RESEARCH IN PROGRESS

# ALGORITHMIC NUDGING FOR SUSTAINABILITY IN E-COMMERCE: CONCEPTUAL FRAMEWORK AND RESEARCH AGENDA

THOMAS WOZNIAK,[1] MIRJAM STIEGER,[1] DOROTHEA SCHAFFNER,[2] MATTIAS SCHU[1] & GUANG LU[1]

[1] Lucerne School of Business, Institute of Communication and Marketing, Lucerne, Switzerland.
E-mail: thomas.wozniak@hslu.ch, mirjam.stieger@hslu.ch, matthias.schu@hslu.ch, guang.lu@hslu.ch

[2] University of Applied Sciences Northwestern Switzerland, School of Applied Psychology, Olten, Switzerland.
E-mail: dorothea.schaffner@fhnw.ch.

**Abstract** This paper synthesizes relevant research fields that build the conceptual foundation of algorithmic nudging specifically for sustainability in e-commerce. The carbon footprint of e-commerce can be reduced by encouraging consumers to engage in more sustainable consumer behaviour with regards to products, packaging, delivery options, and returns. Such behaviour can be steered by employing different nudging techniques along the digital customer journey. The use of artificial intelligence can increase the effectiveness of digital nudges by tailoring them to specific individual contexts. In this article, we propose a conceptual framework for the application of algorithmic nudging to increase sustainability in e-commerce. We also derive several research avenues to spark a wide array of empirical studies to move forward this emerging topic.

**Keywords:** choice architecture, digital nudging, algorithmic nudging, sustainability, e-commerce.

University of Maribor Press

DOI https://doi.org/10.18690/um.fov.4.2022.43
ISBN 978-961-286-616-7

# 1 Introduction

Just recently, the Intergovernmental Panel on Climate Change (IPCC, 2022) released its sixth assessment report. The report finds that climate change is happening faster than expected and calls governments and businesses to take drastic action against it (World Economic Forum, 2022). At the same time, e-commerce is on the rise and continues its growth path. Within the last five years, the worldwide e-commerce turnover increased around 77 percent, reaching 4.2 bn USD (eMarketeer and Statista, 2021). The higher rate of deliveries and returns increase the environmental impact of e-commerce (Fichter, 2003; Frei, Jack, & Brown, 2020; Mangiaracina, Marchet, Perotti, & Tumino, 2015). To mitigate the environmental consequences of e-commerce, all players in the e-commerce value chain need to collectively develop and offer more sustainable products, services, and solutions. Consumers should be encouraged and supported to select them in order to overcome the attitude-behaviour gap (Gershoff & Frels, 2015; Michels, Ochmann, Günther, Laumer, & Tiefenbeck, 2022; White, Habib, & Hardisty, 2019). Behavioural interventions such as nudges can be applied to achieve this (Rankine & Khosravi, 2021; Thaler & Sunstein, 2008). However, the potential of nudges to foster sustainability in the digital space is all but realized. Artificial intelligence (AI) can make digital nudges much more effective and thereby contribute to decrease the environmental footprint of e-commerce. The contribution of this paper is threefold. First, we synthesize relevant research fields that build the conceptual foundation of algorithmic nudging specifically for sustainability in e-commerce. Second, we propose a conceptual framework for the application of algorithmic nudging to increase sustainability in e-commerce. And finally, we derive several research avenues to spark a wide array of studies to move forward this emerging topic.

# 2 Background

## 2.1 The Evolution of Algorithmic Nudging

People face choices every day. These choices are not always guided by rational deliberations, but also by the design of the choice environment in which certain information is presented. In other words, what option we choose often depends on how the options are presented (Johnson et al., 2012). Changes in the choice architecture, so-called nudges, describe any aspect of the choice which alter people's behaviour in a desired and predictable way without forbidding any options or significantly changing their economic incentives. Nudges involve very subtle manipulations that people often barely register, such as putting healthy options at eye level in a cafeteria to encourage healthier choices (Thaler & Sunstein, 2008). Nudges have already been employed in a variety of contexts to alter people's behaviour and there is a growing body of research proving the effectiveness of different types of nudges (Benartzi et al., 2017; Hummel & Maedche, 2019; Mertens, Herberz, Hahnel, & Brosch, 2022; Milkman et al., 2022).

