Objectivity or different levels of subjectivity: A sociomaterial study on the measurement of the quality of the indoor air

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Abstract

Objectivity has often been seen as an important target to aim for in accounting research as well as in society more generally. This study shows how objectivity as related to measurement can be rhetorically used against the experiences of humans, resulting in serious consequences. We thus question the desirable characteristics of objectivity as tied to measurement. The setting is that of indoor air problems which have recently heavily escalated in the Nordic countries; we focus on a public institution in which people's subjective experiences about the quality of indoor air appear to conflict with the "objective" measurements by technical instruments. We take a sociomaterial view on this, recognizing both social (human) and material (measurement instruments, measures) issues intermingled. Measurement is shown as a calculative practice that can have a twofold meaning: objective measurement and subjective experience. It is shown here that the subjective experience is "real" in this setting and that objectivity seems impossible to achieve and thus realize; although the formal view in the organization is exactly the opposite: "reality" is seen exclusively as objective measurements while any subjective experiences are not seen as part of "reality". This contradiction forces organizational members to choose between two realities: "objectivity", i.e. formal, technical results, and "humanity", i.e., people's subjective experiences. We show how objectivity can be replaced with four different levels of subjectivity that have a much more real meaning than the artificial construct of objectivity.

1 Introduction

Objectivity has often been seen as an important target and ideal in accounting research (DeZoort, Holt, & Taylor, 2012; Vélez, Sánchez, & Álvarez-Dardet, 2008; Malina & Selto, 2004; Harrell, Taylor, & Chewning, 1989). Moreover, objectivity is heavily promoted in society more generally: the denial of objectivity is seen as simply inacceptable because it is perceived to consist of individualized hazardous and random opinions not serving any common good. "Objectivity" as related to quantitative measurement has often been artificially raised to the level of an impartially imposed truth that humans cannot deny (Everett et al., 2005; Quattrone, 2009; McKernan, 2007; Shapiro, 1997). However, based on social constructionism (Berger & Luckmann, 1966; Hacking, 2000; Searle, 1995) it is possible to treat objectivity as a social construct, developed by humans to serve their own needs. When qualities are turned into quantities, they begin to artificially define a "reality" that focuses on certain issues, while excluding others; in particular, aspects that are not easily measured are ignored, as being unable to constitute "reality" (Miller & Power, 2013, p. 559; Bourguignon, 2005; Espeland & Sauder; 2007; Espeland & Stevens, 2008).

Here we consider "objectivity" as a social construct that can be used to serve certain human ends; it does not represent an artificial and undeniable "truth" outside of human interactions. We also show how objectivity can be used to produce unwanted consequences; in the case examined here the implications of objectivity consist in the denial and undervaluation of human suffering. Surprisingly, objectivity does not seem to possess only beneficial attributes

but can be used to produce end results that seem rather negative for some of the humans involved in the case.

Here we study objectivity in the context of measurement. Measurement has usually been considered in accounting and performance measurement literature as the application of measurement instruments to human beings who then react to such measures in different ways (Langfield-Smith, 2008; Merchant & Van der Stede, 2007; Alvesson & Kärreman, 2004). Measurement has thus been seen as a sociomaterial affair in which material measures are interconnected with humans (the mainly social dimension) (Pollock & D'Adderio, 2012; Scott & Orlikowski, 2012). The measures could be more material (measures taken directly from a system, such as the performance of a given entity as measured by its profitability), or measures could be estimated subjectively and qualitatively by e.g. superiors when evaluating the performance of subordinates (Ittner, Larcker, & Meyer, 2003). Humans also respond to surveys and act as measurement instruments in this way such as when providing data to internet services such as TripAdvisor (Scott & Orlikowski, 2012). In this paper, we show an application of measurement within which human beings themselves could be used as measurement instruments for the quality of indoor air in a building; humans measure the quality of the indoor air with their own health and with the symptoms they receive from poor indoor air.

Our research questions are: *(1) What kind of unwanted consequences can objectivity have in the context of measurement? (2) How can this objectivity be turned into subjectivity so that such consequences could be avoided?*

We study calculative and measurement practices related to indoor air in a setting in which issues of indoor air are seen as pressing from several employees' point of view. In Nordic countries, and particularly in Finland, inferior indoor air has become a major health hazard, causing a lot of adverse effects to people's health, such as respiratory problems. Our empirical setting is a public institution in which the technical measurements related to indoor air show certain results which are partly contradicted by the views of employees, as they measure the indoor air with their own symptoms. We have interviewed a variety of actors related to the study: employees, their supervisors, administrative personnel responsible for communicating about indoor air measurements with the building owners and with employees, employees responsible for work safety, building owners, and technicians responsible for conducting the actual measurements. We also have been given access to the internal documents of the institution regarding the results of the indoor air –related measurements and the communication that contains the results. Moreover, we have observation data on information events organized within the institution regarding the results.

It is shown how the interviewees' views on the technical measurement instruments differ from the views on human beings as measurement instruments for indoor air. We also show how human beings could more effectively be used as measurement instruments in such cases. The measurement of indoor air quality by human beings is shown as not appreciated because it is not a calculatively objective practice and because objectivity is usually more extensively

related to material (not social) instruments – although, paradoxically, the purpose of indoor air measurement is the improvement of human health.

We also show how, in this institution, the "objectivity" of measurement instruments is not questioned – although the use of such instruments is conceded to be the result of human actions. The "objectivity" of the instruments thus defines "reality" in the organization: if the technical measurements show a certain technical situation in the building, then this situation must be so "in reality". However, several employees present an alternative reality by describing the symptoms they receive from the indoor air of the building and more or less subtly question the "reality" created by the technical measurement instruments. It thus appears that it is the reality of the employees' symptoms which becomes the only reality that matters for them, while the "objective" measurements lose their touch with this reality and become only abstract constructs with no real meaning. From the perspective of the employees, reality thus comes to consist of the experience of humanity and not of the technical and numerical results of the "objective" measurements.

As the connection between human reality and objectivity is severed and objectivity thus becomes a rather questionable construct, we analytically replace objectivity as a representation of reality with four levels of subjectivity: (1) individual, (2) social, (3) material, and (4) sociomaterial experience. Here level 1 reflects a purely individual experience, level 2 relies on social constructions (Berger & Luckmann, 1966; Hacking, 2000; Searle, 1995), level 3 is tied to materiality (as a part of sociomateriality; Orlikowski, 2007; Orlikowski & Scott, 2008; Orlikowski, 2010; Faulkner & Runde, 2012) while level 4 is linked with sociomateriality. We also show a tendency to consider the material experience (3) as "objective" and thus desirable while ignoring a higher level experience (4), the sociomaterial experience, that takes into account both social and material issues in balance.

The study is structured as follows. First we present relevant theory on measurement and its connections with objectivity. Then we describe our methodology and empirical findings. The study ends with a discussion and conclusions section.

2 Theoretical reflections

2.1 Measurement and its connection with sociomateriality

"Measurement" has often been considered in the accounting literature from the point of view of performance measurement (Langfield-Smith, 2008; Merchant & Van der Stede, 2007; Ouchi, 1979), measuring the performance of either organizations or individuals. Measures can be financial, non-financial or "hybrid", including features from both the financial and the non-financial (Malmi & Brown, 2008; Merchant & Van der Stede, 2007). Popular performance measures include for example quality, efficiency, response time (Lillis, 2002, p. 498), profit, and sales (Alvesson & Kärreman, 2004). However, there is also literature that

considers “measurement” and numbers, the turning of qualities into quantities (Espeland & Stevens, 2008; Miller & Power, 2013) and for example the associated commensuration (Espeland & Stevens, 1998), without necessarily directly associating these issues with the measurement of performance.

The field of sociomateriality (Orlikowski, 2007; Orlikowski & Scott, 2008; Orlikowski, 2010; Faulkner & Runde, 2012) that has recently become active promotes the acknowledgement of the material and the social being as fully integrated as possible: “there is no social that is not also material, and no material that is not also social” (Orlikowski, 2007, p. 1437). This would mean that the social and the material are acknowledged as ontologically inherently inseparable (Orlikowski & Scott, 2008, pp. 455-456). Following Orlikowski (2007), materiality is defined here as physicality (Faulkner & Runde, 2012); a physical reality. The social is defined as coordinated human intentionality that acts together with material agency (Leonardi, 2012, p. 42). Latour and Woolgar also discuss the “technical” and the “social” and promote avoiding an artificial distinction between these two. Pollock & D’Adderio (2012) discuss performance measurement in the context of sociomateriality using material graphs such as a specific spreadsheet (p. 575). Vargha (2014) also treats performance measures as material with data on banks’ material queuing systems. Scott and Orlikowski (2012) study TripAdvisor’s Popularity Index as material.

Measurement and quantification can thus be seen as sociomaterial exercises, involving the cooperation of both humans and material measurement instruments which together form sociomaterial ensembles for example in the sphere of ranking (Pollock & D’Adderio, 2012). People who fill out surveys can be seen as social measurement instruments but they still require a material survey form so that their answers are transformed into readable data, such as the form provided by the traveler service TripAdvisor (Scott & Orlikowski, 2012).

Indoor air, the setting of the study, powerfully relates to health and safety issues. The measurement of occupational health and safety in an organizational context serves multiple purposes. First, measurement provides a picture of costs incurred by an organization for ensuring the preservation of employees’ health and for restoring the working capacity of employees after a work accident or illnesses affecting the ability to work (Koehler, 2001; Rikhardsson, 2004). Second, measurement permits the evaluation of organization performance in terms of compliance with standards and norms of occupational health and safety (Chan, 1979). Third, measurement gives information on how creating a healthy and safe working environment for employees, such as eliminating exposure to hazardous substances and dangerous conditions of work, can contribute to organizational performance, as measured by for example efficiency and profitability (Oxenburgh and Marlow, 2005; Fernández-Muñiz et al., 2009).

