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EFFECTING EMPLOYEE ENERGY CONSERVATION BEHAVIOUR AT THE WORKPLACE BY UTILISING GAMIFICATION

Dimosthenis Kotsopoulos
Athens University of Economics and Business, Greece, dkotsopoulos@aueb.gr

Stavros Lounis
Athens University of Economics and Business, Greece, slounis@aueb.gr

Cleopatra Bardaki
Athens University of Economics and Business, Greece, cleobar@aueb.gr

Katerina Pramatari
Athens University of Economics and Business, Greece, k.pramatari@aueb.gr

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Research in Progress

Dimosthenis Kotsopoulos, Athens University of Economics and Business, dkotsopoulos@aueb.gr

Stavros Lounis, Athens University of Economics and Business, slounis@aueb.gr

Cleopatra Bardaki, Athens University of Economics and Business, cleobar@aueb.gr

Katerina Pramatari, Athens University of Economics and Business, k.pramatari@aueb.gr

Abstract

Energy consumption is one of the widely recognised important factors that should be addressed, in reducing CO_2 emissions towards addressing climate change. However, albeit the documented effect of public buildings, in specific, on energy consumption, only a limited body of research focuses on one of the most important factors that could limit it: employees' energy consumption behaviour. Aiming to contribute to this path of research, we have identified gamification as an instrument that, when appropriately utilised, could lead to employees' energy behaviour change. Additionally, we present a behavioural research model for employee energy conservation at work, in alignment with VBN theory of environmentalism, and a questionnaire instrument to validate it combined with practical experimentation. We consider two important categories of parameters that are connected to energy consumption behaviour in the workplace: Employees' personal profile, which also influences the design and effectiveness of gamified apps, as well as level of environmental awareness. Concurrently, we also present preliminary findings from the analysis of the data collected after deploying the forementioned questionnaire instrument.

Keywords: Gamification, Employee, Energy, Behaviour.

1 Introduction

The United Nations Framework Convention on Climate Change has presented the need to intensify our efforts towards reducing CO_2 emissions and protecting the environment (UNFCCC, 2014; UNFCCC, 2016). This was also illustrated by the worldwide participation in the Paris Agreement on climate change (UN News Centre, 2016), which is at its heart an agreement about energy and transformative change in the energy sector – the source of at least two-thirds of greenhouse-gas emissions (International Energy Agency, 2016). At the same time, commercial and industrial sources in the US emitted three times more CO_2 compared to residential sources in 2010 (not including energy generation and transportation), while the buildings sector accounts for 20% of the total delivered energy consumed worldwide (Lülfs and Hahn, 2013). More importantly, electricity is increasingly the preferred energy source in the commercial sector that features the fastest-growing energy demand worldwide – accounting for about 53% in 2012 and expected to reach 62% in 2040, with an average yearly growth of 1.6% (Conti *et al.*, 2016). Therefore, it is important to increase our efforts in reducing energy consumption in commercial buildings.

At the same time, human behaviour is an important factor in the consumption of energy in buildings as it can add – or save – one-third to a building's designed energy performance (Nguyen and Aiello, 2013). Additionally, energy savings in the range of 3-6% – with more than 10% achievable – have been reported on a multitude of studies featuring the application of gamification to reduce energy consumption (Grossberg *et al.*, 2015). Through our research, we aim to utilise gamification towards increasing employee motivation for energy conservation at the workplace. More specifically, we shall explore whether a number of parameters constituting the employees' personal profiles moderate the produced motivational effect. To identify and assess these parameters, we have performed a review of the relevant literature and constructed a research model. Our aim is to validate this model through our ongoing experiments in the context of two EU-funded Horizon 2020 projects on employee energy efficiency. Additionally, to further clarify the most important behavioural factors in our context of study, as well as corroborate suggestions from the literature, we have conducted unstructured interviews with selected employees and designed a questionnaire survey instrument. In the next sections we provide a brief presentation of the relative literature, discuss our research purpose and approach, analyse our research findings, discuss practical and theoretical contributions so far, and conclude the document.

