

Digital Nudging Toward Pro-Environmental Behavior: A Literature Review

Completed Research Paper

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Abstract

Over recent years, attention to the urgency of climate change and creating a more sustainable future has risen significantly. However, many people still have not changed their behavior and gone greener even though they know about the severe consequences. Green information systems (IS) provides a promising research agenda to tackle environmental problems with IT-enabled solutions. Digital nudges can be an especially effective instrument in inducing behavior changes. However, due to the interdisciplinary nature of digital nudging, the concept disperses into different research fields. To structure the existing knowledge, we conducted a literature review including 43 research articles. Our research organizes and analyses the extant work on digital nudges toward pro-environmental behavior. The results show that the effects of digital nudges depend on their moment of application. Based on our results, we derive directions for future research of digital nudging in IS research.

Keywords: Pro-Environmental Behavior, Digital Nudging, Literature Review

Introduction

In 2018, Greta Thunberg started to speak up for actions to contain the harmful effects of climate change, and a lot has since changed in the public perception of environmental issues. Climate issues used to be discussed as a subordinate topic, but over the last few years, the urgency of global warming and the need to develop a more sustainable future of societies in industrial countries has risen significantly (Nevett 2019). However, many people still have not changed their behavior and gone greener even though they know about the future danger that climate change can cause. To promote sustainable behavior, various political and economic actions have been initiated, such as India's "Promotion of electric vehicles" initiative (Jafri 2020) or tax cuts for train tickets from the German government (Reuters 2020), and many more. While all these measures could increase the demand for sustainable products, they are all capital intensive and, therefore, not suitable for being used over a longer period of time to generate long-term behavioral changes.

To tackle the challenge of global warming from a scientific perspective, Gholami et al. (2016) engaged in environmental sustainability research in information systems (IS). This research stream is called Green IS and offers a promising research agenda for approaching environmental problems with IT-enabled solutions. Green IS focuses on the socio-technical dimension to address environmental topics and promotes IT-enabled solutions to "support individual, organizational, or societal goals" (Kranz et al. 2015, p. 8; Watson et al. 2010). For example, Corbett (2013) analyzed the design and development of carbon management systems to support employees' pro-environmental behavior, and Schulz et al. (2020) examined how intermodal mobility ecosystems can simplify door-to-door mobility and contribute to the reduction of private car use. The term pro-environmental behavior (PEB) is used for behavior "that consciously seeks to minimize the negative impact of one's actions on the natural and built world" (Kollmuss and Agyeman 2002, p. 240).

One promising approach to changing individual behavior that has been discussed in recent IS literature is the concept of digital nudging (Henkel et al. 2019; Meske and Amojo 2019; Weinmann et al. 2016). Nudging is defined as a presentation of different choices that can alter people's behavior without changing their economic incentives. Digital nudging transfers this concept into a digital environment, for example, webpages, apps, or Customer Relationship Management systems (Weinmann et al. 2016). For instance, Székely et al. (2016) have encouraged behavioral changes of optional CO₂ offset payments for flight bookings by employing different default settings within the booking system. On the other hand, Degirmenci and Recker (2018) provided evidence for the effectiveness of feedback and peer comparison in a digital environment to reduce paper printing at a university.

Digital nudging is of interdisciplinary nature, and the concept disperses into different research fields. Besides being included in an emerging research stream in Green IS (Corbett 2013; Henkel and Kranz 2018; Lossin et al. 2016), digital nudging for PEB changes are also discussed in psychology (Demarque et al. 2015; Graham et al. 2011; Taube and Vetter 2019), business and marketing (Chang et al. 2015; Grinstein and Riefler 2015; Kronrod et al. 2012), and in environmental sustainability-related outlets (Byerly et al. 2018; Doran et al. 2017; Tiefenbeck et al. 2019). Moreover, previous studies have shown mixed results on the effectiveness of different digital nudges (Henkel and Kranz 2018), which is mostly assigned to different contextual factors, such as the used target groups, the timeframe of the measures, or the application field (e.g., energy-saving, transportation optimization, or promotion of green product purchase).