Health and safety are sociomaterial matters (Abildgaard and Nickelsen, 2013), as the effects of impaired capacity to work is material for both employees and organizations alike and concretize in illnesses and affected organs inside human bodies and in material costs for a company to bear (Koehler, 2001). The social aspect relates to employees’ wellbeing being

affected by their absence from the community in which they are working and the implications for the social relationships at work.

It appears that measuring a certain quantity or quality in an organization may attract the attention of those being measured (Bender, 2004; Pfister, Jack & Darwin, 2014; Simons, 1995, p. 71). However, this effect is not straightforward: even when measures are used, not all of them are given attention equally, the link between measurement and attention is not always automatic, and the causal direction of the relation is not always clear: management actions may cause measurement, not the other way around (Catasús, Ersson, Gröjer & Wallentin, 2007). Attention is not guaranteed for example if measures are perceived as harmfully subjective, incomplete, or unresponsive to relevant employee effort (Simons, 1995, p. 78).

Measurement can change the essence of the object being measured (Espeland & Sauder, 2007). The object may thus become more visible; an object of management and thus of certain concern (Bowker & Star, 2000; Power, 2004). Measurement may also improve any persuasive power of a given argument that relies on a given measure but increase the vulnerability of the object of measurement as its features become more exposed (Kadous, Koonce & Towry, 2005).

Measurement can decrease complexity (Power, 2004, p. 767) and can thus lead to reductionism; measurement is only possible when choosing only certain features of an object to be measured, ignoring others at the peril of losing detail (Power, 2004). Measuring can also re-enforce any status quo in the way that it may exclude issues that do not comply with predefined standards for measurement, being extraordinary on some scale, but whose consideration could benefit the observer who would thus receive a fuller picture of the situation in question (Sauder & Espeland, 2009, p. 73-74). Foucault (1979) has shown how modern systems of measurement discipline us. Measurement normalizes performance, giving ammunition to those who are in the position to judge the acceptability of a certain level of performance (Espeland & Stevens, 2008). However, measurement also disciplines the objects of measurement (such as profitability or quality): they are made to appear as structured and manageable objects (Espeland & Sauder, 2007).

Any successful process of management requires more than only measurement (Power, 2004, p. 779). In many situations the successful completion of tasks requires the consideration of multiple features of the task at hand, only some of which can actually be measured, and measuring only a subset of important issues may cause dysfunctional behavior (Simons, 1995, p. 76-77). Measurement is surrounded by complex organizational situations, such as those related to teamwork and its coordination (Frow et al., 2005), and such complexities affect how measures are taken into account.

Measurement has been presented as creating objective reality. In making objects visible and calculable, accounting measurement creates an appearance of objectivity that can artificially be presented as superior to potentially politically colored points of view (Miller & Power, 2013, p. 559). Measurement can reify the measured objects: any complexity within such

objects is then ignored and their multiple subjectively experienced features can be made to look objective (Bourguignon, 2005). Espeland and Sauder (2007) show how the measured issues can be the only ones that actually produce reality that is perceived as relevant (Espeland & Sauder, 2007). Quantified features of given objects are thus given sizable authority, making them appear more "real" than features and objects that cannot be so easily quantified (Espeland & Stevens, 2008). Naturally, "reality" may appear here at different levels: measures do not necessarily represent an undisputed reality that would be the same for all involved, but may end up circulating in hyperreality; they may no longer connect to reality but perhaps exactly due to that flexibility they may produce calculative predictability that may provide a certain safety net and at least an appearance of actor control (Macintosh, Shearer, Thornton & Welker, 2000). Next we turn to objectivity which measurement may create, and subjectivity as a kind of a counterparty of objectivity.

2.2 Objectivity and subjectivity

Objectivity is associated with the material world, i.e. the world out there, subjectivity with the human mind (Wagner, 1965). However, it is the human mind that defines objectivity; objectivity by its essence may thus be very subjective (Wagner, 1965), resulting in a paradox regarding the existence of objectivity.

Objectivity has been defined in accounting as related to a consensus among a given group of observers or measurers (Ijiri & Jaedicke, 1966). In defining objectivity, Wagner (1965) relies on the idea of professional judgement – dependent on both competence (based on training and experience) and ethicality (ethical principles). Ijiri & Jaedicke (1966) also refer to a lack of bias and Wagner (1965, p. 604) to compliance to certain standards of the profession. Objectivity has also been perceived as mechanical objectivity (impersonality and standardization), disciplinary objectivity (related to professional expertise), and independence (from pressure groups, for example) (Bourgoignon & Chiapello, 2005; Porter, 1992; Megill, 1994) – although Bourgoignon and Chiapello (2005) do concede that these forms of objectivity can contradict each other. In the context of performance measurement, objectivity has been perceived as the act of measurement being independent of the assessing person (Kunz, 2015, p. 29).

Objectivity has been treated in research as an ideal to aim for (DeZoort, Holt, & Taylor, 2012; Vélez, Sánchez, & Álvarez-Dardet, 2008; Harrell, Taylor, & Chewning, 1989). It has been seen as an even certain kind of a law that is under mathematical rules that cannot be contested by humans. "True and fair view" has been promoted regarding accounting standard procedures (Financial Reporting Council, 2014; Frost, 1994); it also implies an objective view of such truth.

Subjectivity has been treated as the opposition of objectivity (Wagner, 1965; Kunz, 2015). Subjectivity has thus been defined as being connected to specific humans and to the human mind in general (Wagner, 1965). As stated, subjectivity within performance measurement has been perceived as a negative issue (Simons, 1995, p. 78) if measures rely on the subjective

views of a given supervisor and perhaps ignore important features of the employee performance in question; in such a setting, more objective measures are favored.

Objectivity has also been critiqued. Objectivity can be used to defend and reify certain dominant points of view, perhaps reinforcing the *status quo* (Bourguignon, 2005). "Objective science" has been criticized because it does not provide grounds for morally judging the correct tasks in the face of the very uncertain future that we face in today's world (Adam, 1995, 170-175). A given subject can only been understood within its subjective world and thus objectivity has been claimed to be an impossible and artificial construction (Adam, 1995, 170-175; Heidegger, 1927/1980, 418). Social constructionism (Berger & Luckmann, 1966; Hacking, 2000; Searle, 1995) investigates the world ontologically from a subjective point of view as this is seen to be the only reality thoroughly and non-artificially available. Objectification has also been portrayed as non-natural but rather an artificial process that serves certain interest groups at the expense of others (Bourguignon, 2005).

Objectivity could be related to a certain kind of "common good", implying an objectively preferable situation for all involved, not relying on certain actors' subjective views only. However, following Levinas (1995, p. 253), such "common good" as a form of objectivity may neither be reachable nor desirable: "[I]f the partiality of the individual, understood as the very principle of his individuation, is a principle of incoherence, by what magic would the simple addition of incoherencies produce a coherent impersonal discourse, and not the disordered din of the crowd?" Such "objective", universal, or impersonal reason is not tied to any real individuals but on totality, something which Levinas (1995, p. 252-253, 300-301) considers as dangerous in that it may ignore individual, real, feelings of fairness. In Levinasian ethics, overall good is achieved through real individual experience (Levinas, 1985, p. 90; 1995), in face-to-face relations between a given self and a given other (Levinas, 1985, 1995).

Accounting and associated measurement have been perceived as sources of objectivity (Everett et al., 2005; Quattrone, 2009; McKernan, 2007; Shapiro, 1997; McKernan, 2007) in connection with numbers, as numbers (in relation to accounting measurement) have been seen as representing "objective" and "value-free" judgements (Quattrone, 2009; Shapiro, 1997). Increasingly there is a "mystical belief in numbers as figures which, for their simplicity and apparent objectivity, are supposed to provide access to a privileged business truth and utility" Quattrone (2009, p. 88). However, financial accounting has been presented as subjective due to such financial calculations constructing a reality, not only reflecting it (Hines, 1988; Morgan, 1988). Accounting also involves the human mind for example in selecting measures; it cannot thus be objective (Wagner, 1965).

Numbers are also seen to represent objective knowledge that transcends and is superior to local and contextualized knowledge (Espeland & Sauder, 2007), creating a certain form of "objective knowledge". Many professions use such objective knowledge and rely on it, such as doctors (medical tests) or financial accountants (financial numbers). However, the professionalism and competence of accountants have also been criticized as a result of

accounting scandals (Carnegie & Napier, 2010); professionalism and expertise are thus not absolutely beyond reproach.

It has been implied that reaching objectivity would entail knowing "the truth". This would also imply that if there is no objectivity, there may be no truth, which is a rather disconcerting idea for humans. Truth relates to reality, which can be both material and social; sociomateriality is thus relevant here as well. In a Latourian view, the objective and the subjective, the social and the material, are artificial constructions that social scientists may use instead of dutifully following the actors and "really" finding out about their reality (Latour, 1987, 2005; Latour & Woolgar, 1986).

Commonly, the material and concrete elements of our world as perceived as objective due to their existence being impossible to deny. They exist out there and anyone could in principle attest to their existence. Social elements, instead, are seen as subjective, because they rely on one's interpretation, which can differ from one person to another. It is the instability of how the "social" is interpreted, with multiple versions of the social coexisting at the same time, which makes the social to be seen as subjective. Objectivity is thus usually linked with the material and subjectivity with the social. This might imply that when using sociomateriality in combining the social and the material, we might be able to produce interesting findings regarding objectivity and subjectivity as well.

3 Methodology

Our project relies on a case study of a public institution, which we call PubOrg. This is an intensive case study, in which we focus heavily on one institution, digging deep into its processes and the subjective views of its employees. However, we do not limit the investigation to the internal actors of this institution, but we also examine the views of its stakeholders, such as building owners and technical experts responsible for indoor air measurements. We use interviews, observations, and internal material on the organization as our comprehensive data set. Our data are predominantly qualitative although we also have access to the quantitative measurement data regarding the organization. Consistent with our theoretical focus, we acknowledge that objectivity cannot methodologically ever be reached and thus aim to create as full a picture as possible of the subjective "worlds of experience" provided by the actors we study through our own subjective world views as researchers (Denzin & Lincoln, 2008, p. 29).