In recent years, more and more decisions are being made online. The design of digital choice environments (deliberately or accidentally) influences people's choices. Digital nudges have two main advantages compared to their physical counterparts: they are easier, faster, and cheaper to implement; and can be personalized (Mirsch, Lehrer, & Jung, 2017). More specifically, digital nudges have the potential to be tailored to the digital footprint of an individual user, based on user data, context, and individual characteristics (Mirsch et al., 2017). Such algorithmic nudges, which leverage Big Data, can be very effective due to their networked, continuously updated, dynamic and pervasive nature (Yeung, 2017). Algorithmic nudging has the potential to change individuals' decisions and behaviours in a subtle way and at large scale (Möhlmann, 2021) and can potentially improve both individual and net welfare by fostering sustainable and climate-friendly behaviour. So far, multiple terms such as adaptive nudging (Burr et al., 2018), Big Data-driven nudges, hypernudging (Yeung, 2017), smart nudging (Karlsen & Andersen, 2019) or algorithmic nudging (Möhlmann, 2021) have been used to refer to these forms of nudges. In this article, the term *algorithmic nudging* will be used.

## 2.2 E-Commerce and Customer Journey

Not only since the COVID-19 pandemic e-commerce is on the rise. As reported by eMarketer and Statista (2021), the worldwide turnover in e-commerce has increased from 2.4 bn USD to 4.2 bn, which corresponds to an increase of around 77 percent within the last five years. Further growth of around 75 percent to 7.385 bn USD is expected by 2025. Digitalization and e-commerce have disrupted shopping behaviour (Velazquez & Chankov, 2019). The higher rate of deliveries and returns makes it inevitable to examine the resulting environmental and economic impact of ordering online (e.g., Frei et al., 2020; Mangiaracina et al., 2015). To better understand how consumers shop online and where specific decisions are made in the buying process, it is useful to consider the e-commerce customer journey. The concept of the customer journey is based on the decision-making process and distinguishes three main phases: the pre-purchase, the purchase, and the post-purchase phase (Lemon & Verhoef, 2016; Tueanrat, Papagiannidis, & Alamanos, 2021). In e-commerce, consumers face decisions such as the choice of an online retailer, specific products, delivery option, type of packaging, and product return (Ignat & Chankov, 2020; Michels et al., 2022; Vakulenko, Shams, Hellström, & Hjort, 2019). These decisions have environmental consequences that can be mitigated by steering consumers towards choosing the more sustainable options.

### 2.3 Nudging Sustainable Consumer Choices in E-Commerce

Although more and more consumers hold favourable attitudes towards sustainable options, the market share of sustainable products and services remains low. Explanations for this attitude-behaviour gap are conflicting needs with regards to convenience, costs, or habits (Kollmuss & Agyeman, 2002). Digital nudging is suggested as one option to make the choice of sustainable options more convenient and to change habitual purchase behaviour (Gershoff & Frels, 2015; Michels et al., 2022; White et al., 2019). Recent research suggests that default, active choice, and self-nudges could increase the choice of more sustainable options in consumer choice areas related to delivery options, packaging, and carbon offsetting in online apparel retailing (Michels et al., 2022). Results of this research remains mixed, disconfirming (Mirbabaie, Marx, & Germies, 2021) or confirming the effectiveness of sustainability nudging (Berger, Nüske, & Müller, 2020; Fechner & Herder, 2022; Katner & Jianu, 2019; Lembcke, Willnat, Engelbrecht, & Lichtenberg, 2020). Based on the methodological approach of online experiments, these studies do not account for the potential of machine learning and AI. In fact, the use of AI to enable sustainable e-commerce practices is a neglected research area (Bawack, Wamba, Carillo, & Akter, 2022).

