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The industry of electric vehicles: environmental, marketing and social aspects of management.

Introduction

This monograph addresses the question of management in the broadly defined industry of electric vehicles. Complexity of electromobility in general is being addressed, and prospects for managerial action are discussed as regards business entities active in the sector. Aspects such as law, spatial economics and marketing are being developed, as well as behavioural patterns observable in both the present and the future customers in that rapidly growing market.

The authors, researchers with the Andrzej Frycz Modrzewski Krakow University, come from management science and from related disciplines. Besides studying the present state of the industry, authors point at the managerial action to be taken by the main players of the industry in order to meet the challenges of electromobility, both globally and locally.

In 2021, 5,5 million electric cars were in use. The value of the electromobility market is estimated at \$244 billion. The forecasted

dynamics of that market are significant: from 5,5 million cars in 2021 to more than 700 million low-emission cars in 2040, which means 1/3rd of the global automotive fleet. In 2018, Poland had some 0,2% of its automotive fleet electric,¹ and that share is predicted to reach half a million cars in 2025, which encompasses passenger cars as well as utility vehicles, and is supposed to contain some 290 000 electric vehicles, and 225 000 plug-in hybrid ones (PHEV).² Norway comes forward as the country with the biggest share of electric cars (full electric and PHEV) in the overall automotive fleet: 10% in 2018.³

Electromobility might become an entirely new phase in the technology of road transport. Transitioning from propulsion by combustion engines to the electric ones means fundamental changes in the infrastructure. Should Poland rely exclusively on electromobility, with 100% of its automotive fleet gone electric, the infrastructure of power supply would require complete remodelling. Nuclear power seems indispensable in this context.

Currently available data suggests that charging stations for electric vehicles form a very different spatial structure from that of gas stations. Currently, there are 7856 gas stations in Poland,⁴ with a total fleet of combustion-based vehicles around 31 million.⁵

¹ *Wsparcie rozwoju elektromobilności. Informacja o wynikach kontroli*, NIK, Warszawa 2020, <https://www.nik.gov.pl/plik/id,23045,vp,25751.pdf> [accessed: 16.02.2022].

² *Rekordy w sektorze elektromobilności*, autoEXPERT, 7.12.2021, <https://autoexpert.pl/artykuly/rekordy-w-sektorze-elektromobilnosci> [accessed: 9.02.2022]. A separate infographic on the same page provides the data: 677 million passenger and utility ZEV (zero-emission vehicles) will be out on the roads of the world by 2040; the share of ZEVs in worldwide vehicle fleet by 2040: passenger and utility vehicles 36%, passenger vehicles 39%, utility vehicles 24%.

³ *Wsparcie rozwoju elektromobilności...*, *op. cit.*

⁴ *Wzrosła liczba stacji paliw w Polsce*, WNP.pl, 4.08.2022, <https://www.wnp.pl/finanse/wzrosla-liczba-stacji-paliw-w-polsce,608896.html#:~:text=Wed%C5%82ug%20danych%20Polskiej%20Organizacji%20Przemy%C5%82u,%2C%20kiedy%20by%C5%82o%20ich%207772%22> [accessed: 3.12.2022].

⁵ The actual number of cars on Polish roads can be lower, as the CEPiK registered cars database is not up to date with the damaged, scrapped and out-of-use cars, see K. Brzeziński, *Ile jest samochodów w Polsce? Mamy*

That gives an average of 3946 vehicles per 1 gas station. On the other hand, there were 2494⁶ charging stations for electric vehicles in Poland by the end of October 2022 (1992 charging stations by the end of January 2022⁷). With a fleet of some 52 000 electric vehicles on the road, it gives an average ratio of 20–21 vehicles per charging station. Density of the charging stations network is fundamentally different from that of gas stations. The latter remain infrastructural installations, whilst the former seem to evolve towards convenience-type appliances, like vending machines or trash containers. That, in turn, suggests different behavioural patterns in the end-users. Management in the business of electric vehicles and in the connected businesses (charging stations, recycling of batteries etc.) is likely to bring entirely new business models.

