People in Smart Buildings: Daily Practices in Automated Areas

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Abstract. Managing the energy needs of buildings is central. This question is deeply linked with people density in urban area which is still increasing. We are at a turning point: reaching the goal of the low carbon transition. As is known, the reduction of this sector's carbon footprint entails the reduction of the carbon dioxide emissions that it produces. Consequently, the search of human and technical solutions in a multi-scale and systemic perspective is a central element of this process. First, we observe uses required by sites managers. Second, we aim to show users' strategies facing automation, both in terms of space occupation and lighting use. Then, we focus on people's involvement and their behavioural change considering the participatory design of services and systems for smart buildings. Finally, we address the power of collective identity, as a quest of good balance between human action and automation.

Keywords: Energy · Daily practices · Behaviour change · Sociology · Geography

1 Introduction

According to World Bank figures for 2014 (http://www.worldbank.org/, 2014), the urban population accounts for 53 % of the total global population. By 2030, almost 60 % of the world's population will live in urban areas (http://www.un.org/en/sustainablefuture/cities.asp, 2014). Veron [1] says that city dwellers will account for over 70 % of the world's population in 2050. The United Nations World Urbanization Prospects has estimated that 79 % of the population in France live in urban settings (http://www.worldbank.org, 2013). In a perspective of durability, as shown by Guermond [2], the phenomenon of population density raises the question of the density's management in territories. Finding good responses entails reflection on the morphologies of cities, their link to hinterlands and the manner to govern these vast areas [3, 4]. One simple solution doesn't exist [5–7]. There is an intense debate between those who defend compactness [8, 9] and those who maintain the idea of a peri-urban area [10–15]. Morphology is a mirror of the urban fabric that can be observed by satellite view [16]. This reflects human beings' habits and their spatial relation with their environment. Human activity depends on the generation of energy resources despite their diminution and their cost [17]. Modification of energy consumption is an

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important question. As Poinsot [18] has shown, it challenges the pertinence of the multi-scale territorial response in France. Pappalardo [19] shows us that cities are the main places of energy consumption in the building sector, housing and tertiary. She has found that in France the building sector is the most energy intensive sector (23 % of national emissions). Reducing the carbon footprint implies the reduction of C02 emission. The Report of the United Nations Conference on Sustainable Development (http://www.uncsd2012.org/ 2012) reaffirms the will to ensure the promotion of an economically, socially and environmentally sustainable future for our planet and for current and future generations. Reaching these goals entails compliance with urban planning measures, particularly their legal regulations and standards (io: In France, Law No. 2010-788 of 12 July 2010 on the national commitment to the environment). Therefore, research on technological innovation can contribute to reduce resource and energy consumption. While many projects have developed technical approaches to generate and maintain energy in the city (Fenix, Rider, and Reflexe), none has enabled a real-time energy monitoring of the entire production chain supply facilities at multiple scales (building and related areas such as districts). Our study is part of a programme with multiple partners that consists of the creation of a technical solution for energy management by building a smart grid demonstrator, which eventually should be broadened to the level of an eco-district. This project involved important firms, leaders in the energy sector, as well as small businesses and academic partners.

Nonetheless, monitoring an energy chain supply is irreducible to a technical approach. If cities are artefacts, they live through human beings' interactions [20–22].

Our project considered these aspects, so we assumed responsibility for the part of the programme work package that concerns the behaviours and daily practices of the people working in the selected buildings.

In this research program what particularly caught our attention was the role of human beings in the heart of that system. Our field study focused on two main sites: two French firms located in the West of Paris. We wondered how a community of actors contributes to the implementation of sustainable and virtuous practices in terms of low-carbon transition. How are roles distributed? What rules govern the interactions in these places? Who makes the rules? What are the effects on the scale of the building and beyond (eco-district)? Is the emergence of good practices effective? Can it be transposed to other locations?

After a brief presentation of our theoretical frameworks and methodologies, this paper will first show the required uses, with dedicated areas, and the place of automation. It will then try to explain the real practices, in terms of space use, lighting use strategies and reactions towards automation. It will further show how involving people, with participatory design of services and systems for smart buildings, can motivate behaviour change. Lastly, this discussion will question the idea of collective identity and the balance automation/human action.

2 Theoretical Framework: A Complex Approach

Ethnology will allow us to create and analyse our observations of actors and his actions in live. This discipline is observation-based and has two dimensions. On the one hand, it is based on facts, details and specificity collection [23], and seeks to "rebuild their

form and meaning" [24]. On the other hand, it tries to "bring closer, generate dialogue, and show what is common in this world of differences". Agier [24] and other ethnologists have contributed to the establishment of our field study. Agier has explained:

"The ground is not a thing, it's not a place, nor a social category, an ethnic group or an institution. It is all of this, maybe, as appropriate, but it is firstly a set of personal relationships where "you learn something". "Doing fieldwork", it means establishing personal relationships with people who we do not know in advance, to whom we somewhat break in and enter into their lives. So we must convince them of the validity of our presence, also that they have nothing to lose even if they have little to win, and most of all they have nothing to worry about. Relationships can be harmonious and friendly with some people, conflictive with others." (p.35).

Our approach also conforms to a "geo-cratic practice" [25, 26] that considers actors' behaviours and their interaction as a social production. Through political geography and not simply a geopolitical geography as posited by Rosière [27], conflicts and cooperation are in the heart of the research. This type of research considers the importance of the citizens' perspectives within a democratic approach in which the researcher is at the service of the power of democracy. Our objective is to question people's power and capacity [28] to produce norms and to reach a new kind of spatial justice. Our approach is also conform to the heritage of the French social geography relating and interrogated by Séchet, Veschambre [29]. This geography is a response to social demand, focused on social inequalities, exclusion, human dramas and that examines the social relations of domination.

3 Methodological Aspects: Crossed Social Sciences Methodologies

We studied these elements from a social sciences perspective, that employs methodologies borrowed from sociology, ethnography and social geography. Our data collection is based on semi-structured interviews, questionnaires and ethnographic observations.

This complex methodological approach enables the collection of quantitative survey data and a qualitative discourse analysis. Observations allowed direct access to users' practices and behaviours on site. Thanks to this methodological tool, we can study how much discourses are far from real practices or not.

The surveys were conducted in two buildings that serve as the headquarters of two leading companies in the energy field.

The qualitative analysis is based on twenty-three semi-structured interviews conducted with the users of these buildings. An interview guide was created that included questions about energy use and behaviour in the building. The data collection process started with semi-structured interviews, which were recorded. Interviews were textually transcribed and analysed with Alceste, a text analysis software. This methodology was completed by systematizing key themes and classical content analysis.

