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Energy efficiency in the building sector: a combined middle-out and practice theory approach

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ABSTRACT

The building sector in Europe is a major energy consumer. Professionals such as architects and different building engineers play a crucial role in the technology adoption process.

This study aims to contribute to the understanding of how and why energy efficiency measures are implemented by professionals in building renovations.

Three renovation projects of a municipality-owned housing company in a middle-sized town in Sweden were followed. Methods applied for this case study are semi-structured interviews, participant observations and document analysis.

An analytical framework is developed, by combining a middle-out perspective with social practice theory (SPT) to enhance the understanding of how and why energy efficiency measures are adopted during the studied renovation meetings.

The middle professionals meet during a renovation and form a temporary constellation. The meeting practice endures because it is repeatedly enacted. One conclusion from the studied processes is e.g. that the aggregated know-how of the professionals are seldom discussed, with the consequence that tacit knowledge is not challenge or re-evaluated. By changing a meeting practice hinders to energy efficiency can be removed.

Keywords:

Professionals;
Renovation;
Meeting practice;

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1. Introduction

The building sector is a major energy consumer, accounting for almost 40% of the total energy use in the EU, including in Sweden. Various international and national agreements and targets exist for climate change mitigation [1, 2]. In the EU as well as in Sweden, energy efficiency is a central objective. The EU member states agreed on the EU's 2030 climate and energy framework, as for instance increasing energy efficiency by 27% (compared to 2007) [3]. The objective in Sweden is to reach a total energy consumption reduction per heated area in homes and other premises by 20% by 2020 and by 50% by 2050 relative to 1995 levels [4]. Trends show that Sweden will not manage the 2020 energy efficiency targets [5] and in order to reach the 2050 targets extensive building renovations are needed [6]. A focus on existing buildings is crucial also because the new construction rate of buildings is relatively small with about 0.5 to 2% growth of the housing stock per year [7]. It is thus well understood that there is a need to take action to reduce both energy demand and CO_2 emissions in existing buildings [4, 8–10]. For the highly fragmented building sector, optimizing available technical and social strategies for buildings is challenging [4, 9, 11, 12]. Janda and Killip [13] claim that the structure of professional practices will need to change in order to achieve

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a real transformation of the sector. Professionals such as architects, heating, ventilation, and air conditioning (HVAC) engineers and electricians are often seen as intermediaries in the technology adoption.

In relation to the growing literature on intermediaries Janda and Parag [14, 15] introduced a middle-out perspective (MOP). The MOP focuses on middle actors for improving energy performance in buildings. The authors argued that change opportunities are actively driven (or impeded) by middle actors. The middle is however frequently overlooked in energy transition studies and the middle is often seen simply as rule followers or fillers [15].

The middle operates in a system where change is commonly seen as flowing from the top-down (e.g., government policy, energy utilities) or from the bottom-up (e.g., from consumer demand, end-users). Studies on intermediaries in the building sector emphasize that intermediaries play an important role regarding spreading innovations or facilitating energy efficiency [16]. The middle is defined as having a mediating role between end-users and technological systems, for example when architects having an intermediating role for the dissemination of passive houses [17].

The MOP perspectives and other intermediary perspectives have overlaps. The perspectives share the view that the 'middle' is more than just a filler. Even though middle actors and intermediaries might operate in the same space, there is a difference in the conception of their influence and abilities. The MOP highlights the unique qualities, functions, strategies for action, and their own characteristics of middle actors for energy transitions.

Earlier research has shown that social relations and discussions, negotiations and agreements between the involved professionals are playing an important role when it comes to renovation projects [21, 22]. Karvonen [23] has argued that a social practice perspective can be useful for gaining an understanding of the complexity of energy-efficient retrofitting or construction. To capture the influence of the middle professional level, and of those situated negotiations and priority setting that take place within the middle level, it is here argued for a combination of the two perspectives into a framework that combines ideas from research on the middle level and social practice perspective (SPT).

The aim of this article is thus to develop an analytical framework combing these two perspectives, the middle out perspective and social practice theory, to arrive at a deeper understanding of how and why energy measures are or are not included by professionals in a renovation project.