## 3 Conceptual Framework

Figure 1 depicts the proposed conceptual framework for algorithmic nudging to promote sustainability in e-commerce. The self-learning algorithm uses personalization and context-awareness to deliver nudges that are relevant to the current situation of the consumer. That is, the algorithm recognizes which nudge could be most effective based on several individual characteristics, or *person factors* (de Ridder, Kroese, & van Gestel, 2022; Karlsen & Andersen, 2019; Matz, Kosinski, Nave, & Stillwell, 2017).

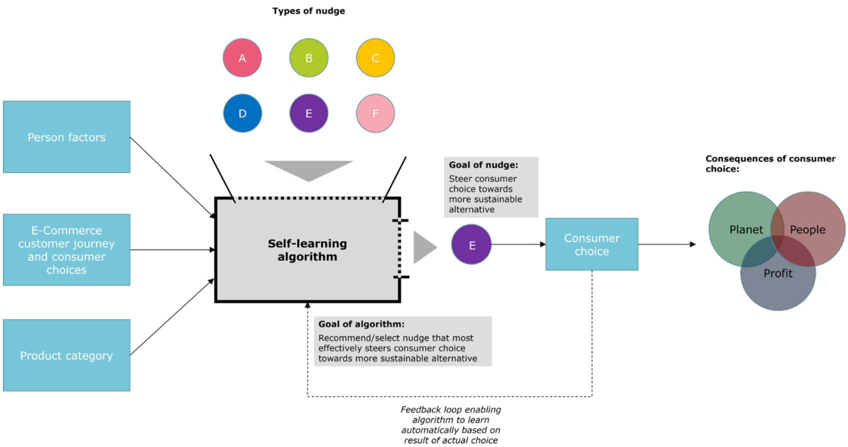


**Figure 1: Conceptual Framework for Algorithmic Nudging in E-Commerce**

Consumers face many different decisions along the *e-commerce customer journey*. Once consumers have selected a certain online retailer, they are confronted with decisions in four different areas (Michels et al., 2022; Vakulenko et al., 2019): (1) Products, (2) delivery, (3) packaging, and (4) product returns. An additional area is the offsetting of carbon emissions induced through a purchase which is increasingly offered by online retailers (Michels et al., 2022). Extant research on the effectiveness of digital nudging in e-commerce has considered a variety of *product categories* (Berger et al., 2020; Katner & Jianu, 2019; Michels et al., 2022; Mirbabaie et al., 2021) and has demonstrated that digital nudging can steer consumers' product choices towards more sustainable options. To effectively nudge individuals into the more sustainable direction, the self-learning algorithm must thus also learn which nudge is most effective for which product category (Shaw & Jones, 2005). There exist different *types of nudges* which can be delivered in the context of an online store. According to Jesse and Jannach (2021), four nudging types can be classified: (1) Information, (2) structure and arrangement of options (e.g., Pichert & Katsikopoulos, 2008), (3) reminders (e.g., Milkman et al., 2021), and (4) information on other consumers' behaviour (e.g., Cheung, Kroese, Fennis, & De Ridder, 2017). On these bases, the *self-learning algorithm* can build up extensive knowledge about consumers and products, and incorporate the goal and the type of nudges to influence consumer behaviour (Sitar-Tăut, Mican, & Buchmann, 2021). Consumers' choices in turn feed into the system to influence the recommendations for the next nudges. Ultimately, consumer choices in e-commerce can have intended and unintended *consequences* for profit, people, and the planet (e.g., Fichter, 2003; Frei et al., 2020).

Generally, the core of debates on nudging has been the question of legitimacy: Is it admissible to subtly steer people's behaviour in a certain direction? Who determines what behaviour is desired by an individual? While nudges should be used to help people make better choices for both the individual and net welfare (Thaler & Sunstein, 2008), this has not always been the case. While unethical nudges may lead to short term gains for a company, they may backfire in terms of loss of goodwill, negative publicity, or even legal action. Especially the usage of algorithmic nudging poses ethical challenges (Möhlmann, 2021).

