions, and this requires traditional means of transportation to be converted to hybrid, electric, or hydrogen vehicles (Holden et al., 2020).

Recently, the passenger transportation industry has undergone changes as a result of the emergence of open online public and private platforms that serve specific urban areas by providing multiple mobility services, such as shared mobility services or more traditional public travel services, and that provide information about how to reach point-to-point specific destinations by mixing public or shared transport services (Alochet, 2020). Multiple applications exist that share information about roads and public transportation, warn of accidents, delays, and congestion, and improve integrated mobility payment systems (Di & Ban, 2019). The purpose of these platforms is to facilitate mobility by giving people greater control over their trips through real-time access information. These platforms rely on service innovation and digitalization and deploy the new paradigm of mobility as a "service" through which the user enjoys a comprehensive mobility offering from a single app (Cabigiosu, 2019). In this way, the user is free to access on his or her own initiative, when and where he or she prefers, the desired mix of mobility services.

A term that is still little known is "open territorialized mobility platforms". These are platforms which can specialize in either a specific mobility service or a mix of services, managed by public or private service providers that operate in an extended region, province, or urban area (Alochet et al., 2021). KINTO is an example of a private mobility service provider which has an open platform that offers shared mobility services. Today, both private and public service providers rely on online platforms and apps to inform clients and sell their services.

Public mobility service providers manage platforms that provide a mix of transport services that cover urban or metropolitan areas and promote sustainable and shared mobility, in turn reducing traffic and pollution. These platforms have been growing rapidly in the past few years and have been introducing green technologies to reduce their environmental impact. However, a lack of clarity remains regarding how public mobility service providers select green technologies and particularly regarding the challenges they face when they decide to substitute traditional combustion engine vehicles with electric vehicles. Such uncertainty poses challenges for urban planners and policy makers to evaluate the strength and weaknesses of these emerging mobility services and to propose effective measures to support green transitions.

In the last years, city administrations have been promoting urban transport electrification due to its environmental benefits. For this reason, this chapter focuses on whether and how different public service providers in European capitals are greening their open mobility platforms, with a focus on bus electrification, because buses are diffused in all city centres and electric vehicles represent the most diffused green technology for buses to date (Ruggieri et al., 2020; Glotz-Richter & Koch, 2016; Cabigiosu, 2022).

Previous studies on the introduction of electrified motorization within platforms operated by public service providers within a specific urban area have emphasized both the environmental benefits of these vehicles and also some challenges related to the use of electric vehicles on a large scale (Mathes et al., 2022), such as price/performance improvements, upfront investments, government policies, and clients' motivations (Dijk et al., 2013; Smith et al., 2010; Stephan et al., 2017; Bohnsack et al., 2014).

Local logics and the complex nature of pre-existing mobility systems vary markedly from one place to another, as shown in Table 9.1 and Fig. 9.1. Thus, places both determine the magnitude and origins of sustainability problems and are characterized by different mixes of transport modes and technologies. Potential solutions should address the environmental and mobility needs of the citizens of a specific city, and we still need studies that explore how open territorialized mobility platforms in different urban areas have been introducing electric vehicles, the challenges they are facing, and the specific electric vehicle technologies selected (Scarinci et al., 2019; Ruggieri et al., 2020). In particular, we need to explore the variables that guide this process, which is both diffused and transversal to different cities and also tailor-made to each city's needs.

The next sections aim to first provide an overview of urban green mobility in Europe, then describe how public service providers in the main European urban areas are greening their vehicles, and finally focus on electric vehicles and on the challenges related to their introduction in historical cities.

9.3 Electrification of Mobility Platforms Managed by Local Public Transport Operators in Europe

Hybrid, plug-in hybrid, and full electric vehicles are all types of electric vehicles (Glotz-Richter & Koch, 2016; Mathes et al., 2022). While electric vehicles have higher environmental performance, we know that they also pose some challenges. First, plug-in and full electric vehicles require a dedicated charging infrastructure whose characteristics depend on the battery technology: slow plug-in chargers are usually installed at depots to recharge batteries that have a high autonomy and require a higher charging time, fast plug-in chargers are also installed at stops to recharge low autonomy batteries, and overhead contact lines or inductive (wireless) chargers are used to recharge vehicles during driving. Second, the power grid should provide enough energy to avoid problems in the provision of other public services and in the energy supply to private homes (Rodrigues & Seixas, 2022). Third, electric fleets are more expensive than ICE fleets due to the cost of electric batteries (Kumar & Alok, 2020). Fourth, electric fleets need dedicated control and security systems (Zhu et al., 2018).

Table 9.2 illustrates how the main public transport operators in major European capitals are approaching the green transition and compares the diverse technological choices. We collected the data by browsing the websites of public transport operators in major European capitals. Table 9.2 shows the findings related to those capitals that are implementing, or have in place, relevant sustainable mobility projects.

Table 9.2 shows a strong presence of electric buses on European roads, although in different years, almost all capitals have been purchasing or replacing bus fleets that have been operating on fossil fuels for years. All the analysed cities, except for Lisbon, have electric buses running, of which the first to start was Barcelona in 2012. This may be due to European sustainability plans that “obligate” the conversion of fleet power to electricity by 2035; cities therefore prefer to invest the money granted by states in electric-powered infrastructure. Interestingly, 10 to 15 cities with full electric buses mix full electric motorization with other sustainable motorization types such as biogas or hybrid buses.

Table 9.2 Sustainable public transport technologies in Europe by city

		Biogas/biomethane bus	Ethanol/rape methyl ester/hydrogenated vegetable oil buses	Hydrogen bus	Bus with induction charging	Electric buses	Hybrid buses	Self-driving electric mini steamers	Self-driving electric mini buses	On-demand hybrid/electric cabs and buses	Solar-powered ferries	Electric ferries	Electric streetcars	Wind-powered trains	Hydrogen trains	Electric trains	Hybrid steamers
Cities	*Public transport service provider*																
Amsterdam	GVB Holding – https://over.gvb.nl/					2018		2016				2020	2020	2017			
Barcelona	TMB – Transports Metropolitans de Barcelona – https://www.tmb.cat/	2012		2021 (test)		2012	2012										
Berlin	BVG – Berliner Verkehrsbetriebe – https://www.bvg.de/de				2015	2019					2021 (test)	x			2021 (test)		
Brussels	STIB – Société des Transports Intercommunaux Bruxellois – https://www.stib-mivb.be/					2016	2019										
Hamburg	VHH – Verkehrsbetriebe Hamburg-Holstein– https://vhhbus.de/					2019	2014										
Helsinki	HSL e Nobina – https://www.hsl.fi					2021			2021								

(continued)

Table 9.2 (continued)

		Biogas/biomethane bus	Ethanol/rape methyl ester/hydrogenated vegetable oil buses	Hydrogen bus	Bus with induction charging	Electric buses	Hybrid buses	Self-driving electric mini steamers	Self-driving electric mini buses	On-demand hybrid/electric cabs and buses	Solar-powered ferries	Electric ferries	Electric streetcars	Wind-powered trains	Hydrogen trains	Electric trains	Hybrid steamers
Cities	*Public transport service provider*																
Lisbon	Carris – Companhia de Carris de Ferro de Lisboa – https://www.carris.pt/												2021				
London	TfL – Transport for London – https://tfl.gov.uk	2015	2013	2013	2021 (test)	2015				2015							
Madrid	EMT – Empresa Municipal de Transportes de Madrid – https://www.emtmadrid.es	2017				2017	2017			2016							
Milan	ATM – Milanese Transportation Company – https://www.atm.it					2017				2019							
Munich	CAM – Compagnie des Autobus de Monaco – https://www.cam.mc/					2019											
Oslo	Ruter As – https://ruter.no	2018				2018						2015	2021				

Paris	Île-de-France Mobilités e RATP – https://www.ratp.fr	2015				2017			2020							
Stockholm	SL – Storstockholms Lokaltrafik – https://sl.se/sl	2017	x			2015	2015								x	
Vienna	Wiener Linien e ÖBB – https://www.wienerlinien.at/					2013										
Zurich	VBZ – Verkehrs betriebe Zürich – https://www.stadt-zuerich.ch/vbz/de/					2020										

Source: Own elaboration

Cities such as Copenhagen, Lisbon, Valencia, and Zurich are focusing their efforts on encouraging the use of micro-mobility devices such as scooters and bicycles, aiming to discourage private car use as much as possible. Copenhagen, famous for being a bicycle-rich city, has developed a bike-sharing project called Bycyklen in cooperation with the public transport operator. Citizens of Copenhagen get around a lot by bike and on foot, while the most frequently used buses are the “harbour buses”; these are boats, not environmentally friendly for now, but an excellent alternative to urban road traffic. Lisbon, famous for its hilly forms, is traversed by electric funicular lines and since 2021 also by *eléctricos*, new-generation electric streetcars (the first dating back to 1901). Valencia, traversed largely by bicycles and scooters, aims to give back space to its citizens through a reduction in the circulating car fleet by offering them the opportunity to walk in quality public spaces and creating light infrastructure for cycling for short trips and lots of public transport for longer-distance travel. In 2018, a “bicycle ring road” sprang up around the Old Town; 5 km was carved out by taking a lane away from cars, but this also allowed for wider sidewalks and improved public transportation stops. Finally, Zurich lags behind in the adoption of environmentally friendly transportation such as electric buses (the first vehicles appeared in 2020), but only because it has invested in micro-mobility since 44% of the population travels by bicycle.

Compared to the city of Barcelona, which began its conversion to more sustainable mobility in 2012, Madrid adopted public transportation such as electric and biogas buses later, in 2017. Nevertheless, its strong point is digitization. The company Geotab, in collaboration with the Spanish public transport operator, chose to install monitoring devices on electric buses to collect data to better understand the fleet’s activities, including the distance travelled, the daily mileage of the vehicles, the daily electricity consumption, the average energy consumption of each vehicle, and the vehicle’s charge value. The data also offered a better understanding of how to adjust charging sessions to avoid creating overloads when charging during peak hours. Digitization and continuously developing technologies allow operators to have more control over their vehicles and create very important future investment forecasts.

Looking at self-driving vehicles, one realizes that the road to adoption in Europe is still long. Only Helsinki and Paris have begun to run driverless electric minibuses on their streets, while in 2016 Amsterdam began to let small "waterbuses" navigate its canals, guiding them by remote control.

As for solar energy and hydrogen, the city of Berlin has been implementing pilot tests since 2021, but due to the high costs of design and testing itself, the results for the adoption of such technology will be seen only in the future. On the other hand, a country that has already been harnessing the power of wind for four years thanks to windmills on its territory is the Netherlands, which, with its wind-powered trains, is the most advanced European country.

As we can see in Table 9.2, capitals have mixed and implemented diverse sustainable mobility projects. The main reasons why we observe diverse mixes of sustainable mobility services in different cities are complex and multifaceted and still need dedicated studies. For example, mobility projects developed in cities in northern Europe are not adaptable to cities in southern Europe and vice versa, due to a number of factors such as weather conditions, traffic, road gradients, different needs of citizens, and the maturity level of the technologies themselves. Mobility systems should be custom designed for the mobility needs and condition of the individual city, and this explodes the complexity and cost of design. The next section deals with this topic, focusing on challenges related to electrified mobility in historical city centres.

9.4 Electrified Mobility in Historical Cities: Challenges and Opportunities

Table 9.2 shows that public transport operators are mixing different green technologies, but since 2013 they have all been mainly introducing electric buses. Electric buses can be hybrid, plug-in, or full electric; full electric buses have batteries that display different durations and recharging times and require dedicated recharging infrastructures.