Therefore, the aim of this research is to organize, structure, integrate, and analyze the extant work on digital nudges for PEB. We conducted an organizing literature review (Leidner 2018) following the guidelines of Webster and Watson (2002). Our results show that there are essential differences in the effects of digital nudges for PEB, depending on their application within a decision process. We considered whether digital nudges are applied before, while, or after a person decides to perform an action. By mapping different kinds of digital nudges to these three stages, we found that digital nudges

applied in the first stage of an action are less effective than digital nudges within the last two stages. This study contributes to IS research by structuring the dispersed knowledge on digital nudges. Moreover, this study provides insights for practitioners and politics that can be used to make PEB more attractive to consumers.

The remainder of this paper is structured as follows: In the next section, we provide an overview of digital nudges' theoretical foundations. Next, we describe the design of the literature review, followed by its results. Last, we present an outlook and discuss the results as well as the expected contributions for researchers and practitioners.

Theoretical Background

Digital nudging in IS

Green IS research focuses on the socio-technical dimension to address environmental topics. It can be employed to support behavioral changes (Loock et al. 2013). Various possible approaches to changing people's behavior exist, but there is evidence that psychological effects can be more persuasive than changes in external circumstances (Hunecke et al. 2010; Möser and Bamberg 2008). Psychological effects include different incentives, either monetary or non-monetary. Typical monetary incentives that promote PEB are subsidies, taxes, or bonus systems. For instance, governments can increase taxes on flights and fossil fuels to promote public transportation, or they can grant financial rewards to households that use solar panels. Nudging is a different kind of promotion. It has been applied in several studies promoting PEB (Henkel and Kranz 2018; Mirsch et al. 2017; Sudarshan 2017).

The concept of nudging has been shaped in the behavioral economics' research field by Thaler and Sunstein (2008). Nudges influence people's behavior without changing their actual economic incentives. This makes them more attractive than monetary incentives. Instead, the design of the choice architecture is altered to change peoples' behavior in a predictable way. A widely known nudging mechanism is the arrangement of products in a grocery store: By placing sustainable products on shelves at viewing height, more people will buy these products compared to when they are placed in other arrangements without changing monetary incentives (discounting prices, for example) or eliminating non-sustainable products from the range (Romaniuk and Sharp 2016). Such changes in the choice architecture can influence people either consciously or subconsciously and are well suited for habitual choices (Thaler and Sunstein 2008).

As more and more decisions are made on-screen, nudging has also been transferred to a digital environment by using IS. It has been employed on web pages, apps, or online shops. It is called *digital nudging* and is defined as "the use of user-interface design elements to guide people's behavior in digital choice environments" (Weinmann et al. 2016, p. 433). Although the nudging mechanisms remain the same for digital nudges, there are significant differences for potential choice architecture alterations and the effects of the respective nudges. For example, grocery stores can adapt the principle of nudging to a digital environment by listing sustainable products first or highlighting them in their online shop. The sales of the products can be pushed compared to non-sustainable products. However, the effects of similar measures in offline and online environments are not always comparable (Meske and Amojó 2019). Therefore, the effects of digital nudges should be evaluated separately from nudges in an offline environment.

Methodological Design of the Literature Review

The main goal of this review is to structure and organize the effects of different digital nudges for PEB. Our methodology is a structured literature review, following the guidelines of Webster and Watson (2002) and including the principles of Leidner (2018) for an organizing literature review. The focus of this review is on empirical work on digital nudging on an individual level. In comparison to other

literature reviews (Byerly et al. 2018; Henkel and Kranz 2018; Mirsch et al. 2017), we focus on digital nudging as one promising kind of incentive but broadened our scope to other research fields due to the interdisciplinary affiliation of the topic. Also, we only took digital nudging for *PEB* into account because we expected the motivation and, therefore, the outcomes for PEB compared to other use cases like healthy diet or marketing of consumer goods to be fundamentally different. Moreover, we only considered *digital* forms of nudging to control for differences that arise due to the digital vs. analog environments.

