5-11-2023

How to increase sustainable engagement in the workplace through green IS: the role of instructional and motivational design features

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HOW TO INCREASE SUSTAINABLE ENGAGEMENT IN THE WORKPLACE THROUGH GREEN IS: THE ROLE OF INSTRUCTIONAL AND MOTIVATIONAL DESIGN FEATURES

Complete Research

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Abstract

Research on green IS has emphasized the value of both instructional and motivational elements in supporting sustainable behavior at work. However, there is still a lack of understanding of these different feature types' individual roles and relevance in inducing sustainable employee behavior. Our study addresses this gap and investigates the use and effects of different instructional and motivational elements in a green IS through a field study with 92 employees in five companies. Our findings based on the analysis of behavioral data show that instructional elements are more relevant in invoking sustainable behavior, but motivational elements can amplify the positive influence of instructional elements, in particular for long-term user engagement. We contribute to theory and practice by revealing the role of instructional and motivational elements in the successful design of green IS for sustainable employee behavior.

Keywords: Green IS, Sustainable behavior, Sustainable employee behavior, Motivation, Learning, Gamification

1 Introduction

The world is in a mood for change. Since the United Nations General Assembly (2015) introduced the Sustainable Development Goals (SDGs) as a guide to a sustainable future nearly a decade ago, research and practical efforts to achieve these goals have gained momentum (Pizzi et al., 2020). As companies are critical actors in society's movement toward sustainable development, research from information systems (IS) and management perspectives has to come together to explore how digital technologies can support the transition to sustainable operations at strategic and operational levels (Brocke et al., 2013; Melville, 2010; R. T. Watson et al., 2021). While the use of strategic IS to calculate and identify the potential to reduce a company's carbon emissions is undoubtedly valuable (Loos et al., 2011; Roohy Gohar and Indulska, 2020), the implementation of efforts to realize this potential is largely dependent on employee participation and engagement (Kim et al., 2017). Employee behavior has been shown to have a significant impact on a company's sustainability performance (Y. Chen et al., 2015; Paillé et al., 2014), and IS can serve a pivotal role to promote individual sustainability behavior (Elliot, 2011; Melville, 2010). To this end, increasing attention is being paid to the use of so-called *green IS* (Brocke et al., 2013; El Idrissi and

Corbett, 2016) to support and encourage sustainable employee behavior in the workplace (Corbett, 2013; Seidel, Recker, and Brocke, 2013).

The features of green IS to promote sustainable behavior in the workplace can be broadly divided into instructional and motivational elements. *Instructional* elements primarily aim to communicate knowledge about sustainability to employees. In their simplest form, instructional elements can be intranet pages with information on sustainability (Jenkin, McShane, and Webster, 2011) or online courses on specific sustainability topics (Hsu and M.-C. Chen, 2021). More advanced instructional elements may include company-wide eco-dashboards of sustainability metrics (Ivan et al., 2017), individual energy consumption statistics (Spence et al., 2018), or daily tips for sustainability (Casado-Mansilla et al., 2020; Hillebrand and Johannsen, 2021). *Motivational* elements, on the other hand, primarily aim to increase the personal relevance and experience of sustainable behavior and to support the motivation to act. These can include, for example, persuasive feedback and positive reinforcement of sustainable behavior in the workplace (Castelli et al., 2015; Khosrowpour et al., 2018; Spence et al., 2018) or goal setting of individual sustainability goals to pursue within a specific timeframe (C.-m. Loock, T. Staake, and Thiesse, 2013; Spence et al., 2018; Wörner and Tiefenbeck, 2018). In particular, green IS also use gamification elements as motivational elements to promote personal relevance. Such *gamified IS* combine instructional elements with motivational elements borrowed from games. For instance, to increase relevance through social interaction, gamification elements can include competitions between employees or teams of employees (Corbett, 2013; Hillebrand and Johannsen, 2021; Iria et al., 2020; Ro et al., 2017), often in combination with incentives. As another example, playful narratives (Oppong-Tawiah et al., 2020; Seidler et al., 2020) can illustrate the impact and pertinence of individual behavior.

However, when it comes to evaluating the impact of green IS, studies fall short in considering the influence of the different elements used. Green IS that include both types of elements are evaluated as a whole, disregarding specific motivational or instructional elements and their relative impact on measured outcomes (Iria et al., 2020; Kaselofsky et al., 2020; Oppong-Tawiah et al., 2020; Ro et al., 2017). Looking at the use and relative influence of instructional and motivational elements in green IS on sustainable employee behavior, though, yields valuable insights into how such systems can best be designed to help employees engage in sustainable behavior. An investigation of this kind promises valuable implications both for further research on green IS to promote sustainable employee behavior and for the practical design and use of such systems in companies to increase sustainable behavior among their employees.

Hence, the primary goal of this work is to *analyze the use and effects of instructional and motivational elements on sustainable employee behavior*. Drawing on a green IS that contains both instructional and motivational elements, we investigate the following research question:

RQ: How do instructional and motivational elements in a green IS influence sustainable employee behavior?

This work progresses as follows. In the next section, we present relevant previous work on green IS and particularly instructional and motivational elements in green IS. Afterwards, we derive hypotheses and a research model for our quantitative study, whose method is described in section 4. Section 5 reports on the results of our analyses, followed by a discussion and implications (6) and limitations and outlook (7).