While we observe from Table 9.2 an increasing relevance of electric public mobility, we still know little about why and how operators select different battery electric vehicles (BEVs) and about the challenges related to the introduction of electric vehicles in the historical city centres that characterize European urban areas. To start exploring this research question, we present the case of AVM (Azienda Veneziana della Mobilità—Venetian Mobility Company), which manages the public territorialized mobility platform of Venice. AVM was founded in 1996 and delivers the mobility services of the metro area of Venice, serving in 2022 a population of 639,000 people moving by bus, vaporetto, ferryboat, funicular railway, tram, and bicycle. AVM represents an interesting case both because it must manage the complexity of integrating land and sea services and because Venice is an ancient city and mobility service solutions have to be integrated in this landscape. Furthermore, Venice is one of the main touristic cities worldwide and the mobility services provided should be projected to support the stress deriving from frequent demand peaks. Overall, Venice constitutes an interesting setting to explore the challenges related to the introduction of electric vehicles in the historical city centres that characterize European urban areas.

Our data sources consisted of primary and secondary data. Primary data were semi-structured interviews (DiCicco-Bloom & Crabtree, 2006), all conducted between 2021 and 2022 with AVM and Venice municipality managers who have different roles but are all the most knowledgeable informants about the Venetian electrification projects. We also collected internal documents, presentations, and reports. Our secondary sources were press articles presenting and discussing these and other electrification projects of public transport, which allowed us to triangulate the information collected during our interviews.

We identified three electrification projects. The first was the electrification of the bus fleet on Venice Lido Island, the second consisted in the electrification of the vaporetti fleet, and the third was the introduction of electric and hydrogen buses in Mestre, which is part of the Venice municipality but is built completely on the land and has a small historical city centre.

The Venice Lido is a small island of about 73 km^2 between the Venice Lagoon and the Adriatic Sea with 20,000 inhabitants. The Lido hosts a small city centre and popular beaches. AVM started the electric bus project in this area in 2018 because it is a circumscribed area where Venice municipality was investing in greening the island and it was economically feasible to substitute all existing buses with electric buses. Furthermore, traffic is not intense, and the bus line is a simple vertical line with only 20 stops. The project was completed at the end of 2021 and involved the introduction of 30 full electric buses. The batteries installed on the vehicles have a limited range of about 60 km in summer and 50 km in winter, the length of the longest line.

In 2015, AVM also started a project of re-motorization of 35 vaporetti currently in service to be transformed into plug-in hybrids, the refurbishment of 12 new boats equipped with a stage 5 endothermic engine, and purchase of 62 new plug-in hybrid boats (vaporetti and others). Re-motorization of some boats, rather than buying them new, was considered the best solution in terms of time, cost, and service level and was concluded by the end of 2021. At the end of 2022, AVM was finalizing the call for hybrid vaporetti construction.

At the beginning of 2022, Venice also received extra funds from the Italian government related to the pandemic crisis that must be used for electric or hydrogen buses. In Mestre, AVM decided to introduce 33 electric buses with a slow recharge system but a high autonomy of about 400 km as well as 90 hydrogen buses. At the end of 2022, 20 electric buses were introduced and the remainder should be introduced by 2026.

Our interviews were specifically aimed at understanding which challenges public service providers face when introducing electric vehicles and why we observe a mix of different technologies, for example hybrid and full electric vehicles. While pros and cons were raised, the first surprising insight was that electric buses require more space than hybrid vehicles for multiple reasons: the battery autonomy of a full electric bus is positively correlated to its recharge time and to the availability of numerous recharging points. In the Lido and Mestre, AVM selected the required electric technology by balancing the bus autonomy required with the space available to build rechargers. In the specific case of the Lido of Venice, which is an island with relevant space constraints, AVM did not have the space for all the slow-charging columns required to recharge its 30 new full electric buses. AVM therefore chose low-capacity batteries with fast-charging stations that can be placed at the bus stops so that buses can be recharged along the way during their daily service. AVM built fast-charging points where the bus recharge time is about 7 minutes as well as some slow-charging columns at the terminal for recharging overnight or for less frequently used vehicles.

On the Lido, however, AVM also had to identify the sites on which to place fast rechargers along the bus routes: many sites are on private property and AVM must obtain permission from the property owners to build the rechargers and from the municipality because the rechargers should respect the existing landscape.

The issues related to space availability to build rechargers for vaporetti are even larger, because vaporetti need more energy and bigger rechargers in an area like Venice, which is part of the UNESCO global cultural property. For these reasons, in the ancient historical city of Venice (about 50,000 inhabitants) AVM decided to use plug-in hybrid vaporetti to avoid landscape constraints and because it was not possible to build rechargers able to supply enough energy for about 100 vaporetti. In fact, in Venice, a relevant aspect to consider is the preservation of the artistic and cultural heritage, and AVM could not build rechargers all around the city.

Another relevant issue in introducing electric vehicles in an area where other public transport services exist is the need to respect pre-existing timetables (where and when the vehicles stop daily). AVM decided to mostly maintain existing routes and timetables to avoid reducing their service level and to ensure coordination with other public mobility services. This implies that the new electric buses and vaporetti should be able to reach comparable performance (mean speed and autonomy) with traditional combustion engine vehicles even if they need longer recharges. This is an additional complexity that service providers must consider when planning their green transition and is a more difficult target to reach in cities where traffic is intense and the autonomy of full electric vehicles is lower.

Finally, routes served by full electric vehicles and rechargers at the bus station are less flexible because they are constrained by the positioning of rechargers. This is an issue in those cities where routes should be modified to serve specific events or new areas or if there is a peak in demand only during certain hours, but recharger capacity limits the number of buses and the number of buses that can serve the same route.

In contrast, in Mestre (with more than 88,000 inhabitants), a city with more space at the depot and more traffic, AVM could introduce buses with high battery autonomy and recharging overnight at the existent depot. They planned to introduce 30 buses and 30 rechargers. Nevertheless, they combined electric and hydrogen vehicles to have buses with higher autonomy comparable to that of ICE buses and shorter charging time and to avoid building a terminal with 123 rechargers, which would have increased the size, cost, and complexity of the recharging infrastructure. Furthermore, Venice municipality is investing in hydrogen technology as a political choice.

Overall, the case of AVM suggests that space and landscape constraints, the existing timetables, the routes' length, and the existing traffic on those routes as well as how many vehicles should be run and recharged along the same route all affect the electric transition of the public transportation service in historical cities and not all electric technologies can be equally viable in the same city.

9.5 Conclusions

This chapter describes and discusses the importance of public transport services in Europe, whose relative share varies widely from one city to another, and how public transport service providers are introducing different mixes of electric vehicles in their service platforms. The chapter shows that, overall, the approaches of European capitals and cities to the green transition of public transport are converging on electric vehicles, but the specific electric technologies adopted and the overall mix of green technologies, which also comprise technologies such as hydrogen or bio fuels, do vary from one city to another. This evidence suggests that different local contexts lead to the adoption of different sustainable technologies to satisfy the mobility needs of their citizens, but we still need studies to explain the drivers of these choices.

Often the debate about sustainable technologies focuses on technological performance, while we still need studies that disentangle their fit with different settings: sustainable mobility systems use new technologies to be applied in a variety of different spaces, including historic cities, that present different constraints, and the same technology may not be applicable in different cities, thus introducing an issue of scalability or replication of the same mobility system solutions in diverse contexts. For example, mobility projects developed in cities in northern Europe may not be adaptable to cities in southern Europe and vice versa, due to a number of factors such as space availability and weather conditions. Mobility systems and green technologies should fit the needs of each city, and this increases problem solving and design complexity, uncertainty, and costs during technological transitions and adoption.

In this vein, this chapter contributes to the debate in the technology and innovation management literature by suggesting that green technological transitions are affected by places and by identifying new avenues for research on specific attributes of places that affect these transitions. The chapter suggests that in the process of public transport electrification, while we are aware that these new technologies pose performance and cost problems, we still need a more explicit spatial perspective on sustainability transitions and to disclose the spatial contingencies of places where transitions take place that affect and shape the transition and increase our ability to understand how to effectively manage it (Coenen et al., 2012; Binz et al., 2014; Kanger et al., 2020; Kumar & Alok, 2020; Thrane et al., 2010). The technological transition to more sustainable innovations should be understood as a process embedded in both contexts and places, to capture the geographical and social dimension of the technological transition and the mix of attributes of well-defined geographically limited areas, such as urban areas, that determine the technology to be adopted and the environmental performance of an electrified mobility system (Bathelt and Glückler, 2014; Soete, 2019): space and landscape constraints, existing timetables, routes' length, traffic intensity, and weather conditions are all examples of variables that may jointly affect the electric transition of public transportation services.

In particular, by relying on the case of Venice, this study shows how places with their local specificities may play a relevant role in sustainable transitions and suggests that while we do have studies that disentangle transitions in multiple countries and industries (Stephan et al., 2017; Silvester et al., 2013), there is still little reflection on the role that specific and transversal attributes of places play in affecting the sustainable transition of public transport at the local level: the same service provider (AVM) selected three different electric technologies for three different areas of the same municipality (Venice). Places affect sustainable mobility system technology, design, and performance, and this chapter opens a call for additional studies that analyse the specific and transversal attributes of places that affect the electrified public transport mobility and for other studies that can similarly be of help in understanding how places affect sustainable transitions.

Different space characteristics may affect the diffusion of a technology as well as how this technology is used and employed in different settings, generating different business cases. We need more business cases that consider the role of places for public transport that will help service providers, policy makers, and stakeholders to envision upfront all variables that should be considered when managing the green transition of an open territorialized mobility platform (Bohnsack et al., 2014; Garud et al., 2010; Sydow et al., 2009; Vergne & Durand, 2010). Coherently, this chapter also calls for more context-specific innovation policies which can guide policy makers in understanding which type of technological innovation can support sustainable mobility in each place, especially in historical city centres that pose specific challenges (Haddad & Benner, 2021). For example, historical cities that have relevant space constraints may face difficulties in relying only on fleets with full electric buses with high autonomy and may need to mix different technologies. Consequently, this chapter also emphasizes the problematic usage or lack of scale in existing transition analyses. Without a concrete analysis of the role of territoriality in the scales of transitions, we might consider innovations as ubiquitous advantageous and overlook specific issues that arise in places within which sustainable mobility transitions are embedded (Coenen et al., 2012).

References

Alochet, M. (2020). *Technological breakthroughs and dynamics of an industry: The transition towards electromobility case* (Doctoral dissertation, Institut Polytechnique de Paris).

Alochet, M., Midler, C., Shou, Y., & Wang, X. (2021). The road to autonomous mobility services: who drives the transition, where, and how? *International Journal of Automotive Technology and Management, 21*(4), 343–364.

Bathelt, H., & Glückler, J. (2014). Institutional change in economic geography, *Progress in human geography, 38*(3), 340–363.

Binz, C., Truffer, B., & Coenen, L. (2014). Why space matters in technological innovation systems—Mapping global knowledge dynamics of membrane bioreactor technology. *Research Policy, 43*(1), 138–155.

Black, W. (2010). *Sustainable transportation: Problems and solutions*. Guilford Press.

Bohnsack, R., Pinkse, J., & Kolk, A. (2014). Business models for sustainable technologies: Exploring business model evolution in the case of electric vehicles. *Research Policy, 43*(2), 284–300.

Cabigiosu, A. (2022). Sustainable development and incumbents' open innovation strategies for a greener competence-destroying technology: The case of electric vehicles. *Business Strategy and the Environment, 31*(5), 2315–2336.

Cabigiosu, A. (2019). *Innovation in knowledge intensive business services: The digital era*. Routledge.

Coenen, L., Benneworth, P., & Truffer, B. (2012). Toward a spatial perspective on sustainability transitions. *Research Policy, 41*(6), 968–979.

Di, X., & Ban, X. J. (2019). A unified equilibrium framework of new shared mobility systems. *Transportation Research Part B: Methodological, 129*, 50–78.

DiCicco-Bloom, B., & Crabtree, B. F. (2006). The qualitative research interview. *Medical Education, 40*(4), 314–321.