Interviews were firstly "groomed", which means formatted to be analysable by our software for text analysis. We then began the analysis through an automated data processing with Alceste. This software cuts the text, making elementary context units (UCE), pieces of text selected and analysed by the software. These UCE are then

spread within classes by detecting strong oppositions emerging from the text. Each speech class groups a number of words belonging to a lexical world distant from those of the other speech classes.

As Rouré and Reinert [30] explain, while the speaker converses, s/he goes through his/her successive. These worlds, having their own objects, impose their own type of vocabulary. The statistical study of this vocabulary's distribution must allow us to track down the "mental environments" successively invested by the speaker. Authors precise we can then see in lexical worlds. Alceste software will help us find these lexical worlds.

To make the cross-sorting with which we analyze specific vocabulary of our corpus, we had to choose one element from this corpus, either one word or one variable. The software has a drop-down list of all the words of the corpus in alphabetical order. As such we can cross each word with the whole corpus. Alceste then gives us significant elements, with Khi-2, and with the repeat factor and the category to which the term belongs.

These category-specific keys are adjectives and adverbs, verbs (of action and movement in particular), the demonstrative …

Throughout these keys, we can get information about interviewed people's position (according to Achard, [31]). Three positions are possible [31]: witness, actor or patient. These positions define people's way of living and acting. Alceste software spread the indicators of these positions into speech classes. Witness position is defined by an over-representation of adjectives, adverbs and nouns (sign of a descriptive discourse), and also descriptive elements, spatial elements and no markers of person like personal pronouns. Actor's position is defined on the contrary by an over-representation of verbs, indicating an action or a move in discourse, associated with markers of person. Finally, the patient's position is defined by discursive relation markers, which indicate argument and storytelling and logical and temporal elements.

These elements are our first guide through the analysis.

For the quantitative analysis, we constructed a questionnaire to be asked to all users of the two main buildings of the study. Since managers wanted to know exactly what we could ask to the building users, this step needed negotiation. Moreover, in the first building, the questionnaire was implemented by the communication service of the company, as they didn't want researchers to have access to their employees' email lists. We were only told that it had been sent to 825 persons. The questionnaire was available for one month on each site and we got 264 answers from users. These answers are the basis of our quantitative analysis. We used Modalisa software to help us analyse the data. Modalisa is a software dedicated to surveys quantitative analysis. It allows the finding of indicators such as type of behaviour or elements of freedom appearing from modalities of energy and space use.

Observations were a more complex process. In none of the buildings the higher hierarchy accepted researchers to come and observe their employees. In fact we had to find ways to be there for others reasons. Interviews on site were one of our best pretexts. When several interviews were made on the same day, we had a good reason to move from one place to another inside the building. Sometimes we could spend lunchtime on site. This was also a moment for informal discussion, and sometimes people showed us one part of the building to underline what they had said. Technical visits also served this purpose. As both buildings aspire to be models of energy efficiency, we visited each building at different times and with different guides, feigning

that we had not understood certain topics or required additional information regarding some technical aspect. In this manner, we were able to visit all parts of both buildings and observe people's use and behaviour in these spaces.

4 Required Uses: Dedicated Areas, Automation

The buildings we studied are located in the West of Paris region (Fig. 1). They are both located in dense urban areas and are, for their respective zone, quite big buildings.

Fig. 1. Maps of buildings' localisation.

The first building is located in a business district, while the second is in a city centre, with residential buildings, office and mixed-use buildings, shops and a park. With its 7

floors, it is one of the highest buildings of this area. The two buildings are quite different in their conception, and that can have an impact on automation and required uses of space.

The first building was constructed in 1986, with a reinforced concrete structure and a stone façade. It has 9 floors, covers an area of 34 000 square meters and roughly 1000 people are working there. Energy efficiency systems have been implemented in the last ten years, quite twenty years after the building's construction.

The second building was constructed in 2001. It is covered with a double skin consisting of a concrete wall and double-glazed façade. It covers an area of 11 814 square meters and roughly 600 people are working there. It was directly built in a perspective of energy efficiency.

The first element we could clearly observe in these buildings was space allocation. It appears that in the designers' mind, energy efficiency design in tertiary buildings begins by allocating a place to each occupant. The floor plans (Fig. 2) of the buildings studied show how space is divided.

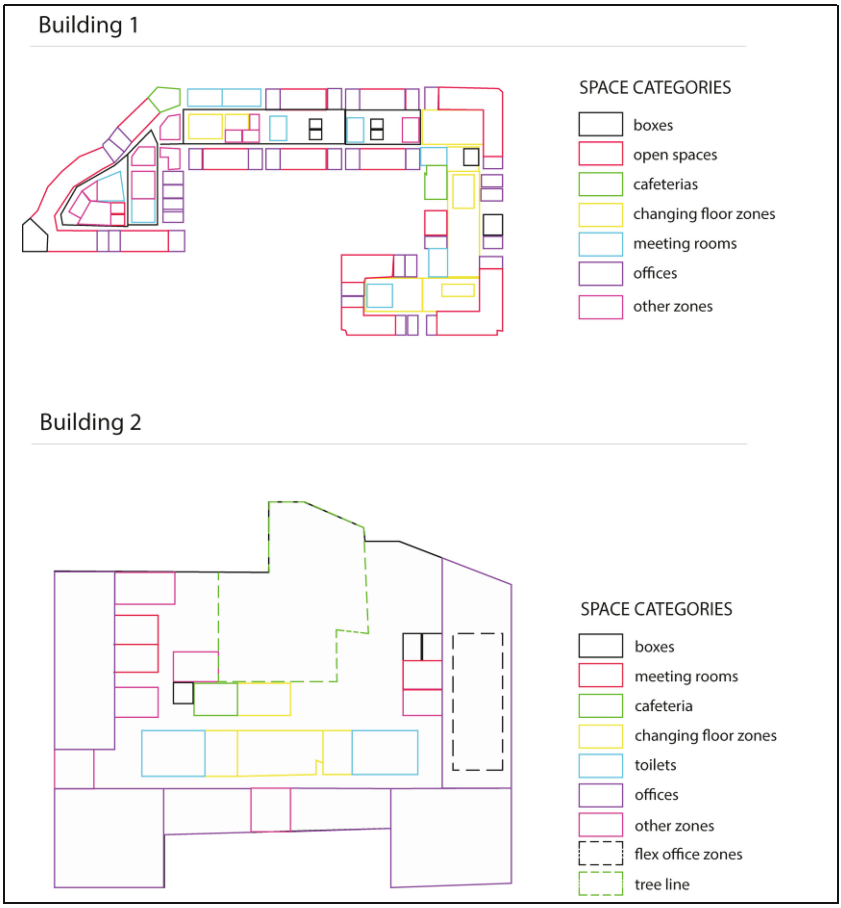

Fig. 2. Floor plans of the buildings studied.

