Scientific Publication of Reviewed Behaviour Change Techniques for Sustainable Logistics

Deliverable 3.1

Version 1.0

Project title:	**Fostering sustainable consumer behaviour with inclusive bicycle logistics infrastructure in urban outskirts**
Project acronym:	**SuCoLo**
Project duration:	01/2024 – 06/2026
Project number:	F-DUT-2022-0007
Work package/Task:	WP3 / T3.1
Project website:	https://sucolo.eu/
Authors:	Michael Thelen, Veronika Hornung-Prähauser, David Leistner, Salzburg Research (SRFG)

This project has been funded by the Austrian Research Promotion Agency (FFG), Ministry of Enterprises and Made in Italy (MIMIT), the Federal Ministry of Education and Research in Germany (BMBF) and the Swedish funding agency (Vinnova) under the Driving Urban Transitions Partnership, which has been co-funded by the European Union under grant agreement no. 905465.

Driving Urban Transitions

Co-funded by the European Union

VINNOVA Sveriges innovationsmyndighet

Bundesministerium Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie

FFG Forschung wirkt.

Finanziato dall'Unione europea NextGenerationEU

Ministero delle Imprese e del Made in Italy

GEFÖRDERT VOM Bundesministerium für Bildung und Forschung

Document versions

Version	Date	Changes	Authors
V0.1	02.07.2024	Establishment of the document	Michael Thelen, Veronika Hornung-Prähauser, David Leistner (SRFG)
V0.2	12.07.2024	Review and formatting	Michael Thelen (SRFG)
V1.0	17.10.2024	Finalisation of the document	Michael Thelen (SRFG)

List of abbreviations

B2C	Business-to-consumer
BCT	Behaviour change technique
CO_2	Carbon dioxide
COM-B	Capability, opportunity and motivation for behaviour change
DHL	Dalsey Hillblom Lynn
GHG	Greenhouse gas
NOFOMA	Nordic Logistics Research Network
SME	Small and medium-sized enterprise

Country Acronyms

BE	Belgium
DE	Germany
MX	Mexico
NL	Netherlands
NO	Norway
UK	United Kingdom
US	United States

Table of contents

List of Tables

List of Figures

Administrative information

Basic information on the SuCoLo project and this deliverable:

Project title	SuCoLo: Fostering sustainable consumer behaviour with inclusive bicycle logistics infrastructure in urban outskirts
Project coordinator	Salzburg Research Forschungsgesellschaft mbH (SRFG), Salzburg, Austria; project coordinator: Michael Thelen
Project partners	Independent L. ONLUS (IND), Italy
	Sustainability InnoCenter (SIC), Sweden
	VIABIRDS Technologies GmbH (VIA), Austria
	Universität Leipzig (ULEI), Germany
	Südtiroler Transportstrukturen AG – Green Mobility Department (STA), Italy
Funding	DUT Call 2022 – European Commission under the Horizon Europe Partnership scheme
	Funding is being provided by the Austrian Research Promotion Agency (FFG), Ministry of Enterprises and Made in Italy (MIMIT), the Federal Ministry of Education and Research in Germany (BMBF), and the Swedish funding agency (Vinnova)
Project nr.	F-DUT-2022-0007
Duration	01/2024 – 06/2026
Website	https://sucolo.eu/
Deliverable nr.	D3.1
Deliverable title	Scientific publication of reviewed behaviour change techniques for sustainable logistics
Authors	Michael Thelen, Salzburg Research (SRFG)
	Veronika Hornung-Prähauser, Salzburg Research (SRFG)
	David Leistner, Salzburg Research (SRFG)
Version & status	Version 1.0
Date	17.10.2024

Purpose of the document

The purpose of this document is to exploratively review currently implemented and tested digital behaviour change techniques in studies and in practice that set out to motivate sustainable consumer choices when it comes to sustainable delivery options on online shops. Here, the various behaviour change techniques are categorized according to the COM-B model (Michie et al., 2011). The aim of this study is to lay the foundation of the current state-of-the-art concerning the use of behaviour change techniques for sustainable delivery choices before novel behaviour change techniques are formulated within the SuCoLo project.

As part of *WP3 Sustainable logistics choices and co-creation*, this review of behaviour change techniques complements the catalogue of best practices of behaviour change techniques for sustainable logistics choices (D3.3a) and will form the basis for further preliminary WP3 activities within the project – the open idea challenge, co-creation workshops, interviews (T3.2). All of these initial actions serve to inform a new inventory of digital behaviour change strategies for sustainable consumer logistics choices (T3.3), which will be used in the Salzburg research pilot, which envisages to develop an experimental webshop prototype simulator for behaviour change techniques for sustainable logistics choices with a novel set of behaviour change techniques that will be tested by users.

As the deliverable title suggests (*"Scientific publication"*), the content within this deliverable was submitted, accepted, and presented at the 36th NOFOMA Conference "Logistics and Supply Chain Management in a Risky and Uncertain World" on 13-14 June 2024 in Stockholm, Sweden.

Executive Summary

Purpose

Currently, 74% of EU internet users aged 16-74 ordered goods and services online (Eurostat, 2021). Same-day and instant deliveries, which have the highest CO2 emissions of all delivery options, are the fastest-growing services in last-mile delivery (World Economic Forum, 2020). Amidst this, digital behaviour change interventions on e-commerce sites that convincingly frame, encourage, and incentivise the use of green delivery and local pick-up of ordered goods are necessitated. The aim of the research is to investigate the scientific landscape for studies that deal with theoretical approaches and methods for digital interventions in e-commerce shopping. Furthermore, it will be investigated whether the results of these studies are reflected in practice.

Methods

The method is twofold. First, a limited meta-analysis of studies concerning the use of digital behaviour change interventions for sustainable consumer delivery choices during the ordering and delivery process of the customer purchase journey was carried out. These included ten research studies during the period 2018-2024 identified on the Scopus, Web of Science and Google Scholar databases via an iteratively updated keyword search. The retrieved studies respectively their examined behaviour change techniques were then classified according to the Behaviour Change Taxonomy by Michie et al. (2013). Secondly, an e-commerce website analysis of the top 65 e-commerce sites by net revenue in 2022 (EHI Retail Institute, 2023) was conducted to identify which, if any, of the theoretically identified behaviour change interventions that promote sustainable delivery and pick-up options were utilised.

Findings

Among the ten studies analysed, we found eleven main theoretical and conceptual approaches (predominantly *sustainable consumer behaviour* and *nudging*), four methods (predominantly using online surveys with a mock web page/shopping basket and stated preference surveys), and six types of behaviour interventions (predominantly *information about social and environmental consequences* and *restructuring the physical environment*).

Among the 65 websites analysed, three percent currently employed one or more behavioural interventions (one pet shop and one drug store). Interestingly, the lack of systematic and overarching analysis on this topic presents the need for a new research agenda that unifies and defines courses of action based on connecting these different studies.

Research Limitations/implications

In order to extend the already limited number of studies in this area, our meta-analysis extended its scope to include two master theses alongside eight peer-reviewed studies. Additionally, only interventions for consumer delivery choices were considered, and not returns. Furthermore, the lack of standardised vocabulary on this topic may have hindered the number of studies included in this research. Only English-speaking studies were analysed.

Practical Implications

This research can serve as a guide for online retailers to make an informed decision about which applications they would like to implement in practice. This state of the art can inform further developments in this area.

Originality and value

To our knowledge, this is the first (limited) meta-analysis on behavioural interventions for sustainable consumer delivery choices on e-commerce sites. Additionally, compared to the current studies, our research is the first to our knowledge that extrapolates the cross-domain behaviour change technique taxonomy of Michie et al. (2013) into the application area of sustainable consumer delivery choices and codifies the current work, preparing ground to a unified classification. The contribution to the research field is to thoroughly analyse current work done in this field theoretically, methodologically and in practice, and to try to chart further courses of action. The value is to lay the foundation for a new research agenda and provide evidence for success factors of employing behavioural interventions in order to serve logistics providers, e-commerce practitioners, and the climate.

1. Background on the NOFOMA Conference

NOFOMA is a society of Nordic researchers in the areas of logistics and supply chain management conference, which hosts an annual conference where researchers, practitioners, and educators from across the globe meet and discuss and exchange latest research and insights (https://www.kth.se/nofoma-2024). The theme of the 2024 conference was “Logistics and supply chain management in a risky and uncertain world”, and was located in Stockholm, Sweden at the Swedish Defence University on 13-14 June 2024.

The process of submitting the conference paper ensured that it was peer reviewed twice: once during the submission of the abstract (which determined whether it was accepted or rejected), and another time during the submission of the full paper, with comprehensive expert feedback from two reviewers received. Thereafter, the revised version of the full paper was submitted once again, and shortly thereafter, presented during the conference in a 20-minute presentation session.

Relevance of the NOFOMA Conference to the research

When reviewing and developing behaviour change techniques for sustainable delivery choices on online shops, it is paramount that the logistics and supply chain management community are aware of and co-develop these choices in order to ensure effectivity. Furthermore, the paper call topics included *“sustainable supply chain management”, “city logistics”,* and *“retail and e-tail logistics”*, where certain sessions were crafted around these topics directly related to the SuCoLo project.

2. Introduction

E-commerce deliveries are increasingly rising, and although its environmental impact in Europe is said to be lower than retail stores (OliverWyman, 2021), it still contributes substantially to air and noise pollution, traffic congestion and greenhouse gas (GHG) emissions. The COVID-19 pandemic further increased the use of e-commerce retail, with global sales growth rates of 26.7% in 2020, 16.8% in 2021, and it is forecast to continue, albeit with a slower growth rate of on average 8.5% in the years 2022-2026 (eMarketer, 2023). When looking into the last mile of delivery particularly, this final segment – transporting goods in parcels from local depots and delivery hubs to the final destinations – is also very expensive, and has gained more attention among e-commerce retailers, consumers, carriers and local authorities. The World Economic Forum estimated that last mile delivery accounts for 53% of the total cost of shipping and 41% of total supply chain costs. With no future interventions, the number of vehicles delivering parcels in major cities could increase by 36% by 2030, with

associated increases of delivery emissions of 32% and congestion of over 21% (World Economic Forum, 2020). Even more, Higgs et al. (2022) estimate that the last mile represents approximately 50% of delivery CO_2 emissions in Europe.