We began the literature search with journals that are included in the Basket of Eight from the IS field, and the proceedings of the two top IS conferences (International Conference on Information Systems and European Conference on Information Systems) to examine the most relevant articles in the IS research field. Due to the interdisciplinary topic, we widened our search to related research fields and included the outlets of the Financial Times 50 (FT50) journals (Ormans 2016) and the top journals from the sustainability and psychology sector (VHB 2019). In all of these research fields, digital nudging has been investigated to a greater extent compared to IS, for example, for marketing purposes (FT50), from a theoretical perspective (psychology sector), or to promote sustainable behavior changes (sustainability sector).

For the initial search, we used web of science for the journal publications, as the database covers the most relevant outlets of all of the above-mentioned research fields and outlets. For the proceedings of IS conferences and IS journals that are not included in the Basket of Eight, we used the AIS eLibrary. With this search strategy, we ensured to include more recent articles, as both topics, i.e., digital nudging and sustainability, have become more and more important in IS research in recent years. In our literature search, we included all journal articles published within the last ten years and conference proceedings from the last five years.

The search term included “(nudge* OR incentiv* OR intervent* OR behavio* change OR promot*)” to find literature that contains behavioral changes or interventions. This broad interpretation of nudging was used to ensure that all relevant literature was included because it is discussed under various terms in different research fields. This term was combined with the string “(sustainab* OR environm* OR ecolog* OR green)” to limit the results to a pro-environmental background. Finally, the string “(information system OR digit* or technolog* OR mobil* OR app* OR web*)” ensured that the nudging process was conducted in a digital environment, such as an app or on a website.

The initial search yielded 731 hits. We screened the title, abstract, and keywords of these publications. If the paper’s fit with the criteria was not clear after this screening, we read the full article to decide whether the paper would be included in the final sample. The criteria for inclusion and exclusion of a paper were as follows: First, the article examines *digital* nudging, e.g., employing a nudging mechanism with the use of e-mail notification or by implementing it within a digital booking system. In addition, no forms of monetary incentives like discounts or bonus payments are considered. Second, the paper must include an empirical study, analyzing the actual effect when a digital nudge is used compared to an effect without such a mechanism. Third, we only considered articles that use digital nudges on an individual level, meaning that no political campaigns or firm-level stimuli are considered. This scope considers that the underlying psychological effects may differ depending on whether people have to behave in a certain way due to company guidelines, political interferences, or monetary incentives compared to decisions made in a private environment. Overall, we selected 15 papers through in this process in our initial search.

We supplemented this initial search with a forward and backward search (Webster and Watson 2002), which resulted in additional 28 papers. Overall, we selected a sample of 43 research articles. Table 1 contains the search and sampling methodology details. The results of the search matrix show that the topic of digital nudging for the promotion of PEB is still scarce in the IS research field. Interestingly, most of the selected research articles were retrieved from the forward and backward search within the energy sector, where the topic has been analyzed more intensively. However, the topic is discussed

within more recent proceedings of IS conferences. This implies that attention to the potential of digital nudges and environmental research aspects within the IS research field is rising. Moreover, there is the opportunity to transfer existing knowledge from other disciplines and enrich this knowledge with socio-technical aspects.

Table 1. Search matrix

Research Field /	Search	Hits	Selected	BW/F
AIS Basket of Eight	(nudg* OR incentiv* OR intervent* OR behavio* change OR promot*) and (sustainab* OR environm* OR ecolog* OR green) and (information system OR digit* or technolog* OR mobil* OR app* OR web*)	58	1	-
IS Conferences		12	2	3
IS Journals		48	-	-
FT 50 Basket		451	5	3
Sustainability		99	4	6
Psychology		63	3	1
Energy		-	-	13
Other	Title Abstract Keywords	-	-	2
Total		731	15	28

Results

The selected research articles were analyzed according to the different kinds of digital nudges they applied. We used an inductive approach to retrieve the digital nudges from the literature and to develop the classification. Webster and Watson's (2002) respective concept matrix is attached as Table 2 in the Appendix. Overall, we found seven distinctively different classes of digital nudges that have been applied to promote PEB, namely: priming, decoy, goal setting, defaults, feedback, social comparison, and framing.