The combined middle-social practice framework is then used to study the uptake of energy measures in renovations of multi-family dwellings in Sweden. Renovation projects of multi-family dwellings involve many different professionals with various skills and backgrounds. These building professionals must work together and coordinate their efforts during the planning of a renovation project. In the planning and design phase meetings of a renovation project, energy measures are negotiated and decisions are made on how a building will be renovated and what energy measures shall be included. This phase is crucial to understand why energy efficiency measures are included or not [24–28]. Thus, this article focuses on the planning and design meetings of renovations.

The remainder of the article is structured in the following way: First, an overview of the framework is presented. Thereafter, these perspectives, the middle-level intermediaries and social practice theory, are applied in relation to three renovation projects in Sweden. Finally, it is discussed how a combination of the two theoretical approaches into the middle-practice framework can contribute to the understanding of energy efficiency in building or renovation projects.

2. Overview of earlier research of the professionals in the middle and SPT

This section gives first an overview of earlier research on the middle level and SPT and then it is discussed how to integrate them into one framework.

2.1. The middle professionals in earlier research

The middle becomes important when it comes to greening the housing sector and promoting energy-efficient solutions [18–20, 29, 30]. Examples of middle actors could be small and medium-sized enterprises, general builders, specialist subcontractors (e.g., roofing contractors), plumbers, heating engineers, electricians, architects, design engineers, project managers, building control inspectors and others. There is also a growing literature on middle actors. Examples of studies focusing on middle actors are an application of the MOP for providers of housing refurbishment [18, 20] heating engineers [30] and facilities managers [19].

The middle has influence in different directions, upwards to the top, downwards to the bottom and sideways to other middle actors Janda and Parag [14, 15] and Janda et al. [18] have defined different modes of influence the middle has. According to the MOP, the middle actors exert influence by enabling (disabling), mediating or aggregating. In our framework, we will use these four modes to analyse the influence of the middle in their meeting practice. The analytical concepts of enabling, disabling mediating and aggregating, defined by Janda and Parag [14, 15], contribute with highlighting different way the professionals can influence the adoption of energy measures. However, the way these concepts have been used in the MOP framework, Reindl [20] argued that they lacked explanatory power and therefore social practice theory can be used to further explore these modes of influence of the professionals. Before going further into SPT, the use of enabling, disabling, mediating and aggregating within the MOP perspective will be discussed.

Enabling (with its opposite disabling) is related to technology adoption. Enabling means that a technology or strategy is allowed to be taken up and used in a project. The professionals adopt a strategy that can work with minor changes in the environment where it is to be implemented. The technology or strategy as such does not have to change in order to fit in the context. To illustrate enabling, Janda & Parag [14] give the example of professionals who install cavity wall insulation to the level required by building regulations. Disabling is just the opposite of enabling and means that a technology or strategy is not admitted to a project.

Further Janda and Parag[14, 15] define mediating as being about participation, change and alteration. A professional who has adopted a technology, strategy or process changes it to some extent in order to adapt it to better suit a given situation or project. Professionals, for example, mediate a strategy on how to relate the specific situation to existing regulations. Mediation can be seen as a participatory mode, a process of iterative discussion. An example of this are professionals who adjust an energy efficiency measure to a specific situation, by installing wall insulation to a higher performance level than required by law, for instance. Over time, building professionals collect and accumulate expertise and experience after having worked on a large number of buildings, which results in their aggregating knowledge. Professionals involved in many projects (concurrently or sequentially) then use what they learn from one project in the next. Professionals' ability to recognize and act upon patterns across the building stock is thus based on their work experience. A professional who, based on his previous experience, can see that a building is in need of a combination of strategies, or who knows what type of insulation fits which building in order to meet the required level of thermal insulation can illustrate this [14, 20].

The concepts of enabling, disabling, mediating and aggregating are interrelated and relatively similar in nature. A way to add explanatory knowledge to these concepts could be to add SPT to the framework, which will be tried out in this paper. Next comes an overview of SPT.