Dijk, M., Orsato, R. J., & Kemp, R. (2013). The emergence of an electric mobility trajectory. *Energy Policy, 52*, 135–145.

Eurostat, ec.europa.eu. (2021). *Eurostat – Motor coaches, buses and trolley buses*. https://www.eea.europa.eu/data-and-maps/data/external/motor-coaches-buses-and-trolley

Garud, R., Kumaraswamy, A., & Karnøe, P. (2010). Path dependence or path creation? *Journal of Management Studies, 47*, 760–774.

Glotz-Richter, M., & Koch, H. (2016). Electrification of public transport in cities (Horizon 2020 ELIPTIC Project). *Transportation Research Procedia, 14*, 2614–2619.

Haddad, C., & Benner, M. (2021). Situating innovation policy in Mediterranean Arab countries: A research agenda for context sensitivity. *Research Policy, 50*(7), 104273.

Holden, E., Banister, D., Gössling, S., Gilpin, G., & Linnerud, K. (2020). Grand narratives for sustainable mobility: A conceptual review. *Energy Research & Social Science, 65*, 101454.

Kanger, L., Sovacool, B. K., & Noorkõiv, M. (2020). Six policy intervention points for sustainability transitions: A conceptual framework and a systematic literature review. *Research Policy, 49*(7), 104072.

Kumar, R. R., & Alok, K. (2020). Adoption of electric vehicle: A literature review and prospects for sustainability. *Journal of Cleaner Production, 253*, 119911–119935.

Mathes, M., Schmidt, M., Käsgen, J., Fievet, B., Tichelen, P. V., Berecibar, M., & Al-Saadi, M. (2022). Heavy-duty battery electric buses' integration in cities based on superfast charging technologies: Impact on the urban life. *Sustainability, 14*(8), 4777.

Mounce, R., & Nelson, J. D. (2019). On the potential for one-way electric vehicle car-sharing in future mobility systems. *Transportation Research Part A: Policy and Practice, 120*, 17–30.

Nemoto, E. H., Issaoui, R., Korbee, D., Jaroudi, I., & Fournier, G. (2021). How to measure the impacts of shared automated electric vehicles on urban mobility. *Transportation Research Part D: Transport and Environment, 93*, 102766.

Rodrigues, A. L., & Seixas, S. R. (2022). Battery-electric buses and their implementation barriers: Analysis and prospects for sustainability. *Sustainable Energy Technologies and Assessments, 51*, 101896.

Ruggieri, R., Ruggeri M., & Vinci, G. (2020). Efficient energy and electric transport in a smart city: Evaluation of sustainability and competitiveness. *2020 IEEE International Conference on Environment and Electrical Engineering and 2020 IEEE Industrial and Commercial Power Systems Europe (EEEIC/I&CPS Europe)*, pp. 1–4.

Santos, G., Maoh, H., Potoglou, D., & von Brunn, T. (2013). Factors influencing modal split of commuting journeys in medium-size European cities. *Journal of Transport Geography, 30*, 127–137.

Scarinci, R., Zanarini, A., & Bierlaire, M. (2019). Electrification of urban mobility: The case of catenary-free buses. *Transport Policy, 80*, 39–48.

Silvester, S., Beella, S. K., Van Timmeren, A., Bauer, P., Quist, J., & Van Dijk, S. (2013). Exploring design scenarios for large-scale implementation of electric vehicles; the Amsterdam Airport Schiphol case. *Journal of Cleaner Production, 48*, 211–219.

Smith, A., Voßb, J. P., & Grinc, J. (2010). Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. *Research Policy, 39*, 435–448.

Soete, L. (2019). Science, technology and innovation studies at a crossroad: SPRU as case study. *Research Policy, 48*(4), 849–857.

Stephan, A., Schmidt, T. S., Bening, C. R., & Hoffmann, V. H. (2017). The sectoral configuration of technological innovation systems: Patterns of knowledge development and diffusion in the lithium-ion battery technology in Japan. *Research Policy, 46*(4), 709–723.

Sydow, J., Schreyögg, G., & Koch, J. (2009). Organizational path dependence: opening the black box. *Academy of Management Review, 34*, 689–709.

Thrane, S., Blaabjerg, S., & Møller, R. H. (2010). Innovative path dependence: Making sense of product and service innovation in path dependent innovation processes. *Research Policy, 39*(7), 932–944.

Vergne, J.-P., & Durand, R. (2010). The missing link between the theory and empirics of path dependence: conceptual clarification, testability issue, and methodological implications. *Journal of Management Studies, 47*, 736–759.

Zhu, J., Wierzbicki, T., & Li, W. (2018). A review of safety-focused mechanical modeling of commercial lithium-ion batteries. *Journal of Power Sources, 378*, 153–168.

10

The Role of Institutions, Social Actors and Public Policies to Support Sustainability in the Automotive Industry in Europe

Davide Bubbico

10.1 Introduction

The automotive industry is facing an epochal transition, since it not only involves the manufacturing sector, affected by the overcoming traditional engine and the perspective of autonomous driving, but also the mobility system in its general meaning. The evolution of the relationship between the ownership and the use of vehicles (see Lanzini in this volume), that is to say considering the car as a service rather than as a private property, could become a more evident dimension of mobility, at least in certain contexts, such as large urban areas (see Furegato and Cabigiosu in this text introducing the concept of "public territorialized mobility platforms"). Whether this evolution will have, as its first consequence, a significant impact on car market, capacity production and employment, what is the

D. Bubbico (✉)
Department of Political and Social Studies, University of Salerno,
Fisciano, Italy
e-mail: dbubbico@unisa.it

A. Cabigiosu, P. Lanzini (eds.), *The Green Transition of the Automotive Industry*,
https://doi.org/10.1007/978-3-031-37200-1_10

role of industrial policies? The objective of the chapter is to analyse, on the one hand, the decisions and guidelines that the European Commission has developed about automotive sector in the last years, and on the other, to examine the industrial policies that have been adopted in individual countries, also to understand similarities, internal differences and the coherence with the guidelines of the European Union. As far as the final impact on employment (which is our main interest), the end of chapter tries to summarise a confrontation between sector associations and trade unions, regarding the ongoing industrial transition and its consequences on the employment.

According to the most recent data (2018), reporting approximately something like 3.5 million employees (direct and indirect), the automotive industry still represents a key sector, not only in the European manufacturing area (11.6% of employment) but also in the continent's economic framework (ACEA, 2022a, 2022b). This sector is even more significant because of the complexity of the automotive supply chain, including areas such as engineering, rubber-plastics, electronics and, in more recent years, IT and energy, thus confirming the growing importance of driver assistance services (especially in the perspective of autonomous and assisted driving) and of the production of new batteries, electric motors and other alternative power systems (such as hydrogen). New investments in electric mobility reflect the process of supply diversification, which has been ongoing for years and corresponds to the search for new market segments; after the diesel gate scandal involving Volkswagen in 2015, such investments are also the consequence of an increased "environmentalist" projection of manufacturers. It is a fact, however, that the decisive input towards electric mobility, as highlighted in Stocchetti's chapter, is mainly due to the decisions on environmental regulations by the European Union.[1] Factors like the transition to the electric car, including the industrial use of lighter materials to balance the weight of

---

[1] Almost half of all transport-related pollutant emissions come from cars and its industry (European Environment Agency, 2018). In September 2020, the European Commission presented the ambitious "2030 Climate Target Plan", proposing to raise the target for the reduction of EU greenhouse gas emissions to 2030 from the previous 40% to at least 55% compared to 1990 levels. However, as Stocchetti's contribution in this volume demonstrates (see Chap. 3), the latest car models by endothermic powertrain have already achieved significant reductions in pollution thanks to the greater efficiency of the engines.

other components such as batteries, together with the increasing use of electronics, are bound to have significant consequences on the composition of the supply chain and the employment itself, not only in terms of reduced employment (given the smaller number of components to be assembled, specifically in the system of powertrain) but also in terms of retraining and acquisition of new skills in the automotive sector, as already described by Zirpoli and Balzarin in Chap. 5.

While the transition to electric cars has taken a significant leap forward with the European Union's decision to ban the sale of polluting cars starting from 2035, many manufacturers and suppliers have already been making significant investments in this direction years ago. This process has principally taken place with weak or no direction in terms of industrial policies within individual (with very few exceptions). In many cases, supply companies, even among SMEs, have already anticipated investments or started reconversion processes in this direction independently, without waiting for the support of local industrial policies, especially in the countries where the automotive sector is more present (including Spain, where the car industry has been established more recently). A greater and more direct commitment of the public sector, both in the traditional field of R&D and in the increasingly decisive field of infrastructures, is now an incontrovertible fact, and this is probably more true today, because of the resources required to manage the current transition of the automotive industry (Calabrese & Vitali, 2018). However, as Anna Cabigiosu writes (see Chap. 7) about innovation, the State seems to have played a minor role so far, especially in the phase of open innovation, while today, in a dominant design context, incentives for innovation can prove crucial to foster vertical and horizontal business networks.

Nevertheless, the automotive sector seems to constitute both a case of strategic industrial policy, and a reactive/defensive issue, according to two logics of action, which are not necessarily opposite to each other (Andreoni & Chang, 2016): both aim at the adjustment of the existing industrial structure and at the necessary restructuring, in the light of the increasing deindustrialisation of Europe and the new international division of labour.

The context of automotive industry is different from that of the early 2000s, when the European production was still high and competitive, almost entirely characterised by US and Japanese production,[2] with exclusive investments of American and Japanese firms in Europe.[3] The growth of China, both as a manufacturer and as a new global economic player, constitutes a not negligible aspect, even for the investments of the main Western car manufacturers in Europe and in the United States, beyond the constraints still present in international trade. Chinese investments in Europe have strongly increased after 2008 (Amighini, 2012), thanks to the acquisition of OEMs (the best-known case is Volvo) and new suppliers, particularly in Germany (56 companies between 2005 and 2016), with the aim to acquire the technological skills held by European companies. Chinese industrial policies themselves have, only in recent years, started to consider more significantly the development of suppliers, rather than final assemblers (Pawlicki & Luo, 2017). More generally, in Southeast Asia, industrial policies have not only aimed at a greater development of the sector but have increasingly been directed towards a gradual substitution of importations (Natsuda & Thoburn, 2022).

It is evident that, with the growth of Asian manufacturers and the Chinese market, the European automotive industry has gradually lost its leadership, albeit strongly contended by the American and Japanese car industry. Up to 2008 Europe was the largest automotive market. However, as some authors pointed out in a report for ACEA a few years after the 2008 crisis, "In contrast to the Commission's view that the industry continues to be very competitive at an international level, the EU automotive sector is suffering from a multitude of competitive pressures. It has lost its global leadership in sales and production; its profits have collapsed, and it is losing employment and investment. With regulatory costs progressively increasing, continued disproportionate regulatory burden will exacerbate the problem" (FTI, 2015, p. 25).

---

[2] In 2005, European car production accounted for 31% of world production, North American production for 25%, and Japanese and Korean production for 21%. In 2020 these values were respectively 22, 17 and 15% because of the enormous growth of Chinese production which jumped to 33% in 2020 from 9% in 2005 (ACEA, 2022a, 2022b).

[3] On the foreign investments of the Japanese automotive industry see Shimokawa (2010); for the case of the American industry Freyssenet et al. (2003).