Within the classification process, we observed that the mechanisms of the digital nudges differ considerably based on their moment of application within a decision process. For example, we categorized the digital nudge priming to operate before a decision is made or an action is conducted. It is used to point out the consequences of specific behavior to a person while they evaluate different actions. Another example, setting a default can increase a consumer's possibility to pay CO₂-offsets when booking a flight (Székely et al. 2016). The default setting influences the consumer's behavior at the point where they are making decisions or when an action is conducted. In this setting, the default setting simplifies the consumer's decision-making and makes PEB more favorable.

We found that such a categorization based on the moment of application within a decision process adds an additional point of view that helps to structure the different digital nudging mechanisms and their mode of operation for behavior changes. Therefore, we followed this procedure with each of the identified digital nudges. Based on these categorizations, we developed a mapping of the digital nudges retrieved from the literature, as shown in Figure 1.

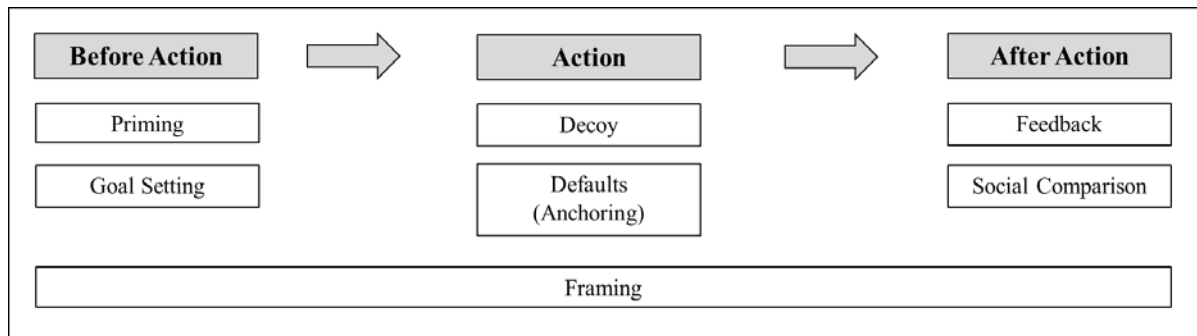


Figure 1. Digital nudging categories for PEB

Digital nudges applied before an action

The nudging mechanism called priming can be used to point out the consequences of a specific planned behavior. An individual's PEB planning requires cognitive effort because the consequences of a planned behavior need to be taken into account (Gollwitzer 1990; McDonald 2014). The desired information (for example, the amount of CO₂ emissions or the amount of unsustainable product wrapping) is provided to consumers before they make decisions by priming them. This forces them to incorporate all consequences of the action (Henkel et al. 2019; Keller et al. 2020). However, the behavioral change caused by priming works subconsciously (Blumenthal-Barby and Burroughs 2012). Although there are many ways to execute priming in a digital environment, the information used often contains certain social norms that cause certain expectations that the individuals then tend to follow in the following decision-making process (e.g., for short trips, it's better to take the train than to fly) (Gollwitzer 1990; Lindenberg 2017).

Priming has been used by media campaigns for a long time to channel the adverse effects of climate change to the public (Staats et al. 1996), but it has also been used on an individual level to promote the use of renewable energy (Momsen and Stoerk 2014) and public transportation (Lieberoth et al. 2018), energy savings (Henkel et al. 2019), and green product purchasing (Grinstein and Riefler 2015). However, the reviewed articles show mixed results for the effects of priming (Byerly et al. 2018), and priming is not statistically significant in changing the behavior for two of the studies (Henkel et al. 2019; Momsen and Stoerk 2014).