2 Theoretical background

2.1 Green IS

While the topic of sustainability has gained importance in management research as early as the 1990s, the role of IS in supporting sustainable development has long been neglected (Melville, 2010). Now that leading research associations such as the Association for Information Systems (AIS) have emphasized the relevance of IS as a key tool for addressing sustainability (Seidel, Bharati, et al., 2017; R. T. Watson et al., 2021), interest in so-called *green IS* (Brocke et al., 2013; Melville, 2010) has increased in recent years. In contrast to the *green IT* view, which is mainly concerned with the environmental impact of information

technology in terms of its energy consumption and carbon emissions and how to avoid them (Dedrick, 2010), the green IS view looks at the potential of IS to change other processes such as transportation or industrial production towards a more sustainable way (Dedrick, 2010; Loos et al., 2011; Roohy Gohar and Indulska, 2020).

This potential also includes changes in individual work practices and beliefs (Brocke et al., 2013), a perspective in green IS research that has gained increasing attention (El Idrissi and Corbett, 2016). Green IS have been shown to influence pro-environmental behaviors at multiple levels: At the micro level, green IS can support individual behavioral changes (Henkel and Kranz, 2018), such as energy consumption (C. M. Loock, T. S. Staake, and Landwehr, 2011; Wörner and Tiefenbeck, 2018), sustainable transport choices (Lembcke et al., 2021), or ecological consumption (Berger, Nüske, and Müller, 2020). At the macro level, green IS can influence collective organizational and societal practices (Henkel and Kranz, 2018). For example, (Hedman and Henningsson, 2016) shows in a case study that some leading individuals enable transformative bottom-up processes that bring green IS onto the organizational agenda. As another example, Henkel, Kranz, et al. (2017) explored how green IS influence individual reconsideration of sustainability beliefs and foster organizational learning, ultimately leading to a shift in organizational culture and strategy toward sustainability.

2.2 Instructional and motivational elements in green IS

Green IS use a variety of different affordances to induce behavior change. On the instructional side, options include intranet pages with information on sustainability (Jenkin, McShane, and Webster, 2011) or online courses on specific sustainability topics (Hsu and M.-C. Chen, 2021), but also providing information content in the form of dashboards (Hsu and M.-C. Chen, 2021) or tips and reminders (Casado-Mansilla et al., 2020; Hillebrand and Johannsen, 2021).

However, green IS also often use motivational elements to further increase engagement in sustainable behaviors. For example, studies have shown that real-time feedback (Ableitner et al., 2018; Tiefenbeck et al., 2018) can significantly reduce individuals' energy consumption, and nudging (Henkel, Seidler, et al., 2019) can affect whether people opt for a more ecological choice, especially when the default option is changed. The importance of setting one's own goals (Wörner and Tiefenbeck, 2018) and the supportive role of incentives (Lossin et al., 2016) in reducing resource consumption have also been highlighted. In particular, gamification elements have been used as motivational elements in green IS. Gamification can be understood as a process of using gameful affordances to make systems more enjoyable and motivating in order to support the utilitarian or otherwise beneficial outcomes of the system (Koivisto and Hamari, 2019; Köse, Morschheuser, and Hamari, 2019). Such gameful affordances can be points, levels and badges, but also competitions, quests or narratives (Koivisto and Hamari, 2019). For example, emotional feedback in the form of a growing tree and competitive feedback in the form of a leaderboard (motivational elements) can support normative information about ecological behavior (instructional element) (Seidler et al., 2020). As another example, the green IS of Oppong-Tawiah et al. (2020) demonstrates that information and tips on personal energy consumption (instructional elements) can be aligned with the narrative of a virtual garden that evolves as a function of employee energy performance (motivational element) to significantly reduce employee energy consumption. As a final example, the KlimaKarl application (Hillebrand and Johannsen, 2021) combines daily tips for sustainable behavior in the workplace and concrete action tasks (instructional elements) with individual and team rankings and team challenges, the achievement of which results in the company donating money to green projects (motivational elements).

In summary, previous research shows that both instructional and motivational elements, when employed in green IS, can help shape employee behaviors towards sustainability. However, there is still a lack of understanding of the individual role of instructional and motivational elements in eliciting such behaviors. Green IS have primarily been evaluated as a whole, neglecting specific motivational or instructional elements and their relative influence on measured outcomes (Iria et al., 2020; Kaselofsky et al., 2020; Oppong-Tawiah et al., 2020; Ro et al., 2017). However, examining the *relative* influence of instructional

and motivational elements in green IS on sustainable employee behavior can provide valuable insights into how such systems can best be designed to help employees engage in sustainable behavior.

3 Hypotheses

Based on the review of previous research, we argue that both instructional and motivational elements in green IS have proven their raison d'être in influencing sustainable behavior in the workplace. However, it remains to be explored how they *interplay* when it comes to shaping employee behavior toward sustainability. Specifically, although both elements may have a positive impact on sustainable employee behavior, their relative importance might differ. Understanding their interaction could contribute significantly to advancing knowledge of how green IS can best be designed to help employees engage in sustainability in the workplace. Thus, to examine the relative importance of these elements in influencing sustainable employee behavior, we consider their impact on performed sustainability actions in a green IS as a reflection of actual sustainable behavior of employees. We argue that both elements, which have been shown to be effective in prior research, can positively influence employees' sustainability actions. However, to address the research gap, we focus specifically on the strength of their impact.