2.2. Social practice theory

Practice theory is not a unified theory, but a fragmented body of theories with different scholarly traditions, albeit with historical and conceptual similarities [31–34]. There is no agreed upon practice theory; rather, practice is a dynamic concept [34]. In a practice, structures and agents are considered and dependent on each other, constituting a duality in a practice context [35]. Gram-Hanssen [36] explains practices as follows: 'Practices are coordinated entities of sayings and doings that are held together by different elements and that are also what make practices collectively shared across time and space' (p. 64).

A practice is an enduring entity and a set of doings and sayings. Further, practices are social, and when a practice is performed, the actor connects not only with those s/he interacts with, but also with everyone else performing the practice. Practices are performed by people in ways that make sense for them. A practice can involve the use of different kinds of materials and technologies, even though people might not be aware of all the resources that are involved [37].

In an organization, different practices, for example, a customer service practice, an advising practice and a meeting practice, are integrated. According to Schatzki [38], a practice memory means that a structure persists from the past to the present. Different practice memories build up an organization's memory, which directs the professionals' performance of actions. A practice memory does not always have to exist the way it does; it can change, either intentionally or unintentionally [38, 39].

Researchers have different opinions on what elements hold a practice together (for an illustrative overview, see [33]). Schatzki [40] suggested understandings, rules

and teleo-affective structures. Later, he added general understandings as a fourth element e.g. [38, 39]. Warde [41] uses the four elements of understandings, procedures, engagements and items of consumption. Shove and Pantzar [42] refer to the three elements of competences, meanings, and material (things, products, technology).

In this paper a slightly revised version of Gram-Hanssen's [32, 33, 36] four elements is used to analyse meeting practice during the studied renovation projects. Gram-Hanssen's elements are the following: (1) Engagement and meaning (which refers here to reasons to construct or renovate a building or the meaning energy questions have in this (re-) construction project). (2) Technology (which refers here to the physical features of the house, its materials and the available measures and technologies used in a building project). (3) Explicit rules (which refers here to different policies, rules and regulations or goals, such as building standards or explicit energy reduction goals). And finally (4) know-how and habit (which refers here to different kinds of skills and know-how attained by building professionals and to routines that are taken for granted–things people do without thinking about them that influence the selection of energy measures).

2.3. The combined analytical framework

As a way to deepen the understanding of how and why energy measures are enabled, disabled, mediated or aggregated during renovations of building an SPT approach has been added to the concepts. The way the modes and the elements are combined is shown in Table 1. This combination of theoretical approaches can been seen as a development of the MOP, with the purpose to add more explanation power for how the professionals influence energy efficiency in the building sector.

3. Method and material

The analysis is based on material collected from three renovation projects in a municipality owned housing company. Their stated goal was improved energy efficiency in all three projects. The material is based on a larger study on the implementation of energy efficiency and saving measures in building renovations [20]

The study was conducted as a case study [43]. The case was selected because of the focus on energy efficiency, besides that it was supposed to be a typical renovation project. The early phase, the planning and design phase was chosen to be studied because decisions on what energy efficiency measures to include is negotiated and decided upon in this phase. Analytical generalisation can be obtained from a case study [43]. Different data sources are used and those are triangulated to increase the validity of the study [44]. Additionally, the researchers were involved in the renovation processes over a long period of time, from when they were initiated to when they were finished [45].

For this case study the internal employees of the housing company and external consultants (architects, building engineers, HVAC and electricity consultants) have been defined as the middle. They are in charge of planning the renovation. On the top in this case is the investment group of the housing company and the tenants of the buildings to be renovated are considered as the bottom. In this article the focus lies on the middle.

Participant observations, a document analysis and semi-structured interviews were conducted. In total 18 planning and design phase meetings and six tenant meetings were observed. Social interactions, measures and actions agreed upon as well as underlying processes influencing decisions on the implementation of energy efficiency and saving measures were studied during the observations [46]. Site-visits for each to be renovated building took place too. During all the different meetings, notes were taken and written up immediately after the observation. 28 semi-structured interviews were conducted with all the actors of the planning and design phase (two project leaders were interviewed twice), which is the actual project group (internal employees and external consultants). Additionally, 5 interviews with the

Table 1: Analytical framework combining mode of influence (MOP) and elements of social practice

	SPT–elements			
Modes of influence	**Technology**	**Explicit rules**	**Engagement, meanings**	**Habits and know-how**
Enable				
Disable				
Mediate				
Aggregate				