Goal setting defines a consumer's aim to accomplish a specific and planned action. The consumer will get a good feeling at achieving this goal, and therefore, goal setting can encourage behavioral change (Blumenthal-Barby and Burroughs 2012; Keller et al. 2020). For example, a PEB goal could be to commute by bike or public transportation twice a week or to use less energy compared to the previous year. The goal-setting theory has been examined and tested extensively in different IS contexts, like software project management or decision support systems. There is scientific evidence that goal setting supports an individual's focus on behavior (changes) that lead to achieving a goal (Locke and Latham 2002). Moreover, goal setting leads to higher persistence and encourages individuals to develop behavioral strategies that lead to achieving a set goal (Keller et al. 2020; LaPorte and Nath 1976; Wood 1990).

Although goal setting is a promising approach (Byerly et al. 2018), we found mixed results for this digital nudging mechanism. Lieberoth et al. (2018) have successfully used different nudges, including digital goal-setting nudges, to promote public transportation. Loock et al. (2013) have analyzed how different default goals affect residents' energy use and found default goal settings to have a significant effect on promoting energy saving. Brandsma and Blasch (2019) have examined goal-setting mechanisms to reduce water and energy use, but they found mixed effects, except when inducing additional monetary incentives. Finally, Han et al. (2013) did not find any significant effects on energy savings induced by goal-setting mechanisms.

Digital nudges applied during an action

Introducing a decoy as one choice can also be used to nudge PEB. When presenting two or more choices—and none of the presented alternatives is clearly better than the other(s)—it is often difficult for consumers to choose. For example, if two products can differ in their price and sustainability, and choice (a) is cheaper and not sustainable, but choice (b) is more expensive but sustainable, objectively, neither of the two options is better than the other. However, by introducing option (c), which is sustainable and dominated by option (b) in its price, consumers tend to choose the desired option (b) because it is a better choice than option (c) (Ariely and Wallsten 1995). Momsen and Stoerk (2014) tested this digital nudge to promote renewable energy tariffs by introducing a decoy tariff that acted in favor of the sustainable option. However, they did not find statistically significant results.

Setting defaults preselects the most desired alternative for the respective situation and influences the presentation of different choices for consumers. Consumers who want to choose differently have to make an active change by opting out of the preselected option. Hence, sticking to the default option requires the least time and effort for an individual to decide (Blumenthal-Barby and Burroughs 2012). Moreover, defaults serve as an implicit recommendation (Johnson and Goldstein 2003; Keller et al. 2020). This leads to a higher probability of a favorable evaluation and sticking to the default, especially when the decision requires difficult considerations of money, personal values, and societal norms. (Gollwitzer 1990; Henkel et al. 2019). All of the reviewed articles that used defaults as a nudge reached a significant increase in favor of PEB. This indicates how effective default settings are. Defaults have been used to promote green online product purchases (Taube and Vetter 2019) or towel reuse by tourists (Theotokis and Manganari 2015), and to promote the purchase of renewable energy tariffs (Ebeling and Lotz 2015) and energy savings (Loock et al. 2013).

Székely et al. (2016) used default settings to successfully encourage carbon offset payments for flight bookings and combined default settings with anchoring. Anchoring describes the evaluation process in a choice decision, where the initial information serves as an anchor for further evaluation (Tversky and Kahneman 1974). Therefore, anchoring describes different variations of default settings. In their study, Székely et al. (2016) showed that the amount of CO₂ offset payments is positively related to the preselected default option.

Digital nudges applied after an action

A Feedback nudge makes a behavior explicit to an individual after their action or choice, for example, how much water has been used for showering or how much gas has been used for their last trip. Providing feedback can help to understand and reflect on behavior or provide information for similar situations in the future (Froehlich et al. 2010; Gollwitzer 1990). Therefore, feedback is especially useful for behavior whose consequences are either intangible or unknown to many people, such as the overall CO₂ emissions of commuting in a private car every day. Providing information about the sustainability of these behaviors as feedback helps consumers learn about and reflect on their actions (Buchanan and Russo 2019). Besides the digital nudging process itself, feedback can differ in the way the information is provided to consumers regarding the information itself, e.g., the used metrics or granularity; the display of the feedback, like the medium or style of the information; or the timing of it (Sanguinetti et al. 2018). This means that the effect of the feedback may differ when a person receives a message with the amount of money saved compared to a message with the amount of CO₂ or kWh saved.

