Frontline employees are ready to accept smart energy-saving technologies, especially when they are engaged at work and when they are concerned about climate change.

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Abstract

As major carbon emitters, organisations have an important role to play in tackling the climate change crisis and reducing energy waste. To date, the contribution of occupational psychology to reducing carbon emissions has been limited, but there are increasing opportunities to direct our competencies towards helping build more environmentally sustainable organisations. The emergence of new technologies such as smart-apps provides a potential tool for helping workers reduce energy use, however there is little understanding of employees' willingness to adopt these technologies. We surveyed frontline workers in retail (N = 402) and healthcare (N = 402) sectors to understand their readiness to accept mobile energy saving applications in their workplace. The results show that overall, there is strong readiness among employees to accept and use these technologies. Additionally, readiness to accept mobile energy saving applications at work is strongest for employees with higher work engagement or higher concern for climate change risks. We discuss the applied implications of these findings for occupational psychology practitioners to help organisations become more sustainable.

Keywords: organisational sustainability, climate change, energy, technological acceptance, work engagement.

Link to OSF with Online Supplementary Materials and data:

https://osf.io/48fkr/?view_only=26a0ca165e1744dca801e65fd968029b

Currently, businesses and the public sector are key carbon emitters, responsible for around 19% of energy use (compared to residential use, which accounts for around 15%; DBEIS, 2021). Within these sectors, employees who manage the day-to-day workplace operations, including equipment and appliances, can make a large contribution to energy saving efforts (Bull & Janda, 2018; Christina et al., 2014; Janda, 2011). This means that there are large potential gains from encouraging these employees to optimise their energy-saving behaviours. Faced with a combination of government regulation, consumer, community and employee demand, organisations are introducing firmer performance targets around climate sustainability outcomes (Allen & Craig, 2016; Flammer et al., 2019). Despite climate change being one of the most significant challenges faced by organisations today, energy-saving among frontline employees remains heavily understudied compared to domestic use. If global emissions targets are to be reached and the worst-case scenarios of the climate crisis averted, governments and businesses must play an important role in reducing energy usage and curbing emissions (Climate Change Committee, 2019). For organisations, saving energy and reducing waste is increasingly important to the bottom line. And, in the face of climate change, employers are starting to recognise that curbing emissions is not only good for the planet, but also for the wellbeing of their employees (Di Fabio, 2017), with sustainability initiatives having the power to increase employee loyalty, productivity and morale (Whelan & Fink, 2016). Occupational psychology researchers and practitioners therefore have a role to play, by directing our values and competencies towards helping organisations achieve their energy-saving ambitions (Glavas, 2016; Lowman, 2013). Although occupational psychology's contribution to organisational sustainability has been limited in the past (Ones & Dichert, 2012), firmer targets are attracting growing interest from organisations in the relationships between workplace sustainability initiatives, employee wellbeing and 'green' behaviours (Jones et al, 2017; Unsworth et al., 2021).

One area of interest is how organisations can leverage new technologies to change employee behaviours and reduce energy waste (Janda, 2011; Stern et al., 2016), with emerging sensor technologies paired with mobile applications ('smart-apps') have the power to motivate savings by putting information about energy usage directly into the hands of employees (Marinakis & Doukas, 2018; Spence et al., 2018). Much like domestic smart-meters, these 'smart-apps' present a technological opportunity to help meet these criteria and avoid rising energy costs. However, it is not well understood if the technologies will deliver the desired changes in employee behaviours (Davies, 2022; Jolles et al., 2021). Research to date has primarily focused on smart energy-saving technologies in domestic rather than organisational settings (e.g., smart-meters; Andrews & Johnson, 2016), and has shown that feedback from these technologies can reduce energy use (Tiefenbeck et al., 2018). Yet, the success of this feedback depends entirely on user engagement (Buchanan, 2015). Nonetheless we cannot assume that domestic findings translate directly to the workplace because employees (a) have a limited visibility of overall energy consumption and their own contribution to it, and (b) are not directly responsible for the costs of this consumption. Recent studies have shown that new technologies delivering visibility and feedback about energy usage can encourage more sustainable energy use in office-settings (Iria et al., 2020; Oppong-Tawiah et al., 2020; Yun et al, 2017). However, the workplaces that rely most on employee initiative for energy-saving are not office-based, rather they are workplaces reliant on frontline workers, like retail and healthcare (ND-NEED, 2020). Compared to domestic and office-based settings, we know very little about employee energy attitudes and behaviours in these workplaces. Successful energy interventions require an understanding of the psychological motivations underpinning them (Unsworth et al., 2013), and this is also true of interventions reliant on the acceptance of new energy-saving technologies.