2   Background

2.1   Energy Conservation through Behavioural Change

Energy in commercial buildings is mostly consumed through heating and cooling systems, lights, refrigerators, computers, and other equipment (Conti *et al.*, 2016). Furthermore, energy conservation through behavioural change should be considered alongside efforts to reduce energy consumption through technological improvements (Delmas *et al.*, 2013). Studies in energy consumption behaviours emerged with the oil shocks of the 1970s, from a wide range of disciplinary perspectives (Stephenson *et al.*, 2010). However, the role of the human factor has been largely overlooked in energy consumption analysis – despite the fact that it also significantly affects the successfulness of technology-based efficiency improvements (Lutzenhiser, 1993). Additionally, a limited number of studies exist in the literature regarding energy conservation in a work environment compared to household contexts, while very few have investigated employee energy-related behaviours in organisations at the individual behavioural level of analysis – none of which involving inter-organisational comparisons (Lo *et al.*, 2012). At the same time, energy efficiency solutions should optimally be considered as a way to introduce people to the intrinsic satisfaction of conserving energy even after the gamified app is decommissioned (Grossberg *et al.*, 2015). More importantly, motivations, as well as incentive structures towards energy conservation for users in organizational settings, are different to private households: As no personal monetary gains are normally expected from a change in behaviours, more altruistic motives – like supporting the organization in energy and monetary savings, contributing to environmental protection, or complying with peer expectations – can be leveraged to engage in energy saving behaviour at the workplace (Matthies *et al.*, 2011).

Promising means for employee energy behaviour change include training in low-energy work routines, changing organisational procedures and norms, and feedback to increase the employees' awareness of their own behaviour and consequences (Lo *et al.*, 2012). Savings from behavioural interventions have been reported in the region of 5-15% for direct and 0-10% for indirect feedback (Darby, 2006). Furthermore, in a meta-analysis of information-based energy conservation experiments conducted between 1975-2012, non-monetary information-based strategies led to reductions in electricity consumption by 7.4% on average – while monetary incentives, in contrast, led to a relative increase in energy usage (Delmas *et al.*, 2013). Tailored information has also been found to be more effective towards energy behaviour change (Matthies *et al.*, 2011).

Demographic factors should also be taken into account when designing behavioural interventions, as they have been correlated to energy behaviour. Engagement towards pro-environmental behaviour

tends to increase with age, while women tend to have stronger environmental attitudes, concern and behaviours than men across age (Gifford and Nilsson, 2014). Additionally, higher levels of motivation to conserve energy have been reported by residential users with children (McMakin *et al.*, 2002), suggesting that this may also be true for employees.

We shall be conducting our research within six different workplaces, located in different countries, while aiming to verify the findings presented in the literature so far, as well as cover extant gaps.

2.2 Gamification at the workplace

A growing number of IT systems and services aimed at changing users' attitudes and/or behaviour are being developed (Oinas-kukkonen and Harjumaa, 2009). However, research on the effectiveness of gamification focusing on the underlying motivational mechanisms in specific, has only recently become the object of empirical research (Mekler *et al.*, 2015). We aim to examine the ways in which the specific motivating parameters that lead to energy conservation at the workplace can be activated or enhanced, by applying gamification towards that end. Gamification, in its most widely accepted definition, has been defined as "the use of game design elements in non-game contexts" (Deterding *et al.*, 2011). It is most commonly utilised to encourage behaviour change in end-users, usually involving increased participation, improved performance, or greater compliance (Seaborn and Fels, 2015). Games have a history of being utilised at the workplace as human resources tools and as entertainment interfaces for repetitive tasks (Nikkila *et al.*, 2011), while at least two precursors to the gamification-of-work movement have also been documented in the literature: The Soviet Union workplace-based "socialist competition" experiments, and the 1990s-2000s American management trend of "fun at work" (Nelson, 2012). In a work environment, gamification can focus on business processes – or outcomes – frequently involving participants outside of a firm and/or within it, to improve employee satisfaction (Robson *et al.*, 2015). Furthermore, when organizational goals are aligned with player goals, employees can become fully engaged with new company initiatives (Dale, 2014).

We emphasize that, the analysis and design of gamification applications in corporate environments, requires different approaches to consumer environments. First of all, gamification often involves storing and processing personal, as well as potentially sensitive, data. This is especially a challenge within company boundaries, where gamification could lead to "transparent employees" or where inappropriate extrinsic incentives might crowd out intrinsic motivation (Blohm and Leimeister, 2013). Secondly, gamification in the enterprise also needs to apply to long-term objectives in addition to initiative-specific objectives (Reiners and Wood, 2015). Additionally players are more invested in intra-group than inter-group competition within a corporate setting (Nikkila *et al.*, 2011). As gamification might also contradict with some personality types and cultural norms (Shahri *et al.*, 2014), it is important to design gamified applications to match the profile of their target users, by distinguishing between different types of end-users, as well as their respective characteristics and preferred game mechanics (Uskov and Sekar, 2015). Developing models to explain and predict the influence of personality on game elements is therefore essential when they are to be introduced in workplace environments (Codish and Ravid, 2014). Finally, when designing gamified applications for the workplace, we have to consider the level of work engagement of the participating employees (Prakash and Rao, 2015).