Feedback as a digital nudge has been used in different contexts, especially for reducing energy and water use for residents or fuel savings for private cars. Almost all reviewed research articles confirmed the positive effects of this digital nudge (Brandsma and Blasch 2019; Emeakaroha et al. 2014; Graham et al. 2011; Karlin et al. 2015; Lossin et al. 2016; Sanguinetti et al. 2020; Tiefenbeck et al. 2018; Tiefenbeck et al. 2019; Willis et al. 2010) except Nilsson et al. (2014). The positive effects of digital feedback from Degirmenci and Recker (2018) to reduce paper printing in a university and from

Tussyadiah and Miller (2019) to reduce water and energy use by tourists are especially interesting because both treatment groups had no motive for financial savings when acting pro-environmentally.

Inducing the digital nudge of social comparison is one way to amplify feedback to consumers where consumers receive additional information regarding the consumption level of peers or consumption norms. The consumer can make an easier evaluation and can be provided an orientation for the planning of similar future actions (Keller et al. 2020). Examples include the distance friends commuted by bike (Wunsch et al. 2015) or the number of public transportation trips traveled by colleagues (Lieberoth et al. 2018). Comparing own behavior to that of others can have a strong influence on personal behavior and, therefore, can have a positive impact (Blumenthal-Barby and Burroughs 2012). Overall, digital nudging using social comparison has led to mixed effects in previous studies. Whereas there have been significant effects in water and energy savings, as well as an increase in bike commuting (Ferraro and Price 2013; Grønhøj and Thøgersen 2011; Wunsch et al. 2015), there is also evidence that initial effects cannot be sustained beyond the experimental phase (van Dam et al. 2010; Wemyss et al. 2019) or no significant effect at all (Buchanan and Russo 2019; Han et al. 2013; Momsen and Stoerk 2014).

Overarching digital nudges

All digital nudges aim to initiate behavioral changes by altering the choice architecture at a certain stage of the decision process, but framing can be applied at all stages. It is used not only as a single nudge but is often combined with others to amplify the desired outcomes. Framing can be defined as “highlighting specific aspects and making [the messages] more salient in communication” (Amatulli et al. 2019, p. 3). Framing as a nudge goes back to Tversky and Kahneman (1981) and describes how an alternative choice is presented in regards to a consumer’s reference point(s). Reference points can include the consumer’s wealth, norms, comparison to other people, or symbolic features. For example, framing is used by Dahlinger et al. (2018a) to frame feedback on people’s driving behavior. They compared the differences in the effects of numerical vs. symbolic feedback, i.e., framing feedback explicitly through numbers or more implicitly through symbols as reference points.

Overall, framing did show significant effects for most reviewed articles for all stages of the decision-making process. Huber et al. (2019) and Grinstein and Riefler (2015) successfully applied goal- and priming-framing to optimize smart charges. Amatulli et al. (2019) and Demarque et al. (2015) found effects by framing information on the sustainability of products in an online shopping environment. Common methods for digital nudging after an action is gain vs. loss framing, meaning that the consumer’s behavior is evaluated from different perspectives (Chang et al. 2015; Ghesla et al. 2020) or symbolic instead of concrete feedback for sustainable behavior (Dahlinger et al. 2018a; Dahlinger et al. 2018b).

Discussion

With this structured literature review, we provide a synthesis of the current knowledge on digital nudges that promote PEB on an individual level. The results show that digital nudges that are applied before an actual action appear to be the least effective. Many studies that apply nudges at this stage show either no or mixed effects for the promotion of PEB. The digital nudges that operate before an actual action are priming and goal setting. Overall, neither digital nudge showed significant effects in behavioral changes.