Offices should be the main workplace for each occupant, but we see that other types of places can be used to work, such as meeting rooms or boxes. These places present different type of lighting and heating regulation. Knowing that energy use is different depending on the type of offices or others places people work in, we first asked people what was their type of workplace. As shown by the figure below (Fig. 3), most people work in an open plan configuration.

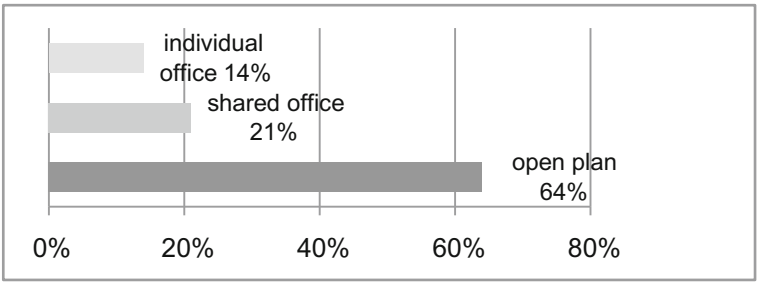

Fig. 3. Workplace.

This means that a space where individual choices are restricted, because of automation and the need to negotiate light and heat uses with other occupants of the open plan. People are expected to stay in their workplace whether their job is adapted or not to that type of place. Whenever they need to speak by phone or with someone else, they can use boxes or meeting rooms, some of which are not really closed by and where light or heating cannot be regulated by the occupant. But in boxes and meeting rooms, occupants can at least get light, even if regulation is not possible. Heating regulation is different depending on the building: in the first one, boxes are semi-open, with no thermal regulation possibility. In the second one, boxes are closed and occupants can set the temperature to a range of 1,5°C warmer or colder. In the meeting rooms, thermal regulation is possible in both buildings. In workplaces, it is interesting to look at people's responses about the possibilities of lighting and heating regulation. These responses show how integrated are the required uses (Table 1).

Table 1. Lighting regulation.

	Number of respondents	Frequency
Non-response	1	0,4%
Yes, by ON/OFF	184	69,7%
Yes, by lighting controller	5	1,9%
No (collective light, for example)	74	28,0%
Total	264	100,0%

Lighting and heating regulations' possibilities:

For lighting regulation, most of people say they can turn light on or off if they want. But 28 % say they cannot. It is interesting because 64 % of people work in open-plan offices, where there is one dial for the whole open-plan. And in the other offices (shared by two people or individual), there is also a dial for the office. It means that 28 % of people think that they must conform to required uses and not touching the lighting dial. Or maybe even more, they really think there is no dial, which would be the highest degree of integration of required uses.

In open plan workplaces, people are expected not to modify heating regulation, even if they can. And there is not too much communication about heating regulations, so that people don't touch it. Indeed, many people explained to us they didn't even know where thermostat for their workplace was. Interviewee N°6 explained to us "Some people are not used to touching. You know that you have one thermostat for a whole open-plan. Someone who doesn't speak to colleagues, doesn't even know there is a thermostat." During our observations, someone showed us where the thermostat was for open plan places: in a corner where you clearly don't see it unless you know it is there. There are also established uses towards heating regulation, asking to let automation play and for human not to touch. During the interviews, one person explained that "we mustn't touch it because it will modify building's regulations, it is better not to touch" (interviewee N°2).

Moreover, so as to be sure that thermal regulation will not be too much used, technical staff explained that they limited the real effect of thermal regulation to a range of 1,5°C warmer or colder, even though +3/-3°C is registered on the thermostat. Interviewee N°7, who is a technical staff member, stated at the beginning regulation was more or less 3°C, but now it is more or less 1, 5°C, so influence is less important.

Intelligent planning of energy efficiency are generally thought as technological processes, with a high degree of automation. For example, a light cut is implemented every day at lunchtime, and another in the evening. There are also presence sensors in the cafeterias, in the toilets and in the corridors. But as observed, light in the corridors is always on due to the sensor's timer, and the fact that it takes one person alone cross a corridor for lights to turn on all the way long. Nevertheless, technical analysis shows that energy management systems allow for energy consumption reduction. Cutting off lights in the evening, which also turns off most of the screens like those in the hall and cafeterias seems to be particularly efficient. This automatic system replaces human action, because designers estimated it to be more efficient to ask an automatic system to do the job.

However, people are still asked to turn off the lights when they use meeting rooms, where they also have to turn off video projector. To understand how automation is implemented and how people perceive it, the following figure (Fig. 4) shows the distribution of places depending on automation, in the speeches of interviewees. The software for text analysis distinguished three speech classes with only class 1 and class 2 having significant impact. Since the software works by significant oppositions, class 3 is more common to all respondents and does not vary by types of people. Class 1 essentially groups discourses of people from technical staff. On the contrary, other occupants are linked to class 2. That's why we choose to present here only some results