In PubOrg problems with indoor air have affected employees clearly at least since 2010, perhaps even earlier. Employees working in these premises, especially certain parts of the building, are complaining about different symptoms of varying intensity, such as respiratory infections, skin irritation, and eye-related allergy-type of reactions. In some cases, symptoms have been so intense that the employees had to discontinue their work in PubOrg premises and had to find alternative places for working (such as offices in other buildings or their own home).

PubOrg suits well our interest in examining the unfavorable effects of objectivity on humans as such effects were visible in our case organization within a clear competition between objectivity and subjectivity in searching for "the truth". Objectivity is simultaneously presented as a highly appreciated construct while also questioned. The research site was selected primarily based on our interest in indoor air quality measurements, as well as the availability and willingness of the organization to cooperate in our research. More details on the research site are provided in the end of the methodological section and in the beginning of the empirical chapter, in connection to actors involved in the case.

Our primary data consist of interviews with a variety of actors involved in the case. We interviewed personnel working at PubOrg, suffering or not from the poor quality of indoor air, but also personnel responsible for the wellbeing of the employees, representatives of the organization responsible for administering the building (i.e. building owners) as well as technicians responsible for the technical measurements. So far, we conducted 27 interviews in 2016-2017. The interview outline is presented as Appendix A and the list of interviewees as Appendix B to this study.

The interview outline covered various themes related to indoor air quality and different possibilities for its measurement, such as factors affecting air quality, the process of measurement taking place at PubOrg, the strengths and weaknesses of technical and human measures as well as possibilities to develop the measurement process (for more details about the interview outline, please check Appendix A). In addition, employees were asked to assess various features of technical and human measures. For this purpose, we gave interviewees a list of features of measures, as identified in our review of accounting and general measurement literature. Interviewees were invited to comment on these features from the point of view of both technical measurement instruments and humans as measurement instruments. The list is also attached within the Appendix A to this study. We adopted a flexible approach to our interviews, aiming for relaxed conversations. After each interview, we have reflected on the most significant and interesting findings emerging from the interview as well as the most relevant points of interest that were raised by the interviewee. This has taken the form of formal notes taken during each interview, but also materialized in reflective notes after the interview on the most important issues stated by interviewees. Notes taken during the interview, together with reflections that the interview elicited in researchers were collected in a Word file. Based on these reflections, the interview outline was also adapted, especially in the early stages of the interviewing process, to include themes not previously considered. This ensured that the researchers remained sensitive to issues that are significant to actors involved in the case and explored them in greater depth in the following interviews.

All interviews were face-to-face gatherings in which at least one author was present; in a few interviews the other author was also present. When both authors were present the interview questions were divided so that both authors asked questions, both primary (planned) and secondary (probing) questions. In cases when only one interviewee was present she naturally asked both primary and secondary questions. All interviews were audiotaped and transcribed *ad litteram* afterwards. We made sure that all interviewees agreed to audio recording at the

beginning of each interview. We also employed network sampling in finding interviewees by enquiring at the end of each interview about suitable candidates for our research. This process assisted us in locating interviewees both within the organization as well as outside of it. Interviewees suggested other interviewees sometimes within their own department but also in other parts of the organization and even outside of it.

In addition to interviews, we have access to the information about indoor air measurements that is being communicated in the organization, mostly as e-mails. Such e-mailed data are in the form of technically oriented qualitative descriptions on the results of the measurements and on upcoming renovations or measurements.

To complement our data, we are also using observations of internal events organized at PubOrg for the purpose of observing firsthand the dialogue between employees and e.g. people working in measurement organizations regarding the issue of indoor air. In this way, we avoid the methodological problem of relying exclusively on the memory of our interviewees. Appendix B details information on data sources used for this study.

Our observation data include various events organized in connection to indoor air problems in the organization. For instance, we observed one event that took place at PubOrg in October 2016, in which employees were given information about the results of the studies concerning indoor air. We made notes on this observational event and cross-checked the content of those notes with another person also present in the event. We have reflected on these notes on the observations and they seem to nicely balance and triangulate the rest of the data. The event was not recorded due to confidentiality concerns and thus transcription of it is not verbatim. The data in the event were mostly qualitative: (a) maps that indicated the specific areas within the building in which findings have been uncovered, (b) figures showing atmospheric pressure measurements, and (c) pictures of places of interest in the building structures that showed e.g. potential places in which air circulation may be suboptimal together with drawings showing the air flows or potential problematic structures such as acoustic panels that may produce fibers. A limited amount of quantitative information in the form of measurement results was also given within the figures and maps.

We rely on a qualitative approach and thematic analysis to interpret our data (Miles et al., 2014). Data analysis is facilitated by the use of NVivo program for the purpose of data coding and observation of patterns that emerge from the data. Data were coded for themes that were planned for before the interviews, such as difficulties related to human or technical measurements. However, other themes emerged during the interview process; such themes were further explored and coded for in the data analysis process. Such emergent themes were the workings of the indoor air steering group (more information will follow on this) and the wider societal field of indoor air measurements in Finland. One emergent theme was also the importance of the objectivity of measurement in the case; initially only one line item in the paper we gave to the interviewees, it expanded to rather large proportions in the actual data. The notes taken during interviews as well reflections after the interview also played a large role in the analysis.

The original idea of the research was to study a well-known proverb in Finland, “a human being is the best measurement instrument”, which is used to mean that people who spend time in a certain building are sometimes claimed to react faster and more accurately to problems of indoor air in that building than technical measurement instruments that are brought in to objectively study the buildings’ indoor air. The popularity of such a proverb is itself testimony to the low quality of the indoor air in many buildings in Finland. We set out to study how a human being can be perceived in this way as a measurement instrument, as compared with technical measurement instruments, using measurement theory to study such two measurement instruments. In the process of the data collection and analysis, we noted the close connections between measurement and objectivity, and that objectivity was a repeated object that emerged in the empirical data regarding measurement. We thus selected the objectivity of measurement as our major focus. We also noted a connection between objectivity and truth and a contradiction regarding this: although almost all interviewees claimed that technical measurements represent a certain kind of an objective truth, while many of them were also willing to simultaneously rather openly question this truth – going against “truth”. Such a contradiction forms the major thread of the empirical data.

PubOrg

The case organization is a part of a larger institution, functioning in Finland, and was employing about 200 individuals in 2016. PubOrg has its own leadership, in the form of a Council, which we here name Organizational Council, although it functions under the management of the larger organization, which sets the budgets and overall strategy for PubOrg. PubOrg provides its services to about 3000 people. While the mother organization operates in multiple buildings, our case organization functions primarily in one building that has been in use for over 50 years. More details about the building are given in the beginning of the empirical chapter.

4 Empirical findings

We start the empirical analysis by providing an overview of the actors involved in our case, after which we give more insights into the process of measurement and how it was perceived by different actors. We also examine two types of measurements (technical and human) in terms of their ability to measure and provide appreciated and particularly “objective” results.

4.1 Dealing with poor indoor air quality –actors involved

Various internal and external actors have been involved in the case and *Figure 1* provides a schematic view of the relationships between them. These relationships are also explained in the following paragraphs.

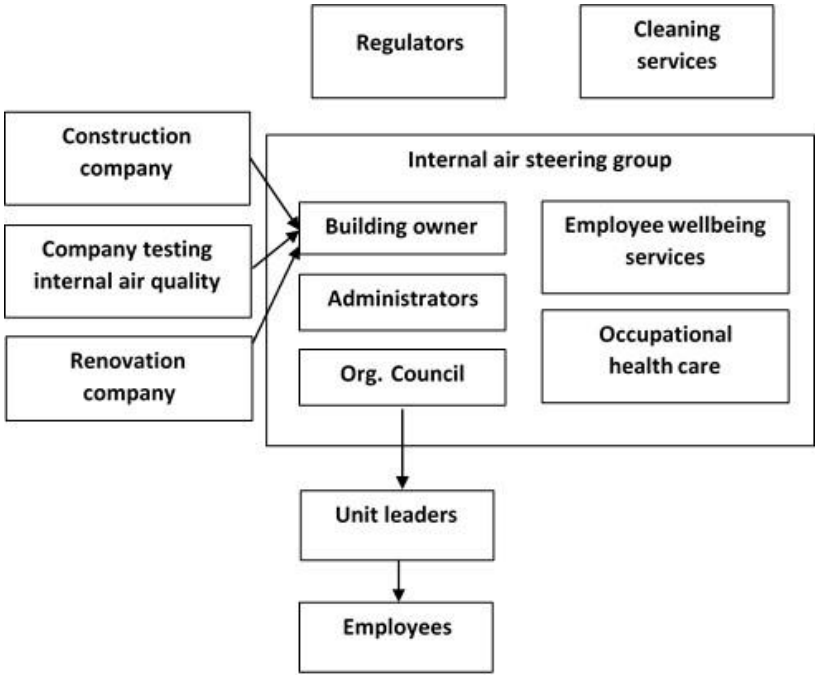

Figure 1: Actors involved in the process of measurement of the indoor air quality at PubOrg.

The building in which PubOrg functions is an office building located in Finland, constructed in three distinct stages during the 1950s, the 1980s, and the 2000s. It includes office rooms, larger meeting rooms, and even larger conference facilities. The building is not in the ownership of PubOrg but of a sizable company which owns and rents a large portfolio of mainly office buildings. *The owner* uses the services of technical administrators to administer and maintain the buildings in good shape.

Complaints of illnesses induced by the poor quality of indoor air started being voiced at least in early 2010s, although employees may have experienced symptoms even before that. Employees have also observed water infiltrations occurring frequently from the roof and penetrating the walls and partly linked them with their health problems. According to interviewees, the reparations of water infiltration problems were superficially performed and moisture may persist under the roof panels and inside the walls, causing symptoms. Some employees reacted to their health problems and made official complaints either to their direct superiors or via an intranet electronic form that directs complaints to the administrator maintaining the building.

