Unpacking the Privacy Paradox for the Internet of Things (IoT) by using aspect listing

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Traditionally, privacy research has used intention to study privacy decisions. However, recent studies have observed an intention-behavior gap that people actually disclose a lot of personal information (behavior) despite showing low/negative sharing intentions (Norberg et al., 2007). Studying the intention-behavior gap is especially critical in the context of privacy in the internet of things (IoT) in households since the privacy decision about what personal information these devices are allowed to collect and share plays a key role in the benefits and risks the technology can bring. On the one hand, the technology will not function appropriately without this personal information, but on the other hand, the information that is shared may be highly sensitive, and privacy infringements can have serious consequences. Yet, no study has yet investigated the intention-behavior gap in IoT in households (Gerber, Gerber, and Volkamer, 2018). Furthermore, none of these earlier studies on the intention-behavior gap tried to study the underlying mechanisms. Hence, this paper investigates the existence of the intention-behavior gap by comparing the user's intention with their actual sharing behavior (RQ1). Furthermore, we study the underlying mechanisms leading to the potential intention-behavior gap by exploring and manipulating the underlying decision processes (RQ2).

Privacy calculus (Culnan & Armstrong, 1999) suggests a potential explanation for the intention-behavior gap. The theory states that people only disclose personal information when the benefit of sharing outweighs the risk of sharing. To test whether the theory explains the intention-behavior gap, we use a verbal protocol method called aspect listing, which traces the decision process by requiring participants to list all the aspects regarding their decisions. The order and the number of aspects of risk and benefit reflect the significance of privacy decisions. In Study 1, we measured whether participants considered benefits or risks more in intentional versus behavioral IoT privacy decisions. Surprisingly, we found a reverse intention-behavior gap, in which participants were more reluctant to actually disclose personal information in a mockup interface of an IoT device than what they intended to share in a survey. Furthermore, we found that when participants made an IoT privacy decision, they were more likely to share in case benefits dominated in the amount or the order in which they were listed in the aspect listing task, which suggests some risk-benefit tradeoffs occur mentally before making the decision.

To test the causal relationship between the risk-benefit tradeoff and the sharing decision, we manipulated the order of the aspect listing in Study 2, where participants in control group were free to list any aspects as in Study 1 while in the two manipulations groups, benefit- and risk-first, participants were asked to list either risk or benefit aspects before the other. In the control condition we replicate the reversed intention-behavior gap: in behavior participants show lower benefit superiority (i.e., the number of benefits aspects minus the number of risks aspects listed) than in intention and they subsequently share less. This reversed intention-behavior gap is moderated by aspect listing order. In the benefit first and surprisingly also the risk-first condition, benefit superiority is higher compared to in the control condition. The higher benefit superiority in aspect listing order manipulation conditions subsequently leads to a higher sharing rate in behavior, where the reversed intention-behavior gap vanishes.

Privacy Concern and Privacy-Protective Behavior: The Privacy Paradox in the Context of Mobile Applications

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Reporting great concern with online privacy does not necessarily correspond to the occurrence of privacy-protective behaviors. This phenomenon is called the privacy paradox. In the context of smartphone applications, a form of protection would be not to provide an app with access to certain data or not to install an app that requires access to unnecessary data. Studies 1 and 2 used a survey to examine if four factors could be predictors of the reported likelihood of installing a mobile app. In both studies, participants were presented with three fictional apps (puzzle, forecast, and message), in counterbalanced order, and inquired about the level of perceived importance of the app, the discomfort that arises from the type of data accessed by the app, their privacy concern, and the likelihood of installing the app. In Study 1 (N = 227), the number and type of data permissions required by each app were informed and varied across participants. The types of data accessed were internal storage (photos and files), microphone, location, and/or contacts. In Study 2 (N = 214), the number and type of data access permissions were not pre-determined; instead, participants were asked to indicate which permissions they would be willing to provide to each app. In both studies, participants often reported great privacy concerns, but only the level of importance was predictive of the likelihood of installation. In Study 2, the number and type of permissions varied across the apps in a manner consistent with their function. These results, therefore, replicate the privacy-paradox in the context of smartphone apps. The implications of these results will be discussed, especially with regards to the importance of understanding the variables influencing the correlation between reporting privacy concern and behaving to protect your own privacy, and designing interventions to improve this correlation.

The effect of perceived privacy and physical safety risks and a cyber-security warning on decision making about smart devices in the home.

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Smart devices are increasingly findings its way to people's homes and are replacing traditional home appliances. While liked for their benefits, they also come with risks, including the risk of being cyber-attacked, potentially leading to both negative privacy and physical safety consequences. Particularly when the devices in the home grow in numbers, opportunities for cyber-attacks increase. It seems that citizens have limited awareness of these risks. Therefore, in this study, we investigate how people weigh the privacy and physical safety risks in deciding about adding an extra device to their set of devices, and test the effect of a warning that is particularly highlighting either the privacy or physical safety risks of adding a device to the set of devices already in the home. We developed a scenario study in which participants are asked to imagine that they already have two smart devices (a smart TV and a smart lock) and are considering adding a third one (a smart speaker), after which a part of the participants received a warning on the risks of adding the third device. Based on data of 643 UK participants, the preliminary results show that (1) perceived privacy and safety risks of buying the additional device are strongly intercorrelated, meaning that we cannot study their separate effects, (2) that in the no-warning group, the combined privacy and safety risks have a significant, small negative effect on attitude towards adding the additional smart device, (3) that a cyber-security warning has a significant, positive effect on privacy and safety risk perception and a significant, negative effect on attitude towards the additional device, independent of whether the warning mentioned a potential privacy risk (hacker having access to conversations in the home) or a physical safety risk (hacker being able to open and close smart lock), (4) that due to the warning, the effect of perceived risks on attitude towards the additional device significantly increases and the effect of perceived usefulness (but not of perceived hedonism) on the same attitude significantly decreases. We conclude that people make little distinction between the privacy and physical safety risks in the presented scenario and that the combined perceived privacy and safety risks have a relatively small effect on the attitude towards adding another smart device to the home which however, strongly increases with a warning, independent of whether the warning mentioned a privacy or physical safety risk as an example of the possible consequences of the devices being hacked.

