

A multi-stakeholder perspective on opportunities and challenges for energy efficiency improvement in university buildings

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Abstract. University buildings are relatively energy-intensive. In Sweden, universities usually operate in rented buildings. In this study, interviews were carried out among three categories of stakeholders in a Swedish university to understand their perceptions of energy use and challenges to improve energy efficiency. As per most interviewees, the university's top management and Akademiska Hus, which owns the buildings, have the main responsibility to reduce the buildings' energy and carbon footprint. The heads of departments raised the concern on the non-availability of energy data to take actions to reduce energy use. The use of sensors and information technologies to monitor space use, energy use, and indoor environment are attractive to different stakeholders. The implications of the interview results are discussed.

1 Introduction

The number of higher education institutions has doubled worldwide since 1990, and this rapid growth is likely to continue in the future. Academic buildings are relatively energy-intensive, and energy use in non-residential buildings, such as academic buildings, is expected to increase by 57% worldwide from 2018 to 2050 [1]. Universities are generally facing increasing financial pressure, which drives them to seek strategies for more efficient campus management, such as using smart tools as means of information to achieve their increasingly ambitious goals [2].

Like other organizations, universities are collectives of people with competing interests and priorities, causing complexities in the decision-making processes [3]. This problem applies to the decisions on the adoption of sustainability measures in universities. There is a large number of stakeholders involved and affected by such decisions. Such challenges vary in different universities as the management structures can influence the decision-making processes [2]. In the Swedish model, a public agency (Akademiska Hus) owns the majority of academic buildings, and the universities are the tenants paying rent for the buildings they use [4].

Generally, decisions on facility management in public buildings aim to add value to the organization's performance [5]. The value added by the interventions might be viewed differently from the perspectives of various stakeholders [5]. The energy use in academic buildings is difficult to interpret due to the diversity of activities and types of spaces such as classrooms, laboratories, and offices. Adopting sustainability measures such as those for energy efficiency

improvement requires complex decision-making processes that involve evaluation of measures regarding energy use, indoor environment quality, investment, and operational costs, security, sustainability, and social factors [6]. Overcoming such complexities requires supportive interventions to align stakeholders' motives towards reaching universities' sustainability goals. Such support could be in the form of information and communication technologies (ICT) and the concept of Internet of Things (IoT) that have potential to support decisions in various applications [7].

In this study, we analyzed the perspectives of different stakeholders involved in the adoption process to recognize the opportunities and challenges related to sustainability measures in university campus buildings. Such knowledge may facilitate devising interventions by the top management that could address the stakeholders' concerns and thereby steer universities towards their sustainability goals. The stakeholders' perspectives on the use of ICT to influence occupants' behaviors in university buildings are also discussed. The study is based on interviews of three categories of stakeholders at Umeå University, (i) teachers (staff members who are involved in teaching activities), (ii) department heads, and (iii) property office.

2 University's building contract

The majority of the buildings in the Umeå University's campus are owned by Akademiska Hus. Energy efficiency improvement is a priority for Akademiska Hus and they aim to reduce 50% of the delivered energy by 2025 as compared to 2000 [8]. The property office, on behalf of the university, has a

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contract with Akademiska Hus. Typically, the heating energy cost is included in the rent paid to Akademiska Hus. Similarly, the electricity costs for some common facilities like street lighting, fans for HVAC systems, lifts are also included in the rent. The electricity costs for all other purposes are paid by the university directly to the electricity provider. University is free to choose its electricity supplier. Akademiska Hus and the property office have discussions and negotiations every year in which the rent will be adjusted. The property office acts as a “nodal” office in dealing and communicating faculty’s/departments interest with Akademiska Hus.

The property office “sublets” the university campus premises to departments. The unit area rent is the same for all departments. The departments pay rent for offices, lecture halls, and laboratories, while they do not pay for the common spaces such as inner courtyards. The property office distributes the rent cost of all common spaces equally among the departments. The rent is mainly based on whether the rooms have windows or not. The rooms without windows have a lower rent as compared to those which have windows. Accordingly, rooms in basements have a lower rent as compared to offices. The electricity cost is included in the rent that the department pays to the property office. Usually, departments have an annual rent contract for the offices, while the lecture halls could be either booked as per their usage and/or by an annual contract. As the energy cost is included in the rent departments pay to property office, there are currently no monetary incentives for departments to reduce their energy use.