First, instructional elements primarily serve to educate employees about sustainable behaviors they can perform in the workplace. As such, they can both promote awareness of the need for sustainable behavior and attribute responsibility to employees, which according to the norm activation model and value-belief-norm theory are crucial norm-based determinants of sustainable behavior (Schwartz, 1977; Stern, 2000). Also, instructional elements can help build self-efficacy, i.e., the belief that one can perform a certain behavior (Bandura, 1982), as an individual determinant of sustainable behavior (Ajzen, 1991). Specifically, this applies to utilitarian elements such as quantification of behavior on dashboards, which can support self-monitoring and promote confidence in behavior change. Therefore, backed by previous research that has incorporated instructional elements into the design of green IS (Casado-Mansilla et al., 2020; Hsu and M.-C. Chen, 2021; Ivan et al., 2017; Spence et al., 2018), we argue that instructional elements can positively influence sustainability actions performed by employees. Consequently, we hypothesize the following:

H1: *Instructional elements positively influence performed sustainability actions*

Second, motivational elements are intended to elicit positive psychological outcomes in behaving sustainably. Specifically, elements such as goal setting can promote employees' psychological need for autonomy (Ryan and Deci, 2000) and, according to goal setting theory, promote sustainable behavior by dividing the broad subject into clear and relevant objectives (Locke, 1968). Real-time feedback and progress in a point system can also satisfy the need for competence (Ryan and Deci, 2000) and thus promote intrinsic motivation for sustainable behavior. In addition, social motivational elements such as competitions, teams, and leaderboards can foster feelings of relatedness (Ryan and Deci, 2000) and trigger upward social comparisons that lead to increased commitment to behavior change (Festinger, 1954). Thus, supported by previous research that has used motivational elements in the design of green IS (Ableitner et al., 2018; Castelli et al., 2015; Henkel, Seidler, et al., 2019; Hillebrand and Johannsen, 2021; Oppong-Tawiah et al., 2020; Seidler et al., 2020; Tiefenbeck et al., 2018; Wörner and Tiefenbeck, 2018), we argue that motivational elements can positively influence sustainability actions performed by employees. Therefore, we put forward the following hypothesis:

H2: *Motivational elements positively influence performed sustainability actions*

Finally, motivational elements may amplify positive effects of instructional elements. Goal framing theory states that motivational elements which support hedonic experiences in sustainable behavior can reinforce the normative goal frame induced by instructive elements by satisfying the hedonic goal frame (Lindenberg and Steg, 2013). While there are few studies examining the interaction of instructional and motivational elements in green IS, a recent experiment has shown that green IS with both instructional *and* motivational elements seem to have more impact on the utilitarian purpose (in this case, sustainable behavior) as opposed to instructional elements alone (Seidler et al., 2020). Therefore, we argue for an

interaction effect of instructional and motivational elements in influencing sustainability actions performed by employees and hypothesize the following:

H3: *There is a positive interaction effect between instructional and motivational elements in influencing performed sustainability actions*

The research model to be examined in this study based on the hypotheses is shown in Figure 1. Because interactions between two independent variables can be equivalently understood as one variable moderating the relationship between the other independent variable and the dependent variable (Andersson, Cuervo-Cazurra, and B. B. Nielsen, 2014; McClelland and Judd, 1993), we modeled the interaction effect as moderation (H3).

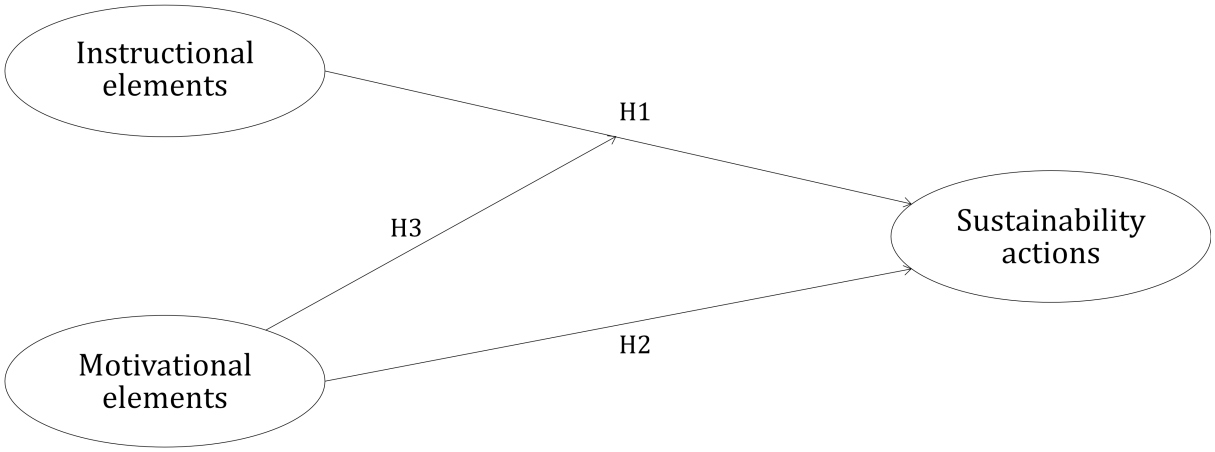

Figure 1. Research model with hypotheses.

4 Research method

4.1 Materials

To investigate the influence of instructional and motivational elements on engagement with a green IS to promote sustainable behavior in the workplace and the impact on employees' sustainability actions in their everyday work, we used the Greenify.work app. The Greenify.work app was developed as part of a design science research project (Krath, 2021; Krath, Morschheuser, and Korflesch, 2022) and contains both instructional and motivational elements to support employees in sustainable behaviors in the workplace. The main *motivational elements* of the Greenify.work app align with motivational elements in previous work on green IS, such as setting clear and relevant goals, enabling self-set goals and freedom of choice, providing immediate positive feedback, allowing self-monitoring, and facilitating social comparison. Specifically, gameful affordances such as points, levels, leaderboards, and badges are also used as motivational elements.