Consequently, reducing the negative impacts and externalities of last mile delivery has been focused on operational solutions (Ignat & Chankov, 2020), particularly by looking at optimal delivery vehicles, logistics hubs and vehicle routing optimisation (Viu-Roig & Alvarez-Palau, 2020). However, amidst this, there is an increasing call for supply-side policies to be accompanied with corresponding demand side approaches that could aid consumers in making more sustainable choices (Lehner, Mont & Heiskanen, 2016). Yet, when promoting sustainable consumer delivery choices on the demand side, the prospect of online consumers' agency to choose the most sustainable choice has often been neglected (Buldeo Rai et al., 2021), and consumers are often unaware of the level of sustainability of e-commerce distribution (Sallnäs & Björklund, 2020). Nonetheless, it has been found that consumer changes can lead to pronounced effects; for example, compared to conventional home delivery, consumers who walk, bike or use an electric vehicle to pick up parcels at lockers or parcel shops can reduce GHG emissions by up to 30% (DHL, 2022).

2.1. Online Consumers' Role in the Sustainable Last Mile

Consumers in recent years have become more aware of the environmental and social impacts of their purchases. Online shoppers now increasingly look for more sustainable products, packaging and delivery. In a DHL survey (2022) of online shoppers across nine European markets, 53% said that sustainability is important to them, and another survey found that 70% of European online shoppers are willing to accept additional costs for sustainability (Seven Senders, 2022). Furthermore, shoppers aged under 35 were twice as likely willing to pay for a green delivery and for sustainable packaging than shoppers aged over 45. Across all age groups, 58% are willing to wait longer for a greener delivery, and in all markets surveyed, shoppers preferred a longer wait instead of paying more for delivery (DHL, 2022). Even more, another international survey from GWI Zeitgeist found that among already eco-friendly online shoppers, 63% say the most important aspect when deciding what to buy is the presence of eco-friendly/carbon-neutral shipping – while cost is deemed less important (42%) (GWI, 2021). Furthermore, to date, retailers are largely seen to be lagging with regard to helping make e-commerce more sustainable. As it stands, consumers have been equipped with little chances to influence more sustainable deliveries. It is vital that online retailers and logistics service providers provide the means necessary for consumers to exercise their (sustainable) preferences (Sallnäs & Björklund, 2020), and that consumers are involved in the co-creation of such constructions. Furthermore, the construction of such interventions that enable more

sustainable delivery choices may possibly aid in closing the *green gap*, known as the inconsistency in what consumers say in terms of their level of environmental concern versus their actual environmentally directed behaviour (ElHaffar, Durif & Dubé, 2020; Muysoms et al., 2021); this attitude-behaviour gap has demonstrated to be very much present among e-commerce shoppers, e.g., in a Zalando study of online consumers (Heiny & Schneider, 2021).

2.2. Encouraging Sustainable Last Mile Delivery Choices with Digital Behaviour Change Techniques

In an attempt to guide and influence consumer behaviour, multiple behaviour change techniques (BCTs) stemming from psychology and behavioural economics, defined as "observable, replicable, and irreducible components of an intervention designed to alter or redirect causal processes that regulate behavior" (Michie et al., 2013:p.2), have been tested; for instance, nudging, persuasive strategies, visualisation, gamification and eco-feedback. A greater number of these interventions is increasingly digitally mediated and focused on smartphones (Hedin et al., 2019). The use of BCTs is predominantly well-known in the applications of health and well-being (Michie et al., 2013); as found from its application in the health sector, a stronger effect of BCTs were found when they came from a foundational basis (Van Rhoon et al., 2020). However, BCTs and their corresponding taxonomy are interdisciplinary and can be transferred across different application areas (Michie et al., 2013), which is not limited to mobility (e.g., Krusche et al., 2022; Luger-Bazinger, Geser, et al., 2023; Luger-Bazinger, Thelen, et al., 2023) and shopping on e-commerce sites (Petersson, 2022) Thus, extending the application of grounded BCTs into the realm of e-commerce and logistics to influence consumer delivery choices is worthwhile.

Most prominently, nudging (Thaler & Sunstein, 2008) is used to guide decisions without restricting or banning options and works by changing the so-called choice architecture, for example, by giving reframing choices through providing different or new information. In this context, the presentation of choice architectures is not neutral, with the possibility to significantly sway decision-making. However, nudging interventions are perceived to be unobtrusive and prompt consumer choices without involving much mental energy. Attempts to guide sustainable consumer behaviour towards a desired selection have sought to address cognitive barriers by introducing concepts such as "future focus", which focuses on producing clear informational messages to address uncertainties (Trudel, 2019). This has been extended to the concept of "green nudges" which aim to nudge towards sustainability (Schubert, 2016). In online retail, the use of non-financial enticements versus differential pricing and financial incentives have been increasingly explored to incentivise consumers to make a desired choice

(Buldeo Rai et al., 2021). Even more, a combination of financial incentives and non-financial BCTs could possibly be more effective than either of these done separately (Nisa et al.,2019).

To date, influencing online consumers' sustainable delivery choices with digital interventions has been devised around three features of the last mile: (1) *delivery speed*, by influencing consumers to choose a slower delivery speed, and thereby better optimising vehicle loads and delivery consolidation; (2) *delivery time*, by influencing consumers to choose a delivery time of day that suits them, and thereby reducing the risk of delivery failures and second redeliveries; and (3) *delivery location*, by influencing consumers to choose collection points, pick-up stations and delivery lockers (Ignat & Chankov, 2020; Buldeo Rai et al., 2021). For example, customers have been incentivised to delay the speed of the delivery in order to make this delivery a greener option. Such digital interventions can manifest into varying forms, including but not limited to the (1) *default rule*, where the more sustainable delivery choice is already picked, (2) *disclosure*, where a specific delivery choice is labelled as sustainable, or (3) *social reference/social comparison*, where it is displayed that a certain amount of people already chose the desired option (Muysoms et al., 2021). In this context, new consumer facing CO_2 calculator tools to measure emissions of different delivery options on e-commerce sites have come to the fore, e.g. Bewust Bezorgd (Thuiswinkel.org, n.d.).

In a study, Bewust Bezorgd's interventions that provided information concerning the calculated CO_2 impacts of various deliveries resulted in double the consumers selecting their delivery at a collection point, which was displayed as the most sustainable option. Furthermore, when a CO_2 information display is combined with a green leaf alongside the most sustainable delivery option, the most sustainable option was selected almost four times more often compared to no intervention (ECommerce Europe, 2021). However, as it stands, there is lack of comparability and communication of CO_2 emissions of various freight transport options, which limits the effectiveness of CO_2 accounting to inform decisions by organisations and incentivising eco-friendly consumer choice (Tölke & McKinnon, 2021).

The overall take-up of freight transport CO_2 accounting and communication is still limited, especially by SME carriers, as a small number (25%) of them are able to calculate transport-related emissions at a consumer level (Tölke & McKinnon, 2021). While different CO_2 calculators are available, these are data-intensive and often complex to carry out; as such, CO_2 emissions are more often calculated in an aggregate company-level (Tölke & McKinnon, 2021; Dubisz, Golinska-Dawson & Zawodny, 2022), e.g., to be used in CO_2 offsetting programs, while seldom implemented in e-commerce platforms to inform consumers about the environmental effects of different delivery and return options. For this, the support of logistics

companies is paramount (Petersson, 2022). Moreover, the displaying of such calculations is a balancing act for online retailers, as they do not want to display too much information and make it too complex for customers just as they are about to buy their items (Sallnäs & Björklund, 2020), running the risk of cart abandonment. Here, careful implementation of BCTs is warranted to ensure that they do not come at the cost of hurting profitability of e-commerce sites. To summarise, there is a knowledge gap concerning the success factors of employing BCTs that incentivise sustainable consumer delivery choices based on the effect of ecological impact information.

2.3. Extrapolating Intervention Methods from Sustainable Product Marketing to Sustainable Delivery: Success Factors and Determinants

To date, studies concerning sustainable consumerism have tended to centre around specific product attributes instead of services like logistics (Frick & Matthies, 2020). Although the use of consumer facing digital behaviour interventions to promote 'green' delivery is still embryonic, the use of other such digital interventions to encourage the purchasing of sustainable products in an online setting is somewhat more mature, e.g., employing BCTs in online grocery stores to foster sustainable food choices (Berger et al., 2020, which tested digital defaults, simplification and social norms), or on e-commerce fashion sites to encourage sustainable clothing purchases (Mirbabaie et al., 2021, which tested digital defaults and social norms). Furthermore, in studies thus far, equipping consumers with knowledge about the possible consequences and ecological impacts of their choices are seen to be generally promising when transferred and applied in different domains and application areas (Buldeo Rai et al., 2021). Given the background of the aforementioned studies, we identify a gap in the success factors of BCTs in the online customer journey process of last-mile delivery mode selection. Our research objective is, amidst calls to develop an overarching, expert-accepted taxonomy of behaviour change techniques that are found and applicable in a vast area of domains, the behaviour change technique taxonomy developed by Michie et al. (2013) has introduced a cross-domain, interdisciplinary classification of distinct BCTs.

In principle, delineating which BCTs were utilised in a specific case, these have the possibility to be transferrable to a different application area. With that being said, attempts have previously been made to transfer BCTs to the mobility sector (e.g., Krusche et al., 2022; Luger-Bazinger, Geser, et al., 2023; Luger-Bazinger, Thelen, et al., 2023) and in the e-commerce industry (e.g., Petersson, 2022). In doing so, discovering which BCTs have been studied or conducted in practice within the domain of consumer behaviour with regard to sustainable

products on e-commerce sites can enable discovering possible new implementations of BCTs which have been un-explored within the realm of promoting ‘green’ delivery on e-commerce sites. This could possibly enable new insights into how to design BCTs in the e-commerce and logistics application area.

3. Methodology

To gain an overview of tested and implemented behaviour change interventions that motivate sustainable consumer delivery choices on e-commerce sites, a limited meta-analysis of current interventions which aim to promote sustainable consumer delivery in studies and in practice has been conducted. Thereafter, the website analysis is conducted in order to find theoretically based interventions in practice on e-commerce sites, in contrast to those BCTs are found to be the most effective in the literature. The classifications of specific BCTs are based on the behaviour change technique taxonomy from Michie et al. (2013), as it is an expert-formulated classification of the most prominent behaviour change techniques that is industry and sector-agnostic and universally transferrable across research and practice domains. We surmise that the BCT categories *information about social and environmental consequences* and *social comparison* will be the most prominent within the context of e-commerce and logistics incentivisation.

3.1. Search Process

The meta-analysis was carried out in February-March 2024. First, a Scopus, Web of Science and Google Scholar database search was conducted to identify studies which have already scientifically tested digital behaviour change interventions to promote sustainable consumer delivery choices. The following keywords were used: “sustainable online delivery choices”, “sustainable e-commerce nudges”, “sustainable delivery nudging”, “sustainable pick-up nudging”, “sustainable delivery choices”, “consumer sustainable delivery preferences”, “consumer preferences for sustainable delivery incentives”, and “green consumer delivery choices”. The process of choosing search terms was iterative, as new terms were discovered during the literature review process. The keywords in finding the studies were all in English. The search resulted in ten studies (including eight peer-reviewed papers in academic journals and two master theses) ranging from 2018-2024.