3 Methodology

This study is based on detailed interviews of 7 employees at Umeå University. Two of the interviewees are head of the departments, while another interviewee had approximately five years of experience as the department head. Two department heads have research experience on energy-related topics. The remaining interviewees include two teachers and two managers from the property offices. Further, one of the department heads has eight years of teaching experience, and we asked him a few questions on his views on booking the lecture halls. Hence the perspective of teachers discussed in this study includes responses from three interviewees. All the teachers work in a natural science department at the university.

The interviews were based on open-ended questions. The questions differ based on the specific groups. For example, teachers were asked about their preference of booking of lecture halls, perceptions on sustainability initiatives of the university, use of ICTs technologies in lecture halls, while the questions to the heads of departments include their perceptions on energy use of the department buildings, what are the challenges and how to incentivize the departments to undertake sustainability and energy efficiency measures. A few questions such as “who do you think has the main responsibility in the university to reduce the energy use

and carbon footprint” were asked to all the interviewees. The interview duration varied from 30 to 60 minutes, and all interviews were recorded and transcribed.

4 Interview Results

4.1 Perspectives of teachers

All the teachers prefer the morning time slots for their lectures. As one of the teachers mentioned:

“8:00-10:00 is ok with me...it could also be from 10:00-12:00, but never after lunch.”

One reasoning for the preference for the morning session is because it could help to engage the students to study for the whole day. An interviewee stated, “I want them on the campus to know that they are up here and studying”. Another teacher mentioned that he prefers lecturers in forenoons as he feels more focused and energy to deliver the lectures in the morning as compared to afternoons. Secondly, it would give teachers time to spend the rest of the day on other activities such as supervision in laboratory works, research, and other administrative works. According to one of the teachers, the students may not have any problem attending the afternoon lectures, even during the last time slot, which is from 15:00-17:00.

The most important factor for the teachers to book the lecture halls is to accommodate all the registered students. The teachers do not consider the environmental and/or energy aspects when they book the lecture halls. As one of the teachers mentioned, “I would guess it would be the same energy use...if I book it or not, the energy use will be the same”. All the teachers who were interviewed stated that they would choose the capacity of the lecture halls in accordance with the students in the course (smallest room possible). The teachers are agreeable to the use of ICT such as occupancy sensors that could reduce the energy use in the lecture halls. As one interviewee mentioned about adoption of demand-control of ventilation system as:

“I think we should so; if we gain something, why not...you do not require forced ventilation in an empty room”.

On being asked about the university’s sustainability initiatives, two teachers were unaware of it, while the third mentioned that more need to be done. The teachers mentioned that the major responsibility to improve university campus buildings’ energy efficiency lies with Akademiska Hus. For example, one of the teachers mentioned:

“Akademiska Hus has the major responsibility. They own the houses and they can decide how to make the buildings efficient if it is worth it”.

One of the teachers mentioned that the head of department might also have a responsibility as he/she can set the rules or allocate resources to choose one alternative over the other. For example, on how the

employees travel, especially to reduce traveling for meetings or recommend taking train when one has to travel long distance such as to Stockholm for work. Simultaneously, the department heads' challenge is to take along the staff with his/her decision. For example, as per an interviewee, if the staff does not follow the recommendation of the department head, then there is not much the department head can do about it.

"I have no answer on how to change the behavior of people without giving a bad feeling of being authoritarian....you have to be a very good psychologist".

A teacher who, in his personal capacity, is very environmentally conscious (he takes actions such as using bicycle instead of car whenever possible) was asked about how to steer the employees to take actions to reduce energy use in university premises. He responded:

"I think you have a different mindset when working...; now it is my employer who should be concerned..., I am just working here."

4.2 Perspectives of department heads

All three interviewees mentioned that as the department head, they never get information on their buildings' energy use. As heads of departments, they monitor the utilization of the lecture halls in the booking system and, based on that information, make the contract with the property office. As per the two heads of departments, the departments can do only limited measures for energy efficiency improvement.

"In some corridors, we have automatic light controls...probably we can order it, but then we have to pay for it, and it is rather expensive."

As per the two heads of the departments, the lack of incentives is a significant challenge for the department to improve its buildings' energy performance. According to one of the interviewees, there is no financial budget for such measures.