## 4 Discussion and Future Research Directions

Research on the application of digital nudging to foster sustainable consumer behaviour in e-commerce is just emerging. So far, most studies only offer fragmented insights specific to certain types of nudges and product categories. Future studies are needed to fill blind spots in the current body of knowledge. Based on our literature review and the proposed framework, we derive two broad areas for future research and several research questions (RQ) (see Table 1). The first area concerns the drivers of the effectiveness of digital nudges that are employed to steer consumer choices towards more sustainable options. The second area concerns the use of algorithms to improve the effectiveness of digital nudging. This area includes the accuracy of different algorithm types and machine learning approaches, antecedents as well as intended and unintended consequences of algorithmic nudging, the integration of algorithmic nudges in the customer journey, the legitimacy of "green" algorithmic nudges, and business model innovation opportunities.

**Table 1: Research Agenda for Algorithmic Nudging in E-Commerce**

| RQ | Research Questions |
|---|---|
| **Research Area I:** Drivers of the effectiveness of digital nudges | |
| RQ1.1 | What are relevant person factors (personality, attitudes, demographics, etc.) that determine the effectiveness of a nudge in online retailing? |
| RQ1.1.1 | Which attitudinal factors affect the effectiveness of a nudge? |
| RQ1.1.2 | How can attitudinal factors be derived from observable online behaviour? |
| RQ1.2 | Which types of nudges do effectively steer consumers towards different types of more sustainable choices along the e-commerce customer journey? |
| RQ1.3 | Which nudges work best for which product category? |
| RQ1.3.1 | How do product category as well as packaging, delivery, carbon offsetting, and potential returns of products in this category affect the effectiveness of a nudge? |
| RQ1.3.2 | To what extent can higher-order product categorizations influence the effectiveness of nudges? |
| **Research Area II:** Use of algorithms to improve the effectiveness of digital nudges | |
| RQ2.1 | Which types of algorithms and machine learning approaches can most accurately recommend the most effective nudges? |
| RQ2.1.1 | How can such algorithms provide good results with minimum vs. maximum available data? |
| RQ2.1.2 | What drives the acceptance of such algorithmic nudges? |
| RQ2.2 | What are the antecedents as well as intended and unintended consequences of algorithmic nudging for increasing the sustainability in e-commerce? |
| RQ2.3 | Considering algorithmic nudges as a new type of touchpoint, how do they need to be integrated in the e-commerce customer journey? |
| RQ2.4 | How does a "green goal" legitimate the use of algorithmic nudging? |
| RQ2.5 | Which opportunities are there from a business model innovation perspective? |

## References

Bawack, R. E., Wamba, S. F., Carillo, K. D. A., & Akter, S. (2022). Artificial intelligence in E-Commerce: a bibliometric study and literature review. Electronic Markets. https://doi.org/10.1007/s12525-022-00537-z

Benartzi, S., Beshears, J., Milkman, K. L., Sunstein, C. R., Thaler, R. H., Shankar, M., … Galing, S. (2017). Should Governments Invest More in Nudging? Psychological Science, 28(8), 1041–1055. https://doi.org/10.1177/0956797617702501

Berger, M., Nüske, N., & Müller, C. (2020). Digital Nudging in Online Grocery Stores – Towards Ecologically Sustainable Nutrition. ICIS 2020 Proceedings, (11). Retrieved from https://aisel.aisnet.org/icis2020/societal_impact/societal_impact/11

Cheung, T. T. L., Kroese, F. M., Fennis, B. M., & De Ridder, D. T. D. (2017). The Hunger Games: Using hunger to promote healthy choices in self-control conflicts. Appetite, 116, 401–409. https://doi.org/10.1016/j.appet.2017.05.020

de Ridder, D., Kroese, F., & van Gestel, L. (2022). Nudgeability: Mapping Conditions of Susceptibility to Nudge Influence. Perspectives on Psychological Science, 17(2), 346–359. https://doi.org/10.1177/1745691621995183

eMarketer and Statista. (2021). Global e-commerce turnover worldwide 2017-2025. Retrieved March 10, 2022, from https://de.statista.com/statistik/daten/studie/244110/umfrage/globaler-umsatz-von-e-commerce/