The automotive industry is facing a key crossroads in Europe, mainly due to the transition to electric cars, particularly facing the challenge with Asian production (in China and elsewhere). The European car industry is even more committed to tackling the problem of production overcapacity and the subsequent management crisis, in terms of employment (which is much more problematic in Europe than in the United States, due to greater regulatory constraints and stronger union pressure to protect employment). At the same time, however, two aspects must be considered. The first concerns the increase in European exports, in terms of value and numbers. The European Union, which has always been a key exporter of cars, has seen its exportations grow from 5.3 to 6.6 million vehicles between 2008 and 2018, respectively equivalent to 29% and 41% of its production. In the same period, the share of imports fell by 2 points, from 19.5% to 17.7% (FTI, 2015). In this context must also be considered the gradual transfer of Western Europe production capacity to Central and Eastern European countries, where is now concentrated one-third of European car production (Bubbico, 2022a). In this perspective, the greater internationalisation of the supply chain[4] and the decreasing role of large national companies had more negative consequences on the employment in Western Europe: "Overall [between 2005 and 2016], job creation was more concentrated in Eastern Europe with 71% of all jobs created, while job loss was more concentrated in Western Europe with 81% of jobs lost. Romania, Poland, Czechia and Slovakia recorded the largest job creation (276,886 jobs), while Germany, France, Britain and Sweden together lost 302,477 jobs" (Pavlínek, 2020, p. 520).[5]

After this general introduction, the chapter is structured as follows: the first paragraph recalls the main actions of the European Union related to

---

[4] However, the recent pandemic crisis has highlighted this as one of the weaknesses of the current configuration of the global automotive industry, with the exemplary case of semiconductors, but not only, regarding the fragility of supply chains to international level (Boranova et al., 2022).

[5] In another recent contribution by the author, the automotive industry in Central and Eastern European countries is, however, still considered peripheral in terms of investment capacity (Pavlínek, 2022). But this is understandable to some extent, due to the absence of domestic manufacturers. This does not mean, however, that Eastern European countries will stay out of investments on electric car. Indeed, the good levels of education of the workforce together with the younger age are proving to be rewarding factors. An attempt to create a domestic industry in the sector is underway in Turkey, which is now one of the main recipient countries of European foreign investment in the automotive sector (Taymaz & Yılmaz, 2016).

industrial policies in the automotive sector; the second paragraph focuses on the policies adopted by individual countries; the third paragraph concentrates on the role that institutional and social actors are currently playing in the accompanying processes. The chapter will close with some brief conclusions.

10.2 The European Union's Industrial Policy for the Automotive Sector

Over the last decade, the European Commission has published, every two years, several documents and communications concerning the new industrial strategies. However, in 2006, the European Commission produced a specific programme for automotive sector called "CARS 2021" (*Competitive Automotive Regulatory System for the 21st Century)* (EC, 2006), while more recently the European Parliament has published a report entitled *The Future of the EU Automotive Sector* (ECORYS, 2021).

More generally, the financial crisis of 2008 and the more recent pandemic emergency have contributed to a revival of industrial policy in Europe (Wigger, 2019). The European Commission published a report on "An Integrated Industrial Policy for the Globalisation Era" (EC, 2010) in 2010, and, two years later, gave birth to a strategy paper entitled "A Stronger European Industry for Growth and Economic Recovery" (EC, 2012).

In this perspective, after a more liberal initial phase, the Commission introduced the so-called IPICEIs (Important Projects of Common European Interest[6]) in September 2017, according to which competition and state aid rules are suspended. In the same groove, and to cope with the consequences of the pandemic, the European Commission has proposed new state aid exemptions, allowing the combination of national funding and Union programmes.

---

[6] The instrument of major projects of common interest is the only instrument at European level allowing to support not only industrial research, but also the development of initial industrial applications.

The support to the automotive sector, as for other industrial sectors, has more often taken place through horizontal policies (training, education, innovation), rather than through sectoral ones. To some extent, most of the European Recovery Plans of the Next Generation EU programme, which have been introduced in the wake of the 2020 pandemic crisis, have also gone in this direction. With regard to the automotive sector support, however, there are some differences between France and Germany and to some extent Spain, compared to Italy (Gaddi & Garbellini, 2021). When looking at French and German policies, they prove to be more manufacturer-oriented than Italian ones, where the aid to the automotive sector is much more conceived as a support for the supply chain (to consolidate it) and for the functional infrastructures of electric mobility development (Bubbico, 2022b).

More frequently in the last years, transversal programmes ended up helping the automotive sector more than other industrial sectors. An example is the "Blueprint for Sectoral Cooperation on Skills" (EU, 2017), a programme for sectoral cooperation conceived to meet short- and medium-term skill needs in certain sectors of the European economy. This programme is not new, but certainly innovative, since it focuses on cross-sectoral skills in different areas of the European economy through the strengthening of sectoral partnerships. The pilot sectors considered, in addition to automotive, were Defence, Maritime Technology, Space (geo-information), Textiles and Tourism.[7]

The Commission has recently defined four main areas of intervention, in order to support the competitiveness of the European automotive sector: (1) smart regulation; (2) international harmonisation; (3) bilateral regulatory dialogues; (4) access to finance and market access support for small- and medium-sized enterprises. In particular, the second area has taken on specific importance in that cars are regulated through EU laws for vehicle-type approval. To improve the level-playing field, increase the trust of consumers, and reduce administrative burden, all policy

---

[7] The project funded under COSME (European programme for small- and medium-sized enterprises) that started in January 2019 complemented the DRIVES project (Development and Research on Innovative Vocational Educational Skills project), focused on addressing empowerment and retraining strategies for SMEs in the sector, also in the countries outside the EU where the automotive sector occupies a prominent position (EU, 2020).

proposals are subject to competitiveness proofing. At the same time Global technical harmonisation is a key factor in strengthening the competitiveness of the EU's automotive industry. Common technical requirements, like those under the UNECE[8] framework, reduce development costs and avoid the duplication of administrative procedures.

One of the most significant initiatives, connected to the development of electric mobility and, thus, to the necessary conversion of the components supply chain, concerns the support of battery production in Europe. The European Battery Alliance, launched in October 2017, is certainly the most relevant one, since it directly intersects the topic of the production transition of the car industry and the greater sustainability of mobility in Europe. As stated in the report *State of the Energy Union 2021*, *Contributing to the European Green Deal and the Union's Recovery* "the EU battery industry is catching up through a combination of investment in battery production, increased demand in EVs, the shift of the EU car industry, and a focus on circularity to address the raw materials issue, also guided by the Batteries Directive" (EC, 2021, p. 21). Currently, the EU is heavily dependent on raw materials from three countries: China, Chile and South Africa. The recent establishment of the European Raw Materials Alliance aims to diversify the supply source of these raw materials, and highlights the importance of recycling versus extraction. When the EU proposed a new Sustainable Batteries Regulation in 2020, it also set new sustainability standards for batteries recycling.

In December 2019, the Commission approved EUR 3.2 billion of state aid aimed at setting up battery factories (the so-called gigafactories) in seven countries, and R&D on lithium-ion and solid-state batteries in four fields: advanced materials, modules and cells, battery systems and battery recycling. The EU's goal is to cover 30% of global battery demand by 2030 and between 10% and 15% by 2025.[9] The European Commission has also identified several initiatives to develop a battery value chain in

---

[8] The United Nations Economic Commission for Europe (UNECE) was set up in 1947 by ECOSOC. It is one of five regional commissions of the United Nations. As a multilateral platform, UNECE facilitates greater economic integration and cooperation among its member countries and promotes sustainable development and economic prosperity.

[9] Today, Europe accounts for less than 1% of the world's lithium battery production, compared to 60% in China, 17% in Japan and 15% in South Korea.

the EU, including the IPCEI Programme dedicated to batteries, but also the development of hydrogen, autonomous and connected driving.

The concentration of battery production in Western Europe is, however, likely to have a direct impact on employment and investment in Central and Eastern Europe (Demitry et al., 2022), although considering what has been stated before about the strong capacity of investments attraction in these countries, including electric cars. In Western European countries, the impact on powertrain production will certainly not be painless, causing a reduction of companies and employment, and also affecting the assembly plants, due to reduced labour requirements (CLEPA, 2021a; Syndex, 2021; IPE et al., 2019; FTI, 2018).

The battery issue confirms, moreover, how the goal of strategic autonomy, as stated in the Commission document of May 2021 entitled "Updating the 2020 New Industrial Strategy: Building a Stronger Single Market for Europe's Recovery", has now become a key factor in European industrial policy.

Together with the directives on the production of electric batteries, the EU took action on the investment side, dealing with the development of autonomous and connected driving with the *Strategy for automated and connected mobility systems*, dated May 2018, with the aim of securing Europe a competitive advantage in this sector as well. Finally, the crisis in supplies, especially semiconductors (with the generalised rise in the prices of some raw materials and other components) has most recently prompted the EU to launch the Chips Act in February 2022 (Duchâtel, 2022). The Act is supposed to promote a trend towards European self-sufficiency in semiconductor production. The US company Intel, for instance, has recently decided to locate two semiconductor mega-plants in Germany, together with a research centre in France, confirming the strategic role of these two countries in European industrial production but also, as Onida (2022) suggests, the importance of the presence of increasingly determined innovation ecosystems in the location choices of large multinational groups.

As previously written, advanced driver assistance systems and innovations to optimise powertrains, have increased the share of electronic and semiconductor systems to 35% of the total car's cost. This value is likely to rise up to 50% with further development of technologies associated with autonomous driving and vehicle electrification. According to the European association of automotive component manufacturers, CLEPA, while revealing the vulnerabilities of the supply chain, the current shortage of chips also offers new opportunities for the semiconductor industry, especially because the automotive industry is responsible for 37% of semiconductor demand in Europe (CLEPA, 2021b).

In this context, the European Commission has identified connected and autonomous vehicles (CAVs) as a strategic cluster in early 2021. The European supply industry holds around 60% of all global patents on autonomous driving, and about 70% of CAV innovations. In CLEPA's view, a supportive policy framework enabling industry to expand its leadership in CAV technologies, should cause an increased demand for more advanced semiconductor chips and a growing attractiveness of Europe as an investment location for semiconductor manufacturing. This should also be fostered by the availability of research and innovation funding, together with other forms of public investment, which can contribute to the industrial transfer of basic and applied research results.

A highly critical approach to European industrial policy—mainly due to the greater focus on the competitive dimension—has been argued by several authors, such as Pianta and Lucchese (2020) and more explicitly by Pichler et al. (2021) who, starting from the case of the automotive industry in Austria, claim that "EU industrial policies at most ecologically modernise and at worst actively preserve the unsustainable structures of the automotive industry. This is because EU automotive industrial policies (1) defend economic growth and competitiveness, (2) focus narrowly on innovation (policy) and refuse to disrupt unsustainable industrial pathways as well as (3) promote ecological modernisation through efficiency instead of absolute emission reductions, as exemplified by the electrification of the car fleet or on-demand mobility services" (Kuhnert et al., 2018; McKinsey and Company, 2016).

Generally speaking, the initiatives that the European Union has put in place to support the automotive sector are various and respond to different objectives (Table 10.1); however, according to Henig and Lee-Makiyama "they might end up legitimising far more market distortive initiatives abroad, with risks of public funding and/or retaliatory spirals" (2021, p. 8) by other countries.