"We want to spend our money for research and education and not to reduce energy use in buildings.... and it (energy efficiency improvement) should be done by someone else."

However, as per another interviewee, the financial aspect is not the main challenge if the department wants to become sustainable. Rather it is important to have proper information on energy use. Without information on how much energy the buildings are using, it is not easy to set an energy target for the department. According to all the interviewees, one of the measures to incentivize the departments to take actions to reduce energy use is that they should receive energy use data of the buildings. One of the interviewees stated on lack of energy use information as:

"We do not see the history, we do not know the present, and we cannot have a vision for future in terms

of energy use or carbon footprint...it is important to have numbers."

According to one interviewee, "energy visualization" as an information tool could help the departments to take initiatives to reduce energy use at the departmental level.

The departmental buildings are relatively new. Hence the interviewees do not think that there is significant potential for energy use reduction through renovations. However, they seem to be positive towards ICT interventions, such as installing occupancy sensors to control ventilation. As an interviewee stated, "... big challenge is not the envelope but the control systems by use of ICTs". According to him, the university currently does not have much information on where (for example, lecture halls, offices) to use ICTs, and it needs to be mapped.

One of the interviewees who has research experience on energy issues mentioned that the department he was managing regularly discussed how to reduce energy use in their monthly meetings. The students in that department are also engaged in sustainability discussions and measures. For example, the students themselves established a sustainability group and provide awards on sustainability initiatives to fellow students during the annual convocation ceremony.

According to two heads of the departments, Akademiska Hus and university's top management are primarily responsible for reducing energy use and carbon footprint as they have the resources and "power". However, as per the third interviewee, the department head has the main responsibility on this front. This is because in a university, "... departments are the units which have a regular cash flow and if the departments do not act then nothing will happen". As per one of the interviewees, for the department heads to take actions to reduce the energy use, the departments should get some benefits (for example, some monetary incentives if they reduce the energy use) for their efforts as otherwise, department heads will not make the energy use reduction a priority.

4.3 Perspectives of property office

The interviewees stated that the top management is always supportive of measures proposed by the property office that is good for the environment. According to property office managers, since 2014, the university has reduced energy and space use through various initiatives. The university has decreased 11500 m² area during the last six years. The property office is finalizing an action plan for energy-saving and optimizing space use. Further, as per one of the interviewees, they are reviewing the university's booking system, "TimeEdit" to optimize the utilization of lecture halls.

The property office prepares every year a 3-year investment plan which includes energy reduction initiatives. The proposals for energy reduction are initiated by property offices, and they seldom come from the departments. According to both the

interviewees, using ICT, such as data gathered from occupancy sensors, could help understand the utilization of various spaces and help improve investment decisions. They have highlighted an ongoing pilot project that uses occupancy sensors to study the occupancy patterns of a select number of lecture halls and offices in the university campus. As per one of the interviewees, the sensors were effective as they provided useful information that property office didn't have before.

According to one of the managers, one of the main barriers for the departments to act on energy use is the low energy cost. According to him, the rental cost is only approximately 10% of the departmental budget, and the share of energy will constitute a small part of it. As per the other interviewee, the departments would take actions to reduce the carbon footprint if there is a directive from the top management. At the same time, it would be good if there is a pamphlet/brochure that provides information on what possible actions the departments can take to reduce energy use. This interviewee also acknowledges that the lack of incentive would be a deterrent for the department to take actions to reduce the energy use "... if they save energy they will not see any reduction in energy cost..., so there are no incentives for them to reduce the energy use..., it is a long step".

According to one of the interviewees, the main responsibility to reduce the energy use and carbon footprint of the university lies with the top management. As per the other interviewee, the responsibility lies with everyone and the top management. According to her, a clear message from the top management with clear targets on reducing the carbon footprint is important. Along with that, all the employees need to take the responsibility to achieve those targets.

5 Discussion

The majority of the interviewees consider that Akademiska Hus, who owns the buildings, and the university's top management has the major responsibility to reduce energy and carbon footprint. The departmental heads pointed out the lack of incentives in undertaking efforts to reduce the energy use of buildings. However, one of the departmental heads believes that they have the main responsibility due to custodian of cash flow in the organizations. According to him, if the head of department desires, then it is possible to make the department more sustainable. This complies with the view that middle management in organizations is closer to operations and is better positioned to recognize effective actions for organizational improvements [3]. However, middle management's decisions could be affected by bounded rationality, and may result in a disparity between their priorities with those of the upper management [3].