Frontline employee readiness to accept sustainability technologies at work

One of the key determinants of new technology acceptance is how users perceive its usefulness (Davis, 1989), which depends on how the technology aligns with the user's goals. Domestic smart-meter acceptance is strongly linked to how useful the technology is perceived to be in helping the user achieve their goals of saving money or protecting the environment (Buchanan et al., 2016; Chen et al., 2017). Cost-saving is a primary motivation behind domestic energy-saving behaviours (Spence et al., 2015; Spence et al., 2018), and although frontline employees do not have a direct financial motivation to save costs, they are likely to perceive usefulness based on whether the technology will enhance their work performance (Venkatesh et al., 2003). This performance may include saving money for their organisation. In industries such as retail and healthcare for whom the primary employee performance focus is 'customer' or 'patient' care respectively, workplace energy-saving has not traditionally been considered part of the job. Even though employees do not directly incur energy costs at work, they might be motivated to save for their organisation. More engaged frontline employees deliver better financial performance (Xanthopoulou et al., 2009), and are more concerned with saving-energy to reduce organisational costs (Ababneh, 2021; Leygue et al., 2017; Jolles et al., 2022). Employee engagement is also a key driver of technological acceptance (Maican et al., 2019; Molino et al., 2020). We might therefore expect that more engaged employees will show greater willingness to adopt mobile energy application technologies at work.

While financial incentives differ in domestic and frontline workplace settings, employees' climate change concerns can be expected to play the same energy-saving motivating role as in domestic settings. As protecting the climate is strong motivation for domestic energy-saving behaviours (Gadenne et al., 2011; Pothitou et al., 2016), we could also expect frontline employees' climate change concerns to shape their acceptance of mobile energy application technologies at work. There is some evidence that climate change concerns predict energy-saving behaviours in the workplace (Leygue et al., 2017) and greater concern for the climate can also lead to people to have more positive beliefs about the value and performance of new sustainable-technologies (Gimpel et al., 2020).

We sought to test if frontline employees' work engagement and concern for climate change risk predicted their willingness to accept a new energy-saving mobile application in their workplace. We surveyed a sample of frontline employees from two different, major UK sectors, retail and healthcare. These sectors were chosen because they are the major employers of frontline workers and represent more than a third of the UK's total workforce (Office for National Statistics, 2017). Additionally, these sectors differ in employee socio-economic and workplace characteristics. Notably, employees in retail earn significantly less on average than their counterparts in healthcare (Office for National Statistics, 2022). There are also differences in the protocols and physical workplace equipment and potential for energy saving. For example, kitchen equipment is a key source of energy in food retailers (Mudie & Vadhati, 2017), compared to heating and cooling in healthcare (Bawaneh et al., 2019). As such, confirmation of hypotheses in both samples would provide more robust evidence of the underlying motivations to accept new energy-saving technologies.

Method

Participants. We recruited 804 participants from the UK who were employed in frontline roles in either retail (*N* = 402; general retail, supermarkets, hospitality, etc.) or healthcare (*N* = 402; pharmacy, hospital, dental, care, etc.) industries using the Prolific platform. The size of each sample gave 90% power to detect a small effect size of $r = 0.15$ in a bivariate correlation analysis. Participants were paid £0.80 to take part in the study, which had a median completion time of around 7 minutes (£5.94 per hour). Participant demographics are shown in Table 1. Sector demographics were as expected based on available UK demographic data (Irvine et al., 2022; Office for National Statistics, 2019), with the average age of Healthcare employees 38 years of age, compared to 31 years in Retail. The majority of responses in both sectors came from women (81% Healthcare, 70% Retail). Healthcare employees had a higher level of education, with 66% holding a Bachelor's Degree or higher, compared to 40% in Retail.

