Reduction of Electricity Usage in Medway NHS Foundation Trust Using Persuasive Technology: A Review

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ABSTRACT. Controlling energy consumption and carbon emission in the United Kingdom represents an ongoing challenge. The National Health Services' (NHS), in the UK, annual spendings on energy are massive with a proportion of them being wasted energy. An initiative came aiming at reducing energy costs in Medway NHS Foundation Trust (MNFT) by inducing pro-environmental behaviour in the hospital with the aid of technology. Numerous researchers targeted human behaviour through the provision of feedback to reduce energy costs. This research focuses on electricity consumption in MNFT while considering designing a system that could be transferred to provide savings on other energy sources as well. Moreover, deploying a technology based feedback system that, with proper motivation, can introduce positive changes in MNFT staff pro-environmental behaviour. With hospitals being a good example of a busy environment, a key contribution would be monitoring occupancy and human dynamics in different areas of the hospital and analysing it against energy data. This paper reviews the literature around various motivational techniques for individuals to conserve energy in the building sector. This includes different types of feedback and addressing human psychology through goal setting, social comparison and so on. In conclusion, a hypothesis is set to address the energy problem in MNFT. The hypothesis involves the effect of using feedback technology on human behaviour and its impact on electricity consumption in MNFT.

1 Introduction

Energy contributes to both economic and social development within a society/nation [1]. Nowadays, energy consumption and carbon emission represent daily struggles for many countries around the world. In the UK, the challenge of controlling them remains active and has not yet come to an end [2–4]. This leads to high costs being spent on energy utilities as well as impacting how green our environment remains. Hence, both the economic as well as the environmental sides are affected.

In the European Union, 40% of the energy consumed goes to buildings [5]. With focus on the healthcare sector, hospitals demand of energy is large as they are big and complex buildings that operate 24 hours on daily basis throughout the year [5, 6]. Hospitals consume energy in different forms and different ways to maintain and improve [7] the quality of health services provided for the patients' wellbeing [5]. Compared to other types of buildings, hospitals are high consumers of energy [8]. In an attempt to control this, energy management in hospitals became crucial and vital; a step forward to achieve economic as well as environmental savings in hospitals. This in return would reduce energy usage, lower the carbon footprint, save money and contribute to the patients' wellbeing.

The National Health Service (NHS) is considered an intense consumer of energy in the UK, if compared to other UK organisations. The NHS spendings on energy, across the UK, exceeds £750 million each year with a significant proportion being wasted, approximately 20%. Energy usage, with focus on electricity, in hospitals falls under building services, for example lighting, medical care (electrical appliances), catering and IT services. With the daily use of office equipment, which represents a fast growing electric load [9], along with other heavy duty medical devices; it is important to keep a close eye on the daily consumption to make sure that everything is used only when needed.

The human behaviour plays an important role and represents a crucial factor in energy consumption in hospitals, as well as other types of buildings. Thereby, it is important to look at how this behaviour affects consumption and how can motivation be used to reduce it. The fact that humans are the ones who consume, provide, and waste energy makes them the focal point when it comes to pro-environmental behaviour.

Similar to most domestic energy use, in a hospital environment the vast majority of staff members do not get to see the bills. In other words, the feedback provided on consumption is invisible to most of the users [10, 11]. This makes acting upon current behaviour and trying to improve it hard to achieve. Hence, it's important for any one individual to be aware of the consumption, by increasing its visibility [12], in an attempt to spread energy awareness and act on positive pro-environmental behaviour. As per [13], feedback in general is the provision of data resulting from a process that, if properly used, can modify a process or a system.

Technology nowadays is handy, affordable and provides solutions to many sectors/domains of the society. With many people of different educational levels using technology in the form of mobile phones, computers, and internet, researchers such as [3, 14] looked into how technology can be used to impact pro-environmental behaviour.

This paper aims at introducing a review of literature around what can motivate individuals to conserve energy in different types of buildings. The reviewed literature starts by discussing different energy saving measures in hospitals. It then looks at the use of different forms of feedback in different environments to address the human psychology through goal setting, social comparison, self-comparison, commitment and others. This paper contributes to the research that aims at deploying a technology based feedback system that, with proper motivation, can introduce positive changes in Medway NHS Foundation Trust (MNFT) staffs' pro-environmental behaviour. This research addresses both human psychology as well as engineering and new technology. In other words, how can technology, through the provision of feedback and monitoring human dynamics, be used to persuade pro-environmental behaviour in a hospital environment.