Moreover, directing colleagues to follow the measures such as sharing offices or allocating offices depending on the occupancy pattern may not be popular among the colleagues. Hence the departmental heads

have to hold a fine balance to avoid being perceived as authoritarian in his/her quest to make the department function sustainably. From the transactional analysis approach, the restrictions associated with the sustainability initiatives should be communicated adequately to the employees to increase the chance of lasting changes in an organization [9]. Accordingly, as pointed out by the property manager, a clear direction and target from the top management may facilitate the departmental head to take along his/her colleagues to adhere to sustainable actions and behavior in their department.

The departmental heads reported that lack of information on energy use in their buildings is a major barrier to take actions to reduce energy use. According to them, the non-availability of energy data makes it impossible to have a target and see progress in their endeavor to reduce energy use. Akademiska Hus and property office may initiate efforts to provide the departments with their heating and electricity use. Installing demand-control for energy systems was pointed by several interviewees as being an effective measure. Due to the variability of reported energy efficiency potentials [7], there is a need for information tools to provide tailored information on potential energy savings. Using IoT-based feedback tools (for example, space use and/or energy use visualizations) might be an effective strategy to influence decision-makers. With the increasing availability and cost-effectivity of sensor and communication technologies, IoT tools can provide information to facilitate the decision-making process for adopting various sustainability interventions. The challenge is to understand how IoT tools can be effectively adapted in organizational and operational processes, as sometimes such knowledge may be missing even after their adoption [2]. Promotion of such tools requires bridging the technical and management aspects on collecting various in-situ data and their visualization [7,10].

The property manager has mentioned that, during the last six years, the university has undertaken several measures to reduce energy and space use. However, most of the teachers and the heads of departments interviewed are not aware of the university's sustainability initiatives. The university should effectively communicate its sustainability initiatives to its employees to raise awareness and promote an organizational culture associated with sustainability goals.

Space use efficiency is an important aspect of sustainability in universities [11], which is an attractive topic for all the studied stakeholders, especially the property office. All the teachers interviewed expressed their preference to deliver their lectures on forenoons. This is in line with [11], wherein the lecture halls were found to be relatively underutilized during afternoons. Teachers' preference for lectures in the morning can be a challenge to optimize space use in lecture halls. One way to influence the teachers to book lecture halls during the afternoon could be by having higher tariffs for the lecture halls during time slots in forenoon compared to afternoon. Currently, there are only two

tariffs for the time-slots during working hours. Time slots between 10:00-15:00 have higher prices, while time slots 8:00-10:00 and 15:00-17:00 have lower prices. The evening time-slots of 15:00-17:00 is the least preferred time slot for the teachers [11]. The property office may consider revising the pricing of this time slot to make it attractive for the department heads to promote these time slots internally. There are many teachers who are either unaware or do not bother about the price difference for the time-slots. The departments should clearly communicate to the teachers the price difference between time-slots of the lecture halls.

6 Conclusions

Many interviewees believe that the top management and Akademiska Hus have the main responsibility to reduce the energy and carbon footprint of the university. The interview results show that stakeholders who could influence energy use, such as department heads, do not have information on energy use in their buildings, which acts as a barrier for them to adopt energy efficiency measures. An important decision support for the university management at department level is that the department heads should be provided with energy use data of their buildings. ICT tools could provide information, such as space use in university premises, that could justify property office's decision to adopt interventions that reduce the university's carbon footprint. Teachers may be less likely to take actions to reduce the energy use in university campus buildings, which may be partly due to their perception of limited *locus of control* in university's energy use: the belief that their individual actions cannot influence the energy use. Property offices and department heads may make more efforts to engage the teachers on energy and sustainability issues. This study is based on a small sample, and hence the generalizability of the results is limited. The study may be extended by involving more participants and external stakeholders such as Akademiska Hus. Further, this study's findings may not apply to universities with different organizational structures and units with different responsibilities than Umeå University. Future research should evaluate the perspectives of stakeholders in other universities and organizations with different structures.

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