Table 1

Descriptive statistics for study samples.

	Sample 1 (Retail)		Sample 2 (Healthcare)	
Sample	*N*	%	*N*	%
N	402		402	
Gender				
Female	280	70%	327	81%
Male	118	29%	72	18%
Other	4	1%	3	1%
Age				
18 – 25	152	38%	15	14%
26 – 40	182	45%	187	46%
41 – 54	48	12%	112	28%
55+	20	5%	46	11%
Education				
GCSEs	63	7%	44	11%
A Level	112	28%	52	13%
Some higher education	67	17%	43	11%
Bachelor’s degree	98	34%	167	42%
Master’s degree or higher	53	6%	96	24%
Personal Income				
Less than £20,000	250	62%	143	36%
£20,000 - £30,000	117	29%	125	31%
£30,000 - £40,000	26	7%	78	19%
Greater than £40,000	55	2%	56	14%

Materials and Procedure. Participants provided informed consent before confirming their eligibility based on being a UK resident and current employment in a frontline role. Eligible participants completed the below measures in a random order before providing demographic information (e.g., age, gender, education, income, years with employer, etc.)

and being fully debriefed. All research was approved based on requirements set out by the first author's institution Ethics Committee.

Energy mobile application acceptance. Participants read a hypothetical scenario where a smart app is being made available for them to save energy at work. They read a short description of the app before responding to questions assessing their acceptance of the app ("*a workplace smart energy mobile application (app) allows you to monitor your energy use at work and helps you to take energy saving actions by sending you notifications...*"). Participants indicated their acceptance of the app by rating their agreement with ten statements about the smart-energy mobile application, e.g., this application would… "be something I would be excited to have in my workplace", "benefit the environment", "be something I would not use at work" (1 = strongly disagree, 5 = strongly agree; see Online Supplementary Materials, Appendix 1). The scale was adapted to the workplace from the nine-item smart-meter technology acceptance scale (Bugden & Stedman, 2019). Negative items were reverse-coded, and the ten responses averaged to form a measure of participant's readiness to adopt an energy mobile application at their workplace, with a higher score indicating greater readiness. The scale was found to be reliable across both samples (Cronbach's $\alpha = .90$).

Work engagement. Participants responded to the 3-item version of the Utrecht Work Engagement Scale (UWES-3; Schaufeli et al., 2019), which assesses three dimensions of work engagement, vigor (or energy while working), dedication and absorption. The measure includes one question for each of the three dimensions, "At my work, I feel bursting with energy" (vigor), "I am enthusiastic about my job" (dedication), and "I am immersed in my work" (absorption). Participants rated how often they felt this way about their job on a seven-point Likert scale (0 = never, 6 = always). The responses were recoded to range from 1 to 7, before being averaged to compute an overall work engagement score, with higher scores indicating higher engagement (Cronbach's α = .85).

Climate change risk concern. Participants were asked to indicate how much risk they believed climate change poses to human health, human safety, economic prosperity and the environment (adapted from Bugden and Stedman., 2019). Participants responded on a scale of 0 (no risk) to 10 (extreme risk). The four responses were averaged to compute a climate change risk concern score from 0 to 10, with higher scores indicating higher perceived risk (Cronbach's α = .86).

Means, standard deviations, alphas and correlations between variables are presented in Table 2.[1]

[1] The complete details of measures used are available in the supplementary materials at OSF here.

Table 2

Descriptive statistics and correlations between measures in Retail (Sample 1; n = 402) and Healthcare (Sample 2; n = 402).