Table 2: Characteristics of the three renovated buildings

	Renovation Project 1	Renovation Project 2	Renovation Project 3 (two buildings)
Building built in	1961	Early 1950s	1961 (partly renovated 1985)
Number of apartments	12	33	32, 4
Building construction	Concrete frame	Lightweight concrete construction	Lightweight concrete construction
Type of windows	3-pane windows	2-pane windows	3-pane windows
Type of ventilation	Exhaust air with inlets under the windows by the radiators	Natural ventilation	Supply and exhaust ventilation with heat exchanger
Energy consumption before renovation (Heat and water)	153 kWh/m^2*year	141 kWh/m^2*year	154 kWh/m^2*year (not known to us from the second building)
Identified problems in the building	Poor external façade and roof construction, poor performance of windows, water damage in bathrooms, problems with balconies	Poor plumbing, inadequate ventilation, outdated wiring, inadequate fire insulation, and limited accessibility	Problems with indoor environment, low and varying indoor temperature, stuffy air and odours

investment group of the housing company, one interview with the Swedish Union of Tenants and 39 semi-structured phone interviews with the tenants were conducted. The interviews were recorded, transcribed and analysed computer-aided with ATLAS.ti.

The analysed documents comprised different building descriptions, drawings and sketches and photos of the buildings, protocols of the meetings as well as the tender documents for the renovation. Additionally, the protocols of a previous conducted renovation project were analysed. The characteristics of the three renovated buildings are presented in Table 2.

4. Results: negotiating energy measures in building professionals' meeting practices

During the planning and design of the renovation projects measures were enabled (i.e. adopted), disabled (i.e. not adopted), mediated (i.e. adopted but in a modified version) or aggregated (i.e. a measure used before was implemented without further reflection). There are also measures that can be understood in more or less all four modes of influence. Wall insulation is an example, where a measure was mediated and aggregated, as from experience the middle actors knew that wall insulation works to get a lower energy consumption in the end and the depth of wall insulation was usually estimated and mediated to fit the conditions of a specific building. Wall insulation can also be understood as enabled. This example shows that in practice there is a strong connection between the concepts aggregating and mediating. The explanatory power of the concepts do however increase if the elements of practices is added, which contribute with a context to the four modes of influence.

In Table 3, the measures discussed during the renovation projects are categorized in relation to the developed framework. Some boxes are left empty, which just reflects that there are no good examples of this in our studied projects; a different study would most likely have other examples with other empty boxes. The idea with this matrix is to develop a framework that can increase our understanding of why certain measures are enabled, disabled, mediated or aggregated in practice.

Below, the examples from Table 3 are discussed in more detail. The different modes of influence, enabling, disabling, mediate and aggregate are discussed in relation to the different element holding a practice together, namely technology, explicit rules, engagement and meaning and finally know-how and habits.

4.1. Enable

4.1.1. Technology

In all cases, the enabled measures were A-labelled appliances, triple-glazed windows, new doors, updated ventilation (e.g. HRV ventilation), added insulation and some updates in the heating system.

Most of the interviewees indicated that usually a common set of 'standard' energy measures were chosen. The interviewees described this as follows:

Table 3: Examples from the studied renovation projects related to the modes of influence and SPT's elements

Modes of influence (MOP)	SPT – elements			
	Technology	**Explicit rules**	**Engagement, meanings**	**Habits and know-how**
Enable	Enabling aggregated and mediated 'standard energy measures' LED lamps New heating system A-labelled appliances Triple-glazed windows New doors Heat recovery ventilation (HRV)	Building norms; regulations and standards Initial goal to focus on energy efficiency and saving in the renovation projects Energy efficiency goal to save 25% by 2025	Energy group Energy consultant New energy goals	Use of estimations and rules of thumb
Disable	New solutions, not tried out before (e.g. new type of insulation) Keeping location of shafts as disabling factor Not more energy-efficient appliances than standard Heat pump Solar panels Automated lighting control	No awareness of the 25–25 goal Not existing measurement of the building's energy use Not obviously used energy calculations	Innovation and risk-taking were discouraged Existence of multiple goals on energy efficiency Financial limitations Households' electricity consumption not important	Quite closed network, the same consultants had participated over the years Lack of discussions of energy measures: using measures they are familiar with Predefined agenda hindering brainstorming Lack of know-how and habit: Pay-off rules
Mediate	'Standard' energy measures adapted Insulation Relining of heating system Improved energy efficiency within standardized budget Fear of rent increase and long pay-off time			
Aggregate	Reuse of technology that has worked in earlier projects (no new measures) District heating		'Standard' energy measures Encouraged to use solutions that have worked in other projects	Trust in tacit knowledge and experience