As indoor air problems in Finland become recently societally more widely acknowledged, it appears that they have been taken more seriously at PubOrg. Following escalating dissatisfaction with the symptoms inducing sufferance in employees, the mother organization of which PubOrg is a part, decided to establish an *indoor air steering group* (IASG) in charge with seeking solutions to potential indoor air problems. Additionally, indoor air steering groups are created at sub-organizational level, such as in the case of PubOrg. In this study, both IASGs are examined. Various actors are active in IASGs, such as representatives of the owner of the building, technical administrators of the building as well as representatives of

PubOrg, which includes members of the *Organisational Council*, which is the highest decision-making level at PubOrg. Additionally, an *employee wellbeing unit* exists in the organization, and this unit is also represented in IASG. Such unit is expected to advance employees' interests in the indoor air matter. PubOrg offers *occupational health care* to its employees via a service that is externalized to a private health care provider. Employees are assigned their own doctors and nurses, which are informed about the illnesses related to indoor air as well as about the offices and other spaces inside the building where health problems have been experienced. Representatives of the occupational health care provider are also part of IASG.

According to legislation in force in Finland, the *constructor of the building* is responsible for hidden defects discovered during the usage phase, which occur due to an inadequate construction process or inappropriate materials used for the building. This responsibility is, however, limited to 10 years only. The formal guarantee of buildings is two years only and during the intervening 8 year period it is the responsibility of the user of the building to demonstrate faults in the building which makes the situation rather difficult for the user. After the 10 year period has expired, it is the responsibility of the owner to fix all the problems related to the building. Therefore, the construction company, while included in *Figure 1*, does not in fact play an active role in the case of PubOrg.

While many actors are active in IASG, there is an unequal distribution of power inside this forum. According to the law, the building owner is the only one with the power to initiate action in terms of deciding the need for conducting investigations and measurements in buildings suspected to have indoor air problems. The tenant of the building has to right to ask for investigations and is legally entitled to benefit from a "healthy" building, which offers safe conditions for spending time in, but this tenant does not have any decisional power.

Regulators, which include state institutions and other technical normative organs, play an indirect role in this case study. They are the ones issuing regulations concerning employees' safety at work as well as technical norms, such as safety limits for values of fibers in the air or accepted humidity levels for rooms to be inhabited. There is strict regulation in Finland requesting employing institutions to safeguard a healthy working environment and protecting employees' rights to healthy air in the building in which they are working.

Cleaning services appeared as an actor frequently mentioned in our interview materials. Its significance relates to the fact that the case building is an office building, in which employees work to a large extent with papers. Offices are in most cases filled with papers and other porous materials, which accumulate a great quantity of dust, and shelves are open, which also favors dust amassing. In this given context, poor cleaning that causes large amount of dust in the air was sometimes associated with potential allergy- and flu-like symptoms – although it was said that often the end causes of the symptoms were in the building structures.

A r*enovation company* was selected in order to conduct agreed reparations, as a result of indoor air measurements. However, at the time of this study, renovations were only in an initial stage, hence this actor plays a minor role.

Employees were the ones negatively affected by the indoor air quality, some to a greater extent, some to a lesser extent, while some employees presented no symptoms. Hence, part of the affected employees were active in advancing their health interests in the organization, while many of those with mild symptoms were rather passive, being too busy with their work or downplaying the significance of their health symptoms. Sufferers very rarely felt that other employees might be unsympathetic to their illnesses and potentially even sarcastic towards "imagined" symptoms; however, such negative attitudes from other employees were also very rare.

Unit leaders were the ones directly responsible for the wellbeing of their personnel and the ones to which an employee could turn when having indoor air related symptoms. However, they only play a mediating role in this case, since they only acted by sending messages forward to IASG or by communicating information from IASG.

4.2 Measurement of indoor air quality: technical measurements and human experiences

We continue our empirical examination by providing insights into the developments occurring inside the organization triggered by employees' frequent complaints about the quality of the indoor air.

4.2.1 Dissatisfactions with the process of measurement

In the aftermath of numerous complaints from employees, a decision was taken to proceed with an investigation of the potential causes for signaled illnesses. The process commonly starts with an initial step taken by the employee, who contacts technical administrators via an intranet site that then sends the complaint to the administrators. Based on the electronic request, technical administrators proceeded with checking those issues that could easily explain and solve the problem: adequacy of ventilation, visible mold or other structural breakages, and potential causes of allergies such as the amount of dust, flowers et cetera. If nothing was found wrong at this stage, then one or two indoor air experts were requested to provide for an in-depth evaluation of the situation and their recommendations were then used in taking a decision on how to proceed. In the case analyzed here, the building owner decided to conduct measurements of the indoor air quality and used the services of an externally specialized provider for this purpose. The measurement company was then mostly responsible for selecting the instruments to be used for measurements.

The use of technical instruments was advocated by technical experts, who consider that the origins of symptoms in humans are generated by material impurities in the air, such as fibers, minerals and other micro-particles. As a consequence, a number of measurements were conducted over a few years. Various measuring instruments were used to track the problems inducing symptoms in humans. Samples were taken to measure micro-materials and fibers, air pressure was measured, moisture was mapped and air flow inside the building was

checked with specific, technical methods. In our case organization, humans played a role in the initial stage of the measurement process, in the sense that their complaints triggered the organizational reaction to proceed with technical measurements.

After a certain part of the measurement process was completed, the results were communicated to personnel in electronic form, after which an interactive event was organized for an in-depth discussion of the results. In addition to employees, participants included representatives of the owner, the company conducting the measurements, technical administrators and occupational health care. In a nutshell, the results indicated only minor indoor air problems related to the presence of mineral fibers in the air, air leakages, high atmospheric pressure and a disturbing smell in some parts of the building. The results introduced to the employees during the interactive event were based on a technical language whose interpretation was done by the measurement company representative. Results suggested that the building is overall a safe place to work in, with minor reparations needed to adjust air flow and renew acoustic panels that were deemed to be the source of the mineral fibers released into the air.

Overall, the employees appeared confused about the official process of measurement, as well as about the results communicated to them. Below, we introduce the main dissatisfactions voiced by the personnel.

First, the process of measurement was deemed unacceptably long, given the negative health consequences for employees and the unknown long-term effects on humans of indoor air problems:

> *About the measurement process. Well, at least it seems to last quite long. […measurement] was being done already then in spring, and now again they are measuring something. And at least it seems that there is no rush. Is it that is really takes so long or [gives a laugh] somehow strangely long time this whole measurement process takes. Does it really take so long to get and interpret the results or what is going on? It is now quite weird that it takes half a year and then again they do new measurements. Given that here people have been working all the time anyway, it's not really good.* [Employee, interviewee 1]

Second, the personnel expressed disappointment with the improper communication of the entire measurement process during this period. Information received on measurements was confusing for employees, as not giving clear understanding on what kind of measurements, by whom, when and for which purposes measurements were done:

> *It was a bit uncertain… there always comes some information that now on that and that week some measurements will be done and now curtains should be moved and table should be moved and do all [that] and then there comes the information that well, we did not do this [measurement] now anyhow and instead, now we do something else and yes, it was a surprise at least to me, nobody warned about it that somebody knocks on my door to do the [measurement]. Yes, I knew that some measurement was [in general] in the process, but they did not [announce], I don't really know if it was announced beforehand.*

And I don't know if some places here have been investigated in a different way or in greater depth and with more instruments, these are never really announced clearly. In my opinion, it would be nice to get information about these in more detail. [Employee, interviewee 9]

Moreover, many employees felt that the information received was contradictory to their personal experiences about the quality of the indoor air. They perceived the overall message given by the officials to be that "one is not supposed to have symptoms in this building", which was in their view a negation of their health problems:

No! I am not really satisfied [with the measurement results]. In my opinion, it was quite funny that, when we had twice water [accidentally] running through the structures, [they were] saying that "it's just concrete, nothings stays on it". For God's sake, the concrete stays humid even decades there and yes, there can be things growing on it, so I don't understand now when he says that "there is nothing there because it's just concrete and there is just a hollow-core slab". To me, this was simply a crazy statement. [Employee, interviewee 5]

Thus, the process of measurement revealed contradictory experiences between the personnel affected by the building they were working in and the technical personnel doing the measurements of the indoor air quality. The human versus technical contradictions were accentuated at the event organized for the employees. In this event, the technical experts attempted to dominate the discussions by keeping them in the sphere of numbers, fibers and micro-particles. Human experiences clashed with this material approach, but employees could not find their views heard, as the technical experts spoke a different language the employees could not understand. For this reason, the discussions, although conceived as being interactive, led to no particular result for the meeting.

To conclude, the measurement process and the results obtained from technical instruments raised dissatisfaction among the personnel, who felt that their health concerns are ignored and they are left with no means to see their health recovered.

4.2.2 Looking for potential explanations for the unsatisfactory results of measurement

The official results were not easily accepted by most employees. Despite lacking technical expertise, employees started to look for explanations to the divergent results given to them. Many felt that the building had more serious problems, such as mold, due to numerous damages related to water leakages over the years, and that the problems communicated to the employees during the event were too mild to explain their health symptoms. Therefore, many employees started to question the adequacy of measurements as a potential answer to their dilemma.