1. Goal setting: employees can set goals that they want to pursue, which is especially important for breaking down the complex topic of sustainability into tangible and achievable steps. The proposed goals are framed in such a way that their relevance and impact for sustainable development are clear, which is an essential prerequisite for them to be perceived as desirable (Krath, Schürmann, and Korflesch, 2021). To allow freedom of choice, the system is developed in a way that employees can choose in which area of sustainability they want to achieve goals and whether they want to be engaged on an individual level, through cooperation or competition (see Figure 2(a)).

2. Feedback on goals and individual progress: employees can immediately see the impact of their sustainability actions on the goal detail pages in a progress bar (see Figure 2(b)). In addition, employees

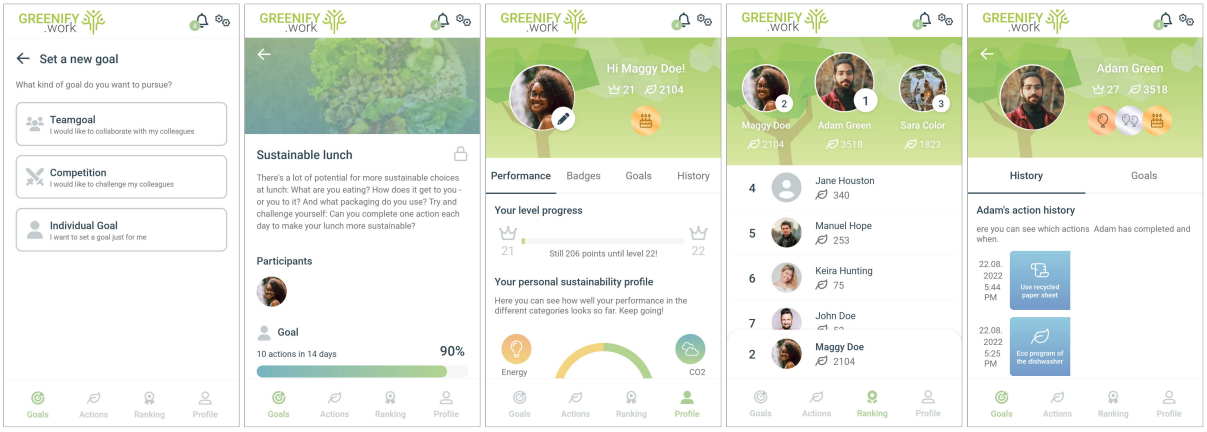

Figure 2. Motivational elements in the Greenify.work app: (a) goal selection in the goal setting process; (b) goal detail page with progress illustration; (c) personal profile with progress illustration; (d) leaderboard with top 10 for upwards social comparison; (e) colleague's profile with information and badges for social comparison and social status.

can self-monitor their individual progress across goals in their profile, which uses total points and levels to quantify sustainability performance over different categories and goals (see Figure 2(c)).

3. Social comparison: allowing employees to see how their peers are performing is considered an important driver of self-efficacy (Krath, Schürmann, and Korflesch, 2021). In particular, *upward comparisons* can be supportive of motivation (Festinger, 1954), so the leaderboard (see Figure 2(d)) is designed to display only the top 10 to allow for upward comparisons, but omits negative social effects toward poorly performing employees. For direct social comparison, employees can receive badges, equip them in their profile, and see the profiles of their peers (see Figure 2(e)) as well as their participation in joint goals, which provides a means of social status and recognition.

The main *instructional elements* of the Greenify.work app include guiding users with personalized content and persuasive messages, similar to previous studies that used tips and reminders, and delivering informational content on sustainability at work.

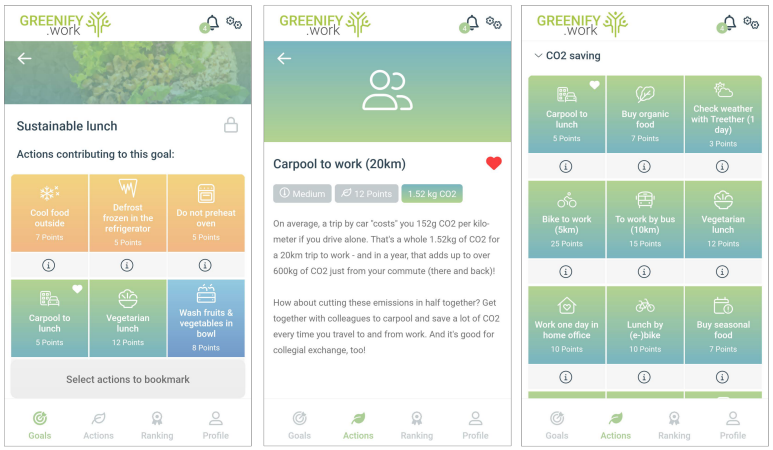

Figure 3. Instructional elements in the Greenify.work app: (a) personalized recommendations for sustainability actions to achieve a goal; (b) detailed information page of an action that explains its relevance and the impact of individual behavior on sustainability; (c) information on all actions that can contribute to sustainability at work.

1. Path to the goal: after selecting a goal, employees receive personalized recommendations for sustainability actions that contribute to achieving that goal (see Figure 3(a)). This is especially important to guide them on how they should behave to achieve sustainability goals.
2. Detailed informational content: providing informational content on actions that can contribute to sustainability (see Figure 3(c)), and that explains why a particular action is relevant to sustainability and how and to what extent it contributes to sustainability in the workplace (see Figure 3(b)) is important for fostering the experience of the relevance of individual behavior and learning how behavior relates to goals.
3. Personalized reminders and cues: employees receive regular sustainable action tips as push notifications beyond the app to remind them of their goals, even if they are not actively using the app at the time, as a form of persuasive messages.