'The most common things that we do are to install an HRV system, add insulation, replace windows,… but it is nothing directly revolutionary.' (Interview, IC-1)

These 'standard' energy measures were enabled based on aggregated knowledge and mediated according to the specific characteristics of a building. For these measures there was no need of lengthy discussions during the meetings and more or less routinely implemented.

4.1.2. Explicit rules

Building codes, regulations or standards were barely part of the discussions at the meetings. The interviews showed, however, that they played a key role and it was understood that the Swedish BBR requirements (90 kWh/m^2/a) had to be met (BBR = Boverkets byggregler, BBR. English: The National Board of Housing, Building and Planning's Building Rules, BBR). Everyone knew about it and followed them, apparently implicitly, as a kind of tacit knowledge. These regulations also had a framing effect on all renovation projects, according to the interviewees.

'The process is the same as usual, as in all projects. We have the building codes to rely on. That is, we need to meet the requirements for kWh/m^2 – that is what we always do and follow. Then, the [energy] requirements of the contractor can be tougher, but that is not so common, but it can happen.' (Interview, EC-5)

Additionally, the renovation projects started out with the goals of improving energy efficiency and reducing energy use. The housing company had also decided on a

goal of reducing energy use by 25% by 2025 in their entire housing stock, the so-called 25–25 energy goal. Almost all interviewees said that energy efficiency and saving had become a more important topic and was included more in these processes than previously.

4.1.3. Engagement and meaning

The housing company had started something called the energy group with the purpose of emphasizing and promoting energy efficiency and saving within the housing company. The existence of the newly created energy group started also to enable more engagement in energy efficiency and saving issues. The group became a symbol of the housing company's commitment to this issue. However, the energy group had not yet brought about any noticeable concrete results. They did not actively promote different energy measures at the meetings. Their own explanation for this was that they were new and had not had any time to establish themselves and become a natural part of different practices. They thought that they first needed to establish themselves within the company before they could start to make a real difference and also enable more radical energy measures.

> *'We have not established all roles and tasks. That is how it is. It will most likely take one or two years and then we will know, but we are working and it is obvious that things go in different directions and …, but we do things and we save energy, we find energy projects. [...] forming this [energy] group is of course a way to get a proper focus both internally and externally.'* (Interview, IC-9)

In addition to the energy group, in one project an energy consultant provided energy calculations. Even though he was present at the meetings, his participation was not very active because there was rarely any time to discuss energy questions and a concrete discussion of the energy calculations never took place. However, he served as a reminder that energy should be looked at as well. The project leader could often end the meetings by saying that energy is important and that it should be discussed more at the upcoming meeting.

4.1.4. Know-how and habit

As mentioned above, the middle professionals were very familiar with the different buildings and knew what measures would work to achieve building standards. At the meetings it become clear that the different selected energy measures were aggregated and enabled through tacit knowledge and rules of thumb. The middle professionals trusted the knowledge they had by having worked with buildings for many years. When it comes to know-how and habit enabling and aggregation becomes fluid and it is hard to clearly separate these.

4.2. Disable

4.2.1. Technology

HVAC and electricity issues played a central role in all renovation projects. These were often prioritized over other issues during the meetings. Energy questions often had to be kept short or were among the issues put off until the next time. Lengthy discussions on the shafts left no time to discuss energy questions in detail. This could be observed during the meetings but was also mentioned during the interviews with the professionals. One of the architects said, for example:

> *'Yes, we also have some influence, but in certain phases of the process they [i.e. the HVAC and electrical consultants] can have too much influence. This is because they have so many issues and so many things to sort out. So, just looking at the time aspect, they take a lot of time during the planning and design meetings.'* (Interview, EC-8)

A-labelled appliances were chosen, but not the most energy efficient ones. When heat pumps came up as a suggestion, this was rejected with the argument that district heating is already in the buildings. Heat pumps could be an option for newly built houses but not for renovations according to the housing company. Photovoltaics (PV) were another technology disabled during the processes. PV was rather quickly dismissed as too expensive, without any calculations made.