For instance, many were wondering themselves whether the measures used in the process were the proper ones for detecting indoor air problems. Likewise, the conditions for conducting measurements were questioned, as some employees suggested measurements had

not been done in those rooms in which symptoms or water damages had been reported but in some other rooms for no clear reasons. Some employees also felt that the measurements did not comply with the technical norms:

> *[It was agreed that technicians] would go separately [to do measurements] in [employee X's] room. Someone came there to measure but then it was said that measurement cannot be done there or it was that window had to be closed so that the room would be kind of sealed before doing the measurement. Well, then the window had been open there all weekend and then it went so that [someone came and said that] "well, we'll measure here anyway some temperature" or something. I said that the window has been open here. Somehow [he decided that] yes, we'll measure here [anyway]: then [the measurement] did not give the correct picture of the room anyway.*[1] [Employee, interviewee 3]

> *It was so that some measurement could not be done because it was frozen weather. It was the wrong kind of weather [for measurement]… but it would have been possible to measure after that when there was frozen weather no longer, if something like this was desired.*[2] *And then two or three Petri dishes somewhere along the corridor. And for instance in our toilet there was none [although there had been water damage in the toilet…]*[3] *I don't know. [I have] such a feeling that [it was done] quite quickly so that [they] get it done*. [Employee, interviewee 5]

Given the low transparency of the measurement process combined with the longish period needed for all the measurements to be completed, some employees started to doubt the willingness of the building owner to find the real problem. Given that reparations in cases of serious damages, such as water leakages, are costly and imply large financial resources to be spent by the owner, employees wondered whether the owner was eager to invest money to rehabilitate the building:

> *This is indeed an interesting question that if measurement is desired, then is its purpose now just to calm down people; that now it has been measured and you don't have to worry. Is it done so that there is no desire to find anything which may generate costs or is it genuinely so that now we want to clarify the issue and we are ready to make the reparations. I hope that it is so but at times it feels that, is it something like: now we bring there some Petri dishes and then they can no longer complain that there are problems. So,*

[1] It is possible that there had been a plan to measure something else but as the window was open, such measurement was not done and only something that could reliably be measured was thus measured. However, in any case the communication of this seemed inadequate.

[2] Typically certain measurements can only be done in frozen weather as otherwise natural mold from outside interferes with the measurement. It may be that the employee in question had misunderstood this issue. However, the communication could have been done better and measurement could have been done in the next frozen season, or could have been done in the previous one, as the issue had dragged along for some years.

[3] It may be that these measurements were about fibers which were perhaps expected more in other rooms than toilets due to air circulation systems, whereas the water damage could have been measured with a different method altogether. However, there seems to be a communications issue here as well, as well as the question on how the water damage should then be investigated.

has the purpose been just to calm down people that there's nothing [wrong] here, I can't say. [Employee, interviewee 9]

As the analysis above indicates, employees were confused by the results of the measurement process and made efforts to rationalize them in a way that would match their experiences. The measurement capacity of instruments was not criticized as such in most cases, rather the specific circumstances of the building in which they were used.

4.2.3 The dominance of technical over human instruments of measurement

While the process of measurement was initiated by human experiences with the building, the technical means of measuring dominated the process thereafter. For technical administrators, air quality translated into something material that took the shape of particles to be found in the air.

In addition to technical instruments, one technical expert in the administration relied on administrative forms to measure indoor air quality. Employees sent complaints via the intranet, which materialized for him into a "complaint request form" that was a signal of "inferior indoor air". Administrative forms, similarly to technical instruments, have an objective appearance, indicating a "real" problem out there in the material world. Thus, the administrative forms transformed the subjectivity of suffering employees into something concrete and material that dutifully arrived on this administrator's mailbox:

Good indoor air is when neither complaint request nor other suspicion comes about it. And poor indoor air is when many people do complaint requests about it. Isn't the definition [of indoor air quality] just as simple as that? [Building engineer at PubOrg, interviewee 12]

In contradiction to technical administrators, employees experienced inferior indoor air by the material effects it had on their bodies and the material illnesses it induced in them. They referred to uncomfortable sensations such as unpleasant smells, lack of oxygen, or symptoms such as itchy eyes or throat, coughing, voice loss, difficulty to breath, skin problems et cetera. Employees measured the quality of indoor air with their own health and only needed technical instruments to objectively reconfirm their symptoms. Measurement was for them not an end in itself, but its purpose was seen as the initiation of concrete actions in order to alleviate their health problems:

In my view, the primary purpose [of measurements] should be that if reparation needs are found so that we get them repaired and the situation would return to normal. This is in my view the primary [purpose] so that we don't measure just for the sake of measurement but we measure because it drives such [reparations]. [Employee, interviewee 6]

While humans acted as initial measures, their capacity to measure was later on forgotten and ignored after technical instruments came into play. This was evidenced in the attitudes of some administrators towards suffering personnel. Employees felt that if humans only fill

complain forms, this is not enough to make administrators and owners of the building react. As one employee explains, repeated complaints had been made in the intranet complaint request form, but actions did not still occur for a long period of time:

> *We waited first that some reparations would be done and then starting in 2011 I really began to move this issue forward. I contacted different parties and different people but this progresses very slowly and it often feels that again we are back to where we started. Again we start doing some complaints and we have been many times on the lists so that it should progress and continue and it was promised that it continues and then again suddenly the situation changes and we send again complaints from square one that there is something [wrong] here.* [Employee, interviewee 2]

Technical measures were promoted by technical administrators to the extent that there seemed to be an emotional commitment to them. For instance, one member of the IASG explicitly acknowledged that she has an emotional take on technical measures because they give the impression of being "trustworthy", although when their result indicates no problem, then she has an ambiguous feeling:

> *I noticed that I relate to these [measurements] with some feelings of a kind. And, you know, it feels much more reliable when [building structures] are opened and [instruments are used for] scratching there and [technical people] are looking and taking [samples]. That one thinks that the problem is there, in the structures, and not necessarily on the surface. Or then it feels more reliable when smoke is spread because then you see whether it comes out from that place. And, aha, it comes, it should not come. Hm… these [technical instruments] perhaps feel kind of rather good. But then, if the result doesn't show anything [wrong]. Then it feels like, well, isn't there still some instrument [that one could try]?* [Member of IASG, interviewee 17]

It was also said that an issue that cannot be measured in monetary terms is a problematic issue. In fact, human experiences were not valued and trusted as much as technical gadgets:

> *Well, I can order a measurement if I need one [instead of trusting myself for measuring] and then, really, we have in some of the newest buildings […] such developed automatic building control systems that we know… we get temperature and carbon dioxide variations, as such, from moment to moment.* [Representative of building owner, interviewee 13]

Moreover, those responsible for technical measures were perceived as sometimes taking a rather arrogant or patronizing attitude to those with health problems. One interviewee described an attitude of "Us" (i.e. people with technical building related experience) versus "Them" (i.e. people suffering from symptoms). In this framework, the sick people were presented as problematic as they "caused" more costs to be paid for building repairs and sometimes the causes of their symptoms could not be clarified with technical measurements. The following quote describes how people's complaints could be inconvenient for the owner in monetary terms.

> *In [IASG] nothing is underrated. It is rather that [renovation] measures are requested from [the owner]. If [the owner] tries to [avoid renovation actions]… for instance there was now a case in [a building], there have been awfully many complaints coming there about indoor air. [The owner] said that they will have an eye on [the building] during the whole year 2017 and renovations will start only during 2018. And this [delay would be] because they haven't included [renovation measures] into their budget: [renovations] were not budgeted for 2017. We didn't accept this. They promised to do it. So then they took the reparations immediately in the making.* [Administrative head, interviewee 25]

The dominance of the technical approach also appears to have affected the IASG meetings at the organizational level. An interviewee explained how the IASG favored technical measurements to human experiences, potentially even endangering employees' safety and wellbeing:

> *And then there is the problem that comes when measurements say there is nothing [wrong]. Then nevertheless people have symptoms. So it feels that now we are not getting forward in any way about the location of the problem… The problem exists but we just don't [do anything]. Or indoor air expert just didn't find [the problem]. So the problem that I experience is that people have symptoms, [but] the measurements tell that there is nothing [wrong]. And then we are in this situation that we don't do anything.* [Administrative head, interviewee 25]

The lack of organizational responsiveness to personnel sufferance and the impossibility of employees to voice their human experiences made the employees resort to their emotional perceptions. In the view of some employees, the technicality of the terms used in the process of attesting indoor air problems are simply incapable to reflect their experiences. One interviewee said that the word "bad" indoor air was an understatement for those who have lost their health and recommended instead that "intolerable" as a term might better reflect human experiences with the building. Examining the instructions given on the intranet to employees for signaling a problem, one could also conclude that the implications of poor air quality for humans was trivialized. The intranet instructions were titled "when you suspect minor sources of irritation / harm / discomfort in indoor air" (translation by the authors), while the health of many employees was seriously impaired. The instructions could more clearly reflect the seriousness of the problem if they were called something like: "when you suspect that the building is trying to kill or at a minimum seriously incapacitate you". The word "suspect" is also of interest here; maybe certain affected people would prefer "when you have observed…" – thus employees may not only suspect but may have personally experienced what the air can do to their health.

Technical instruments were conferred primacy in detecting impurities in the air. Such instruments received decisional power over the quality of air and thus if measurements showed no significantly higher levels of particles in the air than a certain safety limit then this constituted for technical personnel sufficient proof that the building was suitable for humans to spend time in. Technical measures were also seen as beneficial by employees because they could "prove" the existence of an indoor air problem and once such a problem had been in

this way “proven”, the building administrators and the building owner were finally “forced” to react and take action.

In conclusion, technical measurements dominated throughout the process of measurement and were given primacy in the decision-making process, while human measurements were only initially considered as viable triggers, after which they were no longer trusted.

4.3 Views on “good” measurements: technical vs. human

We now turn to examining the features that are normally linked with “good” measurement instruments, such as trustworthiness and objectivity. We focus particularly on those features that have relevance for our interest in objectivity, as these features play a key role in prioritizing technical instruments over the human ones.

4.3.1 Trustworthiness and reliability

Technical instruments were generally seen as *trustworthy and reliable*, even by suffering personnel, because of having the technical capacity to measure what they are meant to measure. Despite this, some interviewees acknowledged that the use of technical instruments is, in the end, based on human views on technical instruments. The instruments provide certain numbers and values but it is humans who interpret the results and decide the limits of what is safe or not safe.