Sections 2 and 3 alongside section 4, represent the main core of the paper.

Sections 2 and 3 review energy conservation techniques in hospitals and residential buildings respectively. Whereas section 4 discusses occupancy monitoring techniques and how can it contribute to energy savings. The paper is then concluded in section 5 where a hypothesis is set to address the factors affecting pro-environmental behaviour in MNFT. Acknowledgments are left to the end in section 6.

2 Energy conservation in hospital buildings

Since the research contemplates a technique to reduce electricity consumption in MNFT, the review starts by looking at researches that considered different approaches in energy management of hospital buildings. The researches discussed in this section along with [15–18] focused mostly on improving the efficiency of the heating, ventilation and air conditioning (HVAC) related systems.

In [5], the authors presented and evaluated current energy saving measures that has been implemented, along with those that are yet to be implemented, in a hospital in Portugal. The authors mentioned that lighting, hot water and heating are responsible for more than 60% of the total energy used in a hospital building. Moreover, it was argued that controlling the indoor climate of a hospital constructs the major requirement of its energy management plan.

Electricity and fuel are the two main powering sources in this hospital. Electricity is used for ventilation, lighting, lifts, medical and office equipment, while fuel is used for various medical and non-medical purposes such as space heating. The energy consumption over a period of five years, 2006 to 2010, was studied to monitor the trend of consumption against the climate changes. A hot year like 2008 had higher consumption compared to a cooler year like 2010. This was due to the greater use of chillers in 2008 compared to 2010 that required more heating. An energy audit was carried out in 2010 to highlight the important factors necessary to construct a clear image of the hospitals' energy consumption. Heating had a big share in the consumption followed by cooling, lifts and lighting. Thereby, the energy saving measures were applied on lifts, lighting, chillers and building envelopes. The measures/solutions considered by the authors were based on replacement and supplying of new equipment as the current ones were not energy efficient. For instance, the authors looked into modernising the lifts by replacing the motors with ones that are equipped with an electronic speed variation control, installing a traffic management system and an alert system. These changes aimed at reducing the amount of power consumed by the circuitry of the old lifts, hence reduce consumption with reference to the number of daily calls. The traffic management system made sure that all passengers are served in order hence avoiding congestion and reducing waiting times. With regards to the chillers, any chiller that was more than 10-15 years old was replaced as this means that it's getting close to the end of its useful life. The replacement chillers had higher Coefficient of Performance (COP), which means it is more energy efficient. COP is the ratio between the amount of heat removed and the amount of input electricity required. The new chillers were found to be more efficient, due to their higher COP, and scored a payback period of 3.8 years. With lighting, the measure involved replacement of the light bulbs with more efficient ones plus the installation of motion sensors to monitor the presence of staff/patients in the halls/areas. The new implemented measures makes the environment more user friendly and gives room for more measures to be implemented such as monitoring occupancy rates which contributes to energy savings in a building environment [19]. The final energy measure looked at building envelopes. The aim was to decrease the sensitivity to the external weather to have more control on the inner climate. This involved fitting double glazed windows instead of the simple windows.

The evaluations performed by the authors on the new upgrades were based on cost, payback period and, where applicable, electrical ratings. As a hospital, it is important to ensure that any work on site does not affect the quality of service provided to the patients. The cost of this is much more important compared to any savings that could be made from this change. In respect to the focus of the research conducted in MNFT, it was important for the authors in [5] to highlight how people were informed about the changes performed in the hospital. This would ensure that the new features are utilised efficiently.

In [6], the aim of the study was to review and analyse different energy conservation techniques, in the hospital sector, that would form the state of the art in this area. Heating, electricity, compressed air and cooling were identified as the four main energy flows. Each has a crucial role within the hospital and each impacts the energy consumption depending on the level of activity. Thereby, it was important to decrease the factors affecting energy consumption by trying to maintain a fixed internal climate that complies with the standards/requirements of a hospital building. The study performed by the authors covered different energy saving measures. Some looked at electricity measures such as installation of high efficient electric motors [18], or the use of LED lighting. Others looked at systems like combined heat and power (CHP), an aquifer thermal energy storage (ATES), fuel cells, photovoltaic based systems, solar thermal and solar cooling systems. All of which have potential to significantly reduce energy consumption and emission of greenhouse gases. The major drawback to most of the previously mentioned systems was their high costs. This makes it difficult and time consuming for a hospital to take a decision to go with any of them. The study also highlighted the role of information and communication technology (ICT) in energy conservation and how it evolved. For instance, addressing energy management in a hospital building using building energy information system (BEIS) and the use of artificial intelligence.