A pressing need exists for the exploration of game elements across contexts, experimental designs, and investigations of several trajectories (Seaborn and Fels, 2015). Bearing in mind the intricacies of applying gamification in a workplace environment already presented, we aim to leverage the motivating power of gamification to effect employee energy conservation behaviour at the workplace.

2.3 Employee Motivation in the context of our study

A multitude of theories, based on different premises, have been developed over the past decades, to analyze and explain employee motivation. At the same time, a variety of the forementioned theories

have been adopted to explain the motivational power of gamification, in an effort to harness its effects and allow for a more efficient deployment of gamification initiatives. However, the majority of researchers suggest that Ryan & Deci's Self Determination Theory (SDT) and its sub-theories should be employed to more efficiently explain and utilize the motivational effects of gamification. SDT suggests competence, relatedness and autonomy as basic antecedents of intrinsic motivation (Ryan and Deci, 2000). In addition, there is a general wide recognition of Csikszentmihalyi's Theory on Flow (Csikszentmihalyi, 2009; Schacht and Schacht, 2012; Killian, 2013) that supports the design of appropriately challenging gamification for all users. Finally, Skinner's Theory on Operant Conditioning (McLeod, 2015) is applicable to choosing appropriate reward schedules in gamified systems.

Motivational theories have also been recruited to explain pro-environmental and energy conservation behaviours in various environments. Values - Beliefs - Norms (VBN) theory links value theory, norm-activation theory and the New Environmental Paradigm (NEP) perspective (Stern, 2000). Furthermore, based on VBN, individual-level factors related to employee energy-conservation behaviours at work have been explored in the literature. More specifically, environmental personal norms and environmental worldviews can be leveraged in organizational interventions concerning employee energy use (Scherbaum *et al.*, 2008). Additionally, when dealing with human attitude – or motivation towards any action or behaviour – in the context of the workplace, employee engagement arises as a prominent enabler or deterrent. Alarmingly, in that sense, Gallup reports that engaged employees worldwide account for 13% of the total workforce, in a phenomenon they call "the worldwide engagement crisis" (Mann and Harter, 2016). Gamification has been suggested as a powerful way to change behaviour, create motivation, increase and sustain employee engagement and productivity within an enterprise (Webb, 2013; Pickard, 2015). Furthermore, if crafted and implemented properly it can increase engagement (Robson *et al.*, 2016), as well as help companies create an active, engaged and productive team (Concur, 2014). Therefore, to reverse the disappointing engagement trends, several leading companies are turning to gamification (Uskov and Sekar, 2015).

The engagement mechanisms common in popular games may be leveraged to promote real-world energy behaviours among players (Reeves et al, 2012). At the same time, energy efficiency games have already been deployed in workplace environments. Examples include "Cool Choices", "WeSpire", "Ecoinomy" and "Carbon4Square" that feature both individual and team play mode, as well as intangible and tangible rewards (Grossberg *et al.*, 2015). More specifically, WeSpire has instigated over 5 million positive actions in 45 countries (WeSpire, 2017), while at the same time Cool Choices has helped more than seven thousand participants, in organizations across multiple industries, to increase their savings and reduce CO_2 emissions, through almost two hundred and sixty thousand energy saving actions (Cool Choices, 2017). However, the motivational effect of any measure depends on the current level of employee engagement. The importance of work engagement in our case stems from the fact that (Prakash and Rao, 2015): (a) engaged employees are prone to contribute towards organisations and therefore, in our case, adopt energy responsible behaviours and gamified initiatives more willingly than their disengaged counterparts, whilst (b) disengaged employees, on the other hand, tend to put time but not energy or passion into their work and (c) actively disengaged employees even go as far as to undermine what their colleagues accomplish – which could include, in our case, the positive behaviours that their engaged counterparts are expected to enact based on our gamification efforts. Hence, the analysis of the employees' level of engagement will help us explain current energy consumption behaviours, as well as future intents with regards to our gamified energy conservation app.

