OPTIMIZATION OF BEHAVIORS BY IOT FOR ENERGY EFFICIENCY IN SMART BUILDINGS

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Overview

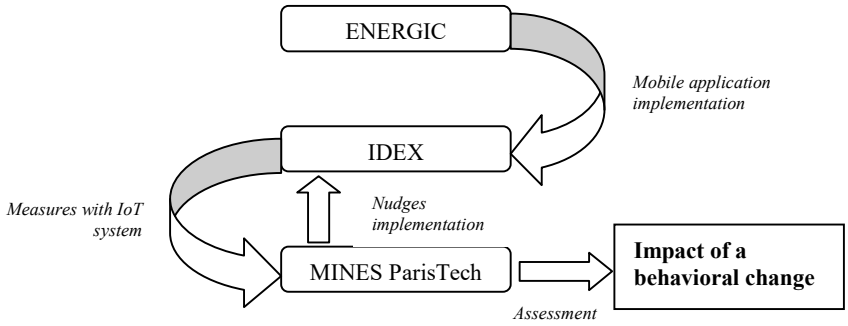
Energy consumption is at the core of environmental issue due to pollution and global warming. Among the challenges to take up, in the past few years, searches, studies and measures have been focusing on the technical performances of buildings, particulary on the envelop and the Heating, Ventilation and Air-Conditioning (HVAC) installations. But technology alone will not achieve building energy performance targets; we need to understand the effectiveness of occupant's behavior to provide energy building performance, combined with technical progress. Monitoring buildings offers new perspectives to master energy building consumption but also raises some questions according to the use and the behaviors adopted by the occupants. Behavioral economics has made major contributions to the development of this literature assuming more realistic individual behaviors than the one usually supposed (Charlier et al., 2018). Several experiments have already been conducted at varying scales testing nudges on energy consumption but they generally concerned households' electricity consumption in residential sites (Allcott, 2011; Ayres et al.,2013; Houde et al., 2013; Sudarshan, 2017). Buildings behavior is driven by many parameters such as climate, uses or occupancy important to consider to guaranty comfort for the occupants and their activities. In this context, the purpose of this study is to develop a methodology to consider consumer's behavior to manage energy efficiency in buildings by using IoT. Practically, the study is based on an experimentation and a behavior occupant analysis in order to calibrate useful items to establish a steering building programm by involving the dynamism of the users. The combination of a technical and behavioral study shall apprehend a real smart building, turning it into an inescapable actor of the smart city.

Methods

The energy system that constitutes a building and its use are very complex and multi-faceted from an activity to another and from a structure to an other. Optimisation algorithms modelling the social, economical and physical behavior can not be done with classic methods. We propose to develop a methodology based on the integration of the users building behavior coupled with the monitoring of IoT with implying the occupants dynamically. In order to put the users at the forefront of the system and make them care about the effects of their doings on the community and the energy consumption on the building, we implement an experimentation with various tools, including nudges, that enables to guide the users to a willing approach of energy efficiency in their dwellings of their work site. According our ambition to combine a technological approach based on sensors and a behavioral approach, we lead simultanealy 1) a relevant analysis based on data collect and treatment – we deploy data mining methods to predict the consumption, the internal temperatures and ways of consumption rehancement - and 2) a behavioral analysis based on specific informations used to make users subscribe to the enhancement of their consumption and the implementation of different nudges fed by the datas collected with IoT and a mobile application. For the second part, we lead different surveys on our users panel. Those are tertiary sector buildings such as nursing homes or offices, located in Nancy (France), and instrumented by the Idex society. Idex is a French firm providing sustainable energy management for their customers by following their consumption and optimizing the efficiency of their installation. We work on the buildings they are monitoring with a start-up called Energic which provides the implementation of a mobile application to stimulate the users. More precisely, that consists of a kind of nudge that put the occupants into a competitive game whose aim is to reduce their energy consumption. Moreover, we work on the implementation of other nudges on those buildings to measures and quantify the energy economy made when consumers change their behavior, voluntary or not. This enable to explore the conditions and perspectives of evolution of individual and collective energy consumption behaviors. Along with this experimental study, a numerical study is to be used to simulate the same buildings behavior energetically by implementing stochastic occupant behavior scenarios.

Results

The purpose of this study is beyond analysing and assessing users behavior in office buildings. On the one hand, we aim at identifying the ways that can reduce the energy consumption of the buildings, and at recommending ways to encourage an individual and collective behavior less energy consuming by complementing those with IoT. In other words, we propose to identify and incentive methods for the energetical education on the users work and life site. And on the other hand, this study proposes an original approach combining sensor data approaches with a behavioral approach that will allow the development of predictive control algorithms for both energy management and community animation in smart building.tool. The stake is to rethink the ways along we master energy in buildings through a better understanding of behavior hand gears we want to implement in several buildings.



The results on both experimentation and simulations would raise some questions up:

- Will the behavioral change have a long-term effect?
- Will the implementation of nudges be accepted?
- What behaviors are optimum for energy consumption?

Conclusions

This work provides the conception of a tool that will bring enlightments and recommandations on the ways to master the building energy consumption more efficientally and systematically. It gets involved with the behaviour economic literature but also the development of smart cities et will represent a support the brainstorming of concrete solutions for energy saving in buildings.

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