Automobile Consumers' Low-Carbon Purchase Intention

Subjects: Behavioral Sciences
Contributor: Nan Xu, Yaoqun Xu

Low-carbon buying consciousness is a kind of tacit knowledge, which was put forward by Michael Polanyi in Philosophy in 1958. "There are two kinds of human knowledge," he argued. "What is usually described as knowledge" expressed in written words, charts and mathematical formulas, is only one type of knowledge. And unexpressed knowledge, like the knowledge that people have when they are doing something, is a different kind of knowledge. He called the former explicit knowledge and the latter tacit knowledge. Scholars have made great achievements in the study of tacit knowledge. Consumers are a group, and the classic model to study the trend of the crowd is the Susceptible Infected Recovered Model (SIR).

Keywords: tacit knowledge ; differential dynamics ; SIR model ; green and low-carbon purchase inclination

1. Introduction

From the point of view of energy security and environmental protection, growth of the new energy vehicle sector is a complex system evolution process; it is composed of interrelated subsystems. Therefore, the development of new energy vehicles not only requires the renewal of ideas and innovation of technology, but also requires the coordinated development of many social factors, such as market mechanisms, infrastructure, consumption habits, policies, culture, and so on [1]. Since 2015, China's production and sales of new energy vehicles have ranked first in the world for three consecutive years. In 2017, the sales volume of new energy vehicles has reached 770,000, and the holding volume has exceeded 1.6 million, accounting for 50% of the total global holding volume of new energy vehicles [2]. By 2020, China's annual sales of new energy vehicles reached 1.37 million, and the market penetration rate increased to 5.4%. The driving range of mainstream new energy vehicles has reached 500–600 km, close to the level of gasoline vehicles [3]. Domestic scholars have evaluated the sustainable development level of the new energy automobile industry from the perspectives of the technological innovation environment, industrial development foundation, social support conditions, ecological environment, economic development and social culture, and innovation ecology [4]. Other scholars evaluated the competition situation of the global new energy automobile industry from the perspectives of market size, industrial chain integrity, public infrastructure guarantee, market development degree, technological innovation and brand recognition, and policy effectiveness [5]. Although people have studied the development of new energy vehicles from various angles, the factor that can directly affect purchase intensity is ignored, that is, consumers' low-carbon purchase intention. Low-carbon purchase intention emphasizes mobilizing people's subjective initiative and improving their environmental awareness. Consumers' subjective recognition and acceptance of low-carbon travel can enable new energy vehicles to occupy an advantaged position in the competition with fuel vehicles. Of course, it is inevitable to improve the performance of new energy vehicles, because they can enhance people's recognition of them.

The development of new energy vehicles in China mainly depends on policy. The country has been promoting the development of new energy vehicles more actively and systematically. Although some achievements have been made, the sustainable and stable development of new energy vehicles cannot completely rely on government support. Researchers should consider whether consumers truly recognize and accept new energy vehicles, and they should increase people's green and low-carbon purchase inclination, which is the fundamental way to ensure the circular development of new energy vehicles. After publicity and education in recent years, more and more people have realized the importance of low-carbon environmental protection and are making their own contributions to the ecological environment with their own actions. If people want to have a green earth, it is vital to raise people's awareness of low-carbon environmental protection.