Priming nudges aim to cause behavioral change subconsciously (Blumenthal-Barby and Burroughs 2012) by explicitly pointing out the consequences of a particular action (Gollwitzer 1990). However, this mechanism is often too weak to cause significant changes in the actual action. For studies where priming did show an effect, it was combined with other digital nudges that operated during or after an action (Grinstein and Riefler 2015; Lieberoth et al. 2018). This affirms that priming in digital environments itself cannot cause behavioral changes by subconscious influences. Moreover, the digital

goal-setting nudges are not sufficient to form goal intentions and initiate further PEB planning (Gollwitzer 1990). However, combining goal setting with other digital nudges that act during an action, such as defaults, showed significant effects (Loock et al. 2013). Therefore, further research should empirically analyze which combinations of digital nudges that operate before an actual action have the most substantial effects on behavioral changes.

Almost all empirical studies reported significant effects for digital nudges in the promotion of PEB that operate during an action. Defaults support the unconscious transition from goal intentions into actions toward goal achievement (Keller et al. 2020). Inducing default settings has also proven to be very effective for making behavioral changes in an offline setting or in a digital environment in other contexts, such as promoting healthier lifestyle choices (Vlaev et al. 2016). Overall, digital default settings have been widely applied and tested and are highly promising for promoting PEB. However, combining digital defaults with anchoring is still an under-researched topic and needs further empirical investigation. Using a decoy as a digital nudge has only been applied in one study. According to the results reported by Momsen and Stoerk (2014), introducing a decoy could not induce PEB. Introducing a decoy should make it easier to choose a potential action. However, decoys may have too little influence on the decision-making process. Further investigation of this topic could yield interesting insights into the application of decoys to promote PEB.

According to our findings, digital nudges that predominantly operate after an action show positive effects on PEB changes. At this stage of the decision process, feedback and social norms were applied in the literature, and - based on our findings - feedback combined with social comparison is one of the most effective digital nudges. Apparently, peer pressure and the influences of social norms regarding PEB can positively influence consumer behavior for repeated everyday tasks by supporting the evaluation process of previous actions (Keller et al. 2020). However, this has mainly been represented in the context of energy and water savings and for eco-driving, and positive effects can often not be sustained after a specific time frame. Therefore, digital feedback and social comparison nudges should be examined in greater detail in other contexts, such as green product purchases, with a focus on long-term effects that can induce sustainable, pro-environmental habit formation.

This study contributes to IS research in various ways. First, we structured the dispersed knowledge on digital nudges for PEB by organizing the findings of the extant literature on this topic. This is vital because digital nudging, in general, is a promising approach to changing individual behavior (Henkel et al. 2019; Meske and Amojó 2019; Weinmann et al. 2016), but based on the findings of our literature review, not all methods of digital nudging for PEB could achieve the desired outcome. Second, the structure of the different digital nudges according to their moment of application within a decision process helps to examine which digital nudges can be effectively combined and whether some combinations may even be counterproductive. Sensible combinations of digital nudges that operate before, during, and after a decision or an action provide an ideal basis for inducing not only selective behavioral changes but long-term PEB effects (Gollwitzer 1990). Third, our organized review can be used as a blueprint for other incentive mechanisms or other contexts. For example, monetary incentives like subsidies or purchase bonuses for PEB changes could be marketed more effectively with a better understanding of the psychological mechanisms that are triggered by such campaigns. Moreover, our findings could be examined and adapted for digital nudging in other contexts, such as healthy food choices (Wilson et al. 2016) or ethical behavior changes, such as donations (Zarghamee et al. 2017).

This study also provides practical implications for politics and for providers of pro-environmental services like public transportation or renewable energy tariffs. On the one hand, our findings on the effects of digital nudges can be used to make PEB less complicated for consumers. It can therefore increase their usage. For instance, designing apps that consider digital nudges can help to pick energy tariffs that use renewable energy sources. On the other hand, a deeper understanding of digital nudging for PEB helps to increase the effectiveness of political measures and can be deployed to support environmental campaigns or to support other incentives to amplify their effects, for example, monetary

incentives. Overall, our study aims to find better solutions to harmful societal problems with the use of IS.