The study also involved several case studies aiming at highlighting the efforts being made when it comes to energy consumption reduction in hospital buildings, a number of which are discussed here. The first was a study that involved a Mexican hospital where the researchers looked into applying a pinch technology in an attempt to reduce thermal power. Pinch technology is based on pinch analysis which is a method for energy reduction through the introduction of thermodynamically based methods. Another study was made on two Polish hospitals. The results were useful in the essence that they gave room for analysing the possibility and feasibility of using renewable energy sources. The study involved monitoring the seasonal changes in the heat consumed used to produce hot water. The consumption was monitored and reported for different periods of the day at different times of the year. A third study in a hospital in Italy looked into the effect of using fuel cells on electricity consumption. The results of their analysis showed that fuel cells can provide enough electricity to cover 86% of the required amount. More case studies were reviewed by the authors, the aim was to point out that simple measures could be taken to achieve up to 10% savings on energy consumption.

In [8], the authors investigated a number of strategies in an attempt to improve the energy performance of the hospital. The strategies were selected by the management of the hospital whilst taking into account the limited economical budget available. The selected strategies were referred to as Cases A, B, C and D. Case A involved thermal insulation of the roofs using polyurethane to reduce their thermal transmittance. Case B on the other hand targeted the supply of hot water. The aim was to regulate the water temperature with reference to the external temperature. This was performed using a three-way valve. The third strategy, Case C, looked at controlling room temperature by installing thermostatic valves for each of the radiators. Hence, controlling its operation depending on the temperature of the room. Upon completion of an energy audit in one of the buildings, it was noticed that the air handling unit (AHU) in one of the rooms operated all day regardless of the occupancy of the room. Thereby, Case D involved automating the AHU control to turn on only if the room was occupied. The building along with fan coils, radiators and the AHU were modelled using TRNSYS along with custom models for those who did not exist in the TRNSYS library. TRNSYS is a tool used to simulate and assess the performance of electrical and thermal energy systems. Due to the limitation on budget, an economic model was also built. Each of the proposed strategies were analysed for annual operating costs savings, energy demand, seasonal thermal comfort indexes and simple payback period (SPB). Case D was found to be the most profitable as savings were achieved during summer and winter and capital costs were low. Furthermore, on a different level, Case B would be more profitable than Case C due to lower SPBs. The research findings indicate that user habits were not the only cause of high energy consumption in the studied hospital and that space heating and cooling largely impacted the consumption. The measures introduced so far were focused on energy efficiency of equipment or medical devices to improve the HVAC systems. Achieving savings through the introduction of the previously mentioned measures does not mean that it will sustain. This was highlighted by Jevons paradox which occurs when the increase in savings leads to an increase in demand [20]. Thereby, it was important to look into how pro-environmental behaviour can be induced to be a habit in the consumers' life. This has been looked at in different domains of the building sector but remains a challenge when it comes to hospitals.

3 Effect of feedback on energy consumption in residential buildings

This section of the review discusses the researches that looked at feedback as a tool to motivate positive energy behaviour in two different forms of residential buildings, dormitories and public dwellings.

3.1 University dormitories

Several points were selected, highlighted and focused on in each of the reviewed papers in this section. This was to form a proper understanding of what forms an effective feedback and how can energy behaviour be improved accordingly. In each of the reviewed researches, the following points were identified: type of feedback provided, frequency of feedback and the motivation techniques used.