Variable	Mean	SD	α	Range						
Sample 1 (Retail)					1	2	3	4	5	6
1. Energy mobile app acceptance	3.92	0.73	.88	1.00 – 5.00	-					
2. Work engagement	4.60	1.02	.82	1.00 – 7.00	.21**	-				
3. Climate change risk concern	8.12	1.40	.81	1.00 – 10.00	.38**	.03	-			
4. Age	31.01	11.02	-	18 – 76	-.10*	.15**	-.22**	-		
5. Income	-	-	-	-	.04	.26**	-.07	.27**	-	
6. Education	-	-	-	-	-.01	-.13**	.05	-.23**	.05	-
7. Years with employer	5.43	4.81	-	1 – 26	.00	.14**	-.13**	.45**	.26**	-.06
Sample 2 (Healthcare)					1	2	3	4	5	6
1. Energy mobile app acceptance	3.85	0.84	.92	1.20 – 5.00	-					
2. Work engagement	4.77	1.08	.87	1.00 – 7.00	.29**	-				
3. Climate change risk concern	8.13	1.64	.91	1.00 – 10.00	.38**	.11*	-			
4. Age	38.35	11.84	-	18 – 77	-.07	.01	-.10*	-		
5. Income	-	-	-	-	.14**	.15**	.04	.06	-	
6. Education	-	-	-	-	.12*	.13*	.15**	-.16**	.43**	-
7. Years with employer	7.11	6.95	-	1 – 40	.01	.05	.00	.51**	.13**	-.04

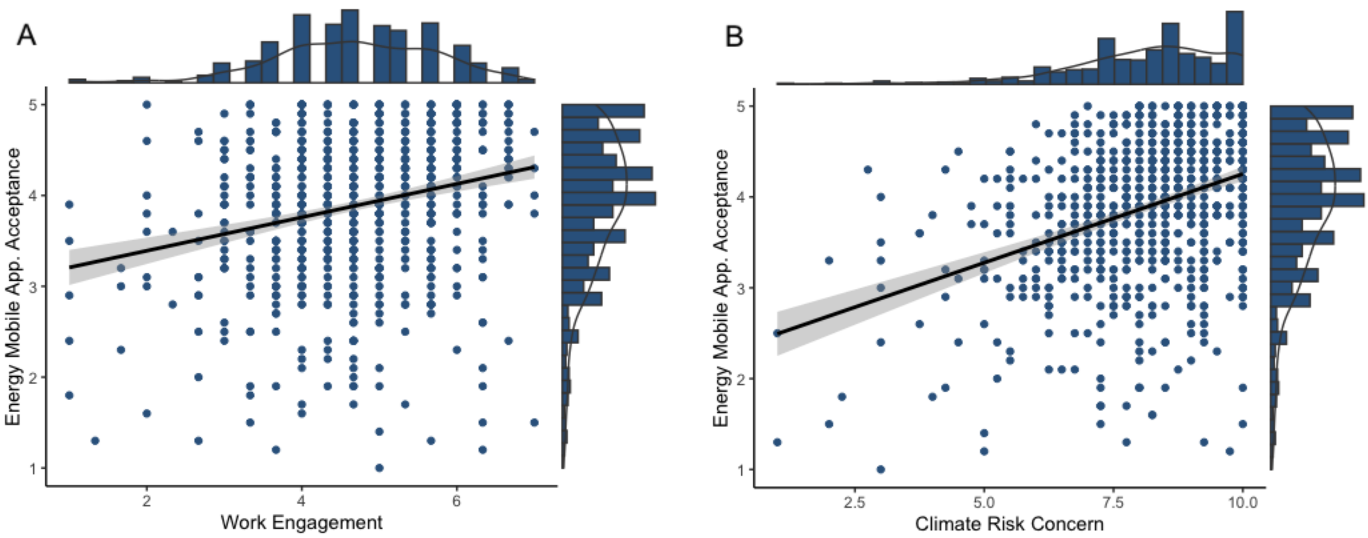
Note. ***p* < .01, **p* < .05; α : Internal consistency, Cronbach's Alpha (not included for single-item measures); See *Participants* for Household Income and Education