2. Research on the Development of New Energy Vehicles

China's National Bureau of Statistics (NBSC) reported that the number of cars was 260 million in 2019, an increase of 8.83%, which causes serious air pollution and is not conducive to the green and sustainable development of the environment. Although the government has issued some corresponding measures, such as restricting car travel, most of the measures have not significantly improved air pollution [6]. New energy vehicles are powered by energy storage batteries, which can greatly reduce carbon emissions. Therefore, they have been adopted and promoted by governments around the world in recent years to improve global warming and environmental pollution [7]. The Chinese government has introduced a series of incentive policies, which have led to the exponential growth of the new energy vehicle industry, which has become the world's largest market [8]. By November 2021, sales of new energy vehicles in China exceeded 7 million units, ranking first in the world, and the market share of newly registered vehicles reached 10 percent. The Chinese government plans to increase the market share of new energy vehicles to 20 percent by the end of 2025. It is expected to maintain a rapid growth trend in the future [9]. New energy vehicles are still in their infancy in China, and inevitably there are some hidden dangers, such as a heavy financial expenditure burden and insufficient charging infrastructure, and core technology has not yet broken through, and so on [10]. Some scholars also believe that carbon emission constraint is an important factor affecting the development of new energy vehicles [11]. These constraints are the result of considering the problem from an objective perspective. In fact, the change of people's subjective consciousness and the enhancement of low-carbon purchase inclination can fundamentally promote the development of new energy vehicles. The improvement of objective factors assists consumers to establish and enhance low-carbon purchase inclination. Therefore, the two should be carried out at the same time to achieve the ideal effect.

3. Research on the Tacit Knowledge Dissemination Model

Nonaka proposed the classic SECI knowledge creation model, pointing out that explicit knowledge and tacit knowledge can be transformed and transmitted through socialization, externalization, integration, and internalization [12]. The classical SECI model shows some limitations and does not study the transmission process of tacit knowledge in the unrevealed tacit state. The infectious disease model is a typical model to solve tacit knowledge dissemination. The SIR (Susceptible Infective Removal) model, jointly developed by Kermask and McKendrick, is the most classic and basic model of the infectious disease model, which makes a fundamental contribution to the dynamics of knowledge transmission in the tacit state. Many scholars apply the SIR model to the field of knowledge dissemination [13]. Bai studied SIR model with time delay [14]. C.N. Agnstmann et al. proposed a fractional SIR model related to age structure [15]. Zhao studied the stochastic SIR model and analyzed the threshold of its diffusion with the non-negative semi-saddle convergence theorem [16]. Li Jingjing used the improved SIR model to analyze the learning network and established the SIRL model by introducing the role of the leader factor, which enriched the knowledge transmission dynamics theory of the complex network [17]. Cowan proposed a knowledge diffusion model and a knowledge growth model on complex networks [18], studied the relationship between network structure and knowledge diffusion, network structure and knowledge growth, and better simulated the dynamic characteristics of knowledge diffusion in economic networks. The reality of complex network simulation is also verified in rumors, information diffusion [19], and the spread of infectious diseases [20]. Moronc and Taylor put forward a general model of knowledge diffusion rules based on the face-to-face network, and put forward some dominant mechanisms of knowledge diffusion called "social learning" [21]. Wang proposed an improved SIRaRu model based on the Sir Model to study the propagation characteristics of information in isomorphic networks and heterogeneous networks [22]. In order to compare the merits and demerits of different forgetting functions, Ncmbhard and Osothsilp used survey data to estimate and verify model parameters [23]. Zhao is one of the few scholars who noticed the defects of numerical simulation. He considered the role of the forgetting mechanism in the rumor propagation model, derived the mean field equation, and carried out some empirical work [24]. Enatsu Y et al. proposed that the stimulation of exogenous variables could easily lead to the re-transformation of some immune nodes into susceptible nodes, and established an SIRS propagation model [25].

4. Research on Consumers' Low-Carbon Inclination

In recent years, environmental protection has become the most concerning issue. People's low-carbon awareness is the subjective motivitation for the improvement of environmental greenness. Many scholars have studied consumers' low-carbon purchase inclination [26]. Some consumers tend to pay higher prices to purchase low-carbon products [27]. Businesses have noticed the change in the consumption concept of consumers', and they have begun to pay attention to the use of low-carbon labels. Some household appliances and other electrical products are labeled with energy saving labels [28]. There are two kinds of government subsidies: subsidies for manufacturers which produce green products and subsidies for consumers who buy green products. A supply chain includes two kinds of power structures: the