Table 10.1 Key EU initiatives impacting the automotive sector

Element	Aim	Status and impact
GREEN DEAL	First climate neutral continent by 2050, making all sectors of the EU's economy ready, 2030 climate targets	Live overall framework setting the direction for EU industry, thus high impact
Fit for 55	EU's climate, energy, land use, transport and taxation policies lead to reduced net greenhouse gas emissions of at least 55% by 2030, compared to 1990	Package launched July 2021. Direct impact on car sector including new approach from various measures including ETS and CBAM (see separate items)
CO2 emission performance standards	EU fleet-wide CO2 emission targets applying from 2020, 2025 and 2030	Entered into force in January 2020, proposed revision under Fit for 55 effectively bans the sale of cars fuelled by fossil fuels from 2035
Euro 7	Update emissions standards framework	Proposals by year end may include constant vehicle monitoring, adding compliance costs
Emissions Trading System (ETS)	Expand and deepen existing scheme to include emissions from road transport and remove free allocation	Proposal in July 2021, implementation by 2026. Will impact on road vehicle sector, as well as increasing cost of goods transported to EU
Carbon Border Adjustment Mechanism (CBAM)	Prevent carbon leakage by requiring importers to buy carbon certificates for some imports	Proposal tabled in July 2021, to be implemented from 2026, shadow running from 2023, includes iron and steel and may be extended for example to car batteries. Will raise cost, may be challenged at WTO
New batteries	Requirements on the sustainability, safety, labelling and recycling of batteries including in electric vehicles	2019 regulation updating one from 2006 under discussion, high impact on car sector. Could lead to potential ban on non-EU batteries given recycled material target

(*continued*)

Table 10.1 (continued)

Element	Aim	Status and impact
OPEN STRATEGIC AUTONOMY	An approach to trade rather than a package of proposals, in which EU seeks policy space that may mean trade restrictions	Trade Policy Review Feb 2021 prioritised supporting transformation, shaping global rules, and increasing enforcement. Measures will impact car sector
Investment screening	Commission and Member States screen inward investment for security or public order concerns	Operational October 2020, potential for affecting inward investment and reciprocation
Due Diligence Act	European Parliament requested Commission to look to mandate corporate due diligence so supply chains do not include deforestation and forced labour	Deforestation proposal published, and overall due diligence obligation to be published shortly, though appears delayed. Potentially significant cost impact on all importers in the EU
Foreign subsidy instrument	EU to investigate financial contributions granted by public authorities of a non-EU country which benefit companies engaging in an economic activity in the EU and redress distortive effects	Regulation proposed in May 2021, potential to lead to trade conflicts if action taken against other countries particularly given expected EU use of state aid within this transformation
INDUSTRIAL STRATEGY	Support twin transition to a green and digital economy that is competitive globally through regulations and spending plans	Live overall framework of initiatives launched in March 2020, updated in May 2021, numerous individual initiatives likely to impact on car industry, e.g. intervention on strategic dependencies
Next generation EU	Post-Covid stimulus package that includes considerable funding to deliver Green Deal and Industrial Strategy	Budget adopted, national plans being considered ahead of funds being released. Individual funding items will impact on car sector

(*continued*)

Table 10.1 (continued)

Element	Aim	Status and impact
European Battery Alliance	Develop an innovative, competitive and sustainable battery value chain in Europe	Set up in 2017, EU battery supply expected to meet demand by 2025, in part by establishing Important Projects of Common European Interest (IPCEI)
Chips Act	Create a state-of-the-art European chip ecosystem, including production, for security of supply and encouragement of European tech	Discussed in the State of the Union speech in September 2021. Timelines to be confirmed. Competition and world trade implications
Sustainable and Smart Mobility Strategy	90% reduction in the transport sector's emissions by 2050	Live from December 2020 a series of initiatives across the transport sector
Connected and Automated Mobility	Ensure that a vehicle remains connected when crossing borders	Strategy presented in 2018, does not appear to be maintained as a formal programme of work, but numerous related initiatives

Source: Henig and Lee-Makiyama (2021) reference to programmes, strategic documents and initiatives of the European Union.

10.3 The National Industrial Policies Supporting the Automotive Industry in Europe

As Landesmann and Stöllinger (2020) write, "expenditure on industrial policy by member states far exceeds the amounts spent at the supranational level. The financial resources from the EU budget flowing to industrial policy related measures amounted to 0.35% of the EU's GDP annually during the period 2014–2017. By contrast, industrial policy spending by member states was in the order of 0.75% of GDP during the same period. Apart from the state aid provided, the latter figure includes member states' contributions to EU programmes financed by the ESIF (known as co-financing by member states)".

Industrial policies to support the automotive sector undertaken in Europe, have, in many cases, followed particularly unfavourable economic cycles (such as the crisis of 2008[10]), adopted very different modalities and pursued objectives depending on the characteristics of the automotive sector at national level. Actually, in the automotive sector, some of the most significant changes occurred, even before the policies of individual countries, thanks to the choices made by companies, as shown by investments in Central and Eastern European countries, not only for the lower labour costs, but also for tax breaks, milder environmental regulations and a low or non-existent bargaining power of trade unions.

If we look at the industrial policies for the automotive sector undertaken in Europe on a national basis, the result is a wide-ranging framework of institutional instruments supporting car industry. France[11] and Germany show a greater prominence, also due to a more relevant tradition of public policies and the important role played by firms' representative associations and trade unions (much more in Germany than in France). Elsewhere, the industrial policies have mainly served to attract foreign investments, as in the case of Spain, which has seen its production levels rise significantly since its entry into the European community in the 1970s (Šćepanović, 2020). It is no coincidence that Spain is now among Europe's largest constructors, despite not owning any car manufacturers but has benefitted from significant foreign investment. On a smaller scale, the policies adopted for the automotive sector in Portugal have followed a similar trajectory (Reis et al., 2016).

---

[10] These initiatives, often defensive and aimed at restructuring management, have, on more than one occasion, brought to light possible conflicts with World Trade Organization guidelines (Seung-Youn, 2014). Similarly, according to Henig and Lee-Makiyama (2021), measures to support the auto sector in the last years, including the framework of the pandemic crisis, could lead to retaliation by the United States, Japan and China. The latter fear, however, seems to be relative when considering both the presence of Japanese and US plants in Europe, and the growing Chinese investment in Europe.

[11] In recent years France, like Italy, has also experienced a significant downsizing of automotive production to the extent that some authors do not hesitate to call a structural decline in automotive production (Pardi, 2020). Unlike Italy, however, while France hosts four big car companies (Stellantis, Renault, Toyota and Daimler) Italy counts the only presence of the Stellantis group; moreover, the sector gains far more government attention than in Italy. To deepen the reasons for the crisis in the French automotive sector, see Head et al. (2020).

The case of Italy and England is different.[12] England, unlike the widespread tendency towards deindustrialisation, has maintained a higher production level compared to Italy, which has been so far considered one of the main countries in the automotive sector, after Germany. On the other hand, also due to the presence of the former Fiat Auto group (now Stellantis), Germany has never been concretely affected by specific action in this direction, since the government has never intervened concretely with an industrial policy instrument. Together with the progressive disengagement of the ownership (the Agnelli family), the main consequence has been a gradual reduction in investment and a very low production capacity, reaching production levels that, even before the pandemic crisis, placed Italy at the back of the main countries in the automotive sector, including some of Eastern Europe countries (Bubbico, 2014).

As written above, particularly after the crisis of 2008, initiatives to support the automotive sector by individual European governments started to become more evident, also to contain the negative consequences on employment. To make an example, both France and Great Britain promoted two structures, respectively Plateforme de la Filière Automobile (PFA) and British Automotive Council (BAC), which in some ways represented a novelty in the framework of state intervention. As Calabrese et al. (2013) wrote, the two bodies, PFA and BAC, despite their different action plans, had the common theme of strategic collaboration between the economic and institutional actors: "The first is based on the fact that the new industrial policies must come from a strategic and long-lasting collaboration between industry and government. The second derives from the fact that for pervasive sectors such as automotive, the involvement of the various levels of government must be integral, horizontally and vertically, and it requires an authoritative coordination to reduce the risk of inappropriate interventions" (p. 6). If, however, the PFA experience aimed at developing national champions starting from first-tier suppliers (as well as the promotion of greater integration between OEMs and

---

[12] In the case of the UK, due to Brexit, Bailey et al. (2022) examined the case of two regions with the highest concentration of activity in the automotive sector, and concluded that more regionally oriented industrial policies are needed to better anticipate and respond to shocks such as the Brexit effects. To deepen the countertrend of the UK automotive sector compared to the rest of the industrial sectors, see Bailey and De Propris (2017).

suppliers), the BAC experience tended to offer a more general support to the industry, in order to improve the business planning. As often happens, both initiatives ceased to exist after a few years, with the economic recovery of the sector, thus confirming the discontinuous nature of such initiatives.

At the same time, Italian government began to consider setting up a similar organisation, called the Italian Automotive Council (IAC), which has never been born. Actually, in Italy, during the 2008 crisis, initiatives to support the territories affected by the presence of the former Fiat group plants have been promoted by the local governments, that is the regions, and other local actors (in the first decade of the 2000s); albeit, in most cases, they had no significant results on the industrial plan (Bubbico, 2013a, 2013b). In a recent document drafted by the Italian business associations of both the automotive and the mobility sector (CONFIN DUSTRIA, ANFIA, AMMA, ANIE, ANITEC - ASSINFORM, ASSITOL, CONFINDUSTRIA ENERGIA, ASSOGASLIQUIDI/FEDERCHIMICA, ANIGAS, ASSOGAS, UNIONE PETROLIFERA, ELETTRICITÀ FUTURA, 2019), the negotiation model has been declined in an inter-company and/or territorial key, given the strong concentration of the automotive supply chain in some specific regions. In this framework, the development of collaborations and synergies between actors belonging to separate supply chains is encouraged; moreover, negotiation tools to support industrial transition are preferable, by adapting existing models, such as development contracts and interventions in complex crisis areas, and by using pilot experiences, such as the regional pacts for industrial transition, recently launched by the European Union. With reference to this specific instrument, for example, the territory of the Piedmont, the historical headquarters of the Fiat group and localisation of about 35% of the Italian automotive supply chain, has been admitted as a complex area of industrial crisis within the "Sistema Locale del Lavoro di Torino" (Turin Local Employment System), in order to develop a programme of Intelligent Specialisation Strategy on a territorial basis.

With the outbreak of the pandemic and the increasing emergence of environmental and health emergencies at the beginning of 2020, the automotive sector ended up becoming the testing ground for the environmental transition and for carbon emission reduction. The decisions taken, dealing especially with the acceleration on the blocking of polluting engines' production, caused deep conflicts between the Commission and the main industry associations belonging to the automotive sector.[13] However, the countries where the automobile industry is crucial, ended up taking measures similar to those promoted by the EU. As Henig and Lee-Makiyama write "As we have noted, the EU's agenda is similar to the approaches of comparable economies, with the US, UK, and China also pursuing government intervention with a view to maintain or renew globally competitive manufacturing, while reducing carbon emissions" (2021, p. 16).

It has to be said that, in the case of European countries, national policies to support the car sector, in the perspective of the progressive transition to entirely non-endothermic engines starting from 2035 onwards,[14] have different directions: from the more traditional one, aimed at supporting the demand, including tax incentives and other measures, to those aimed at strengthening public and private infrastructure for refuelling electric cars, and supporting investment in R&D.

However, some of these measures already exist before the pandemic crisis. This is the case of the Contracte Stratégique de la Filière Automobile 2018–2022 programme, launched in France in 2018 and updated in 2021. Also the "Gran Plan d'Investissement 2018–2022", supporting digitisation in the industrial sector (not only for automotive) has been promoted by the "Alliance Industrie du Futur (AIF)" in 2017 with an endowment of 57 billion over five years. Former programmes aimed at supporting the automotive companies specifically engaged in the production of diesel engine components (industrial conversion projects) or

---

[13] However, as Stocchetti argues (Chap. 3), the "Fit for 55" programme would have found a European ecosystem already ready for change. This is for two reasons. The first because these decisions were known for some time, at least since 2018; the second because the electrified powertrain constitutes a relevant opportunity for the companies themselves in terms of new profits.

[14] The stop on the sale of endothermic cars is one of several points in the European Commission's Fit-for-55 programme approved in May 2021. It must be said, however, that the discussion on the date of 2035 is once again at the centre of the debate, also for the recent energy crisis due to the war in Ukraine. Furthermore, in 2026, when a new European parliament will be elected, it will be called to verify the trend of investments in the sector and to confirm the year 2035 as the last year of production of vehicles with endothermic engines.

promoting the production of components imported from Asia (import substitution programmes, reshoring). More recent programmes, such as "France 2030" (for the period 2021–2025), have allocated almost EUR 1 billion: 0.6 billion will support mergers and acquisitions, the remainder will support R&D. Within this plan specific funds have been set aside for the retraining of workforces of companies with fewer than 1000 employees (EUR 2.5bn) or for expelled workers with business start-up incentives, job-accompanying measures etc. (EUR 0.5bn). These initiatives are promoted as part of active employment policies, either through training or outplacement initiatives managed by public employment agencies. In France, as in Germany, other measures were more specifically aimed at supporting and strengthening small- and medium-sized enterprises operating in the automotive sector with the specific objective, which is not new and not easy, of encouraging their aggregation.