Thereafter, the most effective behaviour change intervention(s) found from the study in question was extracted. First, all e-commerce site interventions seeking to influence or promote sustainable consumer delivery choices were classified. Secondly, the identified interventions were clustered into categories, selected and adapted for the mobility field from the Behaviour Change Technique Taxonomy (Michie et al., 2013), an all-encompassing

taxonomy of expert-filtered and distinct behaviour change techniques used in behaviour change interventions.

Secondly, the top 65 B2C online retailers in Germany by net e-commerce revenue in 2022 (EHI Retail Institute, 2023) were analyzed by one researcher and screened to identify if and which type of behaviour change interventions to promote greener delivery or pick-up options, and of these, which types of interventions were utilised. For this purpose, German online retailers were chosen due to the availability of information concerning the most prominent shops by net revenue and its expansive market size in the European Union. As most sites require a membership registration in order to check out and complete the order, dummy accounts were created. Thereafter, a product from the corresponding online retailer was chosen, and the customer journey until payment was analyzed. The study analyzed the customer journey steps up until the final section, the payment, and thereafter the cart was abandoned. The resulting consumer journey steps were tabulated and coded in an Excel spreadsheet.

3.2. Selection Criteria

For both the meta-analysis and e-commerce site analysis, it was a requirement that the objects of research are (1) consumer-facing, (2) fixated on encouraging sustainable consumer behaviour regarding choosing greener delivery options or products, (3) include at least one BCT, and (4) are digitally mediated BCTs in place of analogue. It is worth noting that this study excluded interventions which were about product returns.

4. Findings

4.1. Meta-Analysis Results: Theoretical Approaches, Employed Interventions and Sampling

Upon a review of the literature, ten studies were found to have studied and tested the effectiveness of formulated BCTs for sustainable consumer delivery choices on either fictitious e-commerce sites or via a survey. This is an emerging topic, as the earliest cited study is 2018 – with the bulk of the studies having been conducted from 2021 onwards. Of the ten studies, ten tested home delivery, three tested pick-up station delivery, and one tested the use of parcel lockers. The studies were conducted among a sample predominantly in Europe, with the Netherlands (three studies), Belgium (two studies), United States (two studies) and the United Kingdom (two studies) being the most represented.

Theoretical and conceptual basis

The ten studies engaged in this review were rooted on varying theoretical and conceptual bases, ranging from supply chain management (Buldeo Rai et al., 2021), consumer centric supply chains (Thomas, Ueltschy Murfield & Ellram, 2022), social exchange theory (Thomas, Ueltschy Murfield & Ellram, 2022), behavioural economics (Thomas, Ueltschy Murfield & Ellram, 2022), sustainable consumer behaviour (Ignat & Chankov, 2020; Nijssen et al., 2023; Agatz, Fan & Stam, 2021; Viet, de Leeuw & van Herpen, 2023), libertarian paternalism (Muysoms et al., 2021), theory of planned behaviour (Agatz, Fan & Stam, 2021), construal level theory (Viet, de Leeuw & van Herpen, 2023), cognitive dissonance theory (Viet, de Leeuw & van Herpen, 2023) and sharing economy (Caspersen & Navrud, 2021). Notably, the concept of nudging was a prominent theme throughout (Caspersen & Navrud, 2021; Kokkinou et al., 2024; Muysoms et al., 2021; Nijssen et al., 2023; Buldeo Rai et al., 2021; Thomas, Ueltschy Murfield & Ellram, 2022).

Behaviour change techniques

Here, the employed BCTs according to the behaviour change taxonomy by Michie et al. (Michie et al., 2013) are, in order by frequency:

Information about social and environmental consequences (frequency: 8)

*Description: "*Provide information (e.g. written, verbal, visual) about social and environmental consequences of performing the behaviour. Note: consequences can be for any target, not just the recipient(s) of the intervention" (Michie et al., 2013).

Use case(s): Displaying sustainability labels, green leaves, CO_2 calculations, better working conditions for delivery drivers, the number of trees saved, less freight traffic, less CO_2, increased safety, particulate matter calculations.

Social comparison (frequency: 3)

Description: "Draw attention to others' performance to allow comparison with the person's own performance Note: being in a group setting does not necessarily mean that social comparison is actually taking place" (Michie et al., 2013).

Use case(s): Displaying others' delivery choices and others' choices to share on social media.

Material incentive (frequency: 3)

Description: “Inform that money, vouchers or other valued objects will be delivered if and only if there has been effort and/or progress in performing the behaviour” (Michie et al., 2013).

Use case(s): Offering discounts for the most sustainable delivery mode.

Restructuring the physical environment (frequency: 2)

Description: “Change or advise to change the physical environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour (other than prompts/cues, rewards and punishments)” (Michie et al., 2013).

Use case(s): Setting the desired delivery mode as the digital default (i.e. “nudge”).

Identification of self as role model (frequency: 1)

Description: “Inform that one’s own behaviour may be an example to others” (Michie et al., 2013).

Use case(s): Offering customers the chance to share their sustainable delivery selection onto their Facebook page.

Behaviour cost (frequency: 1)

Description: “Arrange for withdrawal of something valued if and only if an unwanted behaviour is performed” (Michie et al., 2013).

Use case(s): Creating a cost surcharge for the undesired delivery option.

Study methodologies and sampling

Considering sampling, while some studies recruited participants via formal services such as Amazon Mechanical xTurk (Thomas, Ueltschy Murfield & Ellram, 2022) or Prolific Academic Service (Viet, de Leeuw & van Herpen, 2023), others recruited participants via social media (Ignat & Chankov, 2020; Buldeo Rai et al., 2021; Muysoms et al., 2021), mailing lists (Ignat & Chankov, 2020; Buldeo Rai et al., 2021; Kokkinou et al., 2024; Caspersen & Navrud, 2021) and general snowball sampling (Buldeo Rai et al., 2021; Muysoms et al., 2021).

Regarding the research process, over two-thirds of the studies used an online survey software with mock web page/shopping basket (Thomas, Ueltschy Murfield & Ellram, 2022; Buldeo Rai et al., 2021; Nijssen et al., 2023; Muysoms et al., 2021; Viet, de Leeuw & van Herpen, 2023; Kokkinou et al., 2024; Michels et al., 2022) utilising a between subjects design (Thomas, Ueltschy Murfield & Ellram, 2022; Buldeo Rai et al., 2021; Nijssen et al., 2023; Muysoms et

al., 2021; Agatz, Fan & Stam, 2021; Viet, de Leeuw & van Herpen, 2023; Kokkinou et al., 2024; Michels et al., 2022), while some utilised a stated-preference online survey (Ignat & Chankov, 2020; Viet, de Leeuw & van Herpen, 2023; Caspersen & Navrud, 2021), and one conducted an online simulator study (Agatz, Fan & Stam, 2021). Notably, only one study conducted an in-person survey in a field study (Fu & Saito, 2018).

Considering the interventions in question, some studies tested financial incentives (Ignat & Chankov, 2020; Agatz, Fan & Stam, 2021; Kokkinou et al., 2024), while a majority tested non-financial incentives (Thomas, Ueltschy Murfield & Ellram, 2022; Ignat & Chankov, 2020; Buldeo Rai et al., 2021; Nijssen et al., 2023; Muysoms et al., 2021; Agatz, Fan & Stam, 2021; Viet, de Leeuw & van Herpen, 2023; Kokkinou et al., 2024; Fu & Saito, 2018). Furthermore, half of the studies tested the use of a combination of non-financial incentives (Thomas, Ueltschy Murfield & Ellram, 2022; Buldeo Rai et al., 2021; Nijssen et al., 2023; Muysoms et al., 2021; Viet, de Leeuw & van Herpen, 2023) and three tested a combination of financial and non-financial incentives (Ignat & Chankov, 2020; Agatz, Fan & Stam, 2021; Kokkinou et al., 2024), while other studies tested singular interventions in isolation (Thomas, Ueltschy Murfield & Ellram, 2022; Buldeo Rai et al., 2021; Nijssen et al., 2023; Muysoms et al., 2021; Viet, de Leeuw & van Herpen, 2023; Kokkinou et al., 2024; Fu & Saito, 2018).

Lastly, the studies whose intervention was *Information about social and environmental consequences* utilised a wide variety of means to do so; namely, CO2 calculations (Thomas, Ueltschy Murfield & Ellram, 2022; Nijssen et al., 2023; Caspersen & Navrud, 2021; Fu & Saito, 2018), relative CO2 savings (Nijssen et al., 2023; Thomas, Ueltschy Murfield & Ellram, 2022; Viet, de Leeuw & van Herpen, 2023), personal impact statements (Thomas, Ueltschy Murfield & Ellram, 2022), description of less freight truck traffic (Buldeo Rai et al., 2021; Viet, de Leeuw & van Herpen, 2023), description of less ridden vehicles/vehicle kilometers (Buldeo Rai et al., 2021; Viet, de Leeuw & van Herpen, 2023; Kokkinou et al., 2024), description of sustainability (Buldeo Rai et al., 2021; Muysoms et al., 2021; Kokkinou et al., 2024), green leaf display (Nijssen et al., 2023), green label (Agatz, Fan & Stam, 2021; Viet, de Leeuw & van Herpen, 2023), better working conditions (Viet, de Leeuw & van Herpen, 2023), increased road safety (Viet, de Leeuw & van Herpen, 2023), relative particulate matter levels (Caspersen & Navrud, 2021), relative electricity use (Fu & Saito, 2018), recycled waste calculations (Fu & Saito, 2018) and trees saved calculations (Fu & Saito, 2018).