Results

Overall, employees in both sectors expressed enthusiasm for a mobile energy saving application in their workplace, with a one sample t-test showing a significant positive difference from our 'neutral' mid-scale point of 3, $t(803) = 31.89$, $p < .001$, $d = 1.13$. Positive willingness to accept an application was 84% among healthcare employees and 87% in retail. As hypothesised, we found that higher readiness to accept energy-saving mobile application technologies was significantly associated with both higher work engagement and higher climate risk concern among employees in both retail and healthcare industries (see Table 2, Figure 1).

Figure 1.

Bivariate correlations between energy mobile application acceptance and A) employee work engagement and B) climate change risk concern combined across both samples (N = 804).



To assess if work engagement and climate concerns independently predicted energy mobile application acceptance, we ran a linear regression analysis including demographic variables that may covary with the willingness to accept energy mobile applications at work (Table 3). The results confirmed that both work engagement and climate change concern significantly and independently predicted energy mobile application acceptance, accounting for 18-20% of the variance.[2]

Table 3

Summary of hierarchical regression analyses predicting energy mobile application acceptance from work engagement and concern for climate change risk among frontline employees in Retail (Sample 1 N = 402) and Healthcare (Sample 2 N = 402).

Variable	Sample 1. Retail (N = 402)				Sample 2. Healthcare (N = 402)			
	Step 1		*Step 2*		*Step 1*		*Step 2*	
	b	*SE*	*b*	*SE*	*b*	*SE*	*b*	*SE*
Work engagement	$.14^{***}$	.03	$.14^{***}$	.04	$.19^{***}$	.04	$.18^{***}$	.04
Climate change risk concern	$.19^{***}$	.02	$.19^{***}$	.02	$.18^{***}$	.02	$.18^{***}$	.02
Gender (female)			-.01	.06			-.08	.07
Age			-.01	<.01			<.01	< .01
Income			.01	.04			.05	.03
Education			.-01	.03			-.01	.03
Years with employer			.01	.01			< .01	.01
FΔ (df)	44.37^{***} (2,399)		0.63 (7,394)		51.17^{***} (2,399)		1.32 (7,394)	
ΔR^2			.01				.01	
Total R^2	.18		.19		.20		.20	

Note. $^{***}p < .001$.

[2] Among healthcare employees, more engaged workers did show a higher concern for climate change risk than those less engaged (see Table 1), however regression results showed that both were significant predictors of energy-saving mobile application acceptance at work. We did not find evidence of an interaction effect between work engagement and climate change risk concern in predicting mobile application acceptance.

Discussion

Frontline employees who manage the day-to-day operation of workplace appliances and equipment can have a large impact on energy savings (Bull & Janda, 2018; Christina et al., 2014; Janda, 2011), and emerging technologies have the power to put detailed information about energy usage directly into the hands of these employees (Jolles et al., 2020; Marinakis & Doukas, 2018). Yet, compared to domestic and office-based settings, frontline employees' readiness to adopt energy-saving technologies remains under-studied. Past research has shown employee acceptance of new technologies is strongly related to how useful employees believe the technology will be in helping them to reach their work performance goals (Davis,1989; Venkatesh et al., 2003). Reducing energy usage with the goal of saving costs is important to many domestic users (Spence et al., 2015; Spence et al., 2017), and although employees do not directly incur energy costs in the workplace, more engaged employees are often motivated to save costs for the organisation (Xanthopoulou et al., 2009) and adopt new workplace technologies (Maican et al., 2019; Molino et al., 2020). Protecting the climate is also a key goal behind domestic energy-saving behaviours (Gadenne et al., 2011; Pothitou et al., 2016) and acceptance of new domestic energy-saving technologies (Gimpel et al., 2020). Thus, we aimed to evaluate if these links extend to the workplace. Specifically, if frontline employees who were more engaged at work and had more concern about climate change risks reported greater willingness to accept mobile energy-saving applications in their workplace. Across two large, distinct UK sectors, retail and healthcare, we found that frontline employees who were more engaged with their work and who had greater concern for climate change risk showed greater readiness to accept energy mobile application technologies at work. Crucially, our research showed that while employees are not directly responsible for, nor directly benefit from a reduction in energy costs in the workplace, they show significant willingness to adopt technologies that could contribute to reductions.