In Germany, the measures were even more relevant, due to the primacy and weight of the automotive industry, together with the ramifications of the component sector all over Europe. As part of its programme (Digital Strategy 2025), Germany allocated 4.5 billion to accompany the transformation of the German automotive industry ("Future Investment in the Automotive Industry") in four main areas: modernisation of existing production; new products (autonomous driving); regional innovation clusters; digitalisation. Here, as in France, several programmes have been addressed to improve the workers' training, whose needs have been investigated through surveys in SMEs. The Germany Ministry of Labour is focusing on the construction of "advanced training networks" (funding of EUR 100 million) and a training programme (originally introduced in 2006) for low-skilled older workers, run by the Federal Employment Agency, has been refinanced in 2019. In Germany, however, the lander are the most active institutional actors how economic public support modality, but access to data and information in this regard is not easy, also because these economic aid somehow escape to the established constraints legislation on state aid regimes.

France and Germany have started very close collaborations through their car companies, in relation to electric battery and semiconductor production. For example, SAFT (a subsidiary of TOTAL Group, a battery manufacturer) and PSA have signed a project for the development and the production of lithium-ion cells (a key component in the construction of rechargeable batteries). Even if marginally, Italy has also been involved in these investments through the Stellantis. The ACC (Automotive Cell Company) Joint Venture, established in 2020 and bringing together Stellantis, Opel and SAFT, is one of the most interesting projects. It is currently operational the new R&D Expertise Centre in Bruges (Bordeaux), along with a state-of-the-art Pilot Plant in Nersac (Nouvelle Aquitaine). The first Gigafactory is going to be built in Billy-Berclau Douvrin (Hauts-de-France). A second Lithium-ion Gigafactory has been planned in Germany for 2025. Most recently, a new Gigafactory has been announced in Termoli (Italy), where one of the main engine plants of the old Fiat group is settled.

As in other past experiences, Spain has defined a "Move2future technology platform for automotive and sustainable mobility" financed by the Ministry of Science and Innovation. In the framework of the Next Generation EU policies, the automotive sector has been included in the IPICEI projects. In 2021, the Spanish Government also approved the "Proyecto Estratégico para la Recuperación y Transformación Económica" (PERTE) for the transformation of the sector and the support towards a process of supply chain resilience and renewal, in order to produce an electric and connected vehicle, aiming at strengthening the competitiveness of the Spanish automotive sector and its strategic integration within global value chains.

In other European countries, which are less important compared to France and Germany, due to the absence of large manufacturers and to a lower impact of automotive employment, national governments, especially in Eastern Europe, have essentially continued applying investment attraction policies (especially with tax exemption programmes[15]) and sometimes implemented measures to encourage R&D activities, as in the case of Poland.[16] This country has adopted measures to support the purchase of electric cars and the expansion of related infrastructures, although it is necessary to take into account the different purchasing power of these countries compared to Western Europe markets, where the purchase of electric cars cannot be separated from state aids.[17]

The crisis of the sector, due to sales reduction and supplies difficulties, together with the consequences of the transition to the electric car, is having direct impacts on the entire sector chain (including the sales network). As we will see in the next paragraph, the consequences on the employment are much more relevant. However, the measures adopted in the European countries where the automotive sector is significant (see Table 10.2), represent necessary actions, even though, in the uncertain context of industrial solutions and high costs of electric car, they may prove insufficient in the absence of a sustained economic recovery and an overall reorganisation of the automotive sector concerning, for example, the production of some specific components inside the European territory.

Up to now the social safety nets have been cushioning the employment crisis, while the reconversion and professional retraining processes are trying to anticipate future job competence needs. It is therefore not certain that, at the end of this process, the impact on employment will be as negative as imagined.

---

[15] In Poland, state aid authorisation is foreseen not only for R&D activities, but also for restructuring and rescue cases of companies in the automotive sector.

[16] On the importance of R&D support in Central and Eastern European countries see Zhelyu (2017). As Kaderabkova and Radosevic write about the strategic inclusion of small- and medium-sized enterprises of Central and Eastern Europe (CEE) in innovation chains: "The CEE countries are operating as peripheral economies in terms of technology generation. Consequently, a single policy may not be effective in countries at very different distances from the world technology frontier. In less advanced countries, technology transfer and non-R&D innovation activities are more important drivers of innovation. Therefore, increasing the level of technology transfer and absorptive capacity through R&D and training should be a priority in these countries" (2011, pp. 2–3).

[17] In Italy, some regions and local authorities have also allocated funds for their residents to promote the purchase of zero- or low-emission cars: this is the case of the regions of Lombardy, Piedmont, Emilia-Romagna, Valle d'Aosta and of the autonomous Province of Trento and of the Municipality of Milan.

Table 10.2 Public policies to support automotive sector in principal industrial countries of Western Europe

Country	Programmes	Aim/beneficiaries	Economic resources of public funding
Germany	Future Investment in the Automotive Industry	Modernisation of existing production; new products (autonomous driving); regional innovation clusters; digitization	4.5 billion Euro
	Advanced training networks (2019) by Federal Employment Agency	For low-skilled older workers	100 million Euro
	Digital Strategy 2025	The strategy is based on ten pillars of digitalisation, including a pillar that focuses on introducing digital education and throughout the stages of one's life. Including Industry 4.0	
France	Contracte Stratégique de la Filière Automobile 2018–2022	Ecological transition, autonomous vehicle ecosystem and experiment on a large scale, evolution of skills and employment needs; strengthening of the competitiveness of the automotive sector	300 million industrial diversifications of subcontractors "Fond Avenire Automobile 2", 525 million; support for innovation 220 million
	Gran Plan d'Investissement 2018–2022 by Alliance Industrie du Futur (AIF)	Digitisation processes in the industrial sector	57 billion Euro over five years
	France 2030 (2021–2025)	Supporting mergers and acquisitions; support to R&D;	1 billion Euro
		Retraining of employees of companies with fewer than 1000 employees or for dismissed workers with incentives for business start-ups, accompanying measures for employment	3 billion Euro

(*continued*)

Table 10.2 (continued)

Country	Programmes	Aim/beneficiaries	Economic resources of public funding
Spain	Proyecto Estratégico para la Recuperación y Transformación Económica (2021–2023) within the programme Move2future technology (2014) by the Ministry of Science and Innovation	Transformation of the sector and support towards a process of supply chain resilience and renewal for the realisation of an electric and connected vehicle Move2future technology is a platform for automotive and sustainable mobility financed	877 million Euro
Italy	Ministry of Economic Development: fund for the conversion of the automotive sector (2022)	Support to supply chain and new financing of new sales incentives	8 billion Euro until 2030 (one billion euro)
	Ministry of Economic Development: "development contracts" for the automotive sector (2022)	Support for productive investments and environmental protection linked to the development and reconversion of the automotive supply chain	525 million Euro

Source: National programs.

10.4 The Role of Sectoral Organisations and Trade Unions Within the Framework of Industrial and Employment Transformation in the Automotive Sector

As happens in other fields, the intervention of European policies in the industrial sector within the various countries, suffers from various problems depending, on the one hand, on the different degrees of development of the individual sectors in each country, and, on the other, on the different intervention capacity of national and regional governments combined with the coordination capacity of business associations and trade unions. To some extent, the autonomous action of large companies is potentially conditioned by these factors, but not necessarily constrained by them. In May 2022, the Italian Minister of Economic Development, dealing with a parliamentary question raised by a member of the opposition in the Chamber of Deputies about the production and employment crisis of Stellantis, answered that the Government could do very little in front of the company's autonomy of action.[18]

There's no doubt that the automotive sector is facing an epochal transformation concerning both the production model (organisation of production and work, redefinition of the supply chain, etc.) and the infrastructure supporting electric mobility. The ongoing restructuring process will therefore not only affect direct manufacturing employment, but the whole sector chain, which includes refuelling, maintenance, trading, etc. (as the chapter of Buzzavo shows). CLEPA itself, prior to the Commission's acceleration of the interruption on endothermic car production until 2035, agreed with the EU's new industrial strategy, as it had the potential to provide favourable framework conditions for private investments, so allowing the supply diversification, while retaining the advantages of a global supply chain. The decision to ban sales of diesel and petrol-powered cars after 2035, has actually exacerbated the risks of massive restructuring in too short a time, with serious consequences on employment and competition with the rest of the manufacturers, particularly the Asian ones.[19]

As regards safeguarding employment, the association that brings together industrial trade unions at international level, IndustriAll, has repeatedly emphasised the importance of a fair transition that does not put in danger the European Green Deal. Such a transition, however, requires resources and strong coordination between the actors involved.

---

[18] The member of parliament in object has now become Minister of Enterprise and Made in Italy in the new centre-right government led by Giorgia Meloni.

[19] The European Parliament's decision, at the proposal of the European Commission, to end sales of new petrol and diesel-powered cars in 2035 took place on 9 June 2022 with 339 votes in favour, 249 against and 24 abstentions.

As IndustriAll, CEEMET[20] and CLEPA stated in July 2021 in a joint communication addressed to the Vice-President of the European Commission, Frans Timmermans, "these resources cannot be spread thinner as they are already needed for the important challenge in the coal-dependent and carbon-intensive regions and industries, however they can offer a model for a Just Transition for the automotive and broader mobility eco-system. Such a Just Transition framework must be built on: a) adequate resources; b) policy support and exchanges of best practices; c) transition planning and social dialogue. Inaction has major risks for Europe. Given the number of jobs at stake and the magnitude of the ongoing transformation, social disruption due to a badly managed transition might severely undermine the ability of the European Green Deal to succeed".[21] In this direction, for example, Blöcker et al. (2020) pointed out how, in the German experience, regional transformation councils, which include workers and trade unions, environmentalists, politics and citizens, could act as nodal points to guide industrial conversion. In actual fact, the so-called industrial crisis anticipation strategies (Negrelli & Pichierri, 2010) have, only in few cases, been successful in Europe; as written at the beginning of this chapter, these strategies are affected by the variety and effectiveness of public employment policies, which tend to be stronger and more organised in France, Germany and in Northern European countries, definitely weaker, and less coordinated with the business system in Southern Europe, while are almost completely absent in Central and Eastern Europe.

However, the prospect of a transition with an exclusively negative impact on employment must be considered very carefully. Many authors have highlighted new areas of growth, and a demand for new skills in the sector. Therefore, the topic of skills and new occupational needs will become increasingly relevant in the coming years (ILO, 2020). Even in this circumstance the European Social Fund is Europe's main instrument

---

[20] CEEMET (European Tech & Industry Employers) is the European employers' organisation representing the interests of the Metal, Engineering & Technology-based industries.

[21] The text of the declaration is available at https://news.industriall-europe.eu/Article/632.

for supporting jobs, helping people get better jobs and ensuring fairer job opportunities for all EU citizens. It provides funding for national and local projects with a long-term perspective, focusing on skill development and employment access in cooperation with private and public organisations. For example, the European Globalisation Adjustment Fund for Displaced Workers (EGF) focuses on workers that were laid off on a larger scale due to restructuring. It supports limited-time projects designed to help workers made redundant to find another job or set up their own businesses. However, these tools can prove to be insufficient in relation to the numbers of jobs running the risk of leaving the sector.