Table 1 Overview of literature on digital behaviour interventions for sustainable delivery options

Author	Sample Size	Country	Delivery Type(s)	Tested BCT(s)	Most Effective BCT(s)
Muysoms et al. (2021)	497	BE	Home delivery	Restructuring the physical environment (digital default); Information about social and environmental consequences (sustainability label); Social comparison (others' choices)	Combination of Restructuring the physical environment (digital default) & Information about social and environmental consequences (sustainability label)
Nijssen et al. (2023)	1213	NL	Pick-up station	Restructuring the physical environment (digital default); Information about social and environmental consequences (green leaf, CO_2 calculation, relative CO_2 savings)	Restructuring the physical environment (digital default),
H. Buldeo Rai et al. (2021)	403	BE	Home delivery	Information about social and environmental consequences (less freight truck traffic, less ridden vehicle kilometers, sustainability); Restructuring the physical environment (digital default);	Combination of Information about social and environmental consequences (sustainability label) & Identification of self as role model (social media sharing);

				Identification of self as role model (social media sharing); Social comparison (others' choices to share on social media)	Social comparison (others' choices to share on social media)
Agatz et al. (2021)	1032	US	Home delivery	Information about social and environmental consequences (green label); Material incentive (discount)	Information about social and environmental consequences (green label)
Ignat & Chankov (2020)	248	DE	Home delivery, pick-up station	Information about social and environmental consequences (CO_2 calculation, better working conditions); Material incentive (discount)	Information about social and environmental consequences (CO_2 calculation, better working conditions)
Fu & Saito (2018)	434	MX	Home delivery	Information about social and environmental consequences (electricity saved, CO_2 saved, waste saved, trees saved);	Information about social and environmental consequences (trees saved)
Thomas et al. (2022)	113, 115	US	Home delivery	Information about social and environmental consequences (CO_2 calculation, reduce personal impact); Material incentive (discount);	Information about social and environmental consequences (CO_2 calculation)

				Social comparison (others' choices)	
Viet et al. (2023)	348, 1387	NL, UK	Home delivery	Information about social and environmental consequences (less freight traffic, relative CO_2 savings, better working conditions, increased road safety)	Information about social and environmental consequences (less freight traffic, relative CO_2 savings, better working conditions, increased road safety)
Kokkinou et al. (2024)	228, 258	NL	Pick-up station, parcel locker	Information about social and environmental consequences (less vehicle kilometers driven, less environmental impact); Behaviour cost (surcharge for undesired delivery option)	Behaviour cost (surcharge)
Caspersen & Navrud (2021)	513 (female only)	NO	Home delivery	Information about social and environmental consequences (CO_2 calculation, particulate matter calculation)	Information about social and environmental consequences (CO_2 calculation, particulate matter calculation)

4.2. E-Commerce Site Analysis: Behaviour Change Techniques Implemented in Practice

Out of the 65 online retailers screened, two shops have implemented at least one BCT to encourage green consumer delivery choices: ZooPlus and Dm. Considering delivery option, both sites promoted home delivery, and one promoted pick-up station delivery. Additionally, both BCTs were displayed during the final phase of the customer journey. An overview is below:

Table 2 Overview of digital behaviour techniques for sustainable delivery options

Name	Type	Country	Delivery Type(s)	Implemented BCT(s)
ZooPlus.de	Pet store	DE	Home delivery	Information about social and environmental consequences (better working conditions)
Dm.de	Drug store	DE	Home delivery, pick-up station	Information about social and environmental consequences (less CO_2); Restructuring the physical environment (digital default)

The utilised BCTs according to the behaviour change taxonomy by Michie et al. (Michie et al., 2013) are:

Information about social and environmental consequences (frequency: 2)

Restructuring the physical environment (frequency: 1)

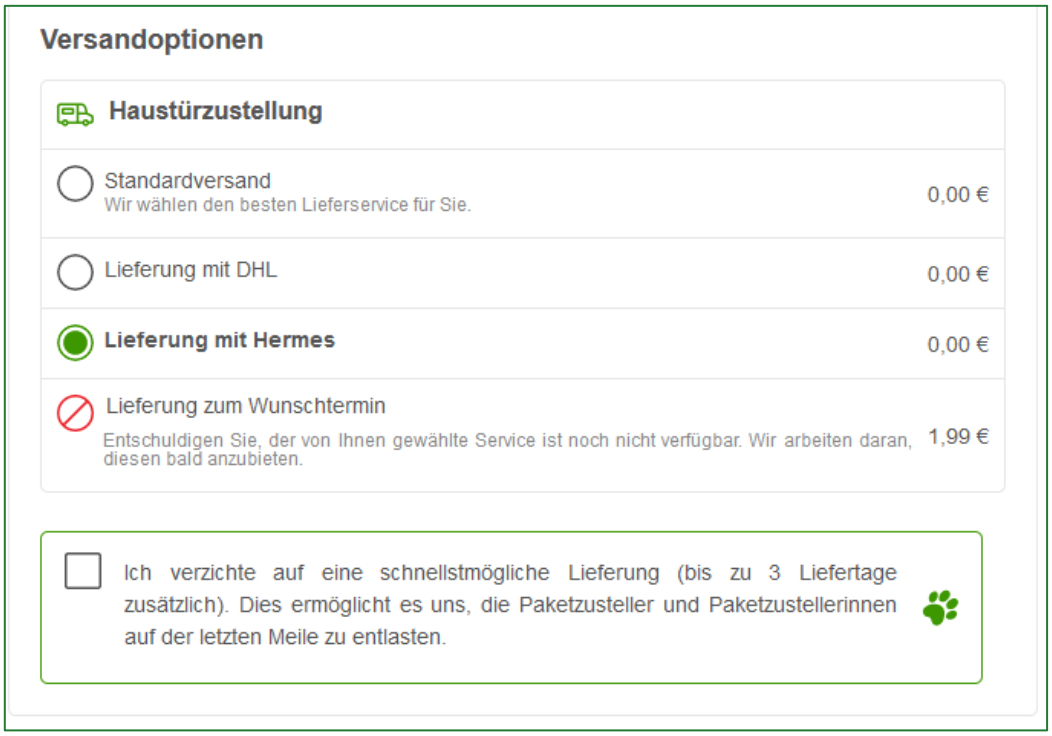

Figure 1 BCT used on Zooplus.de (translation: "I waive the fastest possible delivery (up to 3 additional delivery days. This allows us to relieve the burden on parcel delivery staff on the last mile.")

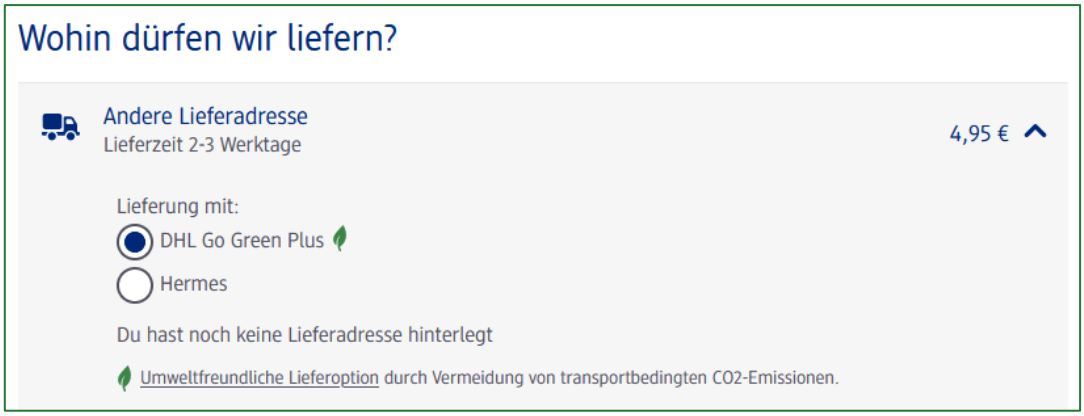

Figure 2 BCT used on Dm.de (translation: "Environmentally friendly delivery option by avoiding transport-related CO2 emissions.")

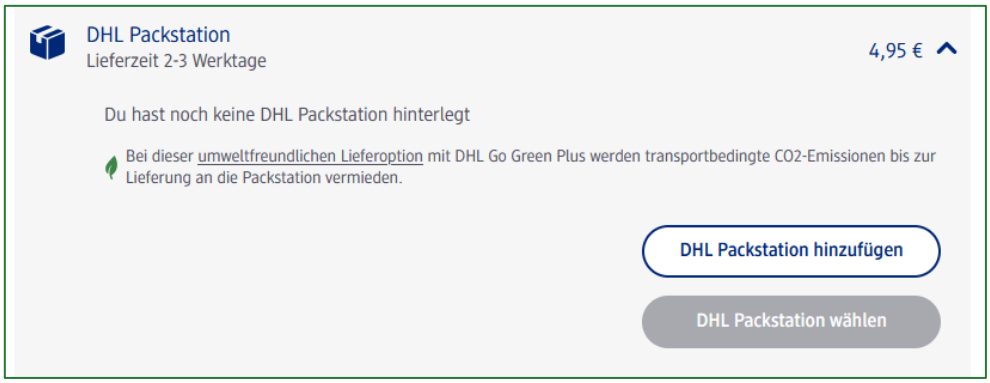

Figure 3 BCT used on Dm.de (translation: "With this environmentally friendly delivery option with DHL Go Green Plus, transport-related CO2 emissions are avoided until delivery to the pack station.")

5. Discussion

Priming vs. non-priming

Notably, only one study primed the respondents before disclosing sustainability information, which was found to have a strong effect (Viet, de Leeuw & van Herpen, 2023). This also confirms prior studies which reveal that priming sustainability concern will increase consumers' awareness of sustainability matters, and in turn, make sustainability a more prominent aspect in their decision making (Lee et al., 2020). Notably, future courses of action can test the additional effectiveness of including priming methods alongside said BCTs.

Product type

Additionally, two studies noted the potential ramifications its use of fashion products in their makeshift e-commerce sites in their experiment (Viet, de Leeuw & van Herpen, 2023; Thomas, Ueltschy Murfield & Ellram, 2022), which is considered a 'low involvement' product that does not necessitate fast delivery (Thomas, Ueltschy Murfield & Ellram, 2022). In fact, out of the mentioned studies who have disclosed the product type in their experiment, half of them have tested clothing and fashion products (Caspersen & Navrud, 2021; Kokkinou et al., 2024; Viet, de Leeuw & van Herpen, 2023; Buldeo Rai et al., 2021; Thomas, Ueltschy Murfield & Ellram, 2022), while one study tested grocery delivery (Agatz, Fan & Stam, 2021), and one study tested book delivery (Muysoms et al., 2021), and three studies did not segment per product category (Nijssen et al., 2023; Fu & Saito, 2018; Ignat & Chankov, 2020). However, different product categories have an influence on how shoppers rationalise and make their purchasing decisions considering time, money, and ease (Nguyen et al., 2019), where sustainability factors may also play a role. (Thomas et al., 2022), Buldeo Rai et al. (2021) and Viet, de Leeuw

& van Herpen (2023) have called on future studies to include different product categories, such as ones that entice more instant gratification, to test the effects of 'sustainability disclosure', i.e., *information about social and environmental consequences.* This also does not coincide with the two types of online retailers which have put such digital behavioural interventions in our analysis, which were a pet store and drug store.