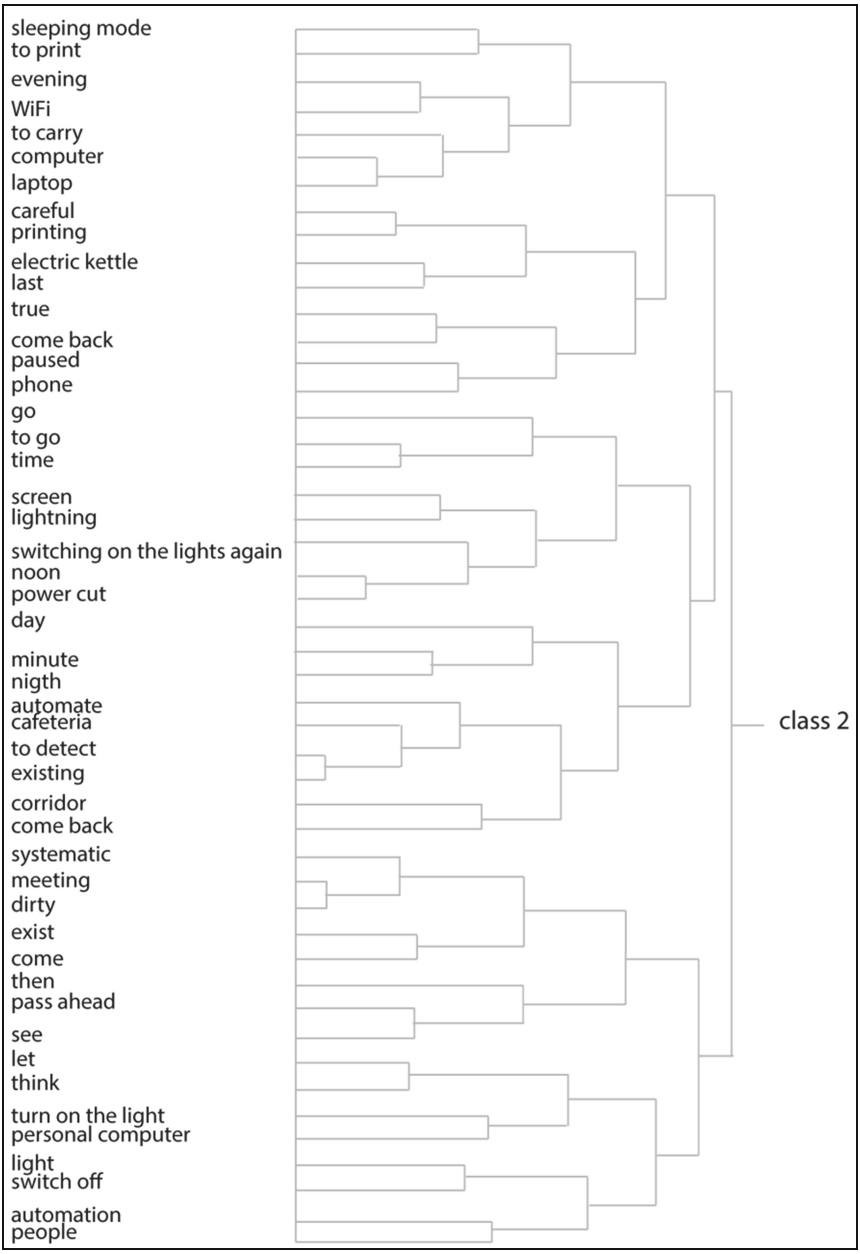

Fig. 4. Ascending hierarchical classification for class 2 of speech.

from this class. The Ascending Hierarchical Classification (AHC) helps to figure local relationships between forms of a same class (Table 2).

Table 2. Heating regulation.

	Number of respondents	Frequency
Non-response	1	0,4%
Yes, as much as they want	16	6,1%
Yes, but to a limited extend (+/-3°C for example)	117	44,3%
No	130	49,2%
Total	264	100,0%

This distribution organises most representative words. We can see how terms like "lighting" or "screen" articulate with "switching on the lights again" and are positioned on the same branch as time indicators like "noon", "day", "night", "minute", but also "to go". Actions in connection with lightning are strongly correlated to time notion, which is a key point as well for automation as for people's action. The distribution that the software proposed is particularly relevant for our analysis. It indicates the different places, with on the one hand "corridors" and "cafeterias" related to automated lightning, that are directly connected to terms "to detect" (mainly referred to sensors) and "automate" (which stands for automation). On the other hand, on the lowest branch of the AHC, rooms, and particularly "meeting rooms" are very close to terms like "let", "turn on the light", or even "light" and "switch off". So two types of places appears: those where lightning is mostly or totally automated, and those where "people" (last term of the AHC) can act on, like meeting rooms.

Moreover, at the very bottom of the graph, the two last terms directly connected are "automation" and "people". This reveals how much interfaces between human and technical systems are important and how much the balance between automation and people's action is to question. People's real practices, including reactions towards automation is a first step to do so.

5 Real Practices: Space Use, Lighting Use Strategies and Reactions Towards Automation

Real practices are not necessary in adequacy with previsions of energy uses.

We can imagine that a configuration with many open plan areas can minimize energy use, which was probably what designers intended. However, as we can see on the next figure, this is not convincing.

We notice that light is mostly on. In fact interviews show that as soon as one person needs light, it seems normal for everyone to turn the light on for the whole open plan. The only exception is the open plan where the responsible for the energy saving program behavioural program sits. In this last place, someone explained us that they must be exemplary there, even if it became sometimes really uncomfortable. Elsewhere, another person told us light was most often on and she didn't need it so much. Her strategy was then to ask technical staff to remove half of the bulbs in her part of the

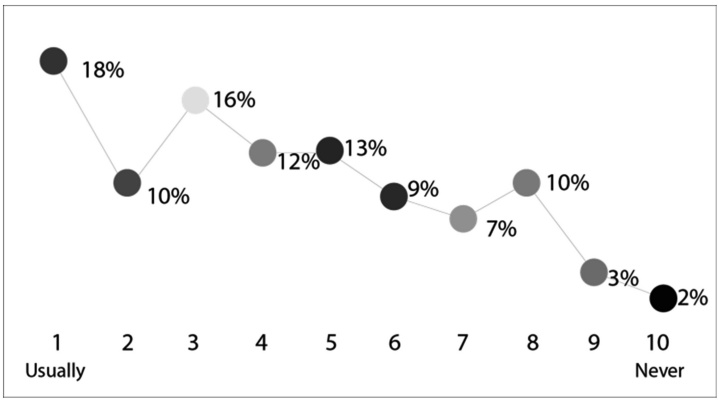

Fig. 5. Light use frequency.

office (Interview n°4): "being close to the window, I asked to remove my lights because I don't need it. But it's true that people next to the corridor needs it" (Fig. 5).

Anywhere, some occupants find solutions to get more comfortable work conditions. These solutions often means diverted space uses. Floor plans (Fig. 6) make it visible.

On these floor plans, it appears people sometimes choose other places than their office to get comfortable work conditions, regarding lighting or heating aspects. There, their strategies are not to fight against automation but to find some ways to make it acceptable. For example, if their office is close to a corridor and light in not enough and they cannot (or don't want to) turn on the light of the whole open-plan, they can go to the cafeteria (Fig. 7). They can sit close to large windows and get light (turning on the dial or simply coming into the cafeteria).

If space uses and lighting and heating uses strategies show occupants' real practices, it is also important to explore their reactions towards automation. Interviewees had some different positions about this subject. These positions range from a will of a total automation to a clear preference for accountability and awareness.