The authors in [14] examined how different resolutions of feedback encouraged electricity and water savings in the dormitories of Oberlin college. The authors developed a website were data, from water and electricity flow sensors, were logged onto it wirelessly. The website was the feedback medium for the students to view their consumptions. A two-week period competition was carried out between 22 dormitories, 4 of which were disqualified due to faulty meters. Two of them were labelled "High Resolution Dormitories", each had three floors, two of which were monitored and displayed while the third was only monitored and acted as a control. Data was pushed to the website for those two dormitories continuously to ensure real-time feedback of data. The remaining 16 dormitories were labelled "Low Resolution Dormitories" as data was provided to them on weekly basis throughout the competition. A three-week pre-competition period was used to collect base-line data for all dormitories without displaying any data for the residents. The authors highlighted that the overall savings reached 32%, with higher savings for the "High Resolution Dormitories". This implies that provision of feedback on regular basis with the proper motive can impact pro-environmental behaviour and reduce energy usage. However, sustainability of the behaviour was not measured as the incentive was removed by the end of the competition. Although the survey indicated that students will continue to practice the energy saving measures. This would not mean that it will be sustained, especially with the very short period of the experiment. Similarly, the authors in [2–4] investigated the effect of real-time feedback on energy conservation behaviour. However, in addition to real-time feedback, they looked into the effect of combining it with energy delegates to achieve the required savings in the University of Kent halls of residence. The role of a delegate was to teach, motivate and alert, using data from the website, the fellow residents to reduce consumption. The authors relied on wireless electricity flow sensors to monitor and log the electricity data on a centralised web-interface. The experiment involved 16 halls of residents divided among two groups, experimental and control. Each group was exposed to different, with some common, conditions. The experimental group was provided with real-time feedback, had appointed energy delegates and took part in a pilot survey. On the other hand, the control group had the same but instead of appointing an energy delegate, the group was sent weekly email alerts on their consumption. The study period was divided into, a baseline data collection week, a four-week intervention period and two weeks of post study data collection. The combined effect of energy delegates and real-time feedback was removed after the completion of the four-week intervention period to investigate its effect. The results were analysed on numerous levels to accurately identify which of the periods and in which group were the most savings achieved. Generally, it was proven that the most savings, 37%, were obtained in the experimental group due to the combined effect of real-time feedback and energy delegates. Students highlighted, through the survey, that they were motivated by the real-time feedback given to them via the web-interface. Furthermore, the combination of delegates and feedback made the students teach themselves how to conserve energy. Data from the post study period revealed that reductions were not as they were during the intervention period. This shows the importance of the combination proposed by the authors to ensure sustainability of the students' behaviour. However, due to the short period of the study, the sustainability of the behaviour, even in the presence of feedback and delegates, could not be guaranteed. From a different perspective, the authors in [21] studied how the effectiveness of an eco-feedback system on energy consumption behaviour could be impacted by cultural difference, which was also discussed in [22]. The study involved four buildings in which three of them were occupied by Chinese students, home students, and the fourth building was taken by the internationals. A six-week baseline period was taken before recruitment where daily consumption data were recorded. The intervention then lasted for seven weeks and started immediately following the baseline period. The intervention involved two groups with two other groups acting as control groups. The intervention groups were given access to the web-interface for feedback on their electricity consumption and were sent weekly emails reminding them to check them. With students, it is important to utilise the time they spend on an activity to the maximum. The time taken to open a reminder email could have been better utilised if consumption data or status were pushed in the same email. When accessing the eco-feedback website, students were provided by their detailed consumption as well as those of other students. This acted as a method of motivation through providing room for competition with other students. The Chinese students in the intervention group managed to reduce their consumption by 16.7%. While the international students in the other intervention group increased their consumption by 23.7%. The authors' explanation to this large difference in results was that international students had their universities pay for their bills, hence a behavioural problem. A number of factors may have contributed to the obtained results; firstly, it was not mentioned when did the internationals start their study, time taken to settle down and get used to the new environment is important. Secondly, if the students were on an exchange program lasting for a month or two then their behaviour is more likely to be different compared to students whom are committed to a large study period. The authors concluded that culture had an impact on the effectiveness of the system. Being a possible factor, the study time and the samples chosen were not seen to be sufficient to draw such conclusion. Unlike the previously discussed researches, the sustainability of the students' behaviour was not mentioned as the aim was to study the impact of cultural differences. However, the provided data about the intervention setup and findings would not guarantee the sustainability of the behaviour among the Chinese students.

In another study, [23], the effect of feedback, in addition to incentives, on energy behaviour was found to be effective. An experiment was carried out to investigate the effect of combining daily feedback, visual prompts and incentives on electricity consumption of two university halls in New Zealand. The halls were randomly assigned to either an intervention or a control group. A three-week period prior to the experiment was used to collect baseline data for both groups. The baseline data conditions were maintained for the control group throughout the experiment. On the other hand, the halls in the intervention group were provided with daily feedback, visual prompts to spread energy awareness and rewards. Feedback was provided daily for the intervention group by providing data about savings, displayed on a whiteboard. The savings were collected and compared to the baseline data as well as the control group. Large posters were used to draw the residents' attention to the thermometer drawn to display the savings as well as give information on possible rewards. Alongside the posters, small notices were used as visual prompts to educate the residents. It was pointed out that the mean savings were higher in the intervention halls compared to the baseline period. However, the fact that feedback was not presented in an efficient way and was only by providing data on savings held back more reductions that could have been achieved. Similar to [14], sustainability of the behaviour was a major challenge as the conditions for saving were removed and the experimental period was small to decide on a possible behaviour to sustain.