4.2 Participants

The Greenify.work app was introduced in five different companies and made available to employees over a period of two months. Due to the content focus of the app, employees were targeted who work in administrative, strategic or operational areas and whose main workplace is an office (rather than a production facility or a completely outsourced site).
Participating companies were diverse in terms of their operations and size. Company A was a medium-sized (± 400 employees) industrial software provider, Company B was a small (± 25 employees) media agency, Company C was a medium-sized (± 150 employees, out of them ± 25 office employees) glass manufacturing company, Company D was a medium-sized (± 280 employees) engineering firm, and Company E was a small (± 30 employees) social media agency, all based in Germany.
A total of 92 employees participated in the field study, with small companies (and the small target group of company C) achieving a participation rate of 26-56% of all employees and the larger companies achieving a participation rate of 8-9.6% of all employees (distribution shown in Table 1). In view of the protection of personal data, no further employee demographic data was collected when registering for participation.

Company	Company A	Company B	Company C	Company D	Company E
Type	Industrial software provider	Media agency	Glass manufacturer	Engineering	Social media agency
No. of employees	± 400	± 25	± 150 (± 25 in office)	± 280	± 30
Participants	32	11	14	27	8
Participation rate	8%	44%	56%	9.6%	26.7%

Table 1. Participating companies and participation rates.

4.3 Data collection and variable operationalization

Log data of participants using the Greenify.work app was collected over a period of two months. This involved tracking each click within the app along with a pseudonymous user ID and timestamp. Clicks included, for example, clicking on a goal detail page, clicking on the ranking tab with the leaderboard, or clicking on the profile tab with one's profile. Each log was stored in a NoSQL database with an ID and a predefined identifier (like SEE_PROFILE).
A total of 10,184 logs were collected from the 92 participants. The database for the study of the independent variables *instructional elements* and *motivational elements* consists of a subset of 4,648 logs. Both variables were operationalized by taking the sum of each user's logs related to the use of the main instructional and motivational elements of the Greenify.work app (see Section 4.1). In addition to these logs, the sustainability actions performed by the participants (i.e., the actual execution of the actions suggested

in the app, e.g., "Turn off the lights before you leave work") were logged for each user. There was no additional control on this logging, i.e., participants self-reported whether they had performed an action without external verification. However, because actions performed by colleagues were displayed on their profiles, there was a form of social control against cheating if participants recorded unrealistic actions (e.g., that they ate vegetarian meals 15 times in one day). A total of 3,971 actions were logged during the study period, operationalizing the dependent variable *sustainability actions*.

4.4 Data analysis

The process of data analysis initially included descriptive analysis of overall engagement with the green IS and sustainability actions performed, as well as the use of various motivational and instructional elements in the app. From the descriptive data, initial conclusions could be drawn about overall usage dynamics and the role of instructional and motivational elements.
Second, to test hypotheses H1-H3, a linear regression analysis (with sustainability actions as dependent variable) was conducted. To ensure that the linear regression results were reliable, we systematically checked the prerequisites for linear regression (Casson and Farmer, 2014; Ernst and Albers, 2017) for the analysis:

1. **Linear relationship between predictors and independent variable:** using the curve estimation function in IBM SPSS Statistics 26, we found that linear functions reflected the relationship between the predictors (instructional and motivational elements) and the dependent variable (sustainability actions) very well.
2. **Independence of residuals:** the Durbin-Watson (DW) statistics for the regression analysis showed that there was no autocorrelation of the residuals, since DW value (DW: 1.742) lied between $d_u = 1.73$ and $4 - d_u = 2.27$ for a sample size of 92 with 3 predictors (Durbin and G. S. Watson, 1992).
3. **No multicollinearity:** we checked the VIF and tolerance values for all predictors in the linear regression, indicating that multicollinearity was not a problem (VIF < 10, tolerance > 0.1 (Hair et al., 1995; Neter, Wasserman, and Kutner, 1989)).
4. **Homoscedasticity of residuals:** scatterplots of studentized residuals against predicted values showed clear cone patterns, indicating heteroscedasticity (Ernst and Albers, 2017) and the need for a more robust regression approach.
5. **Normality of the residuals:** Q-Q plots and significant Shapiro-Wilk tests of the residuals indicated a lack of normality of the residuals, underscoring the need for a more robust regression approach (note that the predictors and independent variables themselves do not need to be normal distributed, only the residuals (Casson and Farmer, 2014; Ernst and Albers, 2017)).

Based on the preliminary analysis, we concluded that although linear regression seemed appropriate for linear relationship analysis, we needed a more robust approach than IBM SPSS Statistics 26 ordinary least squares regression, which was not as sensitive to violations of homoscedasticity and normality. Therefore, we decided to supplement the linear regression performed by bootstrapping with 1,000 samples, a well-known approach for more robust regression analyses (Fox, 2015), to test the hypotheses.