> *It is always easy to say what is the humidity level or the quantity of mold spores or something, this can be measured […] The human, this cherry on the top of all the measurements, it is that who can best evaluate what these results then really [mean], what [the results] tell.* [Employee, interviewee 7]

The technical “expertise” of these instruments was not a question *per se*, rather the ability of these measures to grasp the entire picture of the indoor air quality. The complexity of the phenomenon to be measured came strongly into the forefront since the causes generating symptoms in humans can be varied, from easily fixable problems, such as high amount of dust and many flowers in a room to more serious concerns, such as humidity and mold. The measurement of all possible substances and microbes that could be hazardous to human health is impossible as all such substances and microbes are not yet known. Not all construction materials used in the building industry have been regulated and thus, many materials or construction techniques have been proved harmful only after many years of being in use, when they began causing symptoms in people. The partiality of the technical instruments and the impossibility to provide a comprehensive picture of the indoor air quality was underlined by most employees:

> *Well, yes, I trust that [the results] surely measure just what they are measuring. But it is then a kind of… certainly it is one part of this air quality. It is anyway surely a quite multifaceted thing, this air quality. And this wholeness surely cannot be measured [with one meter] but a certain part [of it] that these precise instruments are meant to measure.*

[Air quality] is surely a quite complex thing to be measured with one meter anyway. [Employee, interviewee 1]

…in my view, neither a human with symptoms as a measurement instrument, nor [the technical instrument], we of course cannot say that they are precise, because, as said, do these official measures take into account all issues related to this building, in its entirety? In this respect, in my view, the person with symptoms perhaps in this building, now, in this moment, is more precise than those [technical measures] that have now been used, because at least what they told there in the indoor air meeting, not all things have been measured [with technical instruments]. [Employee, interviewee 6]

Hence, while valid for the purpose for which they were created, technical instruments are in fact reflecting only a tiny fraction of the "truth". What is held as reliable and trustworthy depends greatly not only on the material features of a metric but also on the use of the metric for measuring what one is interested in measuring. Measuring the right thing appeared as a relevant aspect of trustworthiness of the measurement. As one interviewee mentioned, "one cannot measure what one cannot seek".

On the contrary, human measurements were commonly referred to as subjective and unreliable due to producing different, at times divergent results, given that some humans experience no symptoms at all, while others' health is greatly impaired. Moreover, the variety of symptoms experienced by humans combined with the uncertainty of symptom's origins (as humans can sicken from an office building but also from e.g. mold in their own home) was interpreted as a lack of consistency in measurement and an indicator of unreliability:

…but these are enormously difficult issues and if someone has symptoms here, how can we know her situation at home? How can we know her illness history et cetera? So, is it as clear as day that no doctor would be able to say that "your symptoms now are caused by your office room" because [symptoms] can be influenced by a million things. That person could be allergic for example to some paper bleaching substance, so these are enormously difficult issues. [Employee, interviewee 5]

[humans as measurement instruments are] so awfully subjective […], although at times it feels that symptoms may be connected to this place, as I said, they can also be connected to many other issues, so how do I know what predominantly causes them; is it just a coincidence that today my voice is down when I am here [in the office] or would my voice have been down at home as well or was the cause that I sat in the train for two hours [on my way to here] or something else? [Employee, interviewee 9]

It was also brought up that the interference of social settings in which humans live, as part of social networks, makes humans to be receptive to others' opinions, which in turn may affect their capacity to measure. Some interviewees drew attention to the issue that opening up a discussion on indoor air may affect how apparently non-suffering employees relate to the phenomenon. Non-sufferers may identify within themselves symptoms which are not necessarily related to indoor air and start attributing them to this cause. Likewise, symptoms may feel more intense once discussions with colleagues become passionate:

And then when others have [suffered from poor indoor air] then everyone starts being sensitive and listening to [their own symptoms] and then perhaps draw conclusions that now I also have something, is it also related to indoor air? [Employee, interviewee 7]

…we also of course end up with such a human factor. Is it possible that, when someone gets symptoms within the [same] corridor, then others [in that corridor] start thinking that, are there some problems in these premises, like is my flue also caused by the indoor air problems? [Head of work safety, interviewee 15]

Interestingly, some suffering employees trusted technical measurements to the extent that they ended up distrusting the reliability of their own symptoms. When the results of the official measurement process were communicated to them, they started questioning their own ability to act as a measurement for the indoor air quality. In this case, many sufferers attributed their symptoms to other causes.

Well, [I feel poor air by] those kinds of basic smells and then of course [...] if one comes here one starts coughing or something like this, but myself I am not exactly one of those people who so sensitively reacts to, I don't have this […] like there was [a visitor] coming here from elsewhere a few years ago and she noticed [something in the air] immediately. I am not so sensitive to those [air problems]. But maybe... when [I] have been a longer time [in the premises]… and then when you always think that ok, now maybe there were [symptoms], or was it now just some allergy or something and then you forget about it and then starts again summer holiday or something. But for example last autumn again, summer [was] just fine, of course some minor allergies, and then when I came here [in the office], there were again [symptoms], I had to go quite quickly [after I began work] to the health care. [Employee, interviewee 16]

Moreover, one interviewee placed no value on his/her own ability to measure, despite being contradicted by the expertise of a doctor, who attributed this employee's health problems to the indoor air in the building where this person was working:

Earlier when I ended up in [a hospital] due to my airway symptoms, for several times in fact, there was a doctor who examined me […] Then he asked where I am working, I said that I [work in that building] and when he looked into my nose, he said that, for God's sake, that building should be detonated. [Employee, interviewee 23]

For another employee, technical measurements were the only reliable instruments and the results of them prevailed over his own capacity to measure. The technical results were objectified to match the employee's desire for a healthy building and in this way, the results were given decisional power over the own health of this employee:

Yeah I decided to trust [the results] because I also want to get my work done and feel good in my office […] you have this report that at least officially confirms that there's no issue and I trust in that way that these people also have responsibility […] So in that way, I trust... that... there is an interest from the [measurement] company to report this problem. [Employee, interviewee 19]

However, the reliability of technical measures was greatly contested especially by those sufferers whose health had been severely affected by the indoor air in the building and who had medical confirmation for the causes of their illnesses. The following quote is from such a person whom a doctor had forbidden to work in the building due to health concerns.

> *Well, at least what concerns me, if I think about myself, I have certainly been more sensitive [than technical instruments]… Myself, I have at least experienced so many different symptoms. So, if [technical] devices [in those premises] have not flashed the red light, then… I wonder that… Or then indeed it is so that they are measuring wrong [things] or different things.* [Employee, interviewee 26]

And sometimes people were seen as very reliable measurement instruments.

> *Yes, at least [employee Y] lost her voice equally reliably each time [when she was in the premises].* [Employee, interviewee 3]

Despite technical instruments being perceived as objective, the results contradicting humans' experiences made many employees criticize but also ridicule them, which also shows a distinct face of distrusting their reliability. Employees would call the instruments with different names such as a "funny-box" or a "cubicle" and would laugh at "the sticks" that the technicians would wave around in order to measure humidity, at a measurement instrument that was apparently forgotten by the technical experts in place in some room, or at measurement machines that looked to the employees like they could be "bombs" or "gas containers".

4.3.2 Objectivity vs. subjectivity

Objectivity is a key feature of a valid and trustworthy measure, as frequently articulated in the accounting literature. Indeed, objectivity appeared as a constant concern for the interviewees, who were in a continuous struggle to search for the unique, "real" truth. The objectivity of technical measurement instruments was praised greatly by most interviewees. Measurement with technical instruments was commonly perceived to be a valid path towards discovering "the truth", while human instruments were affected by subjectivity, thus unable to reach the truth.

> *I don't [know why people are not invited to respond with a survey], it can be that… Can it be that [the administrators] wouldn't trust anyway what people say? It is more objective in their view if some value comes from that survey, some certain number and then it can be said that it is <u>really</u> so, but if people say something then it is somehow experienced as if it doesn't exist at all. Which is quite funny because it is anyway people who experience the air.* [Employee, interviewee 1]

Standardization was interpreted as an exponent of objectivity and these two terms were frequently used interchangeably, while flexibility was linked to subjectivity and as such seen as insufficient for proper results. While there was wide agreement on the standardization of technical instruments, the question for some interviewees was which purposes

standardization was serving. Standardization was not necessarily seen as appropriate in all circumstances, despite the universalizing effects of technical methods. Rather, in some circumstances, such as indoor air measurement, humans as instruments may better serve human needs, as an interviewee acknowledged:

> *These technical [instruments] are standardized and human [instruments] are adaptable to different situations, yes. No question about that. But on the other hand, in my view, indoor air testing should be, in a way, adaptable to different situations. [Because] it is subject to [the circumstances of] each situation.* [Employee, interviewee 1]

Objectivity appeared as an end in itself for many but the most affected sufferers were less concerned with strictly searching for objectivity and truth. Personal experiences with indoor air quality or the experiences of close colleagues or family members altered the need to achieve objectivity and replaced the desire for an objective "truth" with an acute desire to find a concrete solution. These persons were sympathetic to sufferers and accepted rather easily their subjective views. On the contrary, putting oneself into the sufferers' position appeared as challenging for some non-sufferers; it was as if entering a different world that one could not understand:

> *I have a different point of view because […] in a way I am the representative of the user [of the building] but I have difficulty in putting myself into the position of that person who [has symptoms], when I am involved [in the IASG meetings] listening about [these issues]. The standpoint, the angle to these [indoor air issues] is just different from the viewpoint of those so called normal users who have experienced symptoms.* [Head of work safety, interviewee 15]

Hence, those having less personal experiences with indoor air problems, emphasized strongly an objectivity perspective and were questioning the extent to which colleagues' sufferance was related to the building. Symptoms received recognition to the extent that they were validated by an external expertise, such as medical proficiency:

> *[In regard to] symptoms, it is so that we try to get information from the occupational health doctor or filtered [information] from the occupational health doctor, so to say, who is able to evaluate this issue for us; … are these symptoms related to the building or are they related to something else, eating habits or whatever […] [The doctor] is then able to filter this information about the symptoms for us. So that we, construction engineers, don't interfere perhaps in vain with these issues… I feel that "symptoms" are symptoms of a certain sickness… and there doctor is then the best expert*. [Representative of building owner, employee 13]