Total Automation: Interview N°2: "in buildings like here, I think the best is to use automation at maximum. To automate because it is difficult to act upon a common building, I think that if anybody can act as he want that can become a problem. It is defeating the very purpose of the optimisation we try to reach. So I think that in a public building we will try to reach the highest level of automation to ensure optimal performance."

Intermediate Position, with a Preference for Automation: Interview n°12: "First is technical aspects and automation. Because changing behaviour… I think bad habits come back and one should make wake-up calls." Interview n°15: "what is good is indeed to implement automation, as for lightning cut offs, which makes things visible. So it is not so bad. Because it is a kind of daily wake-up call. Turning off the light, it turns off. But one should not be dispossessed of some reflexes by saying the system will do anything. It is a fair balance, I think."

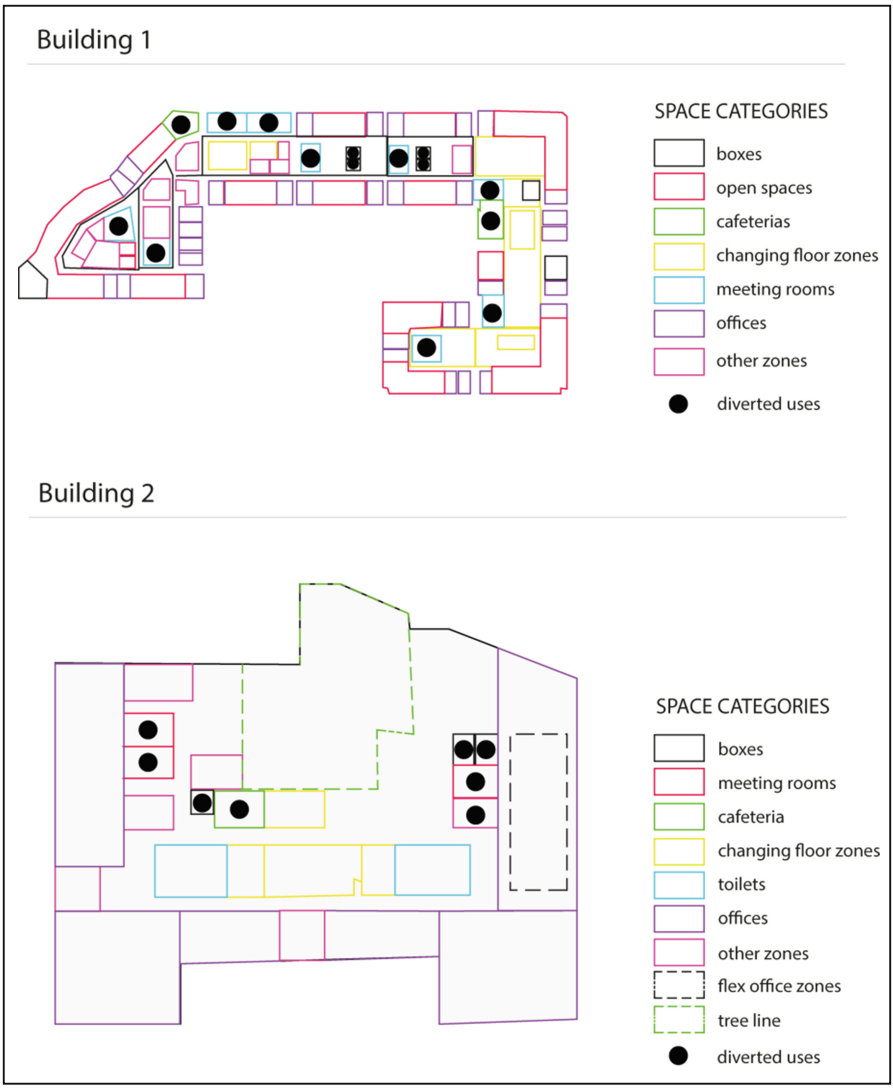

Fig. 6. Floor plans of the building and diverted uses of places.

Intermediate Position, with a Preference for Accountability: Interview n°3: "Accountability would be ideal but as it is hard to obtain a little bit of automation is necessary. Both are needed. Sometimes one should compare practices at home and at work. Automation is sometimes convenient."
Accountability: Interview N°1: "Which is important is much more reaching accountability than automation".

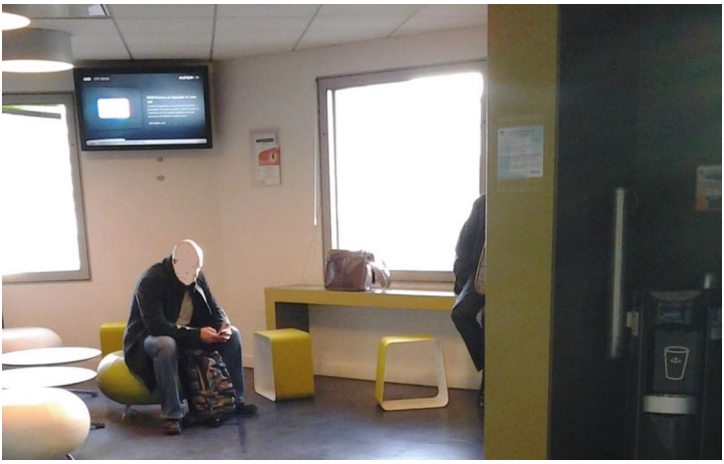

Fig. 7. People working in a cafeteria.

In the straight line of these elements, one question was asked to know how much automation would be accepted. People could choose between the acceptation of a system which would turn off automatically some devices or a system that would remind them to do so.

People were allowed to answer both, that is why there are more responses than the number of people questioned. People mostly prefer a system which inform them but let them free to act rather than a system which would act independently. They mostly want to be able to control what will be done by automation. Here, information is an element to be able to act, keeping control.

We will now question this: Informing only does not suffice, but people need to be involved to maximize efficiency (Table 3).

Table 3. Type of acceptation of automation.

	Number of respondents	Frequency
Non-response	24	
You would accept that a technical system automatically turns off some devices	113	42,8%
You would accept that a technical system reminds you to turn off devices you don't use	177	67,0%
Total/ interrogés	264	

6 Involving People: Participatory Design of Services and Systems for Smart Buildings, Motivating Behaviour Change

Seeing the differences between required uses and real practices, we tried to understand users' attitude towards energy efficiency. Were they interested?

The first question we asked was whether they would accept to get information about energy in their professional environment. We can see the results in the next figure.

Most of people are interested in information about energy and energy efficiency at work. Then we tried to know how they would get information.