5 Results

5.1 Descriptive analysis

In terms of engagement with the green IS and sustainability actions performed, descriptive statistics show that employees used the IS for $M_t = 1,079s$ (18min), $MD_t = 750s$ (12min), $SD_t = 998s$ (17min), indicating a rather uneven distribution due to high standard derivation and skewness, as the median is much lower than the mean. A more detailed analysis shows that the distribution is highly tail-heavy, with the top 10% of users engaging with the IS for $M_t = 3,299s$ (51min), $MD_t = 3,205s$ (49min), $SD_t = 643s$ (13min),

Motivational feature	Explore other participants	Self-monitoring profile	Leaderboard comparison	Other profile comparison
Mean	0.326	6.33	10.9	2.87
Median	0.00	4.00	6.00	0.50
SD	0.743	7.88	14.0	5.68
Sum	30	582	999	264

Table 3. Descriptive use statistics of motivational elements related to social comparison and self-monitoring in the Greenify.work app.

much longer than the overall sample. Similarly, employees performed an average of 43.2 sustainability actions ($M_a = 43.2$, $MD_a = 26.0$, $SD_a = 53.3$), with the top 10% of users performing an average of 167 sustainability actions ($M_a = 167$, $MD_a = 175$, $SD_a = 51.7$). Using the Python Fitter library[1] on our distributions, the Bayesian information criterion (Schwarz, 1978) showed that the distributions are best described as exponential, which is consistent with common usage patterns of participation inequality that 90% of users of online services show very low engagement, 9% are frequently engaged and 1% of users are responsible for most of the activities and content (J. Nielsen, 2006; Sun, Rau, and Ma, 2014).
Regarding the use of instructional and motivational elements, the descriptive statistics show that employees use instructional elements ($M_i = 23.2$, $MD_i = 15.5$, $SD_i = 23.0$) slightly less than motivational elements ($M_m = 26.5$, $MD_m = 16.0$, $SD_m = 29.5$), and considerably less in the upper 10% of the most engaged users ($M_i = 62.8$, $MD_i = 57.5$, $SD_i = 17.0$; $M_m = 84.5$, $MD_m = 94.0$, $SD_m = 28.8$). The differences between means and medians indicate a similar distribution for the instructional and motivational elements as for the sustainability actions performed and IS engagement. Application of the Python Fitter library and the Bayesian information criterion (Schwarz, 1978) to the distributions of the instructional and motivational elements indicated that the distributions are best described as exponential as well.
Specifically, in the instructional elements, employees used the feature of information about all actions that contribute to sustainability the most, followed by looking at detailed information about a particular action, and personalized recommendations for actions that contribute to a goal (see Table 2).

Instructional feature	Personalized action recommendations for a goal	Detailed action information	Information on all actions	Interaction with personalized reminders
Mean	4.00	6.59	12.0	0.652
Median	1.50	1.00	7.00	0.00
SD	6.68	12.9	13.5	1.42
Sum	368	606	1,101	60

Table 2. Descriptive use statistics of instructional elements in the Greenify.work app.

In terms of motivational elements, employees were primarily concerned with social comparison and self-monitoring, such as the leaderboard, their own profile, and other profiles (see Table 3). Goal setting and tracking goal progress were used less than these other motivational elements, with a focus on individual goals as opposed to collaborative or competitive goals (see Table 4).
Due to the difference between means and medians and the high standard derivation, descriptive statistics alone are hardly useful when it comes to the usage patterns of the main users, i.e., those in the tail who use the app over a long period of time (Alstott, Bullmore, and Plenz, 2014). In line with previous research on technology adoption (Coeurderoy, Guilmot, and Vas, 2014), we considered the complementary cumulative distribution functions (CCDF), commonly known as "survival functions" (Bégin, Devillers, and Roche,

[1] https://github.com/cokelaer/fitter

Motivational feature	Goal setting					Goal progress tracking		
	New team goal	Join team goal	New competition	Join competition	New solo goal	Team goal	Competition	Solo goal
Mean	0.033	0.120	0.022	0.044	2.15	0.261	0.228	3.24
Median	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.50
SD	0.179	0.388	0.147	0.205	3.20	1.14	1.19	6.85
Sum	3	11	2	4	198	24	21	298

Table 4. Descriptive use statistics of motivational elements related to goal setting and goal progress tracking in the Greenify.work app.

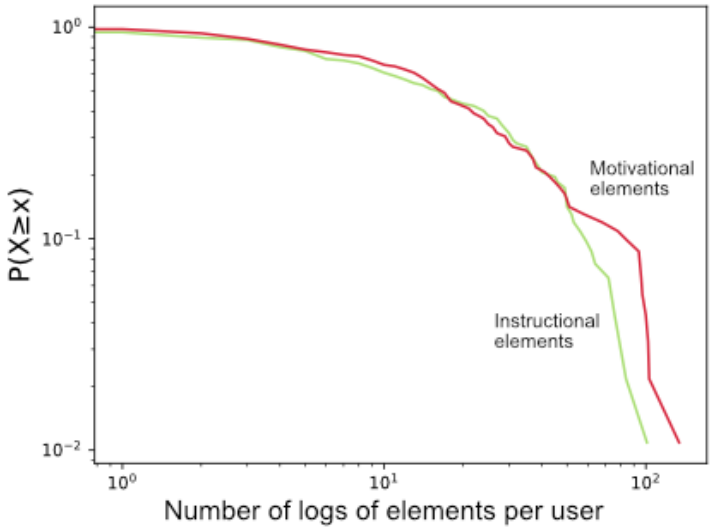

Figure 4. Complementary cumulative distribution functions (CCDF) of instructional and motivational elements in the Greenify.work app. The x-axis represents the number of logs of elements per user and the y-axis ($P(X \geq x)$) represents the probability that an employee uses an element at least x times.

2018), of instructional and motivational elements and analyzed the log-log pot, where the x-axis represents the number of logs of elements per user and the y-axis ($P(X \geq x)$) represents the probability that an employee uses an element at least x times (see Figure 4). To plot the CCDF, we used the Powerlaw for Python library (Alstott, Bullmore, and Plenz, 2014).

The CCDF show that at the end of the distribution, i.e., among highly engaged employees, motivational elements are used more than instructional elements. The visible difference to the pattern of most users occurs at 60 logs of motivational elements, which constitutes the 88. percentile. Thus, the CCDF indicates that for the top 12% of users, motivational elements seem to be more important than for the mass of users.