While objectivity appeared for many as an overarching aim of the measurement process, a contradiction emerged in many interviews. On the one hand, interviewees would attest to the importance of the objective measures as the only means to find the "real" and impartial truth. On the other hand, the same interviewees would express their dissatisfaction with the "truth" that had been found using technical measurements. The employees identified a disconnection

between the truth articulated by technical instruments and the truth experienced by them in their everyday life at work. Their real truth was conveyed by physical symptoms such as coughing and sneezing associated with a person being present in certain premises of the building. Regarding such situations, the symptoms may have started (almost) immediately after returning to the building after holidays or weekends and disappeared when leaving the building for a few days or weeks. This sensory truth was felt as real and contradicted the more abstract truth as portrayed by the measurement instruments saying that "nothing is seriously wrong in the building". Hence, the technical instruments appeared to fail finding the truth or as many claimed, to portray only a partial truth:

> *Yes, I believe that these [technical measurements] are established practices and they measure what they are meant to measure. Do they give a picture of the whole reality, that is another matter.* [Employee, interviewee 4]

In their search for objectivity, many employees downplayed their own symptoms, as they feared their own subjectivity on the issue may affect the truth. This was visible in the way employees reported their own symptoms as compared to symptoms of their colleagues. A given employee might not always explicitly relate his or her symptoms to poor indoor air, while this person's colleagues would clearly see them as a manifestation of problems experienced in the building. Perhaps others' symptoms appeared more objective than own symptoms. The denial of own symptoms articulates an anxiety of being derided by non-sufferers as being a subjective human being and as such, unable to know the truth:

> *Q: How do colleagues relate to your symptoms or in general to people' symptoms?...*
>
> *A: Yes, I know that at times [suffering people] are stamped as being hypochondriac and all that but I haven't experienced myself as now being awfully ill, neither am I totally convinced where my symptoms originate from, so I have at least not experienced [such attitudes].* [employee, interviewee 9]

Indoor air forms sociomateriality in which concrete issues, such as fibers, mold and dust are intermingled with social views on their significance for human lives, with multiple manifestations, for example in human health or in social and organizational interactions. In our case organization, materiality was mostly connected to the building (its walls, fibers, dust) and to the technical instruments for measurement (Petri dishes, humidity yardsticks etc.). Interestingly, the materiality present in humans, such as mucus and slime in respiratory organs induced by the building was not linked to the "objectiveness" that was so diligently sought for by many. Hence, the materiality of buildings was prioritized over the materiality of humans in the same manner that technical objectivity was preferred over humans' subjectivity.

Indoor air experts played a key role in promoting a positivistic worldview of how to find the truth in the case analyzed here. The official norms and legislation in place are based on an objective vision in regulating indoor air measurements based on specific technical instruments, which are selected on a case by case basis by indoor air experts. All measurements are, however, technical, while humans are considered as initiators of the

measurement process only. Decisions are to be taken based on the values returned by technical instruments, which are compared to safe limits regulated by the legislation in Finland. Contrary to this view, an indoor air expert that was not involved in the measurements of the case building but within other buildings by the mother organization, emphasized the significance of humans for the entire measurement process. The person questioned the adequacy of official norms and advocated a human-driven approach to indoor air measurement.

> *Well, it is always, when we talk about a certain technique, we believe that it has been tested so many times that it is, in this way, reliable. And when here there are women and men, there are engineering brains and less engineering oriented brains, then somehow it feels that, when measuring something [with technical instruments], it is then somehow so absolutely clear and objective. But immediately when there is a human, we begin analyzing the human him/herself, the person is detached from the issue, and then we reflect her symptoms or her views or feelings in relation to that person. And then immediately subjectivity comes from those reflections. So that [technical] measurement instrument has been tested, human [measurement instrument] has not been tested.* [Employee, interviewee 7]

5 Discussion

This study has described views on indoor air in an organization in which the objectivity of technical indoor air related measurements is perceived to contradict the views of employees who function in those premises. The positivistic view on measurements is prevailing not only in the case institution but also wider, in society, as the technical means of measurement are institutionalized in Finland. It is worth asking then to which extent we need to hold on to a technical perspective and how objectivity could be altered to better serve human needs. Objectivity, as currently defined and promoted in the phenomenon of indoor air, seems disconnected from the reality of employees. Although theoretically objectivity should serve humans, as buildings are made in order to be inhabited by humans, our study indicated that this is not the case. On the contrary, humans are victims to their own search for objectivity and sacrifice their subjectivity for a universal but untenable truth.

Measurement on indoor air quality was important in this organization, as it assisted in directing the building renovations to correct spots and helped engineers in selecting materials that would not emit substances that could cause harm to people. However, measurement had taken another quality in the organization as well: people with symptoms expected measurements to prove that their symptoms were indeed “real”, thus objectifying their illnesses in the eyes of other organizational actors. The numbers and values shown in material, technical reports would assist employees in eliminating their subjectivity on the matter of indoor air, but unfortunately, this did not occur. In this way, the measures did not deliver what was expected. The objective reality of measures (Everett et al., 2005; Quattrone, 2009; McKernan, 2007; Shapiro, 1997; Miller & Power, 2013, p. 559; Bourguignon, 2005;

Espeland & Sauder; 2007; Espeland & Stevens, 2008) seemed to contradict the subjective everyday reality of employees. People struggled to cope with this contradiction between the two realities. Measurement became an extra social weight placed on people as it seemed to give a message "your symptoms cannot be real". Paradoxically, measurement, as a human need, had become a burden.

In accounting literature there is a concern about "truth" and "fairness" (Financial Reporting Council, 2014; Frost, 1994). People in our case institution felt a need to find a true and fair view on indoor air. Technical measurements were seen to provide a true view on the indoor air, while such a truth was contested by a different kind of subjective experience of people, providing an everyday truth that relied on experiencing the bad smell in the offices and on listening to the coughing of the co-workers. Somehow the truth as provided by the technical measurements did not seem "fair" to the employees while the everyday truth of smells and coughing provided for a fairer view at least to those suffering individuals.

We began our investigation from the point of view of how people can be used as measurement instruments for indoor air quality. It was interesting how people doubted their own ability to measure, as compared to technical instruments, in this engineering oriented Nordic society, while simultaneously bringing in significant doubts about the technical measurement instruments' capability to measure as compared to human capability. Employees had been taught from an early age that technical objectivity is the key to truth, and they were confused when such objectivity seemed to connect less to truth than their own everyday subjective experience.

It was conceded here that it is people who always produce the final meaning even in connection with technical measurements. Technical results alone, no matter how accurate, are meaningless without the interpretation given to the results by technical experts or others. However, the dissatisfaction with technical measurements went further than this rather simple acknowledgement, as the measurement results even with the interpretation given by human experts did not seem to make sense in the framework of everyday truth and reality.

There is a paradox here. The subjective experience of people seems to be very "real" in this setting, while the objective measurements are far from people's reality and do not seem to connect with this reality. However, people still desperately seem to hang on to the idea that "reality" should be objective, a result of objective measurements, denying any subjective experiences as part of "true reality". In some ways the respondents in our case are forced to choose between such two views; either to believe their own noses, eyes and ears, which means throwing away the education that they have undergone over the years as to the importance of objectivity over subjectivity – or to ignore their own sensorial experiences but retain their faith in the objectivity of technical measurement. Obviously they do not want to make such a choice and are left in between, talking at one time in the interview about one reality and perhaps five minutes later about the other one.

Aiming towards objectivity thus causes here unintended consequences: if the objectivity of the measures is taken as the only truth, this means discounting the subjectivity of the human

subjects and thus humanity. We thus show how objectivity can be rhetorically used against the experiences of humans.

It is interesting that objectivity is in this case tied with material issues, such as numbers, measurement instruments, fibers and microbes. The measurement instruments are seen to produce unbiased numerical data about the real world of fibers and microbes. Subjectivity is tied with the social: people are seen as unreliable measurement instruments as their opinions can be influenced by other people, different people can have different experiences in the same office space, people cannot pre-emptively attribute their symptoms to certain material causes of the symptoms such as microbes or fibers, and people can have different experiences that can depend not on office indoor air but on time of day, on fatigue or sickness for other reasons, or even on personal mood. In our case organization, employees feel that the social and material should be connected in order to reach the best possible result related to indoor air measurement and associated actions, but simultaneously interviewees themselves tend to draw a clear distinction between the social and the material, subjectivity and objectivity. In general, the more a person had had severe symptoms, the more he/she was inclined to connect the social and the material, acknowledging a social element (often termed something like human bias) in the material measurement, and perceiving a material element (real sicknesses and real mucus and slime produced by respiratory organs) within the social existence.

The case has so far contrasted objectivity with subjectivity. We now wish to transcend such a division and suggest novel views on both of these constructs. We suggest that what appears as “objective” is often still subjective, as it tends to give priority to a certain point of view. The form of objectivity here in this case gives priority to the technical measurement instruments, leaving less room for individual and even collective experience and for material sicknesses.

The objectivity associated with measurement instruments is dependent on the persons calibrating the instrument and deciding on the specific instrument, the place and circumstances of measurement, as well as on the safety limit value in question. Thus, when digging deeper into objective measurements, they become rather subjective in this way, but clothed in materiality and thus artificially made “objective” (on connecting subjectivity with the social, and vice versa, see Wagner, 1965). Choosing a technical perspective is a subjective decision, alternative perspective could be for example “humanity perspective” – following the clues the employees give on the severity of their symptoms.

Based on the literature (Levinas, 1985, 1995; Latour, 1987, 2005; Latour & Woolgar, 1986), it appears that objectivity cannot realistically be aimed for. Acknowledging that objectivity’s truth value is thus questionable and we do not know even if such objectivity exists, we wish to include what is shown in the case as “objectivity” as four different levels of subjectivity as presented below.

1st level: individual experience: This level is about people experiencing individually many issues that others have difficulties in connecting with; people can have very personal experiences that never open up to others. This is fully subjective from a given point of view.