These findings extend previous findings of a positive relationship between employee engagement and the willingness to accept new technologies in the workplace (Maican et al., 2019) by showing that more engaged employees have a higher willingness to accept energy-saving mobile application technologies that they feel will benefit their organisation. This finding also builds on past work showing that employees are, at least in part, motivated to save energy at work in order to benefit their employer (Leygue et al., 2017). Additionally, we showed that higher concern for climate change risk is associated with greater readiness among frontline employees to accept mobile energy technologies at work, in the same way as this concern is associated with readiness to accept and engage with domestic smart-meters in homes (Bugden & Stedman, 2019). Although there was a (small) association between higher work engagement and greater concern for the climate among healthcare workers (see Table 2), among workers from both industries higher work engagement and climate concern both independently predicted higher willingness to accept the energy mobile application at work.

Our finding that frontline employees who reported higher work engagement and climate concern were more ready to accept energy mobile applications in their workplace were consistent across the two sectors. While there were clear demographic differences between employees in these sectors (healthcare employees were older with longer tenure, more educated and reported higher incomes than their retail counterparts), we found a very similar pattern of results in both sectors confirming our hypotheses.

Implications for Practice

Given the urgency of the climate crisis, occupational psychologists have an imperative to direct their skills and competencies towards helping organisations reduce environmental impact (Glavas, 2016; Lowman, 2013). As researchers and practitioners, we should not forget that creating more sustainable organisations is not only good for the planet, but also the wellbeing of employees (Di Fabio, 2017; Whelan & Fink, 2016). It is clear that organisations value energy-saving for financial and environmental reasons, however to date, it has been uncertain whether frontline employees shared this view. Our research suggests frontline employees in retail and healthcare do share their organisations' energy-saving concerns, as indicated by the 86% ready to accept a mobile energy-saving application. Given the variety of new technologies being considered by businesses as part of these sustainability initiatives, before investing, it is important to understand if employees are ready to accept the technologies and who among frontline staff are most likely to champion them.

Our research encourages investment in mobile energy-saving technologies as part of the organisation's broader sustainability agenda by showing an appetite among frontline employees, especially for those concerned about climate change and those engaged in their work.

Limitations and Future Directions

These are two limitations to our findings that should be noted. First, our research is cross sectional, which makes it hard to attribute causation. However, the relationships between work engagement and concern for climate risk on energy mobile application acceptance are unlikely to be reverse-causal (i.e., employee work engagement is more likely to influence readiness to accept an energy-saving mobile app than vice-versa) and cross-sectional research is valuable in establishing these relationships as a basis for further research and interventions (Spector, 2019). Secondly, although we found support for mobile energy-saving applications among frontline employees, the usability and distinct features of the app were not fully described to respondents, thus this support is more 'in principle'. While understanding readiness is a first step, implementation of a new technology brings new challenges (Shachak et al, 2019). For example, a device that is not user friendly enough will not be used even if it has been ‘installed’ by the user. Residential smart-meters have been popular, but the design of these meters has not always been effective in engaging users (Buchanan et al., 2015; Buchanan & Russo, 2019). We therefore would expect the useability, design and features of mobile applications to be important to employee acceptance and eventual engagement in practice (Kuciapski, 2017; Davis, 1989).

Conclusion

Emerging energy-management technologies are giving organisations new tools that put information directly into the hands of employees, with the aim of saving energy. Overall, our research shows that there is a readiness to accept mobile energy-saving technologies among frontline employees, and that this readiness is higher among more engaged workers and those with higher concern for the risks posed by climate change.

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