manufacturing leader and the retail leader [29]. Xu et al. constructed the differential pricing model of green products and non-green products with government subsidies from the perspective of reducing the cost of green products, and obtained the optimal pricing strategy [30]. In regard to carbon-concerned demand, Du et al. studied how low-carbon supply policies affect supply chain performance [31]. Yu et al. analyzed the green policy effect of optimal production with consumer environmental awareness [32]. Based on the analysis of the pricing and emission reduction optimization strategy, a contract mechanism for supply chain coordination and optimization was designed by using the Robinson bar buying model [33]. Meng et al. considered two competitive firms, one of which adopted low-carbon technology and the other did not, and studied the product selection problem with carbon tax [34]. Song and Gao designed a revenue-sharing contract in order to improve the greening level of the products of a supply chain [35]. Su et al. concluded that when the government subsidizes consumers, the carbon emission level and retail price are directly proportional to the subsidy coefficient under the two power structures [36]. The safety, maximum speed, battery capacity, comfort, and price of new energy vehicles have a significant impact on purchase inclination [37]. The capacity of the power battery directly affects the range of the car, which is also one of the most concerning factors for consumers [38]. The Chinese government has adopted some policies conducive to the development of the new energy vehicle industry, such as tax exemptions and direct subsidies, which have played a positive role in promoting consumers' low-carbon purchase inclination [39].

5. Study on the Process of Knowledge Transmission in Groups

The spread of tacit knowledge among groups is influenced by personal experience, preference, and interest. Nonaka and Konno et al. believe that customer tacit knowledge is reflected in customers' evaluation, feedback, thoughts, feelings, and expectations related to products and services, as well as perceived customer habits, preferences, and interests [40]. From the network perspective, Haas et al. believe that knowledge sharing is constructed based on the binary network relationship of "provider–seeker" and is a process in which knowledge providers share knowledge with emotionally connected seekers [41]. From the perspective of interaction, the essence of knowledge sharing is the communication and interaction between subjects, and it is a behavioral process [42]. From the perspective of exchange, knowledge sharing is an activity of exchanging knowledge between at least two subjects [43][44]. It is a process in which individuals exchange explicit and implicit knowledge and jointly create new knowledge [45]. As far as learning is concerned, knowledge sharing is the process of learning between subjects and forms a learning atmosphere between them. The sharing subject transfers its expertise (experience and skills) to the other subject and makes it master as much as possible [46].

References

1. Geels, F.W. From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. Res. Policy 2004, 33, 897–920.
2. Cai, P.; Wu, J. Mechanism research on the future development system of new energy vehicles. J. Syst. Sci. 2019, 27, 35–40.
3. Su, L. Evaluation and enlightenment of China's new energy vehicle development policy implementation. Environ. Prot. 2021, 49, 41–47.
4. Pan, S.; Li, B.; Nie, H. Study on coupling coordination and prospect forecast of new energy automobile industry and beautiful China Construction. Res. Sci. Technol. Manag. 2019, 39, 123–129.
5. Bai, M. Study on competition pattern of global New energy automobile industry. Price Theory Pract. 2020, 14, 25–31.
6. Wu, X.; Wu, Y.; Zhang, S.; Liu, H.; Fu, L.; Hao, J. Assessment of vehicle emission programs in China during 1998–2013: Achievement, challenges and implications. Environ. Pollut. 2016, 214, 556–567.
7. Zhang, L.; Qin, Q. China's new energy vehicle policies: Evolution, comparison and recommendation. Transp. Res. Part A Policy Pract. 2018, 110, 57–72.
8. Zhang, X.; Wang, K.; Hao, Y.; Fan, J.L.; Wei, Y.M. The impact of government policy on preference for NEVs: The evidence from China. Energy Policy 2013, 61, 382–393.
9. Zhang, R.; Hanaoka, T. Deployment of electric vehicles in China to meet the carbon neutral target by 2060: Provincial disparities in energy systems, CO2 emissions, and cost effectiveness. Resour. Conserv. Recycl. 2021, 170, 105622.
10. Zuo, W.; Li, Y.; Wang, Y. Research on the optimization of new energy vehicle industry research and development subsidy about generic technology based on the three-way decisions. J. Clean. Prod. 2019, 212, 46–55.
11. Zhang, L.; Li, Z.; Jia, X.; Tan, R.R.; Wang, F. Targeting carbon emissions mitigation in the transport sector—A case study in Urumqi, China. J. Clean. Prod. 2020, 259, 120811.