Moreover, most of the middle professionals were sceptical about new solutions or any kind of innovation. Their attitude towards any new energy measure or innovation was to 'let others make the mistake of using it'.

4.2.2. Explicit rules

Even though there was the 25–25 energy goal formulated (25% purchased energy reduction until 2025) to encourage energy measures, it was hard to see how it was translated into the practice of the renovation projects. Probably this is because there was a knowledge gap in that not all involved professionals knew about the 25–25 energy goal. During the interviews, when it was asked whether the interviewees knew about or had heard

about the goal, it became clear that the external consultants were unfamiliar with it.

> *'I have not a clue what it is, if it's about, say, 25 years to reduce energy demand by 25% or whatever it is, whatever goals they have.'* (Interview, EC-4)

However, the internal employees usually assumed that all the external consultants were familiar with the 25–25 goal and were working actively with it.

It was observed, the energy goal was never properly communicated at the meetings. It was merely stated that the energy use for the building should be reduced as much as possible within economic limits, but the 25–25 energy goal was not presented.

The followed renovation projects were stated to be an important part of the 25–25 energy goal fulfilment by the internal employees. The researchers expected that all buildings would be measured regarding their energy use and that each building would get defined reduction goals. During the participant observation, however, the researchers realized that there were no measurements of how much energy a building actually used before the renovation. Energy calculations had been done for all projects to give an estimate of how much energy a building used. However, these calculations were never presented or used in the planning and design meetings. Furthermore, no specific energy reduction goal was set for any of the studied projects, e.g. in relation to the overall 25% reduction goal. Instead, the goal was simply to 'achieve as much energy reduction as possible'.

> *'The goal of the project is that the energy savings will be "as good as possible". The housing company has no explicit demands or requirements for how much energy efficiency should be achieved.'* (Meeting minutes, 2013-01-18)

4.2.3. Engagement and meaning

The general attitude was that it is preferable to avoid risk-taking and thus to reject new and innovative solutions. The tendency towards risk aversion also disabled energy efficiency or saving measures. Many of the involved professionals discouraged a stronger focus on innovation, new solutions or risk-taking. A typical statement was:

> *'Let the others make the mistake, we do not need to.'* (Interview, EC-1)

There existed a plurality of contradicting goals, which disabled a clear message and focus on energy – there was the 25–25 energy goal that many did not know, the financial goals as well as the BBR demand. The consultants also did what they usually did and the meaning and engagement stayed the same as usual. If the housing company does not introduce or communicate this goal, then a new meaning will not develop, and the engagement will not change either. It will remain a businessas-usual project. The choice of measurements was also guided by financial considerations. Any (energy) measures could be selected as long as the pay-off time was less than six years. In general, the economic restrictions came mainly from the investment group; however, thinking in terms of economic limitations was also part of the middle's work.

In addition, the middle actors did not focus on households'/tenants' electricity consumption. First, it was seen as too little to count for anything major in the big picture of the whole building's energy consumption. Second, water and heat are included in the rent for the tenants, but tenants pay for electricity themselves, which might be a reason why it is not prioritized, as the housing company does not pay for it.

4.2.4 Know-how and habit

The building sector in a medium-sized Swedish town such as the one studied here is not particularly large, so the same professionals worked together in different projects. The network was quite small and it seemed like the professionals knew everyone who was working in the building sector in the region. The professionals were familiar with each other, and the meetings took place in a relaxed and friendly atmosphere. The participants were joking with each other, had inside jokes, remembered stories and told funny anecdotes from previous projects. Most of them also had nicknames for each other.