Beyond nudging

As stated, the concept of nudging was a prominent theme (Caspersen & Navrud, 2021; Kokkinou et al., 2024; Muysoms et al., 2021; Nijssen et al., 2023; Buldeo Rai et al., 2021; Thomas, Ueltschy Murfield & Ellram, 2022), whose paternalistic approach is focused on "incentivising positive choices by creating the conditions, social pressure, systems or environments in which people want to make a choice for their own benefit, or have to make little effort to "choose" a personally and social desirable course of action. 'Choice architecture' is the process of designing systems and services in such a way that the 'good' choice is the east and rewarding one and it does not take much effort to make" (French, 2011:p.157). However, manipulating users' choice architecture can be perceived as top down, paternalistic and controlling, and nudging by itself is insufficient to create a desired outcome; other forms of interventions are needed in conjunction (French, 2011). There is a call for interventions to be informed by customer insight and by noting what has worked in the past; rather than mindless choosing on the consumers' side, reasoning is needed while making complicated choices (Grist, 2010, as stated in French, 2011). Future approaches can benefit from going beyond the passiveness of default selections and manipulation of choice architecture to engaging users to make complex and well-thought-out decisions by means of other forms of BCTs (French, 2011), such as the ones included in this paper and beyond.

Customer segmentation

Caspersen & Navrud (2021) recommends that last-mile delivery intervention solutions should best be personalised to satisfy different user preferences. Additionally, Buldeo Rai et al. (2021) recommends that testing user groups differing in age, gender, level of urbanisation, online consumption behaviour and opinions on sustainability. Further testing among groups that are more clearly less susceptible to acting on sustainability interventions is useful.

Complexity of interventions

Nijssen et al. (2023) tested different interventions of varying degrees of complexity and found that the most complex informational interventions of consumers' environmental impact (e.g., displaying the number of grams of CO_2 saved, instead of merely stating that it is lower/higher in emissions) was more effective in getting consumers to choose the desired delivery option

than simpler messages. Further, Thomas, Ueltschy Murfield & Ellram (2022) has echoed the same findings.

Type of promoted delivery mode

Of the ten studies, a majority (eight studies) tested home delivery, three tested pick-up station delivery, and one tested the use of parcel lockers. Ignat & Chankov (2020) and Kokkinou et al. (2024) have tested different desired delivery modes in their experiments, where they gave respondents room to choose which desired option they preferred. Further research is necessitated to demonstrate how consumers, who are accustomed to free next day delivery, change their online shopping behaviour to accept surcharges for less sustainable delivery options (i.e., next day delivery). Further, framing the more sustainable delivery option as a discount is a relevant consideration in future research (Kokkinou et al., 2024), e.g., as done by Viet, de Leeuw & van Herpen (2023). Additionally, no study among the sample tested the use of different delivery vehicles from which the consumer can select for their delivery, such as last-mile delivery by cargo bikes – which most logistics service providers are already testing with for emission-free deliveries (Buldeo Rai, Verlinde & Macharis, 2019).

6. Conclusion

This study aimed to create an analysis of the state-of-the-art of harnessing digital behaviour change techniques to promote sustainable consumer delivery choices on online retailers, considering what has been done in studies and in practice by conducting a limited meta-analysis and a website analysis of the top 65 e-commerce sites in Germany by revenue (EHI Retail Institute, 2023). Among the ten studies analysed, we found eleven main theoretical and conceptual approaches (predominantly *sustainable consumer behaviour* and *nudging*), four methods (predominantly using online surveys with a mock web page/shopping basket and stated preference surveys), and six types of behaviour interventions (predominantly *information about social and environmental consequences* and *restructuring the physical environment*). Additionally, a variety of approaches have been utilised to explore customer sentiment; namely the use of priming mechanisms, exploring different product types, testing the desired delivery option as the default option, examining the effects of varying degrees of complexity of BCTs, and promoting particular delivery modes. Furthermore, among the 65 websites analysed, three percent currently employed one or more behavioural interventions (one pet shop and one drug store). Both the analysis of screened websites and reviewed studies have predominantly employed the BCT *information about social and environmental consequences*. Interestingly, there are a number of techniques tested in an experimental setting which have not yet been introduced in practice on the most prominent German e-tail

sites (i.e., *behaviour cost*, *social comparison*); this gap between theory and practice necessitates further exploration. All in all, the recency of the few studies concerning this topic and the low number of online retailers employing behaviour change techniques for sustainable consumer delivery choices in our sample suggest that using BCTs within the context choosing sustainable consumer delivery choices is embryonic, however, an emerging topic which has started to gain traction in the past few years. It is envisaged that this analysis can provide a clear picture of what has been done so far in this realm to inform future courses of action.

Limitations

Like all studies, this also carries its limitations. Additionally, this study employed a focus solely on interventions for consumer delivery choices, and not returns. Furthermore, the lack of standardised vocabulary on this topic may have hindered the number of studies included in this research. In order to extend the already limited number of studies in this area, our meta-analysis extended its scope to include two master theses alongside eight peer-reviewed studies. Furthermore, the meta-analysis did not assign statistical weights to the studies and did not statistically analyse the studies, as is customary in a meta-analysis (Borenstein, Hedges & Rothstein, 2007). Also, only English-speaking studies were analysed. Additionally, as there was a lack of a unified list of the top e-commerce websites in Europe, the scope was narrowed to test the top e-commerce sites in Germany, as it is the largest consumer market in the European Union (International Trade Administration, 2023).

Directions for future research

In light of the reviewed research and e-commerce websites, we recommend that future studies take into account the use of priming mechanisms, which was understudied in the literature sample. Additionally, it is recommended that future research extends the scope of varying product types (e.g., non-urgent vs. urgent) and analysing customer sentiment based on these distinctions. Additionally, further segmentation of respondents based on socio-demographic factors in future studies can identify target groups which are less susceptible to sustainable delivery interventions, and to define further courses of action that appeals to these customer groups. Lastly, future research can promote multiple desired delivery modes instead of only one (e.g., testing slow home-delivery options alongside pick-up station delivery options, as was already put into practice by dm.de in our website analysis) and to examine the disparity of effects between them. By presenting more than one desired delivery mode, customers can have more agency to choose between the different choices instead of being limited to only one real desired option. In the same way, desired last-mile delivery vehicles can be listed as a delivery option and promoted (e.g., cargo bike delivery by a local courier) via BCTs. As our study lays the foundation for the creation of novel BCTs for sustainable consumer delivery

choices, an eventual next step is to create both a practice-based and theoretically based set of interventions. As demonstrated in a complementing study (Luger-Bazinger, Geser & Hornung-Prähauser, 2023), the development of such new behaviour change interventions can best be formulated taking to account psychological models of behaviour change to increase their effectiveness, such as the COM-B Model (Michie, van Stralen & West, 2011), along with corresponding codifications of the interventions based on an expert-agreed taxonomy of behaviour change techniques (Michie et al., 2013).

References

Agatz, N., Fan, Y. & Stam, D. (2021) The Impact of Green Labels on Time Slot Choice and Operational Sustainability. *Production and Operations Management*. 30 (7), 2285–2303. doi:10.1111/poms.13368.

Berger, M., Nüske, N. & Müller, C. (2020) *Digital Nudging in Online Grocery Stores - Towards Ecologically Sustainable Nutrition*. 1.

Borenstein, M., Hedges, L. & Rothstein, H. (2007) *Introduction to Meta-Analysis*. www.Meta-Analysis.com.

Buldeo Rai, H., Broekaert, C., Verlinde, S. & Macharis, C. (2021) Sharing is caring: How non-financial incentives drive sustainable e-commerce delivery. *Transportation Research Part D: Transport and Environment*. 93, 102794. doi:10.1016/J.TRD.2021.102794.

Buldeo Rai, H., Verlinde, S. & Macharis, C. (2019) The “next day, free delivery” myth unravelled: Possibilities for sustainable last mile transport in an omnichannel environment. *International Journal of Retail and Distribution Management*. 47 (1), 39–54. doi:10.1108/IJRDM-06-2018-0104.

Caspersen, E. & Navrud, S. (2021) The sharing economy and consumer preferences for environmentally sustainable last mile deliveries. *Transportation Research Part D: Transport and Environment*. 95. doi:10.1016/j.trd.2021.102863.

DHL (2022) *Understanding the European Online Shopper (and how to make them buy)*.

Dubisz, D., Golinska-Dawson, P. & Zawodny, P. (2022) Measuring CO2 Emissions in E-Commerce Deliveries: From Empirical Studies to a New Calculation Approach. *Sustainability 2022, Vol. 14, Page 16085*. 14 (23), 16085. doi:10.3390/SU142316085.

ECommerce Europe (2021) *Collaborative Report on Sustainability and e-Commerce*. www.ecommerce-europe.eu.

EHI Retail Institute (2023) *E-Commerce-Markt Deutschland*. https://www.ehi.org/produkt/poster-e-commerce-markt-deutschland-2023-pdf/?action=downloadrequest&id=728d5bed511152e3270db4479ded1f79#payment-form.

ElHaffar, G., Durif, F. & Dubé, L. (2020) Towards closing the attitude-intention-behavior gap in green consumption: A narrative review of the literature and an overview of future research directions. *Journal of Cleaner Production*. 275, 122556. doi:10.1016/J.JCLEPRO.2020.122556.

eMarketer (2023) *Global Retail Ecommerce Forecast 2023*. 2023. https://www.insiderintelligence.com/content/global-retail-ecommerce-forecast-2023 [Accessed: 14 February 2024].

French, J. (2011) Why nudging is not enough. *Journal of Social Marketing*. 1 (2), 154–162. doi:10.1108/20426761111141896.

Frick, V. & Matthies, E. (2020) Everything is just a click away. Online shopping efficiency and consumption levels in three consumption domains. *Sustainable Production and Consumption*. 23, 212–223. doi:10.1016/j.spc.2020.05.002.

Fu, A.J. & Saito, M. (2018) *'Would You Be Willing to Wait?': Consumer Preference for Green Last Mile Home Delivery*. Massachusets Institute of Technology. https://dspace.mit.edu/handle/1721.1/117624.

GWI (2021) *Commerce: GWI's flagship report on the latest trends in commerce*.

Hedin, B., Katzeff, C., Eriksson, E. & Pargman, D. (2019) A systematic review of digital behaviour change interventions for more sustainable food consumption. *Sustainability (Switzerland)*.11 (9). doi:10.3390/su11092638.

Heiny, K. & Schneider, D. (2021) *It Takes Two How the Industry and Consumers Can Close the Sustainability Attitude-Behavior Gap in Fashion Publisher: ZALANDO SE Contents*.

Higgs, G., Katta, A., Lam, P., Tumer, A., Leistman, V., Krogh, M., Sreenivas, S., Gopal, S., Mann, H. & Robertson, A. (2022) *Revealing the secret emissions of e-commerce*.