3.2 Public residential buildings

Although public dwellings fall under the residential building sector, occupants' behaviour differs, if compared to university dormitories, as their ages vary widely. A few points were looked at in this part of the review to identify the key points that formed an effective feedback environment. Existing literature intensively reviewed interventions made aiming at identifying what forms an effective feedback. Researches such as [10, 11] discussed the different types of feedback, such as direct and indirect. Along with what forms a good feedback such as the frequency, display units and so on [24]. Others such as [25] reviewed interventions to identify what best motivates and encourages people to reduce consumption. On a different level, the importance of the feedback medium such as the use of displays or smart metering was discussed in [11, 26].

The effectiveness of feedback relies on several factors that need to be considered in a design. Feedback, in general lay terms, is the process of taking an output from a process and feeding it to the input. In this essence, taking energy readings or equivalent cost or environmental impact and visualising it to the user. This could be in various forms, some of which are direct or indirect [10]. Although, in the literature, direct feedback has shown more effectiveness compared to other types. It is important to identify what form will suit the environment/audience that feedback is being given to. In other words, identify the energy culture. Feedback is given to notify, alert and teach users about their energy consumption. Hence, for it to do this, it needs to be put in a comfortable and effective form. Froehlich, J. in [27] introduced the "ten design dimensions of feedback technology" which the author considered to be overlapping together however each still had its' own impact. The aim was to identify several factors to consider when attempting to design or evaluate a Human-Computer Interaction (HCI) based feedback system. Some of the factors were frequency, measurement units, continuous availability of the data, medium and location. The author used existing studies in in-home energy usage to illustrate and support the proposed dimensions. The main aim was to outline the role HCI can play when it comes to in-home energy usage and feedback systems. The reviewed studies showed that in-home feedback technology can achieve 10-15% reduction in energy use. However, sustaining such reductions remained a challenge.

A number of techniques involved the use of different forms of displays to provide feedback on in-home energy consumption [26, 28, 29]. In [26], the authors discussed the use of central and local displays to motivate in-home energy users to conserve energy. With displays, it was important to identify their location, how will they motivate users and how would data be represented on them. The authors discussed several options to locate the displays, including static/mobile central displays and displays that are embedded into the appliances. To motivate the in-home energy users, provision of comparative data was proposed. This involved, comparing appliances, comparing utilities, comparison to historical data or to other families and so on. The aim was to create a medium where users feel the need to conserve to be better. Moreover, the use of rewards and motivation through goal setting were proposed by the authors. Each of which showed success in previous studies reviewed by the authors. To ensure effectiveness, the authors discussed how data would be visualised on the displays. The main points considered were, the numerical unit, that is kWh or £, method of display, that is table form or chart. Furthermore, categorisation of data, that is by energy source or by room, and whether the user would be able to interact with the display. The experiment in [28] tested the effect of combining goal-setting with feedback via monitors on the in-home usage of natural gas. The experiment involved different groups, each was subjected to a set of conditions with some of them acting as control groups. The reduction in usage of natural gas achieved, with daily feedback, was 12.3% which was not the same with other groups. Although a post-experimental study, that involved removal of the experimental conditions, showed reduction compared to the baseline data. The reduction was achieved but did not differ among the groups. In [29], an approach that proved itself promising in the area of ambient awareness in energy management was the energy puppet. The energy puppet, designed, would be attached to home appliances and continuously display consumption data. The approach relied on visual prompts such as LCD displays and LEDs. The authors vision was to influence behavioural change through spreading consumption awareness via the energy puppets.

4 Monitoring occupancy and human dynamics in MNFT

The large demand of energy in the building sector is strongly related to how they were used, aside from their design and the way they were built with [30]. Along these lines, it is valid to assume that the occupant behaviour contributes and is related to the energy consumption of a building. This strong relation between occupancy and consumption highlights the importance of monitoring rates of occupancy in MNFT. Several studies about the relationship between building occupancy and energy were reviewed and are presented in this section.

The aim set, was to count the number of people in a ward/area of the hospital and report it to be analysed against electricity data collected for this same ward/area. Doing that would require consideration of traffic, entrances to the same ward/area and accuracy of the data. Prior research work has introduced various techniques such as Radio Frequency Identification (RFID) [31, 32], Wi-Fi [33] and sensor networks [30, 34] to monitor occupancy for different reasons and not only energy consumption. Other than analysis of energy consumption, reasons included safety and security[35, 36].