Our study is subject to certain limitations. First, the search and literature covered may not include all relevant research articles due to restrictions in our keywords and outlets. Moreover, we covered only the last ten years of journal publications and the last five years of conference proceedings. Second, we focused on empirical investigations of digital nudging. Therefore, other studies that covered the topic from a different angle, such as theoretical approaches, may not be included in our sample. Hence, future work could uncover other aspects of digital nudging for PEB with a different scope or perspective on the extant literature.

For future research, an empirical examination of the presented findings will be needed to isolate the single steps and gain further understanding of digital nudging mechanisms. Also, following the principles of Hong et al. (2014), we expect differences in the effects of digital nudges based on the research and underlying decision context. For example, Stryja et al. (2017) report that priming positively affects the adaption of pro-environmental innovations in the context of e-vehicles. In contrast, Henkel et al. (2019) did not find evidence for the effects of priming in an experimental study in the context of energy savings. Moreover, it remains unclear whether monetary incentives and digital nudges should be used in combination. The findings of Sudarshan (2017) imply that the effects of monetary incentives almost entirely remove the positive effect of nudges for energy savings. Therefore, contextualizing the presented findings to define context-sensitive mechanisms of digital nudging will generate a more detailed perspective to promote PEB.

Overall, this review contributes to a deeper understanding of IT-enabled behavioral changes that tackle environmental problems. In the course of our research, we organized and analyzed 43 articles on digital nudges toward PEB. Our literature review affirms that digital nudges can be an effective instrument to induce such PEB changes. However, the results also show that there are essential distinctions in the effects of digital nudges that need to be considered.

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Appendix

In the course of our literature review, we identified seven distinctively different classes of digital nudges that have been applied to promote PEB, namely, **priming**, **decoy**, **goal setting**, **defaults**, **feedback**, **social comparison**, and **framing**. According to the principles of Webster and Watson (2002), we constructed a concept matrix to categorize and organize our findings (see Table 2).

Table 2. Concept Matrix

Author(s)	Digital Nudges							Effective
	Priming	Goal setting	Default	Decoy	Feedback	Social comparison	Framing	
Amatulli et al. (2019)							x	yes
Aydin et al. (2018)					x			yes
Brandsma/Blasch (2019)		x			x		x	mixed
Buchanan/Russo (2019)					x	x	x	no
Byerly et al. (2018)	x	x	x		x		x	mixed
Chang et al. (2015)					x		x	yes
Dahlinger et al. (2018)					x		x	mixed
Dahlinger et al. (2018)					x		x	yes

Degirmenci/Recker (2018)					x	x		yes
Demarque et al. (2015)							x	yes
Doran et al. (2017)						x		mixed
Ebeling/Lotz (2015)			x					yes
Emeakaroha et al. (2014)					x			yes
Ferraro/Price (2013)						x		yes
Ghesla et al. (2020)							x	yes
Graham et al. (2011)					x			yes
Grinstein/Riefler (2015)	x						x	mixed
Grønhoj/Thøgersen (2011)					x	x		yes
Han et al. (2013)		x			x	x		mixed
Henkel et al. (2019)	x		x					mixed
Huber et al. (2019)							x	mixed
Jain et al. (2013)					x		x	yes
Karlin et al. (2015)					x			yes
Kronrod et al. (2012)					x		x	yes
Lieberoth et al. (2018)	x	x			x	x		yes
Loock et al. (2013)		x	x		x			yes
Lossin et al. (2016)					x			yes
Momsen/Stoerk (2014)	x			x		x	x	mixed
Nilsson et al. (2014)					x			no
Sanguinetti et al. (2020)					x			yes
Schultz et al. (2016)					x	x		yes
Székely et al. (2016)			x					yes
Taube/Vetter (2019)			x					yes
Theotokis/Manganari (2015)			x					yes
Tiefenbeck et al. (2018)					x			yes
Tiefenbeck et al. (2019)					x			yes
Tsirimpa et al. (2019)					x			yes
Tussyadiah et al. (2019)					x			yes
van Dam et al. (2010)					x	x		mixed
Vassileva et al. (2013)					x	x	x	mixed
Wemyss et al. (2019)					x	x		yes
Willis et al. (2010)					x			yes
Wunsch et al. (2015)	x				x	x		yes

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