12. Nonaka, I.; Toyama, R.; Konno, N. SECI, Ba and Leadership: A Unified Model of Dynamic Knowledge Creation. Long Range Plan. 2001, 33, 5–34.
13. Kermack, W.O.; Mckendrick, A.G. Contributions to the mathematical theory of epidemics: IV. Analysis of experimental epidemics of the virus disease mouse ectromelia. Epidemiol. Infect. 1937, 37, 172–187.
14. Bai, Z.; Wu, S.L. Traveling waves in a delayed SIR epidemic model with nonlinear incidence. Appl. Math. Comput. 2015, 263, 221–232.
15. Angstmann, C.N.; Henry, B.I.; McGann, A.V. A fractional-order infectivity SIR model. Phys. A Stat. Mech. Its Appl. 2016, 452, 86–93.
16. Zhao, D. Study on the threshold of a stochastic SIR epidemic model and its extensions. Commun. Nonlinear Sci. Numer. Simul. 2016, 38, 172–177.
17. Li, J.; Zhang, Y.; Man, J.; Zhou, Y.; Wu, X. SISL and SIRL: Two knowledge dissemination models with leader nodes on cooperative learning networks. Phys. A Stat. Mech. Its Appl. 2017, 468, 740–749.
18. Cowan, R.; Jonard, N.; Ozman, M. Knowledge Dynamics in a Network Industry. Technol. Forecast. Soc. Change 2004, 7, 469–484.
19. Qian, Z.; Tang, S.; Zhang, X.; Zheng, Z. The independent readers involved SIR Rumor model in complex networks. Phys. A Stat. Mech. Its Appl. 2015, 429, 95–102.
20. Wang, Y.; Jin, Z.; Yang, Z.; Zhang, Z.K.; Zhou, T.; Sun, G.Q. Global analysis of an SIS model with an infective vector on complex networks. Nonlinear Anal. Real World Appl. 2012, 13, 543–557.
21. Morone, P.; Taylor, R. Knowledge diffusion dynamics and network properties of face-to-face interactions. J. Evol. Econ. 2004, 14, 327–351.
22. Wang, J.; Zhao, L.; Huang, R. SIRaRu rumor spreading model in complex networks. Phys. A Stat. Mech. Its Appl. 2014, 398, 43–55.
23. Nembhard, D.A.; Osothsilp, N. An empirical comparison of forgetting models. IEEE Trans. Eng. Manag. 2001, 48, 283–291.
24. Zhao, L.; Xie, W.; Gao, H.O.; Qiu, X.; Wang, X.; Zhang, S. A rumor spreading model with variable forgetting rate. Phys. A Stat. Mech. Its Appl. 2013, 392, 6146–6154.
25. Enatsu, Y.; Nakata, Y.; Muroya, Y. Lyapunov functional techniques for the global stability analysis of a delayed SIRS epidemic model. Nonlinear Anal. Real World Appl. 2012, 13, 2120–2133.
26. Wu, D.; Yang, Y. The Low-Carbon Supply Chain Coordination Problem with Consumers' Low-Carbon Preference. Sustainability 2020, 12, 3591.
27. Basiri, Z.; Heydari, J. A mathematical model for green supply chain coordination with substitutable products. Clean. Prod. 2017, 145, 232–249.
28. Baldini, M.; Trivella, A.; Wente, J.W. The impact of socioeconomic and behavioural factors for purchasing energy efficient household appliances: A case study for Denmark. Energy Policy 2018, 120, 503–513.
29. Du, W.; Fan, Y.; Yan, L. Pricing Strategies for Competitive Water Supply Chains under Different Power Structures: An Application to the South-to-North Water Diversion Project in China. Sustainability 2018, 10, 2892.
30. Xu, C.Q.; Zhao, D.Z.; Yuan, B.Y. Products Differential Pricing and Supply Chain Coordination Mechanism under the Government Subsidy Policy. Syst. Eng. 2014, 32, 78–86.
31. Du, S.; Li, H.; Li, W. Low-carbon supply policies and supply chain performance with carbon concerned demand. Ann. Oper. Res. 2017, 255, 569–590.
32. Yu, Y.; Han, X.; Hu, G. Optimal production for manufacturers considering consumer environmental awareness and green subsidies. Int. J. Prod. Econ. 2016, 182, 397–408.
33. Peng, H.; Pang, T.; Cong, J. Coordination contracts for a supply chain with yield uncertainty and low-carbon preference. J. Clean. Prod. 2018, 205, 291–302.
34. Meng, X.; Yao, Z.; Nie, J.; Zhao, Y.; Li, Z. Low-carbon product selection with carbon tax and competition: Effects of the power structure. Int. J. Prod. Econ. 2018, 200, 224–230.
35. Song, H.; Gao, X. Green supply chain game model and analysis under revenue-sharing contract. J. Clean. Prod. 2018, 170, 183–192.
36. Su, C.; Liu, X.; Du, W. Green Supply Chain Decisions Considering Consumers's Low-Carbon Awareness under Different Government Subsidies. Sustainability 2020, 12, 2281.