2nd level: social experience: This could be described as the way things are "generally seen to be" in a specific context or society. Individuals jointly construct a reality that is comfortable for them based on shared values and beliefs. This is commonly perceived to be based on social constructions (Berger & Luckmann, 1966; Hacking, 2000; Searle, 1995). Here it is acknowledged that although people may have personal experiences, such experiences are not entirely random but can be attributed to more general social factors and situations in a given society. Here subjectivity is constrained with dominant social frameworks.

3rd level: material experience: Technical instruments form black boxes as a result of multiple people's efforts (people who developed the microbiology behind the instruments, people who developed the instruments, people who calibrate them, use them, or communicate the results), based on Latour (1987, 2005). Such black boxes are then taken for granted, as something to be blindly trusted as they are based on material reality, which is claimed to be devoid of "human bias". This level of subjectivity is often mistaken for "objectivity" and thus becomes an ideal to be aimed at.

4th level: sociomaterial experience: Here we acknowledge that instead of drawing a dividing line between the social and the material experiences, it would be possible to more fully combine them, based on Latour (1987, 2005). This would imply fuller acknowledgement of both the social and the material, and their interrelations. For example, the material is not only about technical instruments and e.g. microbes that those instruments measure, but also about the mucus in a given person's throat, disallowing breathing. Similarly, the social is not only about the random opinions of individuals (see level 1) but well-thought-out observations that make sense in a specific, well-defined context and can be extended to other contexts as well with limitations. Material instruments are never able to make such observations as such instruments are always bounded by chosen calibration settings and the specific context of measurement.

These four levels are artificial as they are produced through the interviewees' reflections that drew separating lines between the levels. To our surprise such levels were rather dominant in the case data although they could be seen as very artificial through a critical analysis. Latour (1987, 2005) has criticized researchers for drawing such dividing lines between the social and the material, and we acknowledge that regarding objectivity, our interviewees also predominantly insisted on rather clear divisions between these. This insistence was not tied to

the position of a given employee in the organization but rather to the extent of indoor air symptoms: the less symptoms the clearer distinction. We do trust that in the work life, such employees rather fluently connected the social and the material, using their social expertise with the help of material papers and office equipment, but when specifically talking about objectivity, they would resort to such divisions much easier.

We claim that once one gives up the search for artificial objectivity on the level 3, can one move to level 4 and be free from such futile efforts and find a deeper level understanding, approaching "truth" (if there ever was one). Thus the present ideas on objectivity (Frost, 1994; DeZoort, Holt, & Taylor, 2012; Vélez, Sánchez, & Álvarez-Dardet, 2008; Harrell, Taylor, & Chewning, 1989) may be standing on the way of a truer type of objectivity, recognizing also both the social and material subjectivity to the fullest.

How is it possible to reach level 4? A method for this could include a listing of many kinds of social and material issues in order to remind people of the importance of such multiple issues. Such a listing could be appended with information on how such issues could be categorized; otherwise, a simple long listing of issues is unlikely to invite cooperation from people. The listing alone is not informative. Moreover, the listing should be adapted to the individual needs of the people in that specific organization, as well as to the needs of the organization itself, as the situations and relevant issues are likely to vary from one organization to another.

We referred to how the technical or material perspective is constrained to a certain point of view and the sociomaterial perspective could be an alternative, which is, however, not seriously considered in the case. The issue is also how such alternatives could be more effectively combined to serve human needs. Are there other conceivable alternatives? These could be found in a more eternal sphere such as a religious perspective or an ethical perspective. Moreover, both the social and the material in the case are heavily connected with human-made environments, a nature perspective could thus provide a different point of view entirely. Studying such alternative perspectives could provide for interesting research projects for the future. As a further research avenue, we wish to offer the empirical testing of such a subjectivity structure. It might also be interesting to know if objectivity also has such categories. We do not acknowledge objectivity as more than a rhetorical category, but its division to subcategories would still be an interesting subject of study.

Practical implications

We also wish to present certain practical implications of our study. Not all chemicals can ever be measured with material instruments, and it is time that we acknowledge that we will have to in any case use humans for this purpose. Humans can provide hints as to the affected structures and substances that cause symptoms and their capacity to measure in this way should not be underestimated. The associated human suffering here tells that some kind of technical measurement device is missing: we do not know all the causes generating symptoms in humans. One practical contribution of our study is thus that measurements

cannot cover all issues that affect humans; something very important for humans is really missing here in this context and measurements are incapable to signal it.

This is a very difficult issue as measurement can involve the loss of health for an employee unlike for the material measurement instrument which was meant for this purpose. However, we humans were also "made" for this purpose; for thousands of years people have developed to react to outside stimuli in order to protect their health – as a trivial example, touching a hot surface, we get an automated reaction to withdraw our hand immediately. Believing in human experience can save humans from a lot of trouble. However, in any case the ethical issues and problems as related to this have to be seriously considered.

Those people who easily become sick from indoor air have been named "sensitive" to indoor air, chemicals et cetera. We suggest that such people could be referred to as being "capable of measurement" in order to give this capability a more positive connotation.

A human being is a good meter in the sense that different people seem to get slightly different kinds of symptoms: By looking at many people's symptoms, it is possible to get an overall picture of the quality of the indoor air. In fact, one expert in indoor air quality measurements who was interviewed for the purposes of this study claimed that examining human symptoms is the best way to determine the origins of poor air. He even had a more or less formal process for taking the human measurement instrument into account and presented this process to us in paper format. Such attitude is contrary to the idea of objectivity being exclusively tied to technical measurement within which idea it is assumed that all measurement instruments should optimally react similarly to similar substances in a certain building in order to produce objectivity.

People feel that indoor air should be materially measured, because it specifically affects them – although the problems are in the building structures. However, people do not experience the building structures as such, rather the air they breathe, so they point to that air first and foremost. Could this human instrument be developed further in this way by educating? Nowadays many measurement instruments that measure the indoor air are very inaccurate and give results only on major quantities of hazardous substances. Even experts often recommend taking samples directly from building materials as these are much more reliable. Building users may be requiring indoor air samples that may not then actually show any results although the building may have significant problems.

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Appendix **A**

Interview outline

Representatives of personnel were asked questions on the following themes:

Interviewee background and current work tasks

Quality of indoor air in the building and in general

Own and others' symptoms attributable to indoor air

Factors affecting indoor air quality

Consideration of own opinions and symptoms, measurement of the quality of the indoor air with symptoms: challenges and benefits

Information received about the formal measurements, opinions about them and about the instruments used to make them, associated trust, as well as challenges and benefits

Comparison between human beings as measurement instruments and technical instruments

Opinions on the measurement process and on the cooperation with the measurement company

Opinions on the communication of the results in the organization

Effects of poor indoor air

Effects of indoor air measurement process

Development ideas for indoor air measurement

Comparison of indoor air measurement and own performance measurement

Accountabilities related to indoor air

Deeper meaning of indoor air measurement

The interview outline for technical experts additionally included themes about the general field of indoor air measurement in Finland, the surveillance of the field, choice of measures, and the development of the indoor air measurement and associated building renovation fields over time. Moreover, questions for technical and administrative experts were formulated so that they were first asked questions about technical measurement with which they were presumably more comfortable and knowledgeable to talk about.

Those who were part of the IASG were additionally asked questions about the functioning of the team, its atmosphere, effectiveness, meeting practices, accountabilities, and the consideration of the interviewee's own opinions at IASG.

When discussing the comparison between humans as measurement instruments and technical measurement instruments, we first asked about this in general, as not to guide the interviewee to answer in a certain way. After we received an answer, we provided the following outline in paper format for the interviewee, so that we could also get detailed information on the features of these different instruments. The text was most of the time in Finnish although a few respondents also received it in English.

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How would you compare (1) person with symptoms as a measurement instrument and (2) technical measurement instruments to each other?

Do these two types of instruments fulfil the features of "good measurement instrument":

- precise
- valid (measure what they are intended to measure)
- trustworthy (result does not get altered by chance)
- objective or subjective
- standardized or adaptable to different circumstances
- felt as fair for everyone involved
- give results in due time (speed of getting results)
- practically implementable
- cost efficient
- results informative
- acceptable for all
- easy to use in practice
- take into account external factors' influence
- some other criterion, which?

Is there something these cannot measure?

Appendix **B**

Interviewees

1. Employee	27.10.2016	53 min
2. Employee	14.11.2016	46 min
3. Employee	14.11.2016	1h 21 min
4. Supervisor	17.11.2016	51 min
5. Employee	17.11.2016	43 min
6. Employee	8.12.2016	1h 19 min
7. Employee	9.1.2017	1h 27 min
8. Employee	10.1.2017	1h 39 min
9. Employee	10.1.2017	1h 14 min
10. Employee	18.1.2017	54 min
11. Employee	18.1.2017	1 h 1 min
12. Building engineer at PubOrg	20.1.2017	1 h 35 min
13. Representative of building owner	24.1.2017	1 h 9 min
14. Head of administration, member of IASG	30.1.2017	1h 25 min
15. Head of work safety	9.2.2017	1h 33 min
16. Employee	9.2.2017	58 min
17. Communication expert, member of IASG	16.2.2017	1h36 min
18. Employee	22.2.2017	1h 26 min
19. Employee	22.2.2017	57 min
20. Expert on indoor air measurement	13.3.2017	1h 45 min
21. Expert on indoor air measurement	14.3.2017	2h
22. Employee	14.3.2017	50min
23. Employee	20.3.2017	1h
24. Expert on building space design at PubOrg	31.3.2017	54 min

25. Administrative head, member of IASG	31.3.2017	1h 34 min
26. Employee	3.4.2017	1h 29 min
27. Employee	10.4.2017	1 h 3 min

Other empirical materials:

A collection of emails and indoor air measurement results from the period June 2016 to the present day

Attendance in an indoor air information session on the 5th of October 2016

Another indoor air information session is planned to be attended on the 11th of May 2017