One of the proposed techniques, in the literature, to get hold of occupancy data was to count the number of Wi-Fi connections [33]. This would indicate the level of occupancy in the area covered by the wireless network. The aim was to identify whether the occupancy has a high impact on the energy consumption in Massachusetts Institute of Technology (MIT) or not. The results have shown that occupancy did not represent a major factor in relation to consumption of HVAC systems while it did constitute an impact on electricity levels. This supports the approach taken to study human occupancy in wards/areas of MNFT knowing that the main study was intended on electricity consumption. Although wireless technology currently represents a handy and cheap solution in all sectors of the society. Using them for this purpose, especially in a hospital environment, does not represent the optimum solution. The assumption that each person present on the MIT campus has only one Wi-Fi enabled device is crucial to ensure high accuracy. A hospital represents an environment that accommodates people of all possible ages from different social levels. Thereby, it is hard to assume such an assumption knowing that one can easily have more than one Wi-Fi enabled device while another may not have any.

Two other studies [31, 32] considered the use of RFID to monitor human occupancy against energy efficiency and efficient building lighting control respectively. The first investigated the effect of combining occupancy monitoring using RFID with Passive Infrared (PIR) sensors on building lighting control. The results have shown accuracy of 91.43% and estimated savings of 13%. The latter reviewed different measurement technologies such as motion, CO_2 acoustics, Radio Frequency (RF) signals and so on while classifying them according to their function and the method they use. The review highlighted the advantages and disadvantages of each technology and whether they can provide accurate occupancy information alone or combined. The authors settled for the use of RFID in their study due to its intermediate cost and accuracy compared to other solutions. The results of the study have shown that occupancy did not have a significant impact on appliance energy usage, mostly personal computers (PCs) as per the authors. However, this does not rule out the relation between occupancy and energy consumption. Although computers do save electricity when in idle mode, they still draw some and would be better off shutdown if not in use, for example over lunch time [37]. Staff members in various organisations tend to leave their PCs on to easily resume work after lunch. In this essence, it was important to focus on the behavioural aspect and raise awareness of the impact of PCs on the total electricity consumption to achieve reasonable savings from the study. Nevertheless, the use of RFID in hospitals represents a challenge due to the difficulty of tagging each person in the hospital, especially visitors.

5 Conclusion

A review of literature that overviewed different techniques used in the building sector to reduce energy consumption was presented in this paper. The aim was to identify various approaches considered by researchers to tackle the energy consumption problems in the building sector with emphasis on inducing pro-environmental behaviour in a hospital environment. In hospitals, the measures introduced considered the use of non-behavioural related techniques to reduce the consumption. Although, for some studies, improvements were achieved in the consumption, sustainability was not guaranteed. Same applies to the studies that investigated the effect of using feedback and different psychological techniques to influence pro-environmental behaviour in residential buildings.

A hypothesis was set, while considering the strengths and weaknesses in the presented literature, to address the factors affecting pro-environmental behaviour in MNFT. A questionnaire was designed to collect behavioural data and measure energy awareness of MNFT staff. The survey was intended to collect information on staff preferences for electricity data representation in MNFT to ensure maximum effectiveness of the feedback system. The following points were taken into consideration to ensure the development of a sustainable pro-environmental behaviour in MNFT:

- Installing a smart sub-metering system to log electricity data onto a centralised web-interface providing feedback on consumption to MNFT staff.
- Feedback would be frequent, available for MNFT staff to log in and view the consumption at any time whenever they need. Moreover, represented both graphically and in figures.
- Data on electricity consumption is to be provided for individual wards/areas of the hospital. Hence, making it easy to identify areas of high consumption and analyse it.
- Appointing energy delegates to monitor, motivate, educate and alert MNFT staff. Delegates would ensure that proper behavioural measures are undertook in the wards/areas they oversee. This would ensure sustainability of a green behaviour in MNFT.
- Delegates would set goals and use historical electricity data to motivate MNFT staff to conserve electricity.
- Following a baseline period, a long experimental period, three to six months, would be carried out to test and validate the system success.
- Data on occupancy monitoring of wards/areas in the hospital would facilitate building an understanding of energy consumption trends in the selected areas. Hence, contribute to the energy management and sustainability systems in MNFT.

Considering the previous points would provide a strong base and a step towards bridging the gap between human psychology and technology through the development of persuasive technology.

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