As in all industrial restructuring processes, the best equipped countries, with strong public policies and with well-tested representation systems (starting with industrial relations), have an inevitable advantage in managing employment crises and reconversion. In the framework of the current crisis, which is sharpened by the risk of recession caused by the cost of energy and the war in Ukraine, even the most virtuous countries should be able to face such problems. The experiences gained so far in the field of trade union concertation, even in countries with more solid traditions in industrial relations and not necessarily inspired by social concertation (such as England and France), show obvious limitations, such as the irregular nature of collaborations conditioned by the crisis phases. In other countries, like Italy, the massive recourse to social shock absorbers has often been one of the main solutions, together with incentives to encourage the voluntary exit of workers (this is the case of Stellantis in both Italy and France).

In this context, the proposals coming from the trade union sphere go in the direction of an overall rethinking of the mobility system, with more investment in public transport, that is to say supporting the railway industry rather than the bus manufacturing industry. The Next Generation EU plan envisages specific investments in this area. It is therefore no coincidence that some authors emphasise the importance of allocating more resources to the public transport industry while reducing subsidies for the automotive industry (Demitry et al., 2022; VV.AA., 2021).

10.5 Conclusions

In the last decade, industrial policies at European and national level have been experiencing new impulses from the ecological transition and the strategic repositioning of certain industrial sectors, aimed at increasing the competition with Asian industry. The role of the state as a key player in the transition has also been highlighted with reference to the investments underway (Mazzucato, 2015). In this context, France and Germany have been more favourable, for example, to the emergence of European champions, that is to say encouraging a process of concentration of large industrial groups, even if the European Commission did not agree with such approach, as in the case of the proposal to merge Alstom and Siemens. These are the reasons why Germany and France are envisaging a revision of EU competition law, to allow the active creation of "European champions" in the industrial sector.

As Calabrese et al. (2013) pointed out, the role of governments, especially in the automotive sector, remains central for several reasons since "The inadequate presence of the government and its representatives in the structure of governance, the lack of a direct coordination between industrial policy objectives and tools, the right of veto left to the carmakers and, more fundamentally, the inability of the government to develop the required skills is likely to reduce the potential of these operating structures" (p. 22).

If the automotive sector plays an important role in the framework of international competition challenge, particularly with Asian countries, a cut-throat competition for innovation may mean further market exits by EU brands if they lag behind. As Henig and Lee-Makiyama claim "It is normal for the EU to have a busy legislative schedule, various overarching initiatives and individual regulations progressing at any point in time. What is different now is three overlapping transformative visions on decarbonisation, trade assertiveness and industrial policy enabled through multiple regulations and initiatives underpinning all other reforms. At the end of this impressive journey, the EU will, if successful, have a different industrial structure delivering the same economic benefits despite significant transitional costs" (2021, p. 7).

This brief review of the industrial policies promoted within the European Union as well as within individual countries suggests the need for greater coordination, which cannot, however, ignore a more structural collaboration with the main car manufacturers and the associations representing supplier companies. A concentration of investments and restructuring processes with a loss of employees in less strong areas from an industrial point of view, risks reducing the "spatial spread" of the automotive industry in Europe as we know it today (Bailey et al., 2010); even considering the desirable advantages that car manufacturers can get from the concentration of the supply chain and appropriate research and development activities.

If the automotive industry in Europe will experience an overall downsizing, in terms of employment and industrial structure, at the end of this transition, maybe this will not be as serious as expected. The greater involvement of sectors such as IT, electronics, and non-fossil fuels, both in R&D and manufacturing areas (at least downstream), should, even if partially, offset the expected losses in terms of industrial production, economic results and employment.

To conclude, the framework of national policies discussed in this work, shows a certain coherence with the strategy set by the European Union in relation to the new frontiers of automotive production, even if the national plans for automotive sector are necessarily conditioned by many factors (nature of OEMs, dimension of supply chain, capacity production installed, industrial relations model, etc.) and eventually by specialisation of the automotive supply chain in each country. In this perspective, the existence of large national groups among carmakers and suppliers can contribute to a better implementation of the European Commission's indication. The research conducted by Pichler et al. about Austria case study confirms that "the results have shown the crucial importance of meso-level governance like industrial and environmental policies, particularly on the EU level. In this process, EU policies predefine national corridors and room for manoeuvre" (2021, p. 142).

References

ACEA. (2022a). *The automobile industry. Pocket guide 2022/2023*, Brussels 2022.

ACEA. (2022b). *The automobile industry. Pocket guide 2020/2021*, Brussels 2020.

Amighini, A. (2012). Chinese FDI in the European automotive sector. In L. Ciravegna (Ed.), *Sustaining industrial competitiveness after the crisis* (pp. 114–133). Palgrave Macmillan. https://doi.org/10.1057/9781137010988_6

Andreoni, A., & Chang, H.-J. (2016). Industrial policy and the future of manufacturing. *Economics and Industrial Policy, 43*, 491–502.

Bailey, D., & De Propris, L. (2017). Brexit and the UK automotive industry. *National Institute Economic Review, 242*, 51–59. https://doi.org/10.1177/002795011724200114

Bailey, D., de Ruyter, A., Hearne, D., & Ortega-Argilés, R. (2022). Shocks, resilience and regional industry policy: Brexit and the automotive sector in two Midlands regions. *Regional Studies, 57*, 1141. https://doi.org/10.1080/00343404.2022.2071421

Bailey, D., de Ruyter, A., Michie, J., & Tyler, P. (2010). Global restructuring and the auto industry. *Cambridge Journal of Regions, Economy and Society, 3*(3), 311–318. https://doi.org/10.1093/cjres/rsq029

Blöcker, A., Dörre, K., & Holzschuh, M. (2020). *Auto-und Zulieferindustrie in der Transformation*. Beschäftigtenperspektiven aus fünf Bundesländern.

Boranova, V., Huidrom, R., Ozturk, E., Stepanyan, A., Topalova, P., & Shihangyin, Z. (2022). Cars in Europe: Supply chains and spillovers during COVID-19 times. *International Monetary Fund, WP/22/6*, 1.

Bubbico, D. (2013a). Attori economici e istituzioni locali nelle iniziative a sostegno del settore auto nel Mezzogiorno. *QA Rivista dell Associazione Rossi-Doria, 4*, 43–77.

Bubbico, D. (2013b). Local industrial policy for the automotive industry in Italy: Innovation, export support and the crisis of the Fiat Group. In A. Stocchetti, G. Trombini, & F. Zirpoli (Eds.), *Automotive in transition challenges for strategy and policy* (pp. 179–196). Edizioni Ca' Foscari.

Bubbico, D. (2014). *Radiografiat. Indagine nazionale della Fiom-Cgil sugli stabilimenti italiani dei gruppi FCA e CNH Industrial*. Edizioni META.

Bubbico, D. (2022a). Stellantis Italia: i rischi di residualità industriale e occupazionale. *Critica marxista, 1*, 22–32.

Bubbico, D. (2022b). Il Pnrr italiano e l'industria nazionale: alla ricerca di una politica industriale. *Autonomie locali e servizi sociali, 2*, 309–329. https://doi.org/10.1447/105087

Calabrese, G., Coffey, D., & Pardi, T. (2013). *New industrial policies for the automotive industry in Europe*, Working Paper CNR-Ceris, n. 21.

Calabrese, G., & Vitali, G. (2018). Industrial policy and new technologies in the automotive industry: Risks and opportunities. *Quaderni IRCrES*, (5), 13–29.

CLEPA. (2021a). *Electric vehicle transition. Impact assessment 2020–2040: Study on workforce of automotive suppliers.*

CLEPA. (2021b). *EU industrial strategy: In-depth review comes at the right time; building on existing technology strengths is essential*, document available at the web address https://clepa.eu/mediaroom/eu-industrial-strategy-in-depth-review-comes-at-the-right-time-building-on-existing-technology-strengths-is-essential/

CONFINDUSTRIA, ANFIA, AMMA, ANIE, ANITEC - ASSINFORM, ASSITOL, CONFINDUSTRIA ENERGIA, ASSOGASLIQUIDI/FEDERCHIMICA, ANIGAS, ASSOGAS, UNIONE PETROLIFERA, ELETTRICITÀ FUTURA. (2019). Strategie di politica industriale e mobilità sostenibile. *Proposals for the relaunch of the automotive industry in Italy.*

Demitry, N., Koepke, G., & Mewes, S. (Eds.). (2022). *Just transition in the European automotive industry. Insights from affected stakeholders*. Adelphi Research gemeinnützige GmbH.

Duchâtel, M. (2022). *Semiconductors in Europe: The return of industrial policy*. Institute Montaigne, Policy Papers, Paris.

ECORYS. (2021). *The future of the EU automotive sector*. Publication for the committee on Industry, Research and Energy, Policy Department for Economic, Scientific and Quality of Life Policies, European Parliament, Luxembourg.

European Commission (EC). (2006). CARS 21. A competitive automotive regulatory system for the 21st century. *Final Report.*

European Commission (EC). (2010). *An integrated industrial policy for the globalisation era.* Putting Competitiveness and Sustainability at Centre Stage European Commission.

European Commission (EC). (2012). *A stronger European industry for growth and economic recovery*.

European Commission (EC). (2021). *State of the Energy Union 2021.* Contributing to the European Green Deal and the Union's Recovery.

European Environment Agency (EEA). (2018). *Greenhouse gas emissions from transport in Europe*, document available at the web address https://www.eea.europa.eu/data-and-maps/indicators/transport-emissions-of-greenhouse-gases/transport-emissions-of-greenhouse-gases-1

European Union (EU). (2017). *Blueprint for Sectoral Cooperation on Skills. Responding to skills mismatches at sectoral level. A key action of the New Skills Agenda for Europe*. Publications Office of the European Union.

European Union (EU). (2020). *Blueprint for sectoral cooperation on skills: Towards a common vision on addressing SMEs skills needs in the automotive sector: Strengthening the development of upskilling and reskilling strategies*. Publications Office of the European Union.

Freyssenet, M., Shimizu, K., & Volpato, G. (2003). *Globalization ore regionalization of the American and Asian car industry?* Palgrave Macmillan.

FTI Consulting. (2015). *Regulation and competitiveness of the EU automotive industry*. Final report. Study prepared for ACEA.

FTI Intelligence. (2018, May 5). *Impact of electrically chargeable vehicles on jobs and growth in the Eu. Particular focus on the EU automotive manufacturing and value chain*.

Gaddi, M., & Garbellini, N. (2021). Le politiche industriali nel Pnrr. *Quaderni di Rassegna Sindacale*. Works, no. 2, pp. 33–41.

Head, K., Martin, P., & Mayer, T. (2020). Les défis du secteur automobile: compétitivité, tension commerciales et relocalisation. *Les notes du conseil d'analyse économique*, no. 58, Juillet.

Henig, D., & Lee-Makiyama, H. (2021). *The future of EU leadership in the car industry: Still global*. ECIPE Policy Brief, no. 16.

International Labour Office (ILO). (2020). *The future of work in the automotive industry: The need to invest in people's capabilities and decent and sustainable work*. Issues paper for the Technical Meeting on the future of Work in the Automotive Industry, Geneve.

IPE (Institut für Politikevaluation GmbH). (2019). Fka GmbH und Roland Berger GmbH. *Automobile Wertschöpfung 2030/2050.* Studie im Auftrag des Bundesministeriums für Wirtschaft und Energie, Endbericht.

Kaderabkova, A., & Radosevic, S. (2011). Innovation policy in multi-tier Europe: Introduction. In S. Radosevic & A. Kaderabkova (Eds.), *Challenges for European innovation policy: Cohesion and excellence from a Schumpeterian perspective* (pp. 1–8). Edward Elgar.

Kuhnert F., Stürmer C. and Koster A. (2018), Five trends transforming the Automotive Industry, PricewaterhouseCoopers GmbH, Wirtschaftsprüfungsgesellschaft: , 1.1, 1–48.

Landesmann, M., & Stöllinger, R. (2020). *The European Union's industrial policy: What are the main challenges?* Policy notes and reports, no. 36. The Vienna Institute for International Economic Studies.