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. doi:10.1108/IJLM-11-2019-0305/FULL/XML.

International Trade Administration (2023) *Germany - Country Commercial Guide* . 2023. https://www.trade.gov/country-commercial-guides/germany-market-overview [Accessed: 13 May 2024].

Kokkinou, A., Quak, H., Mitas, O. & Mandemakers, A. (2024) Should I wait or should I go? Encouraging customers to make the more sustainable delivery choice. *Research in Transportation Economics*. 103. doi:10.1016/j.retrec.2023.101388.

Krusche, A., Wilde, L., Ghio, D., Morrissey, C., Froom, A. & Chick, D. (2022) Developing public transport messaging to provide crowding information during COVID-19: Application of the COM-B model and behaviour change wheel. *Transportation Research Interdisciplinary Perspectives*. 13, 100564. doi:10.1016/j.trip.2022.100564.

Lee, E.-J., Choi, H., Han, J., Kim, D.H., Ko, E. & Kim, K.H. (2020) How to "Nudge" your consumers toward sustainable fashion consumption: An fMRI investigation. *Journal of Business Research*. 117, 642–651. doi:10.1016/j.jbusres.2019.09.050.

Lehner, M., Mont, O. & Heiskanen, E. (2016) Nudging – A promising tool for sustainable consumption behaviour? *Journal of Cleaner Production*. 134, 166–177. doi:10.1016/J.JCLEPRO.2015.11.086.

Luger-Bazinger, C., Geser, G. & Hornung-Prähauser, V. (2023) Digital Behavioural Interventions for Sustainable Mobility: A Review of Behaviour Change Techniques in Mobile Apps. In: *The Behavioural Economics Guide*. pp. 68–75. https://www.behavioraleconomics.com/be-guide/.

Luger-Bazinger, C., Thelen, M., Leistner, D., Hornung-Prähauser, V., Loidl, M. & Seeber, M. (2023) *Handbook: Digital nudging for sustainable mobility*. Salzburg, Salzburg Research.

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. In: *Proceedings of the Annual Hawaii International Conference on System Sciences*. 2022 IEEE Computer Society. pp. 4707–4716. doi:10.24251/hicss.2022.574.

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., Eccles, M.P., Cane, J. & Wood, C.E. (2013) The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine*. 46 (1), 81–95. doi:10.1007/s12160-013-9486-6.

Michie, S., van Stralen, M.M. & West, R. (2011) The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*. 6 (1). doi:10.1186/1748-5908-6-42.

Mirbabaie, M., Marx, J. & Germies, J. (2021) *Conscious Commerce-Digital Nudging and Sustainable E-commerce Purchase Decisions*. In: 2021 Australasian Conference on Information Systems. p.

Muysoms, J., Celis, M., Geuens, M. & Heeremans, E. (2021) *Nudging E-commerce customers towards more sustainable delivery options*. https://lib.ugent.be/catalog/rug01:003010496.

Nguyen, D.H., de Leeuw, S., Dullaert, W. & Foubert, B.P.J. (2019) What Is the Right Delivery Option for You? Consumer Preferences for Delivery Attributes in Online Retailing. *Journal of Business Logistics*. 40 (4), 299–321. doi:10.1111/jbl.12210.

Nijssen, S.R.R., Pijs, M., Van Ewijk, A. & Müller, B.C.N. (2023) Towards more sustainable online consumption: The impact of default and informational nudging on consumers' choice of delivery mode. *Cleaner and Responsible Production*. 11. doi:10.1016/j.clrc.2023.100135.

Nisa, C.F., Bélanger, J.J., Schumpe, B.M. & Faller, D.G. (2019) Meta-analysis of randomised controlled trials testing behavioural interventions to promote household action on climate change. *Nature Communications*. 10 (1), 4545. doi:10.1038/s41467-019-12457-2.

OliverWyman (2021) *Is e-commerce good for Europe?* .

Petersson, E. (2022) *Nudging consumers towards more sustainable alternatives when shopping online: A cross-sectional qualitative study of behavior change design and digital nudging techniques for use in the e-commerce context*. Malmö University.

Van Rhoon, L., Byrne, M., Morrissey, E., Murphy, J. & McSharry, J. (2020) A systematic review of the behaviour change techniques and digital features in technology-driven type 2 diabetes prevention interventions. *DIGITAL HEALTH*. 6, 205520762091442. doi:10.1177/2055207620914427.

Sallnäs, U. & Björklund, M. (2020) Consumers' influence on the greening of distribution – exploring the communication between logistics service providers, e-tailers and

consumers. *International Journal of Retail and Distribution Management*. 48 (11), 1177–1193. doi:10.1108/IJRDM-07-2019-0213/FULL/XML.

Schubert, C. (2016) *Green nudges: Do they work? Are they ethical?* .

Seven Senders (2022) *Roadmap 2025: Nachhaltigkeit im europäischen E-Commerce. Strategien und Kunden-Erwartungen zur Reduzierung des CO2-Fußabdrucks im E-Commerce*.

Thaler, R.H. & Sunstein, C.R. (2008) *Nudge. Improving Decisions About Health, Wealth, and Happiness*. Pengiun.

Thomas, R.W., Ueltschy Murfield, M.L. & Ellram, L.M. (2022) Leveraging sustainable supply chain information to alter last-mile delivery consumption: A social exchange perspective. *Sustainable Production and Consumption*. 34, 285–299. doi:10.1016/J.SPC.2022.09.014.

Thuiswinkel.org (n.d.) *Bewust Bezorgd*. https://www.thuiswinkel.org/webshops/diensten/bewust-bezorgd/ [Accessed: 14 February 2024].

Tölke, M. & McKinnon, A. (2021) *Decarbonizing the operations of small and medium-sized road carriers in Europe An analysis of their perspectives, motives, and challenges*. www.smartfreightcentre.org.

Trudel, R. (2019) Sustainable consumer behavior. *Consumer Psychology Review*. 2 (1), 85–96. doi:10.1002/ARCP.1045.

Viet, N.Q., de Leeuw, S. & van Herpen, E. (2023) The impact of social vs environmental sustainability information disclosure on consumer choice of delivery time with varying sustainability concerns. *International Journal of Physical Distribution and Logistics Management*. 53 (11), 26–52. doi:10.1108/IJPDLM-09-2021-0392.

Viu-Roig, M. & Alvarez-Palau, E.J. (2020) The impact of E-Commerce-related last-mile logistics on cities: A systematic literature review. *Sustainability (Switzerland)*.12 (16). doi:10.3390/su12166492.

World Economic Forum (2020) *The Future of the Last-Mile Ecosystem* . www.weforum.org.

Annex I: BCT taxonomy: 93 hierarchically-clustered techniques

Goals and planning

Table 3 Annex I Goals and planning (Source: Michie et al., 2013)

Label	Definition
(1) Goal setting (behaviour)	Definition of a goal in terms of the behaviour to be achieved (goal setting is recommended if there is evidence that goals set as part of the intervention; if the goal is unspecified or is a behavioural outcome use *goal setting outcome,* or if the goal defines a specific context, frequency or duration of the behaviour, action planning should be used).
(2) Problem solving	Analysis, or prompt the person to analyse, factors influencing the behaviour and generate or select strategies that include overcoming barriers and/or increasing facilitators.
(3) Goal setting (outcome)	Set or agree on a goal defined in terms of a positive outcome of the behaviour that is strived for.
(4) Action planning	Prompt detailed planning of the performance of the behaviour (must include (at least one) either context, frequency, duration of intensity). The context can be environmental (physical or social) or internal (physical, emotional or cognitive => includes *implementation intentions*); Evidence of action planning does not automatically imply goal setting, only code latter is sufficient evidence
(5) Review behaviour goal(s)	Review behaviour goal(s) jointly with the person and consider modifying goal(s) or behaviour change strategy in terms of the achievement. This may lead to re-setting the same goal, a small change in that goal or setting a new goal instead of (or in addition to) the first, or no change; If the goal is specified in terms of behaviour, code *Review behaviour goal(s)*, if the goal is unspecified, code *Review outcome goal(s)* and if discrepancy is created consider *Discrepancy* between current behaviour and goal.
(6) Discrepancy between current behaviour and goal	Draw attention to discrepancies between a person's current behaviour (in terms of the form, frequency, duration, or intensity) and the person's previously set outcome goals, behavioural goals or action plans (goes beyond self-monitoring of behaviour); If discomfort is created only code *Incompatible beliefs* and not Discrepancy between current behaviour and goal; if goals are modified, also code *Review behaviour goal(s)* and/or, *Review outcome goal(s);* if feedback is provided, also code, *Feedback on behaviour*.
(7) Review outcome goal(s)	Review outcome goal(s) jointly with the person and consider modifying goal(s) in light of achievement. This may lead to resetting the same goal, a small change in that goal or setting a new goal instead of, or in addition to the first; If the goal is specified in terms of behaviour, code *Review*

	behaviour goal(s), if goal unspecified, code *Review outcome goal(s);* if discrepancy is. created consider also *Discrepancy*
(8) Behavioural contract	Create a written specification of the behaviour to be performed, agreed on by the person, and witnessed by another person; also, code *Goal setting (behaviour)*
(9) Commitment	Ask a person to affirm or reaffirm statements indicating commitment to change the behaviour; If it is also defined in terms of behaviour to be achieved also code *Goal setting (behaviour)*

Feedback and monitoring

Table 4 Annex I Feedback and monitoring (Source: Michie et al., 2013)