The development of electromobility is determined by a range of factors, including markets, social relations and environmental issues. In the market of electric vehicles, customer relations are being built similarly to the general automotive market. Integrative customer relations entail attentive listening to customers' opinions, and individualized approach.⁸ First-hand customers' experience

*konkretne dane. Wyglądają naprawdę nieźle, Moto.pl, 26.03.2023, <https://moto.pl/MotoPL/7,88389,29596338,ile-jest-samochodow-w-polsce-mamy-konkretne-dane-wygladaja.html>; M. Kamiński, *Wiemy ile pojazdów jest w Polsce i jak dużo z nich nie ma OC i badań technicznych*, Auto Świat.pl, 19.01.2023, <https://www.auto-swiat.pl/wiadomosci/aktualnosci/wiemy-ile-pojazdow-jest-w-polsce-i-jak-duzo-z-nich-nie-ma-oc-i-badan-technicznych/fjcn5s> [accessed: 29.03.2023].*

⁶ Rynek elektryczny.pl, <https://www.rynekelektryczny.pl/infrastrukturaladowania-pojazdow-elektrycznych/#:~:text=Liczba%20stacji%20%C5%82adowania%20pojazd%C3%B3w%20elektrycznych,koniec%20pa%C5%BAdziernika%202022%20r.> [accessed: 3.12.2022].

⁷ *Licznik elektromobilności: rośnie liczba stacji ładowania w Polsce*, PSPA, 17.02.2022, <https://pspa.com.pl/2022/informacja/licznik-elektromobilnosci-rośnie-liczba-stacji-ladowania-w-polsce/> [accessed: 3.12.2022].

⁸ A. Sudolska, *Zarządzanie doświadczeniami klientów jako kluczowy czynnik w procesie budowania ich lojalności*, „Zeszyty Naukowe Uniwersytetu Szczecińskiego. Ekonomiczne Problemy Usług” 2011, no. 72, pp. 275–284, https://bazhum.muzhp.pl/media/files/Ekonomiczne_Problemy_Uslug/Ekonomiczne_Problemy_Uslug-r2011-t-n72/Ekonomiczne_Problemy_Uslug-r2011-t-n72-s275-284/Ekonomiczne_Problemy_Uslug-r2011-t-n72-s275-284.pdf [accessed: 18.12.2021].

and the resulting emotions are principal frames of reference in the process of co-creating and consuming the product.⁹ In the automotive market, customers invest in their relations with suppliers just as much as suppliers invest in customer relations. A new vehicle, including a zero-emission one, is an investment for the customer: even without formalized amortization, this is a durable capital good exploited over a lifecycle of many years. In that perspective, in the long term, customers' opinions and behaviour shape electric vehicles as a product.

Road transport is a significant source of CO₂ emissions, thus contributing to the greenhouse effect. In 2021, total emissions of CO₂ from that source were the highest in North America, with Europe coming at the second place, and Asia at the third. Electromobility should contribute to reducing CO₂ emissions.¹⁰ The implications of electromobility in urban agglomerations, the issue of bus lanes, expansion of charging stations, and the implementation of low-emission zones are being studied.¹¹ Therefore, businesses active in the sector of electric vehicles should display a pro-environmental orientation, which can be interpreted as part of a general pro-social orientation. In that thread of study, broader environmental aspects are taken into account, including the recycling of vehicles and their parts (e.g. batteries).

Legislative action is important for the development of electromobility in Poland, such as the amendment to the Electromobility and Alternative Fuels Act, as of December 2, 2021¹², and a few

⁹ Z. Waśkowski, *Możliwości i ograniczenia wykorzystania koncepcji zarządzania doświadczeniem klientów przez uczelnie wyższe*, „Marketing Instytucji Naukowych i Badawczych” 2017, vol. 24, no. 2, pp. 1–14, http://minib.pl/wp-content/uploads/2017/05/Zygmunt-Waskowski_Mozliwosci-i-ograniczenia-wykorzystania-koncepcji-zarzadzania-doswiadczeniem-klientow.pdf [accessed: 30.11.2022].

¹⁰ *Rekordy w sektorze elektromobilności*, *op. cit.*

¹¹ E. Sendek-Matysiak, Z. Łosiewicz, *Analysis of the development of the electromobility market in Poland in the context of the implemented subsidies*, „Energies” 2021, no. 14, 222, <https://www.mdpi.com/1996-1073/14/1/222> [accessed: 30.11.2022].