Fechner, W., & Herder, E. (2022). Digital Nudging for More Ecological Supermarket Purchases. AMCIS 2020 Proceedings, 284–292. https://doi.org/10.1145/3450614.3464620

Fichter, K. (2003). E-Commerce: Sorting Out the Environmental Cosequences. Journal of Industrial Ecology, 6(2), 25–41. https://doi.org/10.1162/108819802763471762

Frei, R., Jack, L., & Brown, S. (2020). Product returns: a growing problem for business, society and environment. International Journal of Operations & Production Management, 40(10), 1613–1621. https://doi.org/10.1108/IJOPM-02-2020-0083

Gershoff, A. D., & Frels, J. K. (2015). What Makes It Green? The Role of Centrality of Green Attributes in Evaluations of the Greenness of Products. Journal of Marketing, 79(1), 97–110. https://doi.org/10.1509/jm.13.0303

Hummel, D., & Maedche, A. (2019). How effective is nudging? A quantitative review on the effect sizes and limits of empirical nudging studies. Journal of Behavioral and Experimental Economics, 80, 47–58. https://doi.org/10.1016/j.socec.2019.03.005

Ignat, B., & Chankov, S. (2020). Do e-commerce customers change their preferred last-mile delivery based on its sustainability impact? International Journal of Logistics Management, 31(3), 521–548. https://doi.org/10.1108/IJLM-11-2019-0305

IPCC. (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (B. R. H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, Ed.). Cambridge University Press.

Jesse, M., & Jannach, D. (2021). Digital nudging with recommender systems: Survey and future directions. Computers in Human Behavior Reports, 3, 100052. https://doi.org/https://doi.org/10.1016/j.chbr.2020.100052

Johnson, E. J., Shu, S. B., Dellaert, B. G. C., Fox, C., Goldstein, D. G., Häubl, G., … Weber, E. U. (2012). Beyond nudges: Tools of a choice architecture. Marketing Letters, 23(2), 487–504. https://doi.org/10.1007/s11002-012-9186-1

Karlsen, R., & Andersen, A. (2019). Recommendations with a Nudge. Technologies, 7(2). https://doi.org/10.3390/technologies7020045

Katner, K., & Jianu, R. (2019). The Effectiveness of Nudging in Commercial Settings and Impact on User Trust. Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems, 1–6. https://doi.org/10.1145/3290607.3313065

Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? Environmental Education Research, 8(3), 239–260. https://doi.org/10.1080/13504620220145401

Lembcke, T. B., Willnat, M., Engelbrecht, N., & Lichtenberg, S. (2020). Behavioral design in online supermarkets: How virtual shopping cart functions impact sustainable consumption. AMCIS 2020 Proceedings, (2). Retrieved from https://aisel.aisnet.org/amcis2020/sig_hci/sig_hci/2

Lemon, K. N., & Verhoef, P. C. (2016). Understanding Customer Experience Throughout the Customer Journey. Journal of Marketing, 80(6), 69–96. https://doi.org/10.1509/jm.15.0420

Mangiaracina, R., Marchet, G., Perotti, S., & Tumino, A. (2015). A review of the environmental implications of B2C e-commerce: a logistics perspective. International Journal of Physical Distribution and Logistics Management, 45(6), 565–591. https://doi.org/10.1108/IJPDLM-06-2014-0133

Matz, S. C., Kosinski, M., Nave, G., & Stillwell, D. J. (2017). Psychological targeting as an effective approach to digital mass persuasion. Proceedings of the National Academy of Sciences, 114(48), 12714–12719. https://doi.org/10.1073/pnas.1710966114

Mertens, S., Herberz, M., Hahnel, U. J. J., & Brosch, T. (2022). The effectiveness of nudging: A meta-analysis of choice architecture interventions across behavioral domains. Proceedings of the National Academy of Sciences, 119(1). https://doi.org/10.1073/pnas.2107346118

Michels, L., Ochmann, J., Günther, S. A., Laumer, S., & Tiefenbeck, V. (2022). Empowering Consumers to Make Environmentally Sustainable Online Shopping Decisions: A Digital Nudging Approach. Proceedings of the 55th Hawaii International Conference on System Sciences, 4707–4716.