Through our research, we aim to analyse the participants' energy consumption behaviour based on VBN theory, while bearing in mind their existing levels of work engagement. More specifically, we shall be designing our experiments mainly focusing on activating and increasing the intrinsic motivation of employees towards energy conservation by applying gamification.

3   Research Outline

Based on the review and analysis of relative literature, we have devised a research model aimed at explaining the enactment of energy conservation behaviour at the workplace (see Figure 1). We posit that both the personal and environmental awareness profiles of an employee, together with the introduction of a targeted gamification initiative in the workplace, shall influence their energy consumption pattern. Additionally we also hypothesise that the employees' personal profile shall also influence their preferences in the gamification application. We furthermore analyse the personal profile of an employee as consisting of their demographic characteristics, personality traits, adherence to gamification user types and work engagement levels. The employees' environmental awareness profile is considered in accordance with VBN theory, as consisting of their environmental worldviews and personal norms, as well as behavioural intentions towards energy conservation (Scherbaum *et al.*, 2008).
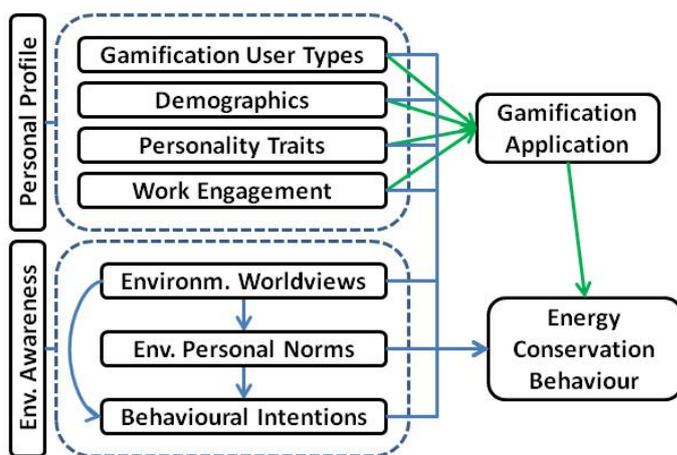

Figure 1: Research Model

As part of our research, we plan to design & develop gamified applications in the course of two EU H2020 research projects, whose objective is to motivate employees towards reducing energy consumption at the workplace. We aim to verify our model, by conducting experiments in six pilot installations, featuring different work environments and located in different EU countries. They include a municipal service in Greece, a public office in Spain, a museum in Luxembourg, a technology business incubator in Italy, a university campus in Spain and a technology park in Switzerland. Our ambition is to investigate if and how gamification applications can motivate employees towards a more energy-sensitive behaviour in the workplace. This unfolds into the following research questions: (a) What is the effect of gamification on employee motivation towards energy conservation at the workplace? (b) Do personal profiles have an impact on the motivational effectiveness of gamification towards inducing the reduction of employees' energy consumption in a corporate environment? (c) What is the effect of an employee's environmental awareness profile on their motivation towards reducing the consumption of energy in a corporate environment?

Behaviour in context is the key starting point of behavioural intervention design, as behaviour can only be understood in relation to context (Michie *et al.*, 2011). Furthermore, when describing a persuasive system, a very clear description of the technology context is needed, as much of the success or failure of an application can be attributed in many cases to technological infrastructure rather than the design of the system (Oinas-Kukkonen, 2010). Therefore, we have already conducted unstructured interviews with a selected sample of employees and surveyed the different pilot sites, in order to ascertain their characteristics and the opportunities for energy reduction extant therein. As the process of designing behaviour change interventions usually begins with determining the broad approach that will be adopted and then working on the specifics of the intervention design (Michie *et al.*, 2011), we plan to use the information gathered through the interview process to better design our experiments. Additionally, we have also deployed a questionnaire – analysed in the next section – that is currently being completed by the prospective gamified app users/employees, to optimally design the gamified app. A series of experiments will consequently be simultaneously implemented in order to answer our research questions, while avoiding bias. We shall record both the users' perceived impact of the apps on their energy consumption, as well as the compared actual energy measurements before and after the application of gamified services. Baseline measurements on the consumption of energy, before any

gamification methods are applied, are currently being acquired. We shall compare this data to the consumption of energy during the experimentation phase, to draw our conclusions after the completion of the experiments. We plan to assess gamification's effect on the consumption of energy between groups of employees using a gamified app designed to match the contextual characteristics of their workspace. That way, we shall be in a position to compare the respective effects of the gamified apps on employee motivation. We shall furthermore analyze, group, and / or contrast our results, to address the research questions we have set forth.