Label	Definition
(1) Monitoring of behaviour by others without feedback	Observe or record behaviour with the person's knowledge as part of a behaviour change strategy; Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if feedback given, code only, *Feedback on behaviour*, and not, *monitoring of behaviour by others without feedback*; if monitoring outcome(s) code, *Monitoring outcome(s) of behaviour* by others without feedback; if self-monitoring behaviour, code, *Self-monitoring of behaviour*
(2) Feedback on behaviour	Monitor and provide informative or evaluative feedback on performance of the behaviour (e.g. form, frequency, duration, intensity) Note: if Biofeedback, code only, *Biofeedback* and not, Feedback on behaviour; if feedback is on outcome(s) of behaviour, code, *Feedback on outcome(s) of behaviour*; if there is no clear evidence that feedback was given, code, *Monitoring of behaviour by others without feedback*; if feedback on behaviour is evaluative e.g. praise, also code, *Social reward*
(3) Self-monitoring of behaviour	Establish a method for the person to monitor and record their behaviour(s) as part of a behaviour change strategy Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if monitoring of outcome of behaviour, code *Self-monitoring of outcome(s) of behaviour*; if monitoring is by someone else (without feedback), code *Monitoring of behaviour by others without feedback*
(4) Self-monitoring of outcome(s) of behaviour	Establish a method for the person to monitor and record the outcome(s) of their behaviour as part of a behaviour change strategy Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if monitoring behaviour, code, *Self-monitoring of behaviour*; if monitoring is by someone else (without feedback), code, *Monitoring outcome(s) of behaviour by others without feedback*
(5) Monitoring outcome(s) of behaviour by others	Observe or record outcomes of behaviour with the person's knowledge as part of a behaviour change strategy; Note: if monitoring is part of a data collection procedure rather than a strategy aimed at changing behaviour, do not code; if feedback given, code only, *Feedback on outcome(s) of behaviour;* if monitoring behaviour code, *Monitoring of behaviour by others*

without feedback	*without feedback*; if self-monitoring outcome(s), code, *Self-monitoring of outcome(s) of behaviour*
(6) Biofeedback	Provide feedback about the body (e.g. physiological or biochemical state) using an external monitoring device as part of a behaviour change strategy; Note: if Biofeedback, code only, *Biofeedback* and not, *Feedback on behaviour* or, *Feedback on outcome(s) of behaviour*
(7) Feedback on outcome(s) of behaviour	Monitor and provide feedback on the outcome of performance of the behaviour; Note: if Biofeedback, code only, *Biofeedback* and not *Feedback on outcome(s) of behaviour*; if feedback is on behaviour code *Feedback on behaviour*; if there is no clear evidence that feedback was given code m*onitoring outcome(s) of behaviour by others without feedback*; if feedback on behaviour is evaluative e.g. praise, also code *Social reward*

Social support

Table 5 Annex I Social support (Source: Michie et al., 2013)

Label	Definition
(1) Social support (unspecified)	Advise on, arrange or provide social support (e.g. from friends, relatives, colleagues,' buddies' or staff) or non-contingent praise or reward for performance of the behaviour. It includes encouragement and counselling, but only when it is directed at the behaviour; Note: attending a group class and/or mention of 'follow-up' does not necessarily apply this BCT, support must be explicitly mentioned; if practical, code *Social support (practical);* if emotional, code *Social support (emotional) (*includes *'Motivational interviewing'* and *'Cognitive Behavioural Therapy')*
(2) Social support practical	Advise on, arrange, or provide practical help (e.g. from friends, relatives, colleagues, 'buddies' or staff) for performance of the behaviour; Note: if emotional, code *Social support (emotional)*; if general or unspecified, code, *Social support (unspecified)* If only restructuring the physical environment or adding objects to the environment, code *Restructuring the physical environment* or *Adding objects to the environment*; attending a group or class and/or mention of 'follow-up' does not necessarily apply this BCT, support must be explicitly mentioned.
(3) Social support (emotional)	Advise on, arrange, or provide emotional social support (e.g. from friends, relatives, colleagues, 'buddies' or staff) for performance of the behaviour; Note: if practical, code, *Social support (practical);* if unspecified, code *Social support (unspecified)*

Shaping knowledge

Table 6 Annex I Shaping knowledge (Source: Michie et al., 2013)

Label	Definition

(1) Instruction on how to perform a behaviour	Advise or agree on how to perform the behaviour (includes 'Skills training'); Note: when the person attends classes such as exercise or cookery, code *Instruction on how to perform the behaviour, Behavioural practice/rehearsal* and *Demonstration of the behaviour*
(2) Information about antecedents	Provide information about antecedents (e.g. social and environmental situations and events, emotions, cognitions) that reliably predict performance of the behaviour
(3) Re-attribution	Elicit perceived causes of behaviour and suggest alternative explanations (e.g. external or internal and stable or unstable)
(4) Behavioural experiments	Advise on how to identify and test hypotheses about the behaviour, its causes and consequences, by collecting and interpreting data

Natural consequences

Table 7 Annex I Natural consequences (Source: Michie et al., 2013)

Label	Definition
(1) Information about health consequences	Provide information (e.g. written, verbal, visual) about health consequences of performing the behaviour; Note: consequences can be for any target, not just the recipient(s) of the intervention; emphasising importance of consequences is not sufficient; if information about emotional consequences, code *Information about emotional consequences*; if about social, environmental or unspecific consequences code *Information about social and environmental consequences*
(2) Salience of consequences	Use methods specifically designed to emphasise the consequences of performing the behaviour with the aim of making them more memorable (goes beyond information about consequences); Note: if information about consequences, also code *Information about health consequences, Information about emotional consequences or Information about social and environmental consequences*
(3) Information about social and environmental consequences	Provide information (e.g. written, verbal, visual) about social and environmental consequences of performing the behaviour; Note: consequences can be for any target, not just the recipient(s) of the intervention; if information about health consequences, code *Information about health consequences*; if about emotional consequences code *Information about emotional consequences;* if unspecific, code *Information about social and environmental consequences*
(4) Monitoring of emotional consequences	Prompt assessment of feelings after attempts at performing the behaviour
(5) Anticipated regret	Induce or raise awareness of expectations of future regret about performance of the unwanted behaviour; Note: not including *Information about emotional consequences;* if suggests adoption of a perspective or

	new perspective in order to change cognitions also code *Framing/reframing*
(6) Information about emotional consequences	Provide information (e.g. written, verbal, visual) about emotional consequences of performing the behaviour; Note: consequences can be related to emotional health disorders (e.g. depression, anxiety) and/or states of mind (e.g. low mood, stress); not including *Anticipated regret*; consequences can be for any target, not just the recipient(s) of the intervention; if information about health consequences code *Information about health consequences*; if about social, environmental or unspecified code *Information about social and environmental consequences*

Comparison of behaviour

Table 8 Annex I Comparison of behaviour (Source: Michie et al., 2013)

Label	Definition
(1) Demonstration of the behaviour	Provide an observable sample of the performance of the behaviour, directly in person or indirectly e.g. via film, pictures, for the person to aspire to or imitate (includes 'Modelling'); Note: if advised to practice, also code *Behavioural practice and rehearsal*; If provided with instructions on how to perform, also code *Instruction on how to perform the behaviour*
(2) Social comparison	Draw attention to others' performance to allow comparison with the person's own performance; Note: being in a group setting does not necessarily mean that social comparison is actually taking place
(3) Information about others' approval	Provide information about what other people think about the behaviour. The information clarifies whether others will like, approve or disapprove of what the person is doing or will do

Association

Table 9 Annex I Association (Source: Michie et al., 2013)

Label	Definition
(1) Prompts/ cues	Introduce or define environmental or social stimulus with the purpose of prompting or cueing the behaviour. The prompt or cue would normally occur at the time or place of performance; Note: when a stimulus is linked to a specific action in an if-then plan including one or more of frequency, duration or intensity also code *Action planning*
(2) Cue signalling reward	Identify an environmental stimulus that reliably predicts that reward will follow the behaviour (includes 'Discriminative cue')

(3) Reduce prompts/ cues	Withdraw gradually prompts to perform the behaviour (includes 'Fading')
(4) Remove access to the reward	Advise or arrange for the person to be separated from situations in which unwanted behaviour can be rewarded in order to reduce the behaviour (includes 'Time out')
(5) Remove aversive stimulus	Advise or arrange for the removal of an aversive stimulus to facilitate behaviour change (includes 'Escape learning')
(6) Satiation	Advise or arrange repeated exposure to a stimulus that reduces or extinguishes a drive for the unwanted behaviour
(7) Exposure	Provide systematic confrontation with a feared stimulus to reduce the response to a later encounter
(8) Associative learning	Present a neutral stimulus jointly with a stimulus that already elicits the behaviour repeatedly until the neutral stimulus elicits that behaviour (includes 'Classical/Pavlovian Conditioning'); Note: when a BCT involves reward or punishment, code one or more of: *Material reward (behaviour); Nonspecific reward; Social reward, Self-reward; Reward (outcome)*

Repetition and substitution

Table 10 Annex I Repetition and substitution (Source: Michie et al., 2013)

Label	Definition
(1) Behavioural practice/ rehearsal	Prompt practice or rehearsal of the performance of the behaviour one or more times in a context or at a time when the performance may not be necessary, in order to increase habit and skill Note: if aiming to associate performance with the context, also code *Habit formation*
(2) Behaviour substitution	Prompt substitution of the unwanted behaviour with a wanted or neutral behaviour; Note: if this occurs regularly, also code *Habit reversal*
(3) Habit formation	Prompt rehearsal and repetition of the behaviour in the same context repeatedly so that the context elicits the behaviour; Note: also code *Behavioural practice/rehearsal*
(4) Habit reversal	Prompt rehearsal and repetition of an alternative behaviour to replace an unwanted habitual behaviour; Note: also code *Behaviour substitution*
(5) Overcorrection	Ask to repeat the wanted behaviour in an exaggerated way following an unwanted behaviour
(6) Generalisation of target behaviour	Advise to perform the wanted behaviour, which is already performed in a particular situation, in another situation

(7) Graded tasks	Set easy-to-perform tasks, making them increasingly difficult, but achievable, until behaviour is performed

Comparison of outcomes

Table 11 Annex I Comparison of outcomes (Source: Michie et al., 2013)

Label	Definition
(1) Credible source	Present verbal or visual communication from a credible source in favour of or against the behaviour; Note: code this BCT if source generally agreed on as credible e.g., health professionals, celebrities or words used to indicate expertise or leader in field and if the communication has the aim of persuading; if information about health consequences, also code *Information about health consequences*, if about emotional consequences, also code *Information about emotional consequences*; if about social, environmental or unspecified consequences also code *Information about social and environmental consequences*
(2) Pros and cons	Advise the person to identify and compare reasons for wanting (pros) and not wanting to (cons) change the behaviour (includes 'Decisional balance'); Note: if providing information about health consequences, also code *Information about health consequences*; if providing information about emotional consequences, also code *Information about emotional consequences*; if providing information about social, environmental or unspecified consequences also code *Information about social and environmental consequences*
(3) Comparative imagining of future outcomes	Prompt or advise the imagining and comparing of future outcomes of changed versus unchanged behaviour

Reward and threat

Table 12 Annex I Reward and threat (Source: Michie et al., 2013)

Label	Definition
(1) Material incentive (behaviour)	Inform that money, vouchers or other valued objects will be delivered if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement'); Note: if incentive is social, code *Social incentive* if unspecified code *Non-specific incentive*, and not *Material incentive (behaviour)*; if incentive is for outcome, code *Incentive (outcome)*. If reward is delivered also code one of: *Material reward (behaviour); Non-specific reward; Social reward, Self-reward; Reward (outcome)*