> *'I know them, yes it is as I say […] you know most of them.'* (Interview, EC-1)

> *'We have a few old hands who have always been involved and know the housing company's requirements pretty well, so they probably do quite a lot on routine, for better or worse.'* (Interview, IC-6)

Because the professionals knew each other well, they also knew what to expect from each other. They had often worked together before, reinforcing and carrying on the practice of the planning and design phase. Longer

discussions on energy efficiency issues were not in the middle professionals' routine, and this was hard to change by simply introducing a company-level energy goal and an energy group.

Routines governed the meetings, and they were organized according to a predefined agenda that had been used in previous renovation projects. On the agenda, the topic of energy was added in the followed renovation projects. However, energy was usually discussed only briefly at the end of the meetings, or sometimes it was postponed until the next meeting. The predefined agenda and the know-how on how to conduct such meetings disabled the discussion of energy questions.

These existing routines might be broken up by recruiting new people. The studied renovation projects included two new architects from other towns. In the interviews they revealed that they had a hard time understanding the meeting practices; they had no introduction to the project nor to the other involved actors. They also found it difficult to learn and understand the existing routines, habits and meanings of the meeting.

The meetings usually followed a predefined agenda, which allowed little time and space for brainstorming or the discussion of new solutions.

Furthermore, the investment group said that the way they calculated pay-off time for energy efficiency or saving measures was more pessimistic compared to how other housing companies calculated. However, they also emphasized that it was new for them to consider implementing more energy measures and that a good way to calculate pay-off times had not yet been established. In this case the lack of know-how and habit disabled the uptake of energy measures.

4.2. Mediate

4.3.1. Technology

The 'standard' energy measures were mediated and adopted in each of the studied renovation projects. The enabled 'standard' energy measures were mediated based on aggregated knowledge

> *'It is easy to take the solution you have used before. You know it was good then and when you get a bit in a hurry and … and … [the job has to get done] so, as a quick solution, you implement it in the next one again, with some adjustments'.* (Interview, EC-9)

Additional insulation was mediated in all projects. It was used and adapted for each building by rule of thumb.

In two of the buildings, the old pipes were exchanged, whereas in one building it was not economically feasible to do so. In this case, relining was chosen instead as a mediation for the pipe exchange.

Due to pay-off time and fear of rent increases, measures were changed or adapted. If the pay-off time became too long or if the rent was to be raised due to implementation of an energy-efficient measure, the plans were changed.

> *'You need to realize that someone will need to pay. We can renovate, we can remove concrete tiles and install new ones, we can paint the façade, and we can paint the windows … but someone needs to pay for it, otherwise we erode our real estate value.'* (Interview, IC-2)

Additionally, chosen measures were adopted and mediated according to budget restrictions.

4.3. Aggregate

4.4.1. Technology

Technology that was used in the past, like for instance the 'standard' energy measures were used again as the middle actors know with a rule of thumb how to apply them for different kinds of buildings

Both the housing company studied here and the energy company, which has the district heating system are owned by the municipality. This connection by ownership was one reason that district heating was chosen. Another reason was that it was reliable and comfortable. Furthermore, it was chosen over other heating systems as it was already in place.

4.4.2. Engagement and meaning

Measures were chosen that the middle actors knew from before and had experience with. During the observations, it was also noticed that it was encouraged to use measures everyone was familiar with as a way to avoid costly mistakes. Thus, for all chosen solutions, the middle professionals fell back on their aggregated knowledge base and rules of thumb.

> *'We have done some before, so you have learned a lot of lessons and bring them with you.'* (Interview, EC-10)

4.4.3. Know-how and habit

The middle professionals had routinized their selection of energy efficiency or energy saving measures and they trusted in their tacit knowledge and relied on experience and rules of thumb.

5. Discussion and conclusions

The modes of influence highlight how the middle professionals can enable, disable, mediate or aggregate energy measures. These can sometimes be the same or similar to each other. Furthermore, why, energy measures where enabled, disabled, aggregated or mediated was however identified as a research gap. Prior literature has discussed the need to recognise the influence of the middle professionals, but there are few empirical assessments of how and why energy measures are included or excluded in the planning of an energy renovation. Addressing this gap allows us to identify where adoption of energy efficiency measures in buildings falls shorts and whether these shortcomings can be addressed in future planning and management of renovations.