Regarding energy efficiency, we observe that 63 % of people questioned would choose the intranet if was possible for them to use an information channel at work. The second choice (which is used by hierarchy) is the diffusion of those information by using screens in different locations such as cafeteria or reception (29, 5 %). We notice this is not the most preferential choice of users.

In "other" choice, people proposed the creation of a dedicated website, email alerts or pop-up windows, or smartphone application. Generally, people would like to have an easy, personal and private access to the information. Ideally they wish to obtain that information when they want (Fig. 8).

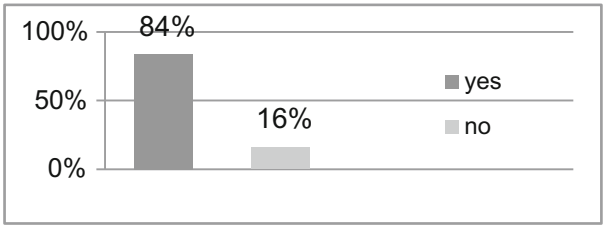

Fig. 8. Willing of information about energy at work.

By the way, users' reactions and perceptions towards information strongly differs depending on communication tools that provide them messages (Table 4).

Table 4. Preferred channel to get information about energy efficiency.

	Number of respondents	Frequency
Non-response	34	
Displayed on a data box that you can place in your office or your workplace	70	26,5%
Displayed on screens in different places (main hall, cafeterias...)	78	29,5%
Displayed on the intranet	166	62,9%
Other	6	2,3%
Total/ questioned	264	

basis of questioned people

There is a significant difference between the use of digital signage screens and classic advertising billboards. The digital signage screens seems to be more attractive for the buildings' occupants. Moreover, time and location need to be taken into account. In fact, digital signage screens are placed in friendliness places during informal periods. In this case, people take the time to watch the information messages and have the possibility to talk to each other. The classic advertising billboards, located in corridors, rooms, are not proper for exchange. Indeed, the corridors are dedicated to passage, usually people don't stay there, and they go fast. They don't stop. So, information is partially taken into account. Rooms are dedicated to work. For that reason people are fully concentrated on their task. Time is precious, consequently, information about energy savings belongs to moments it flew. The inscribable info signs are considered by users as the worst tool used by the company. People have not enough time to read it. The responses about awareness campaign are really interesting to study. It introduce a time notion: the campaign is organized in a short given time. This is thought as a real event. This short time allows people to catch quickly the information. People are not disturbed for a long time. Indeed, the multi-canal information is employed and individuals can choose the method of the message and the preferential location to receive it (Table 5).

Table 5. Communication tools making people tick.

	Number of respondents	Frequency
Non-response	14	
Awareness campaigns	146	55,3%
Scientific books and papers	69	26,1%
Day, breakfasts/events around energy themes	80	30,3%
Info sign	40	15,2%
Postings in the hall/corridors/rooms	98	37,1%
Displayed on screens in different places (main hall, cafeterias...)	142	53,8%
Total/ questioned	264	

Once that was established, we needed to go further, and see what type of message people would get (Fig. 9).

We clearly see that not only people are interested in energy efficiency and want to be actors in the process (item how to save energy), but they also want to know what their firm does: 80 % want to know more about energy saving actions implemented, and around 60 % want to know projects the company is involved in. We can see here collective identity elements.

We also asked people what compensation would they require for their effort in contributing to energy savings. Once again we noticed that most employees are ready to make an effort without a need for compensation, as shown in the next figure.

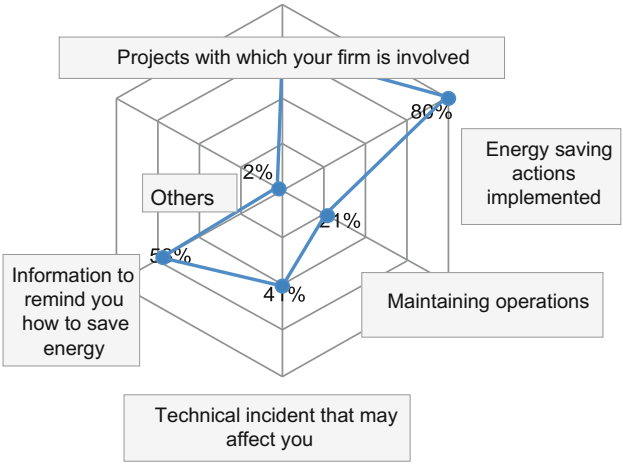

Fig. 9. Type of message users would like to receive.

The first compensation asked is funding for environmental projects. People are not individualistic, they want a better environment for everyone (Fig. 10).

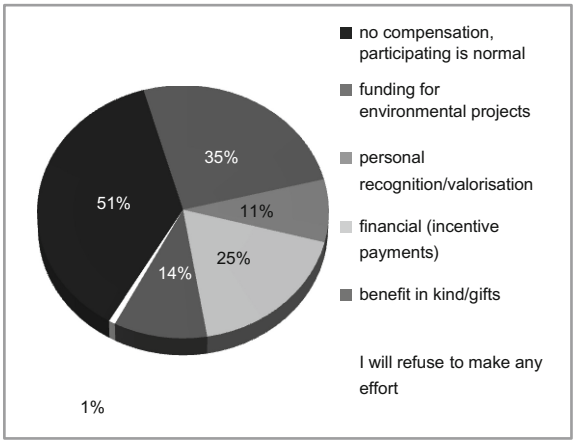

Fig. 10. Compensations for energy savings.

As it can be seen, for an efficient intelligent energy management system to be implemented, there is a real need to inform, co-construct and make users actors of energy efficiency programs and systems. It seems we must not forget that "*Actor doesn't exist out of system defining his freedom and the rationality he can use in his action. But the system only exists by actor who is the only one to build it, make it alive and possibly change it*" [32]. In this perspective, some tools for another type of intelligence could be useful [33, 34].

7 Discussion

Each practice has got a structural framework, as mentioned by Maresca and Dujin [35]. We must thus remind that this study couldn't be transposed to another context, although we can learn many lessons from it.

Several elements strongly modify occupants' practices and behaviour towards energy use: type of workplace, situation from natural light and heating sources and degree of automation of technical devices and systems are the main ones.

Energy sources are still a geopolitical stake even on a building's scale. Among possible actions, lighting is especially important in occupant's discourses. Our quantitative data shows a strong use of lighting, so we can wonder if its use and will of saving really exists. But we must get in mind that 63,6 % of respondent' s workplace is an open plan area, where lighting must be negotiated. And we saw that it maximized light use.