(2) Material reward (behaviour)	Arrange for the delivery of money, vouchers or other valued objects if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement'); Note: If reward is social, code *Social reward*, if unspecified code *Nonspecific reward*, and not *Material reward (behaviour)*; if reward is for outcome, code *Reward (outcome)*. If informed of reward in advance of rewarded behaviour, also code one of: *Material incentive (behaviour); Social incentive; Non-specific incentive; Self-incentive; Incentive (outcome)*
(3) Non-specific reward	Arrange delivery of a reward if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement'); Note: if reward is material, code *Material reward (behaviour)*, if social, code *Social reward*, and not *Nonspecific reward*; if reward is for outcome code *Reward (outcome)*. If informed of reward in advance of rewarded behaviour, also code one of: *Material incentive (behaviour); Social incentive; Non-specific incentive; Self-incentive; Incentive (outcome)*
(4) Social reward	Arrange verbal or non-verbal reward if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement'); Note: if reward is material, code *Material reward (behaviour)*, if unspecified code *Non-specific reward*, and not *Social reward*; if reward is for outcome code *Reward (outcome)*. If informed of reward in advance of rewarded behaviour, also code one of: *Material incentive (behaviour); Social incentive; Non-specific incentive; Self-incentive; Incentive (outcome)*
(5) Social incentive	Inform that a verbal or non-verbal reward will be delivered if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement'); Note: if incentive is material, code *Material incentive (behaviour)*, if unspecified code *Non-specific incentive*, and not *Social incentive;* if incentive is for outcome code *Incentive (outcome)*. If reward is delivered also code one of: *Material reward (behaviour); Non-specific reward; Social reward, Self-reward; Reward (outcome)*
(6) Non-specific incentive	Inform that a reward will be delivered if and only if there has been effort and/or progress in performing the behaviour (includes 'Positive reinforcement'); Note: if incentive is material, code *Material incentive (behaviour),* if social, code *Social incentive* and not *Non-specific incentive*; if incentive is for outcome code *Incentive (outcome)*. If reward is delivered also code one of: *Material reward (behaviour); Non-specific reward; Social reward, Self-reward; Reward (outcome)*
(7) Self-incentive	Plan to reward self in future if and only if there has been effort and/or progress in performing the behaviour; Note: if self-reward is material, also code *Material incentive (behaviour)*, if social, also code *Social incentive*, if unspecified, also code *Non-specific incentive*; if incentive is for outcome code *Incentive (outcome).* If reward is delivered also code one of: *Material reward (behaviour); Non-specific reward; Social reward, Self-reward; Reward (outcome)*
(8) Incentive (outcome)	Inform that a reward will be delivered if and only if there has been effort and/or progress in achieving the behavioural outcome (includes 'Positive reinforcement'); Note: this includes social, material, self- and non-specific

	incentives for outcome; if incentive is for the behaviour code *Social incentive, Material incentive (behaviour), Non-specific incentive* or *Self-incentive* and not *Incentive (outcome).* If reward is delivered also code one of: *Material reward (behaviour); Non-specific reward; Social reward, Self-reward; Reward (outcome)*
(9) Self-reward	Prompt self-praise or self-reward if and only if there has been effort and/or progress in performing the behaviour; Note: if self-reward is material, also code *Material reward (behaviour),* if social, also code *Social reward,* if unspecified, also code *Non-specific reward*; if reward is for outcome code *Reward (outcome).* If informed of reward in advance of rewarded behaviour, also code one of: *Material incentive (behaviour); Social incentive; Non-specific incentive; Self-incentive; Incentive (outcome)*
(10) Reward (outcome)	Arrange for the delivery of a reward if and only if there has been effort and/or progress in achieving the behavioural outcome (includes 'Positive reinforcement'); Note: this includes social, material, self- and non-specific rewards for outcome; if reward is for the behaviour code *Social reward*, *Material reward (behaviour), Non-specific reward* or *Self-reward* and not *Reward (outcome).* If informed of reward in advance of rewarded behaviour, also code one of: Material incentive (behaviour); Social incentive; Non-specific incentive; Self-incentive; Incentive (outcome)
(11) Future punishment	Inform that future punishment or removal of reward will be a consequence of performance of an unwanted behaviour (may include fear arousal) (includes 'Threat')

Regulation

Table 13 Annex I Regulation (Source: Michie et al., 2013)

Label	Definition
(1) Pharmacological support	Provide, or encourage the use of or adherence to, drugs to facilitate behaviour change; Note: if pharmacological support to reduce negative emotions (i.e. anxiety) then also code *Reduce negative emotions*
(2) Reduce negative emotions	Advise on ways of reducing negative emotions to facilitate performance of the behaviour (includes 'Stress Management') Note: if includes analysing the behavioural problem, also code *Problem solving*
(3) Conserving mental resources	Advise on ways of minimising demands on mental resources to facilitate behaviour change
(4) Paradoxical instructions	Advise to engage in some form of the unwanted behaviour with the aim of reducing motivation to engage in that behaviour

Antecedents

Table 14 Annex I Antecedents (Source: Michie et al., 2013)

Label	Definition
(1) Restructuring the physical environment	Change, or advise to change the physical environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour (other than prompts/cues, rewards and punishments); Note: this may also involve *Avoidance/reducing exposure to cues for the behaviour*; if restructuring of the social environment code *Restructuring the social environment*; if only adding objects to the environment, code *Adding objects to the environment*
(2) Restructuring the social environment	Change, or advise to change the social environment in order to facilitate performance of the wanted behaviour or create barriers to the unwanted behaviour (other than prompts/cues, rewards and punishments); Note: this may also involve *Avoidance/reducing exposure to cues for the behaviour*; if also restructuring of the physical environment also code *Restructuring the physical environment*
(3) Avoidance/ reducing exposure to cues for the behaviour	Advise on how to avoid exposure to specific social and contextual/physical cues for the behaviour, including changing daily or weekly routines; Note: this may also involve *Restructuring the physical environment* and/or *Restructuring the social environment*; if the BCT includes analysing the behavioural problem, only code *Problem solving*
(4) Distraction	Advise or arrange to use an alternative focus for attention to avoid triggers for unwanted behaviour
(5) Adding objects to the environment	Add objects to the environment in order to facilitate performance of the behaviour; Note: Provision of information (e.g. written, verbal, visual) in a booklet or leaflet is insufficient. If this is accompanied by social support, also code *Social support (practical);* if the environment is changed beyond the addition of objects, also code *Restructuring the physical environment*
(6) Body changes	Alter body structure, functioning or support directly to facilitate behaviour change

Identity

Table 15 Annex I Identity (Source: Michie et al., 2013)

Label	Definition
(1) Identification of self as role model	Inform that one's own behaviour may be an example to others
(2) Framing/ reframing	Suggest the deliberate adoption of a perspective or new perspective on behaviour (e.g. its purpose) in order to change cognitions or emotions

	about performing the behaviour (includes 'Cognitive structuring'); If information about consequences then code *Information about health consequences, Information about emotional consequences* or *Information about social and environmental consequences* instead of *Framing/reframing*
(3) Incompatible beliefs	Draw attention to discrepancies between current or past behaviour and self-image, in order to create discomfort (includes 'Cognitive dissonance')
(4) Valued self-identify	Advise the person to write or complete rating scales about a cherished value or personal strength as a means of affirming the person's identity as part of a behaviour change strategy (includes 'Self-affirmation')
(5) Identity associated with change behaviour	Advise the person to construct a new self-identity as someone who 'used to engage with the unwanted behaviour'

Scheduled consequences

Table 16 Annex I Scheduled consequences (Source: Michie et al., 2013)

Label	Definition
(1) Behaviour cost	Arrange for withdrawal of something valued if and only if an unwanted behaviour is performed (includes 'Response cost'); Note if withdrawal of contingent reward code, *Remove reward*
(2) Punishment	Arrange for aversive consequence contingent on the performance of the unwanted behaviour
(3) Remove reward	Arrange for discontinuation of contingent reward following performance of the unwanted behaviour (includes 'Extinction')
(4) Reward approximation	Arrange for reward following any approximation to the target behaviour, gradually rewarding only performance closer to the wanted behaviour (includes 'Shaping')
(5) Rewarding completion	Build up behaviour by arranging reward following final component of the behaviour; gradually add the components of the behaviour that occur earlier in the behavioural sequence (includes 'Backward chaining'); Note: also code one of *Material reward (behaviour); Non-specific reward; Social reward, Self-reward; Reward (outcome)*
(6) Situation-specific reward	Arrange for reward following the behaviour in one situation but not in another (includes 'Discrimination training'); Note: also code one of *Material reward (behaviour); Non-specific reward; Social reward, Self-reward; Reward (outcome)*
(7) Reward incompatible behaviour	Arrange reward for responding in a manner that is incompatible with a previous response to that situation (includes 'Counter-conditioning'); Note:

	also code one of *Material reward (behaviour); Non-specific reward; Social reward, Self-reward; Reward (outcome)*
(8) Reward alternative behaviour	Arrange reward for performance of an alternative to the unwanted behaviour (includes 'Differential reinforcement'); Note: also code one of *Material reward (behaviour); Non-specific reward; Social reward, Self-reward; Reward (outcome)*; consider also coding *Problem solving*
(9) Reduce reward frequency	Arrange for rewards to be made contingent on increasing duration or frequency of the behaviour (includes 'Thinning'); Note: also code one of *Material reward (behaviour); Non-specific reward; Social reward, Self-reward; Reward (outcome)*
(10) Remove punishment	Arrange for removal of an unpleasant consequence contingent on performance of the wanted behaviour (includes 'Negative reinforcement'

Self-belief

Table 17 Annex I Self-belief (Source: Michie et al., 2013)

Label	Definition
(1) Verbal persuasion about capability	Tell the person that they can successfully perform the wanted behaviour, arguing against self-doubts and asserting that they can and will succeed
(2) Mental rehearsal of successful performance	Advise to practise imagining performing the behaviour successfully in relevant contexts
(3) Focus on past success	Advise to think about or list previous successes in performing the behaviour (or parts of it)
(4) Self-talk	Prompt positive self-talk (aloud or silently) before and during the behaviour

Covert learning

Table 18 Annex I Covert learning (Source: Michie et al., 2013)

Label	Definition
(1) Imaginary punishment	Advise to imagine performing the unwanted behaviour in a real-life situation followed by imagining an unpleasant consequence (includes 'Covert sensitisation')
(2) Imaginary reward	Advise to imagine performing the wanted behaviour in a real-life situation followed by imagining a pleasant consequence (includes 'Covert conditioning')
(3) Vicarious consequences	Prompt observation of the consequences (including rewards and punishments) for others when they perform the behaviour; Note: if observation of health consequences, also code *Information about health consequences;* if of emotional consequences, also code *Information about emotional consequences*, if of social, environmental or unspecified consequences, also code *Information about social and environmental consequences*