Mazzucato, M. (2015). The green entrepreneurial state. In I. Scoones, M. Leach, & P. Newell (Eds.), *The politics of green transformations* (pp. 134–152). Routledge.

McKinsey & Company. (2016). *Automotive revolution - perspective towards 2030.* How the Convergence of Disruptive Technology-driven Trends Could Transform the Auto Industry. Advanced Industries.

Natsuda, K., & Thoburn, J. (2022). *Automotive industrialisation. Industrial policy and development in Southeast Asia*. Routledge.

Negrelli, S., & Pichierri, A. (2010). *Imprese globali, attori locali. Strategie di anticipazione e governance dei processi di ristrutturazione economica*. Franco Angeli.

Onida, F. (2022, March 29). Nella lunga marcia verso l'autonomia strategica l'Unione è ancora disunita. Il *Sole24Ore*.

Pardi, T. (2020). Searching for industrial policy: The long decline of the French automotive industry. In V. Covarrubias & A., Ramírez Perez, S. (Eds.), *New Frontiers of the automobile industry. Palgrave studies of internationalization in emerging markets*. Palgrave Macmillan. https://doi.org/10.1007/978-3-030-18881-8_5

Pavlínek, P. (2020). Restructuring and internationalisation of the European automotive industry. *Journal of Economic Geography, 20*, 509–541. https://doi.org/10.1093/jeg/lby070

Pavlínek, P. (2022). Relative positions of countries in the core-periphery structure of the European automotive industry. *European Urban and Regional Studies, 29*(1), 59–84. https://doi.org/10.1177/09697764211021882

Pawlicki, P., & Luo, S. (2017). China's cars and parts: Development of an industry and strategic focus on Europe. In J. Drahokoupil (Ed.), *Chinese investment in Europe: Corporate strategies and labour relations* (pp. 41–59). ETUI.

Pianta, M., & Lucchese, M. (2020). Rethinking the European Green Deal: An industrial policy for a just transition in Europe. *Review of Radical Political Economics, 52*(4), 633–641. https://doi.org/10.1177/0486613420938207

Pichler, M., Krenmayr, N., Schneider, E., & Brand, U. (2021). EU industrial policy: Between modernisation and transformation of the automotive industry. *Environmental Innovation and Societal Transitions, 38*, 140–152.

Reis, A., Heitor, M., Amaral, M., & Mendonça, J. (2016). Revisiting industrial policy: Lessons learned from the establishment of an automotive OEM in Portugal. *Technological Forecasting and Social Change, 113*, 195–205. https://doi.org/10.1016/j.techfore.2016.04.006

Šćepanović, V. (2020). Transnational integration in Europe and the reinvention of industrial policy in Spain. *Review of International Political Economy, 27*(5), 1083–1103. https://doi.org/10.1080/09692290.2019.1652670

Seung-Youn, O. (2014). Shifting gears: Industrial policy and automotive industry after the 2008 financial crisis. *Business and Politics, 16*(4), 641–665.

Shimokawa, K. (2010). *Japan and the global automotive industry*. Cambridge University Press. https://doi.org/10.1017/CBO9780511730283.004

Syndex. (2021). *Électrification de l'automobile et emploi en France. Étude pour la Fondation Nicolas Hulot pour la Nature et l'Homme*, Paris, Juin 2021.

Taymaz, E., & Yılmaz, K. (2016). Political economy of industrial policy in Turkey. The case of automotive industry. REF Rekabet Forum, Working Paper n.1.

VV.AA. (2021). *The need for transformation challenges for the international automotive sector voices from unions, workers, climate movement*. Industry. Rosa Luxemburg Stiftung.

Wigger, A. (2019). The new EU industrial policy: Authoritarian neoliberal structural adjustment and the case for alternatives. *Globalizations, 16*, 353–369.

Zhelyu, V. (2017). The EU industrial policy and SME development in Central and Eastern Europe. In B. Galgóczi & J. Drahokoupil (Eds.), *Condemned to be left behind? Can Central and Eastern Europe emerge from its low-wage model?* (pp. 189–208). ETUI.

Dialogue between authors

Dialogue Between Authors

Technological transitions involve multiple stakeholders: firms that innovate, their suppliers, complementors but also clients, policy makers, trade unions and firms of ICT and energy sector. The same transition may be more or less disruptive for each stakeholder implying the acquisition of new resources, competences and thus learning and adaptation processes (see Chap. 7).

The first contribution of Part II is a call to broaden the scope of analysis as to consider with equal focus the whole ecosystem participating to the electric transition: while carmakers and suppliers clearly represent key-actors, it is worth stressing how so far many policy makers and academics have marginalized a more fine-grained analysis of consumers' behavior (Chap. 6), of dealers active involvement in the servitization process (Chap. 8) of the automotive industry, of existing spaces and communities where the electric transition unfolds (Chap. 9) and of policy makers (Chap. 10) and their impact in the analyzed scenario. All these stakeholders are agents that can shape the new ecosystem and are affected by the sustainable transition of electrified mobility and understanding how the new technologies impact, dialogue and interact with them is likely to become a driver of competitive advantage for the incumbents and new players entering the mobility industry. Academics know well that in *winners-take-all* markets the technological performance per se does not explain firms' market share, but despite this awareness they have not yet provided a far-reaching vision of how clients, complementors, retailers and policy makers participate and affect the value generation and appropriation processes in the new electrified mobility ecosystem.

Accordingly, as stated above this new ecosystem requires new resources and competences and some of them are distant or imply enacting competence destroying processes and generate opportunities and threats.

The second contribution of Part II is emphasizing how stakeholders are managing this process of resources exploration, acquisition and integration correlated to new mobility ecosystem. Our chapters highlight how carmakers have been acquiring these resources via an open innovation strategy to then increase their control over crucial phases of the value chain central to maximize the value appropriation correlated to the new electrified mobility. Upstream we are observing an increased level of vertical integration to ensure the supply of electric batteries at competitive prices (see Chap. 7) and states are economically supporting the local production of electric batteries (see Chap. 10). Yet, interestingly we are observing also downstream a shift toward a higher control and involvement of automotive distributors to deploy new service offerings and to increase the understanding of clients' needs (see Chaps. 6 and 8). And once again in this scenario policy makers play a pivotal role in how they distribute additional economic resources and prompt learning processes along the overall automotive supply chain (see Chap. 10). The transition process toward the electric car is placing the role of the public actor as discriminating within this ecosystem. The relevance of the institutional dimension of community-oriented industrial policies is therefore confirmed, albeit in the context of a debate that in recent months has focused on the issue of technological neutrality. The decisions taken on the subject of environmental transition in relation to the automotive sector in Europe therefore re-propose a binding role of the Union although within a diversified position of national governments considering the different weight of the automotive industry in the different countries of the Union.

Some point out that the automotive distribution architecture traditionally based on networks of authorized dealerships is obsolete and a much more direct role of OEMs—meaning greater vertical integration downstream—is the way to go, often pointing at Tesla as a leading example. There is no doubt that the accelerating pace of change in industry and market conditions has been pushing for dramatic change, however this picture may be an oversimplification of reality missing some important points.

Why does a distribution architecture relying on a network of retailers matter?

First, consumers are stakeholders playing an important role in the equation, as discussed by Lanzini in Chap. 6. The transition to electrified vehicles and the provision of more evolved mobility services—based more on use than on ownership—besides calling for careful communication and reassurance aspects, requires a deeper understanding and greater attention to the value of the whole customer lifecycle rather than just the sales element. A consolidated and competent network of retailers and service providers in place can play its part, while it appears quite challenging for OEMs who have traditionally operated with a business-to-business mentality to switch to a business-to-consumer approach. In other words, there is the need to implement a bi-directional flow of information, so that dealers have the chance of hearing the voice of customers, going beyond a mere collection of info about clients, their purchasing behaviors and the level of customer satisfaction. Rather than taking a picture of what clients do, it would be relevant to shed light on the real motives underpinning choices and attitudes, with an inferential rather than descriptive approach as pointed out by Lanzini in Chap. 6. The results of such analyses should be then shared with OEM as to frame sound strategies. For instance, when it comes to electrification many dealers are experiencing a steady increase in the number of clients that are interested in the rental of e-vehicles. Yet, this might be both for a new approach to vehicles (no purchase, but limited rent when needed), for the willingness to try the new technology before actual purchase and so on.

Second, turbulent times and uncertainty over technologies and dominant design variables require players to maintain a sharp focus on constant learning and flexibility, as discussed by Cabigiosu in Chap. 7. Massive integration, albeit allowing greater degrees of control and efficiency, often hinders the opportunities to detect changes early, then learn and react accordingly. Collaborating with a network of players who are in constant touch with market needs can result in the ability to rely on 'intelligent terminals' at the periphery, feeding precious information upwards to the 'control tower' plus allowing degrees of flexibility. Even more, actual and prospective clients (and travelers/commuters at large) should be included themselves in the loop of open innovation, in a sort of stakeholder engagement that resembles that of SUMPs (Sustainable Urban Mobility Plans), where relationships between players at the local level are built and strengthened, as to foster shared innovation boosting collaboration on multiple levels (see Chap. 6).

Thirdly, dealing with the provision of mobility services unavoidably requires attention to local geographies that make the replicability of standard approaches often quite difficult. Adaptation then becomes of paramount importance, as discussed by Cabigiosu and Furegato in Chap. 9. Centralized strategies clash with local needs while physical infrastructure crafted according to local needs can be an asset: think of responding to specific needs such as vehicle trade-in and switches throughout time, service provision, customization and so on. This is where a solid distributed infrastructure of partners may become a complementary asset winning over hyper-centralized solutions, be it run by OEMs or by other purely digital players. Lanzini in Chap. 6 further stresses how the need to focus on the specificities of the territory is also connected to the relevance of socio-economic and cultural features of different communities, so that one-size-fits-all strategies are bound to be ineffective, while a tailor-made approach would exploit rather than be exposed to the peculiar features of each context.

Finally, one cannot overlook the crucial role of institutions and public policy in the automotive transition, as discussed by Bubbico in Chap. 10. Aspects such as regulations and infrastructures play an even more critical role in a context where the service matters more than the product itself. One of the challenges to overcome is the risk of too much ideological tone in the debate: such ideology can unfold in tensions between OEMs and consumers, with accessibility likely to be a constant example on the debate. Ideology however can also show up in OEM-retailer discussions where the risk to argue over the share of the cake for each respective portion is relevant, while there is a growing need to adopt a more pragmatic approach and to join efforts beyond a zero-sum game, toward more value-adding initiatives. Dialogue and cooperation between OEMs and the network of retailers/service providers become a critical ingredient to shape the adequate public policy so much needed today to support the overall transition.

We may see distribution architectures evolving not as a whole system but with different paths: with the fragmentation of channels and the differentiation of strategies we will see in the near future which brands will have placed their bets on the value-adding role of a network of retailers and service providers versus those who were lured by greater vertical integration.

In the context of this analysis, we must not forget the impact on employment and industry (in terms of the restructuring processes underway) which are affecting the entire supply chain. It is not merely a question of job losses, but rather a pervasive need of updated skills in the automotive sector and connected businesses (from repair to distribution), which is bound to become more evident in years to come. Also in this case, albeit in a very fragmented form, European governments are offering diversified support processes which will have a very differentiated impact in relation to the innovation potential, not only of OEMs but also of OESs, in the States of the Union. The risks of re-proposing a multi-speed Europe in terms of infrastructure, industrial capacity innovation and renewal of the car fleet (also commensurate with income levels) could arise precisely in relation to the different diffusions of electric mobility among the countries of the Union.

Index[1]

---

[1] Note: Page numbers followed by 'n' refer to notes.

A. Cabigiosu, P. Lanzini (eds.), *The Green Transition of the Automotive Industry*,
https://doi.org/10.1007/978-3-031-37200-1