Who makes the rules? Collective pressure?

Groups generally adjust their practices to expressed needs. Therefore, as soon as an individual needs lighting, light is turned on in the whole open plan.

Nevertheless there are specific places exceptions, being collectively invested as exemplarity zones, as shown by our interviews analysis. The following extract clearly states it:

"in fact I think we… we have felt over in… we try to much to reduce consumption and we never light up our open plan. Sometimes this is really annoying for me. Because I don't see anything, I can't see my screen. It is really tiring for me. Since we are in the [awareness program] cradle, we can't fight it, we must let the light off."

As recently shown by Vanolo [36], this extract reveals how a person can accept practices which go against their comfort, but are conform to the mission they accepted to fulfil and the role they accepted or chose to play.

Consequently, valuating actions towards energy efficiency is a key factor for the success of energy management programs.

Is the emergence of good practices effective?

People's involvement toward energy efficiency seem to contribute to a more or less long-lasting perspective, as we saw that more than 50 % respondents are interested in an history of consumption, for example. In order to get people involved, they need to appropriate this subject by anchoring it in their daily lives. To achieve this, maybe they will need to bypass or hijack some elements planned for them, without them [37].

Who should regulate the system? Automation or reason?

Strong differences appear when balancing awareness/automation. Most people believe in behavioural change efficiency for long term effect, but many also think that automation is better for short term outcomes. Others underline the weakening their responsibility brought about by automation, which "does all for me" (interview extract).

This question about the mode of action efficiency, either human or automation, is a key point for buildings energy efficiency understanding [38].

What are the effects on the scale of the building and beyond (eco-district)?

This paper underlines how much human/machine interaction is a big stake to go through urban project in a multi-scale perspective. It is no longer only the point to

know how organizing governance with stakeholders able to agree about a common objective. Neither it is to solve the equation of interpersonal contradictions to give meaning to the project.

From a philosophic point of view, there is a deep question of the acceptance and the use of the Reason notion. Can we entrust to independent technology (power of algorithm) the capacity to shape human being's behaviour inside the buildings and beyond (the ecodistricts, the cities)?

Should we preserve our control to trace our destiny based on controversy and imperfect choices?

Two essential questions catch our attention. Firstly, the increase in databases numbers and their exploitation, and the centralizing of individual data, create a colossal ecosystem to exploit. It's progressively invested due to spectacular augmentation of computer's power algorithmic capacities. NBIC convergence is unavoidable [39, 40]. Secondly, should we let the algorithm establish a standard for energetic buildings production? Should we let computers choose the best energetic needs of buildings, based on the exploitation of interconnected databases and composed by many local levels of data collection?

In which case, the occupant would not be an adjustable agent that could devote itself to the task for which it was employed by the company. This is no longer science fiction [41].

In an optimistic perspective, this action research raises the issue of the emergence of a sustainable and stable collective intelligence through space and time [42–45]. In other words, to be an efficient pathway for change, information must be connected to people's involvement towards elements influencing their daily life at work.

Most people believe in eco-district concept's impact on the inhabitants' social relationships. This element is extremely interesting because it shows that a place can be, in people's mind, a source of social relationships change [46, 47]. A collective will of expression appears, reminding that intelligent energy management must favour this belonging feeling [48].

This feeling of belonging to a collective identity [49] not yet constructed or reinforced is essential. Indeed it fixes the common basis to involve buildings occupants in co-construction actions with site managers and other stakeholders. As such these actions will not only be accepted by occupants but also done with enthusiasm.

This element needs to be looked alongside the need of appropriation [50–52] of programs and actions linked to energy efficiency. Occupants need to feel they are actors in their workplace, regardless of whether technical system acceptance and/or practices and behavioural changes are pertinent.

Aside from this researchers have shown that the appropriation of an idea, a program or a technical device permits deeper changes in behaviour and practices. Malhotra and Galetta [53] explained: "*when social influences generate a feeling of internalization and identification on the part of the user, they have a positive influence on the attitude toward the acceptance and use of the new system. The findings also suggest that internalization of the induced behavior by the adopters of new information system plays a stronger role in shaping acceptance and usage behavior than perceived use-*

fulness". In a general way, many recent papers in human and social sciences show the need for people's support [54] in changing their environment. These papers are mainly addressing private housing or public space, but we see that our data about tertiary buildings and professional environment come aligns with these.

These questions feed an interesting debate. How to hybrid natural ecosystems and computing ecosystem to invent or reinvent the cities of the 21st century?

8 Conclusion

In this paper, we have shown what were required uses towards space and energy use, particularly lighting and heating, and the place of automation in the daily lives of users. We then saw that real practices were not necessary alongside required uses. Next, we showed how involving people, with participatory design of services and systems for smart buildings, can motivate behaviour change. Lastly, the discussion brought into the open the different elements at stake for occupants of intelligent buildings, such as the questions of appropriation of a program and the power of collective identity.

On future work, we will try to implement programs that enhance collective intelligence and collective identity in intelligent buildings.

We are convinced that individual capacities are ignored. We will explore that phenomenon at different scales to broaden our field of research. This energy potential based on the emergence of social links run could be in the long a real engine of a true ecological and sociological transition. We will both use social geography and computing. Our goal is to build interfaces. We want to understand the different forms of empowerment mechanisms created by citizen groups, before their political capture.

Placing the modelling in the centre of our field of research is one of our main goal. We consider social interactions as a basis of modelling. Indeed, we will include spatial dimension both using spatial analysis and social geography. To explore that possibility, we will use geographical information system, (through web mapping solutions) at the scale of the building, integrating vertical dimension (the different floors). The beginning of a reflexion about indicators will help us to understand and define the good balance between automation and humans' behaviours (Fig. 11).