4   Questionnaire Design

To further explore the relationships described in our suggested behavioural model, as well as optimally design the gamified applications we shall be using in our experimentations, we developed a questionnaire that is based on related literature. We plan to analyse the answers we shall collect through this composite instrument, together with the observations through our experiments, to evaluate the behavioural model we have proposed. The first part of the questionnaire assesses the participants based on the Five Factor Model (FFM) (McCrae and Costa, 1987), a model that describes personality based on five factors, also referred to as the "Big Five" personality traits: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism. It has been studied within a variety of individual behaviours, including the behaviour within games, as well as pro-environmental behaviour. The most widely used brief measure for the FFM is the TIPI (Gosling *et al.*, 2003). Personality should be considered in the design of gamified systems (Ferro *et al.*, 2013). With regards to pro-environmental behaviour, the FFM has been connected to environmental engagement (Milfont and Sibley, 2012), as well as concern (Hirsh, 2010). The FFM has also been examined with regards to gamers' style of play (Bean and Groth-Marnat, 2014; Tekofsky et al., 2013), motivations to play games (Park *et al.*, 2011; Jeng and Teng, 2008), difficulty adaptation (Nagle *et al.*, 2016) and speed of action (Tekofsky *et al.*, 2013).

The second part of the questionnaire is the UWES-9, that assesses the employees' work engagement, the "positive work-related state of fulfilment that is characterized by: (a) Vigour, (b) Dedication and (c) Absorption (Schaufeli *et al.*, 2006). In the third section of the questionnaire, the participants' individual energy consumption profile is assessed, according to a published questionnaire that connects VBN theory and energy consumption at the workplace (Scherbaum *et al.*, 2008). The aim is to record the adherence to a number of different daily behaviours identified as energy offending, delineate the current situation in the different sites with regards to energy consumption, as well as identify the values, beliefs and norms instilled in the employees. The fourth part of the questionnaire is directed towards designing our gamified app to fit its' prospective users' gamification profiles. While player typologies are related to personality types, categorising players into "player types" has been implemented as a means of explaining various behaviours exhibited during play (Ferro *et al.*, 2013). The "Hexad" gamification user-types model, has been designed to aid in personalizing gamified systems to users' personalities, while a survey response scale to score users' preferences towards the six different gamification user types described in the Hexad framework: "philanthropist", "socialiser", "free spirit", "achiever", "disruptor" and "player". They have also reported on significant associations of the Hexad user types with the Big-Five personality traits (Diamond et al., 2015; Tondello et al., 2016).

Poor game design, through the introduction of game elements without considering the needs of different user groups, is one of the key reasons for gamification projects' failure via inadequately attracting and motivating the users (Söllner, 2016). By understanding the relationship between player types, personality types and traits in relation to game elements and game mechanics, more appropriate and meaningful choices can be made for gamified systems (Ferro *et al.*, 2013). The fifth section of the questionnaire ascertains the participants' personal preferences for a game aimed at reducing energy consumption at the workplace. Choosing game elements based on the players' profiles may make them intrinsically motivating to them (Ferro *et al.*, 2013). We have based the categorization of game

elements, as well as their definitions, on the "legend of game element terminology" provided by Seaborn & Fels (Seaborn and Fels, 2015). The introductory question to this section was phrased as follows: "The following table includes and explains the functionality of game elements that a game may include. Please state how important it is for you, that each one is utilized in a game aimed at reducing energy consumption at the workplace, by selecting between 1-Not Important to 7-Very Important". We shall compare to the declared game elements preferences in this section to the inferred from the Hexad section, to reach our final decisions regarding the utilisation of specific game elements in our gamified application. The last section of the questionnaire is designed to record the demographic characteristics of our sample (age, sex, role in the organisation, having children). We shall utilise the answers collected from this part towards exploring the connection between demographics and employees' game preferences, as well as energy consumption behaviour during the next steps of our research.