5.2 Influence of instructional and motivational elements on sustainable behavior

Evidence from bootstrapped linear regression analysis of instructional and motivational elements on performed sustainability actions shows that both elements together explain 72.9% of the variance in performed sustainability actions ($R^2 = .729$, $F = 78.782$, $p < .001$). Instructional elements have a significant influence on performed sustainability actions ($\beta = .603$, $p < .001$), supporting H1. Motivational elements, however, show no significant main effect on sustainability actions performed ($\beta = -.231$, $p = .119$),

so H2 must be rejected. However, there is a significant positive interaction effect between instructional and motivational elements ($\beta = .495$, $p < .01$), supporting H3 and suggesting that although the use of motivational elements alone has no effect on sustainability actions performed, they support the positive effect of instructional elements.
Figure 5 summarizes the results of the linear regression analyses in the research model.

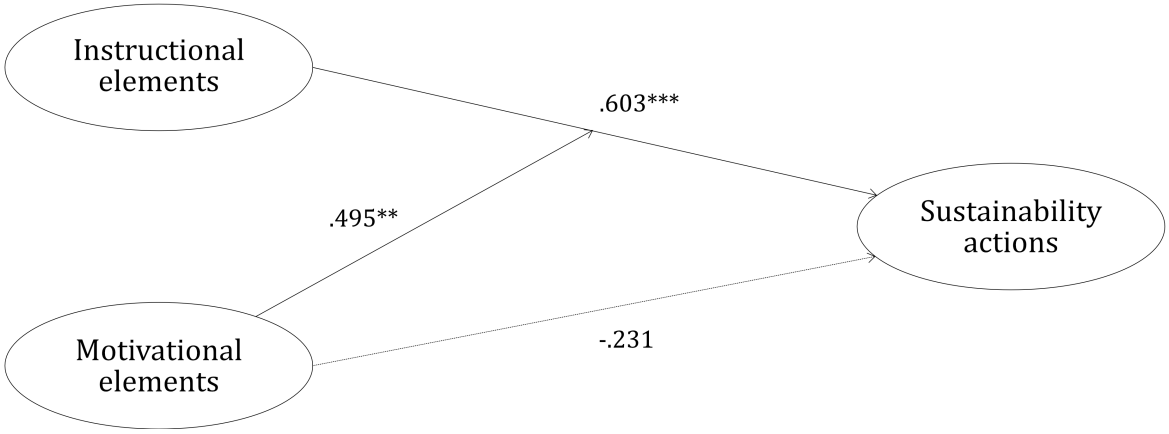

*Figure 5. Results of the linear regression analysis in the research model (*** = $p < .001$, ** = $p < .01$).*

6 Discussion and implications

Building on previous work on green IS for sustainability that has used a variety of different instructional (Casado-Mansilla et al., 2020; Hillebrand and Johannsen, 2021; Hsu and M.-C. Chen, 2021) and motivational (Ableitner et al., 2018; Iria et al., 2020; Oppong-Tawiah et al., 2020; Seidler et al., 2020; Tiefenbeck et al., 2018; Wörner and Tiefenbeck, 2018) elements in the past but has not yet examined the relative impact of these different elements, the goal of this study was to *analyze the use and effects of instructional and motivational elements in a green IS on sustainable employee behavior*.
Overall, our analysis shows that 2 of the 3 hypotheses can be accepted, whereas H2 must be rejected (see Table 5). Our descriptive analysis also reveals that the majority of employees use instructional and motivational elements fairly evenly, whereas the top 12% of users who are most engaged with the green IS use motivational elements considerably more than instructional elements. These motivational elements tended to focus on social comparison and self-monitoring rather than goal setting and goal tracking. While the rejection of H2 is at odds with previous studies that have reported positive outcomes from green IS that incorporated motivational elements into the design (Ableitner et al., 2018; Oppong-Tawiah et al., 2020; Tiefenbeck et al., 2018; Wörner and Tiefenbeck, 2018), there are several possible explanations for this finding. On the one hand, our study examined the *relative* influence of motivational elements versus instructional elements on sustainability actions, rather than assessing the design as a whole, meaning that it may have discovered a new observation that *instructional elements account for relatively the largest share of green IS effects*, as opposed to a small relative influence of motivational elements. On the other hand, it could be that users who were most engaged with green IS and used motivational elements significantly more than instructional elements logged less of their sustainability actions over time, as this logging had to be done manually and some logging fatigue may have set in, a problem known from studies of IS for fitness and health (Rabbi et al., 2015). In this case, the greater use of motivational elements would not have translated into a greater number of sustainability actions, which could explain the lack of relationship, but does not necessarily mean that the engaged users are behaving less sustainably - they just may not log it after a while.

Designation	Hypothesis	Accepted/Rejected
H1	Instructional elements positively influence performed sustainability actions	Accepted
H2	Motivational elements positively influence performed sustainability actions	Rejected
H3	There is a positive interaction effect between instructional and motivational elements in influencing performed sustainability actions	Accepted

Table 5. Overview of hypotheses testing.