In order to increase the explanatory power of the concepts of mode of influence of the MOP, a social practice theory approach was added. Combining theories, the MOP and the modes of influence with the elements from SPT makes it possible to analyse how and why the professionals can enable, disable, aggregate or mediate certain energy measures from a new perspective by focusing the elements. Studying meeting practices through the perspective of elements of practices makes it possible to pinpoint the difficulties of enabling energy measures and why they are disabled, how certain measures are mediated or why they are aggregated. It gives the modes of influence a context that was lacked before. By combining these theoretical perspectives, it is possible to arrive at a deeper understanding of what needs to be changed to achieve a highly energy-efficient renovation. In Figure 1, the framework is visualized.

The middle professionals in the project group here studied, form a temporary constellation conducting the meetings. However, these professionals meet regularly in this as well as similar constellations for other projects. Thus, the meeting practice endures because it is repeatedly enacted. The middle professionals build relations to each other and establish a professionals' practice during their meetings in the renovation project. These meetings are moments of sayings and doings where different elements of a practice come together and the professionals are carriers of a renovation practice. They each bring their own work practice as well as different opinions, knowledge and expertise on how to handle energy questions.

Studying the building professionals planning and design meetings as practice helps to understand how and why they enable energy measures or what might hinder the uptake of energy measures in relation to different elements (table 2 above summarises the results from that analysis).

This in turn helps to understand what might have to be changed in the renovation process. Even though there is an organisation memory it does not mean that a practice cannot be changed. Schatzki [38, 39] argues that changes in a practice are commonly fragmentary and gradual. However, there is also the possibility to change practices

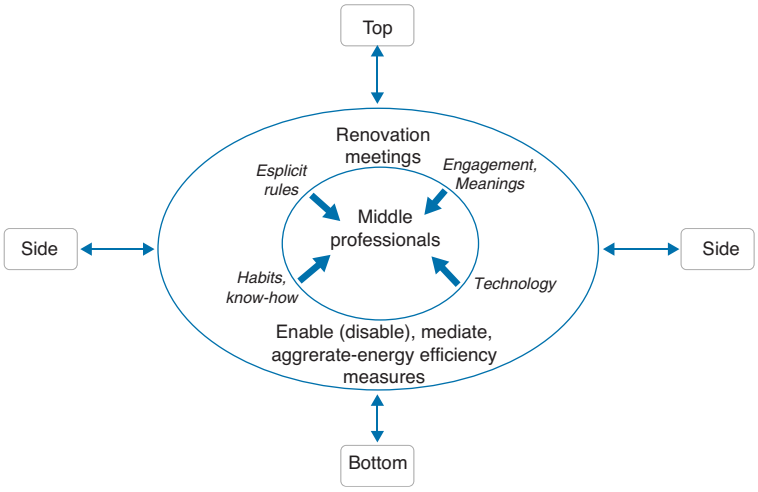

Figure 1: The middle-social practice framework including the modes of influence and elements of practices

if conscious interventions are made. In the empirical example described here the housing company could try to actively change the meeting practice in different ways. Clarifying energy targets is one step, but they also need to change the meaning of the renovation to change the practice. The dominating view of avoiding taking risks by introducing new technology or new system solutions needs to be changed in favour of having energy efficiency as an overruling target in all decisions. There is also a need to verbalise the aggregated know-how of the professionals, to be able to re-evaluate tacit knowledge and discuss what consequences this embedded knowledge has for the possibilities to achieve a real transformation with real ambitious energy achievements. A change of practices requires interruption and changes in the included elements, but in this case it was a lack of such interruptive processes and the practice remained.

Studying the building professionals' meetings as practice helps us to better understand the mode of influence of middle actors. It gives the decisions a context that has been lacking in the MOP. This in turn helps us understand what might have to be transformed, to have meeting practices supporting a more sustainable built environment in the future. However, there are also issues with using the elements of a practice combined with the mode of influence as there are certain overlaps as for instance in itself know-how and habit (SPT) and aggregated knowledge (MOP) convey a similar content. Still, the developed framework give an additional understanding of why energy efficient renovation takes place or not. In future research it might be possible to develop the framework further, if applied on other cases in other contexts.

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