¹² Ustawa z dnia 2 grudnia 2021 r. o zmianie ustawy o elektromobilności i paliwach alternatywnych oraz niektórych innych ustaw, Dz.U. [Journal of Laws of the Republic of Poland] 2021, item 2269.

other acts. These specific legislative changes are relative to such issues as: the creation of low-emission zones, b) installation of new charging points for electric vehicles, c) the use of hydrogen as automotive power source,¹³ d) systematic review of legal definitions regarding electric vehicles, hybrid vehicles, LNG-powered vehicles, hydrogen-powered vehicles, charging stations and hydrogen-refuelling stations.¹⁴ Basic definitions of vehicles are also covered by the Road Traffic Act.¹⁵

Individual chapters of this monograph treat different aspects of market-related changes (including customer awareness), as well as technological changes in the sector of electric cars. Changes in customer behaviour and technological development of electric vehicles as products have been studied from the point of view of opportunities and threats. It is stressed that marketing communication should be addressed to the groups of innovators and early imitators in the first place, including house owners, residents of suburbs and satellite towns, thus persons with a generally good level of education and a high level of environmental awareness (chapter by D. Fatuła).

Managerial action in the sector of electric vehicles is connected to the way that businesses work at the level of manufacturing, as well as the exploitation of those vehicles. Business models have been discussed, in connection with the lifecycle of technologies and the financial aspect. Three case studies are presented (chapter by K. Waśniewski). In their search for excellence, businesses active in the sector of electric vehicles can use the accumulated experience

¹³ M. Ćmikiewicz, *Nowe regulacje w przedmiocie „czystego transportu”, czyli zmiany w ustawie o elektromobilności*, Sozosfera.pl, <https://sozosfera.pl/prawo/nowe-regulacje-w-przedmiocie-czystego-transportu-czyli-zmiany-w-ustawie-o-elektromobilnosci/> [accessed: 10.02.2022]. Consolidated text of the act: Ustawa z dnia 11 stycznia 2018 r. o elektromobilności i paliwach alternatywnych, Dz.U. 2018, item 317.

¹⁴ Ustawa z dnia 11 stycznia 2018 r. o elektromobilności i paliwach alternatywnych, version effective from 24 December 2021 to 30 June 2024, Dz.U. 2021, item 110, <https://sip.lex.pl/akty-prawne/dzu-dziennik-ustaw/elektromobilnosc-i-paliwa-alternatywne-18683445> [accessed: 10.02.2022].

¹⁵ Prawo o ruchu drogowym, Dz. U. 2021, item 450, as amended, <https://sip.lex.pl/akty-prawne/dzu-dziennik-ustaw/prawo-o-ruchu-drogowym-16798732/art-2> [accessed: 10.02.2022].

as regards environmental, social, and innovative orientations. It is proposed to use the ECSR concept (Environmental Corporate Social Responsibility) to achieve excellence in organization, based on the EFQM model (chapter by A. Chodyński).

Excellence in the sector of electric vehicles can be achieved through process excellence, too. Practical utility has been assessed as regards the concept of process maturity in an organization, with a focus on environmental aspects (chapter by W. Huszłak). Environmental orientation in managerial action, particularly as regards Human Resource Management, has been studied in the sector of electric vehicles (chapter by M. Leśniewski). The importance of electromobility has been studied in connection with the general EU policy of termoemissions, including in the context of the war in Ukraine (chapter by A. Bałamut).

Specific questions regarding marketing strategies, manufacturing, media, and urban planning have been addressed. Modern forms of online education, including informed consumer choices, can contribute to environmental awareness, an important factor of development in the sector of electric vehicles (chapter by M. Woźniak-Zapór). Solutions such as Cost Deployment, in the field of cost management, borrowed from other manufacturing systems, can be used by the producers of electric vehicles (chapter by E. Bąchor).

Household budgets play a significant role for the consumers' purchasing decisions in the market of electric vehicles, which has been documented with specific examples (chapter by B. Oliwkiewicz). Media and their relation to the development of electromobility are an important factor as well, which is studied with a focus on the city of Kraków (chapter by D. Baran). Electric cars also have a role in the planning of urban parking spaces (chapter by A. Damasiewicz).