37. O’Neill, E.; Moore, D.; Kelleher, L.; Brereton, F. Barriers to electric vehicle uptake in Ireland: Perspectives of car-dealers and policy-makers. Case Stud. Transp. Policy 2018, 7, 118–127.
38. Bryden, T.S.; Hilton, G.; Cruden, A.; Holton, T. Electric Vehicle Fast Charging Station Usage and Power Requirements. Energy 2018, 152, 322–332.
39. Zhang, X.; Bai, X.; Shang, J. Is subsidized electric vehicles adoption sustainable: Consumers’ perceptions and motivation toward incentive policies, environmental benefits, and risks. J. Clean. Prod. 2018, 192, 71–79.
40. Nonaka, I.; Konno, N. The Concept of Ba, Building a foundation for knowledge creation’, California Management Review. Calif. Manag. Rev. 2010, 40, 40–54.
41. Haas, M.R.; Criscuolo, P.; George, G. Which Problems to Solve? Online Knowledge Sharing and Attention Allocation in Organizations. Acad. Manag. J. 2014, 58, 680–711.
42. Huang, F.; Ma, J.; Huo, R. Rational behavior model of knowledge sharing among enterprise employees. Manag. Sci. Res. 2010, 31, 120–126.
43. Tangaraja, G.; Rasdi, R.M.; Ismail, M.; Samah, B.A. Fostering knowledge sharing behaviour among public sector managers: A proposed model for the Malaysian public service. J. Knowl. Manag. 2015, 19, 121–140.
44. Aksoy, Y.; Ayranci, E.; Gozukara, E. A Research on the Relationship between Knowledge Sharing and Employee Performance: The Moderating Role of Unethical Behaviors in Organizational Level. Eur. Entific J. 2016, 12, 1857–7881.
45. Bart, V.; Ridder, J.D. Knowledge sharing in context: The influence of organizational commitment, communication climate and CMC use on knowledge sharing. J. Knowl. Manag. 2004, 8, 117–130.
46. Bandi, R.K.; Mehra, V. Knowledge Sharing in Repository-Based KM Systems: A Study in the IT Services Enterprises in India. In Knowledge Management for Development; Springer: Boston, MA, USA, 2014.