5 Preliminary Questionnaire Results

Although we are still in the process of collecting insight from our targeted user base, we already have delineated some initial feedback from the questionnaire results. Having gathered the completed questionnaires from the six pilot sites, we proceeded to – as a first step – analyse the responses of our sample based on describing the frequencies they presented within the 7-point Likert scale answers. We have so far acquired and present hereunder the following indicative results:

Game Element	% Important
Progression	76.8
Levels	69.9
Points	68.1
Rewards	61.1
Badges	58.2
Status	58
Leaderboards	57
Roles	56.7

Table 1.   Preferences of our sample in game elements

With regards to their preference in game elements, our sample (N=226) assessed their importance in a gamified app aimed at energy conservation at the workplace in decreasing order as can be seen on Table 1. Importance was deduced by merging answers between 5 and 7 within the 7 point Likert scale of 1-Not important to 7-Very important. Indicatively, progression was deemed the most important whilst roles the least preferable. Therefore, to make the game more appealing to our sample, we have to bear these preferences in mind when designing the game design. At the same time the environmental personal norms of our sample seem to be activated to an adequate degree for 91.5% of our sample, while based on their self-reported behavioural intentions, 91.9% would be willing to assist in the process of conserving energy at their workplace (answered 5-7 in the relative likert scale questions). However as 40.7% of our sample admit to frequently not adhering to basic energy saving actions (rated 1-4 in the relative questions), a lag between behavioural intentions and actual enactment of energy saving actions has been identified. Furthermore, as the mean work engagement score of our sample was recorded at a little over 4/6, we expect our gamified initiative to be adequately adopted by our target

HEXAD Type	Present study	Tondello et al.
Achiever	**23.70**	22.18
Philanthropist	23.50	**22.36**
Free Spirit	22.75	22.09
Socialiser	22.63	20.33
Player	19.88	20.99
Disruptor	14.88	14.94

Table 2. HEXAD user type mean scores

user base. As per our sample's recorded answers in the Hexad gamification user typology questionnaire (N=98), the mean scores for our sample can be found in Table 2. Compared to the scores presented in other studies (Tondello *et al.*, 2016), we can see that – in contrast to their findings – the most highly rated user type in our case is Achiever, with Philanthropist in the second place. A reversal of places can also be noticed between Socialiser and Player, as in our case they were rated fourth and fifth respectively. These two reversals may be a product of the different setting in which the two studies were performed – a university vs workplaces. It may therefore be that in a workplace environment, such as the one we administered our questionnaire in, Achiever is more popular than Phi-

lanthropist, while Socialiser is more popular to Player gamification motivations. However, these findings need further investigation towards their explanation. We plan to conduct a more thorough analysis of the data we are collecting through the questionnaire instrument administered, to gain further insight and reach additional conclusions within the scope of our research.

6   Discussion & Conclusion

A large number of gamification applications have been implemented in various contexts over the past few years. However, there is a need for further investigation into the application of gamification in a corporate environment, especially towards energy conservation. Through our research so far, we have managed to uncover a research gap that exists in the bibliography, with regards to the effect of gamification towards employee motivation for energy conservation at the workplace. Our study is specifically focused on this area. We have additionally designed a research model to explain and measure the respective effects of the parameters that influence employees towards conserving energy at the workplace. Furthermore, we have designed a questionnaire, supported by literature, to aid in the validation of our proposed model, as well as the design of gamified applications in the context of our research. Preliminary results from analysing the answers collected so far indicate that Hexad user types may be differentially represented within workplace environments – a result that needs further investigation. We have also delineated and presented our samples' preferences in game elements within a gamified app towards energy conservation at the workplace. Our future plans include to thoroughly analyse the survey results we receive through our survey instrument, towards gaining further insight in our field of application.

Apart from its merits, our research also bears limitations. First of all, we have so far relied on self-reported measures exclusively, which are known to include personal bias. Towards covering this limitation, we aim to corroborate our findings by taking the actual energy consumption behaviour of the participants into account. We shall be in a position to do so, by recording energy consumption using specialised infrastructure within our planned future experiments. A further limitation of our research lies in the fact that we have employed the Hexad gamification user typology, a relatively new measure, backed up by limited research. We plan to reinforce the validity of this typology through our research, in our context of study, by applying it in workplaces and in real live conditions.

In conclusion, we aim to additionally complement the theory on employee motivation, through our research, by deriving guidelines into the application of gamification towards energy conservation at the workplace. Furthermore, we plan to contribute to the available studies on employee behaviour, by identifying how employee profiles are associated with the effect of gamification on their behaviour towards energy conservation. At the end of our study, we expect to be in a position to also provide additional general guidelines into the application of gamification in a business environment. These guidelines shall assist future researchers, as well as practitioners, in developing gamified apps, and energy conservation apps in specific, for use in a work environment.

Acknowledgement

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