Milkman, K. L., Gandhi, L., Patel, M. S., Graci, H. N., Gromet, D. M., Ho, H., … Duckworth, A. L. (2022). A 680,000-person megastudy of nudges to encourage vaccination in pharmacies. Proceedings of the National Academy of Sciences, 119(6). https://doi.org/10.1073/pnas.2115126119

Milkman, K. L., Patel, M. S., Gandhi, L., Graci, H. N., Gromet, D. M., Ho, H., … Duckworth, A. L. (2021). A megastudy of text-based nudges encouraging patients to get vaccinated at an upcoming doctor's appointment. Proceedings of the National Academy of Sciences, 118(20), e2101165118. https://doi.org/10.1073/pnas.2101165118

Mirbabaie, M., Marx, J., & Germies, J. (2021). Conscious Commerce – Digital Nudging and Sustainable E-commerce Purchase Decisions. ACIS 2021 Proceedings. https://doi.org/10.48550/arXiv.2202.08696

Mirsch, T., Lehrer, C., & Jung, R. (2017). Digital Nudging: Altering User Behavior in Digital Environments. Proceedings of 13th International Conference on Wirtschaftsinformatik, 634–648.

Möhlmann, M. (2021). Algorithmic Nudges Don't Have to Be Unethical. Retrieved from Harvard Business Review website: https://hbr.org/2021/04/algorithmic-nudges-dont-have-to-be-unethical

Pichert, D., & Katsikopoulos, K. V. (2008). Green defaults: Information presentation and pro-environmental behaviour. Journal of Environmental Psychology, 28(1), 63–73. https://doi.org/10.1016/j.jenvp.2007.09.004

Rankine, H., & Khosravi, D. (2021). Applying Behavioural Science to Advance Environmental Sustainability An overview for policymakers. Retrieved from https://www.unescap.org/kp/2021/applying-behavioural-science-advance-environmental-sustainability

Shaw, E., & Jones, D. G. B. (2005). A history of schools of marketing thought. Marketing Theory, 5(3), 239–281. https://doi.org/10.1177/1470593105054898

Sitar-Tăut, D.-A., Mican, D., & Buchmann, R. A. (2021). A knowledge-driven digital nudging approach to recommender systems built on a modified Onicescu method. Expert Systems with Applications, 181, 115170. https://doi.org/10.1016/j.eswa.2021.115170

Thaler, R., & Sunstein, C. (2008). Nudge: Improving decisions about health, wealth, and happiness. London, UK: Penguin Random House.

Tueanrat, Y., Papagiannidis, S., & Alamanos, E. (2021). Going on a journey: A review of the customer journey literature. Journal of Business Research, 125, 336–353. https://doi.org/10.1016/j.jbusres.2020.12.028

Vakulenko, Y., Shams, P., Hellström, D., & Hjort, K. (2019). Service innovation in e-commerce last mile delivery: Mapping the e-customer journey. Journal of Business Research, 101, 461–468. https://doi.org/10.1016/j.jbusres.2019.01.016

Velazquez, R., & Chankov, S. M. (2019). Environmental Impact of Last Mile Deliveries and Returns in Fashion E-Commerce: A Cross-Case Analysis of Six Retailers. 2019 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), 1099–1103. https://doi.org/10.1109/IEEM44572.2019.8978705

White, K., Habib, R., & Hardisty, D. J. (2019). How to SHIFT Consumer Behaviors to be More Sustainable: A Literature Review and Guiding Framework. Journal of Marketing, 83(3), 22–49. https://doi.org/10.1177/0022242919825649

World Economic Forum. (2022). What the IPCC Report tells us about the need for radical climate action. Retrieved March 12, 2022, from https://www.weforum.org/agenda/2022/03/what-the-ipcc-report-tells-us-about-the-need-for-radical-climate-action/

Yeung, K. (2017). 'Hypernudge': Big Data as a mode of regulation by design. Information, Communication & Society, 20(1), 118–136. https://doi.org/10.1080/1369118X.2016.1186713