Our gradient of interaction is based on two axes of reflexion. Each axe is composed by the association of keywords. Those are considered as nodes in the road of automation. Each node symbolises a step in terms of human/machine interaction. Using this principle can help us to understand the degree of social and spatial acceptance relative to automation. On the one hand, the first axe called 'systechnic' is composed by a series of four terms: acceptance, appropriation, implication, and co-development. On the other hand, the second axe called 'spaces of social species' is composed by the same keywords as shown in the first axe, but in a different order. We could also place the interviewees' attitudes in one of the quarter of our gradient. Moreover this gradient is not static. We integrate the time in the process. Doing this will help us to understand behavioural changes of users facing modifications depending on automation. Each node is a marker. If we consider that an actor clearly rejects automation, we can ask him to determinate this reject using a percentage. As a result, for each keyword node we can

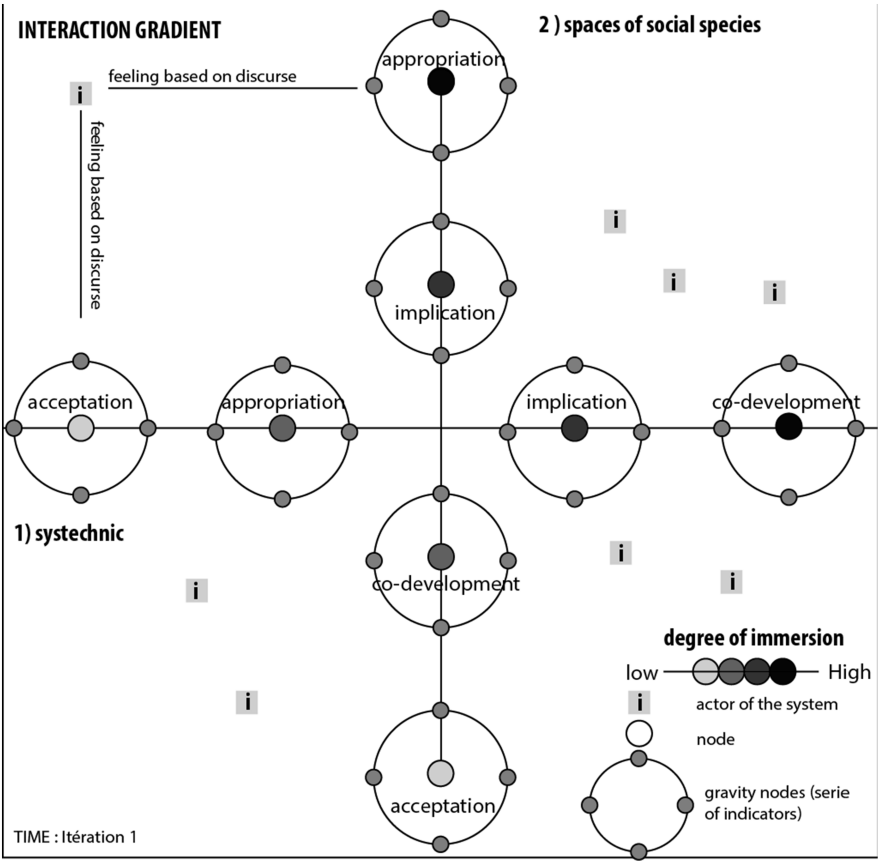

Fig. 11. Interaction gradient for development of technical systems and human beings involvement and social relationships.

place gravity nodes associated to indicators. The aggregation of each gravity nodes will allow us to determine the location of each person in our gradient of interaction.

Furthermore, being focused on the work context is important in that type of study. It allows us to understand barrier effects which could block the process of cooperation. A typology of hierarchical pressure inside buildings and sites could be an interesting field to exploit. Hierarchical pressure could have a real impact in terms of programme based on energy efficiency. That's why a second gradient could be built. It will oppose first competitive and cooperative working climate. Secondly, we could observe the degree of pressure at work, classified by a list of companies, based on interviews.

We will use cross-cutting methodologies both from the social sciences and the computer Science. Indeed, according to different authors of those fields of research, collective strategies are often more effective than individual strategies. This is demonstrated, in many cases in games theory as shown by [55] and also in social science [56, 57]. Using an interdisciplinary approach is from our point of view a good

way to find a pragmatic equilibrium in human and machine interactions. That helps at understanding human needs and then to think the norms of intelligent buildings. Moreover, this principle allows us to think social and ecological transition with technologies. However human cooperation based on collective experience is essential to regulate and control the system. That's an essential part of our definition of smart city: we want to accord a central place to social and spatial justice concepts in the intelligent buildings construction process, effectively integrated to the cities. The intelligent buildings should not only be reduced to symbols of green value: they should be also strong places of the emergence of collective will of ecological transition (Fig. 12).

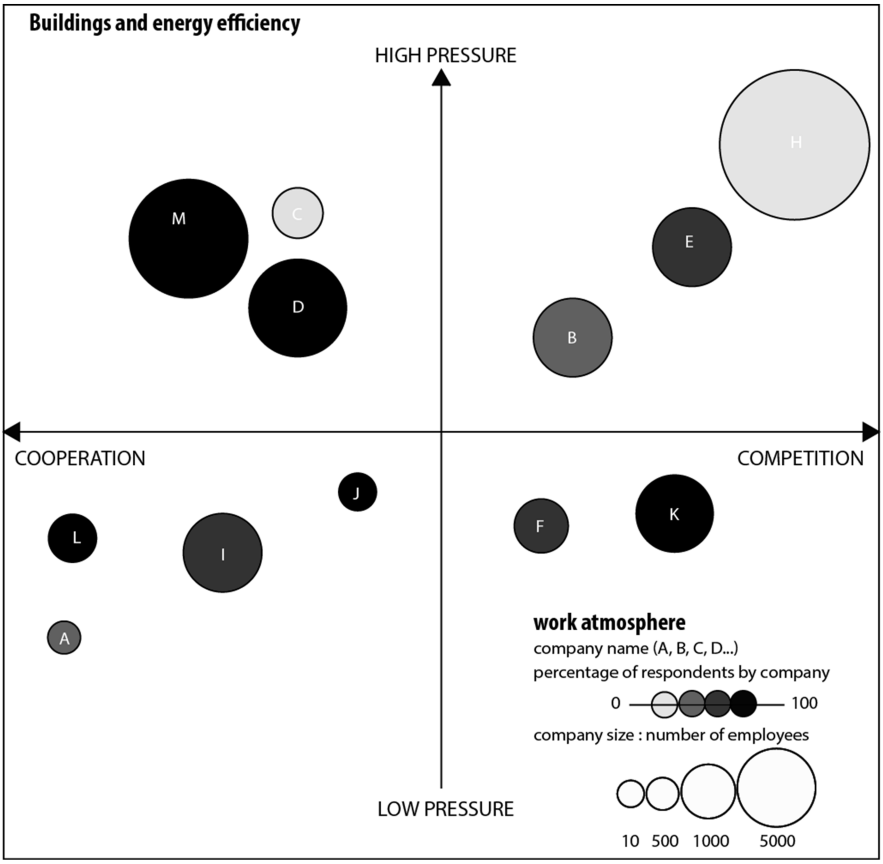

Fig. 12. Hierarchical pressure and type of social interactions.

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