Our findings contribute to understanding user behavior in green IS and how green IS design can impact sustainable employee behavior. From the results of our study, we can draw three key learnings that are valuable for both the theoretical understanding of user behavior in green IS and the practice of green IS design:

First, *instructional elements are essential for the majority of employees to support sustainable employee behavior*, supporting their relevance highlighted in previous studies on green IS (Casado-Mansilla et al., 2020; Hillebrand and Johannsen, 2021; Hsu and M.-C. Chen, 2021; Ivan et al., 2017; Spence et al., 2018). The mass of users use instructional elements and motivational elements on a roughly equal basis (with motivational elements slightly dominating), meaning that users appear to have spent about equal amounts of time reading the action suggestions and action details to learn more about sustainability in the workplace, and looking for their position on the leaderboard or monitoring their own progress on their profiles. It is noteworthy that the instructional elements in particular had an impact on how many sustainability actions employees performed (H1), and thus had a stronger impact on the utilitarian purpose of the green IS (behavior change) than the motivational elements. One possible explanation for this result could be that sustainability is a rather complex topic and therefore employees feel the need for guidance on how to implement sustainable behaviors (Draghici et al., 2021; Krath, Morschheuser, and Korflesch, 2022). Previous studies of environmentally-friendly behavior among employees in general have shown that a company's sustainability goals are often intangible to them and that they need guidance to work toward their goals (Aguilera et al., 2021). Our study suggests that instructional elements in green IS can be a valuable tool for this purpose.

Second, *motivational elements are particularly important for long-term use of green IS*. The top 12% of users who were most engaged with the green IS primarily used motivational elements, especially self-monitoring and social comparison, and they used them substantially more than the mass of users. This result suggests that the needs of the mass of users and the "tail" that contributes the most (J. Nielsen, 2006; Sun, Rau, and Ma, 2014) may differ in terms of how green IS should be designed.

Third, and most insightful, *motivational elements enhance the positive influence of instructional elements on sustainable employee behavior*. This finding suggests that while motivational elements alone do not appear to have an impact on sustainable behavior, likely due to the instructional needs in the complex topic of sustainability reflected earlier, they are critical to supporting the use and impact of instructional features. This finding supports the purpose of motivational features to elicit positive or hedonic experiences when engaging with an IS, which in turn supports the utilitarian purpose (Koivisto and Hamari, 2019; Köse, Morschheuser, and Hamari, 2019). For example, features such as self-monitoring may satisfy psychological needs (e.g., the need to feel competent (Ryan and Deci, 2000) in sustainable behavior) or evoke self-efficacy (Bandura, 1978) in sustainable behavior, which may promote motivation to continue engaging in the sustainability actions learned through the instructional elements. On the other hand, social comparison may promote upward comparison (Festinger, 1954) so that employees become more engaged in sustainable behaviors learned through instruction. Although previous research has generally argued for such an interaction effect of motivational elements, especially gamification elements, in terms of their hedonic purpose supporting the utilitarian purpose (Hamari and Koivisto, 2015; Köse, Morschheuser,

and Hamari, 2019; Lindenberg and Steg, 2013), to our knowledge, our study is the first to empirically demonstrate this interaction effect between motivational and instructional elements in green IS.
While management research has emphasized the role of e.g. transformational leadership (Robertson and Carleton, 2018; Yue et al., 2022) and training programs (Pinzone et al., 2019) to guide and motivate sustainable employee behavior, our study shows that instructional elements in green IS are a valuable tool to guide employees toward sustainable behavior in the workplace, and motivational elements in green IS reinforce this positive effect of instructional elements to motivate long-term engagement in sustainable behavior. Therefore, our study underscores the value of bringing together management and IS perspectives to explore how best to support sustainable employee behavior (Brocke et al., 2013; Melville, 2010; R. T. Watson et al., 2021).
In summary, our study contributes to previous research on green IS by showing that *both instructional and motivational elements play a crucial role* in achieving positive effects of green IS on sustainable employee behavior, but that *their roles are different*: while instructional elements are most important to educate the majority of employees on how to behave sustainably, and therefore directly influence the extent to which they do so, motivational elements are vital for eliciting hedonic experiences when using the green IS to drive long-term engagement.

7 Limitations and outlook

We acknowledge several limitations of our study that provide opportunities for future research to build on this work and further explore the role of instructional and motivational elements in green IS to support sustainable employee behavior.
With respect to our sample, we concede that due to data privacy constraints, we were unable to include participant demographics as control variables in our model. However, because age may have an impact on employees' attitudes or knowledge about sustainable behaviors and their interaction with motivational characteristics (Wiernik, Dilchert, and Ones, 2016), we invite future studies to examine these variables to gain a better understanding of the use and impact of instructional and motivational elements. In particular, we encourage also investigating how the needs and motivations of highly engaged users (the top 12%) who use motivational elements more than the mass of users differ from the majority of employees, and how green IS design might be adapted to meet the needs of different types of users or to promote the transition from a "lurker" to a "high performer"(J. Nielsen, 2006).
Second, the participation rates in our companies suggest some risk of self-selection bias, since participation in the field study was voluntary. Thus, we may have been dealing with a user base of employees who, if not knowledgeable, were at least interested in the topic of sustainability and may share a positive attitude toward sustainable behavior. This could have reduced the effects of the implemented motivational elements and thus, in addition to our suggested explanations, supported the rejection of H2. Further studies should investigate whether and how employees who are not yet in the awareness stage for sustainable behavior (Prochaska and Velicer, 1997) could be motivated by green IS to engage in sustainable behavior at work.
Third, our analysis is based on a field study of a specific green IS. We invite further research to validate the generalizability of our findings with other green IS to strengthen theory building through practical IS research (Lehnhoff, Staudt, and R. T. Watson, 2021) and to vary aspects of the design to gain more insights into the particular impact of the specific design of instructional and motivational elements in green IS.

8 Acknowledgements

This work has been supported by the Academy of Finland Flagship Programme [Grant No. 337653 - Forest-Human-Machine Interplay (UNITE)] and the Foundation for Economic Education [Grant No. 190111 - GamEmOrg] and [Grant No. 210301 - GAMETH].

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