Safety and security or safety vs security? The benefits of tension venues to deal with safety and security in high-risk organizations

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Contemporary technological societies are faced with a great variety of calamities, such as environmental catastrophes, technological and industrial disasters, and terrorist attacks or a mix of these. High-risk organizations, such as industries in chemical, nuclear, transportation and energy sectors are exposed to this increasing risks complexity. Analyzing it, academics and institutions increasingly advocated the integration of safety and security concepts in such industries. Often portrayed as two sides of the same coin, such an integration, according to these discourses, would permit to increase synergies between safety and security and eventually improve the protection of the environment and the population.

This paper compares those dominant discourses on safety and security interplay with empirical observations in a high-risk organization, a nuclear research center located in Belgium. Mobilizing Actor-Network Theory and Vulnerability Analysis, it traces and characterizes all actants directly involved in the enactment of safety and security. Through literature and documents analysis, onsite ethnography and interviews, it stresses discrepancies between dominant academic and institutional discourses and the interactions of other types of actors (such as onsite meetings, human practices, technologies, processes etc.). While the former promotes an integrative and synergetic vision of safety and security interplay, the latter highlights the predominance of tensions amongst the actors directly involved in onsite safety and security enactment. Thereby, the paper highlights the predominance of tensions between safety and security in the Belgian Nuclear Research Center. However, rather than seeing them as deleterious for the organization's resilience as it is done in dominant discourses, it finally argues that tensions are inherent and might be positive if structurally embraced. To do so, this paper proposes to create spaces, labelled "tension venues", dedicated to bring at the fore and work on safety and security tensions.

The Two Faces of Intensive Livestock Farming: Perceptions of Residents, Farmers and Other Stakeholders

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Currently, there is a societal debate in the Netherlands about the future of intensive livestock farming characterised by knowledge uncertainty about the effects on residential health, overlapping value-driven concerns and stakeholder diversity. As a consequence, public meetings with stakeholders such as farmers and residents rarely result in fruitful discussions. Therefore, it is essential to identify and become aware of the core issues at stake across stakeholders. Using the mental models approach, we explored the current beliefs and concerns towards intensive livestock farming, in particular on human health. Interviews were held with in total 44 farmers, residents and other stakeholders. We found that farmers and residents hold substantial contrasting beliefs and concerns towards intensive livestock farming and the effects on human health. Moreover, human health is only one aspect of the problem, as other concerns prevail among resident and farmers: animals and nature, image of farmers, envision of the future and dissatisfaction with authorities. By applying the wicked problems framework to intensive livestock farming we argue that solely a science-informed approach to policymaking is insufficient. A collaborative approach is advised to address the multiple beliefs and concerns.

Value Conflicts in Designing for Safety: A Case Study of Miniaturization Processes using Hydrogen Cyanide

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One of the most acknowledged values in the fields of chemical engineering, biochemistry and biotechnology is safety. To ensure (bio)chemical processes to be acceptably safe for society, animals and the environment, multiple approaches have been developed over the last decades. Examples of such are the 12 principles of Green Chemistry (Anastas & Eghbali, 2010), Safety Management Systems (Reniers, Ale, Dullaert, & Soudan, 2009), Inherent Safety and the Inherent Safety Principles (ISPs) (Kletz, 1996). In the field of chemical engineering, in particular the ISPs have been widely adopted (Khan & Amyotte, 2003; Kletz, 2003) and aim at eliminating or minimizing the risks of hazardous chemicals or syntheses by using conditions or chemicals with less dangerous properties. The Safe-by-Design (SbD) approach, which is derived from the notion of inherent safety, has been gaining foot in the field of nanotechnology (Kelty, 2009; van de Poel & Robaey, 2017), biotechnology and synthetic biology (Bouchaut & Asveld, 2020; Robaey, Spruit, & van de Poel, 2017) over the last decade. Although both the ISPs and SbD revolve around measures for safety, the concepts do seem to have a slightly different approach towards safety in itself. That is, the ISPs provide guidelines for risk-reducing measures or the development of add-on safety features, while SbD already questions the initial use of certain chemicals or carriers during the early stages of development more strongly. However, some SbD strategies, for example the usage of kill switches (Robaey, 2018), could be argued to also fit within one of the ISPs as its goal is to reduce any possible negative consequences might anything unforeseen happen. The other way around, SbD questioning the already initial usage of certain hazardous chemicals or carriers could also be classified as one of the ISPs, namely substitution – the replacement of hazardous chemicals with less hazardous ones (Khan & Amyotte, 2003; Kletz, 1996).

As it seems that the distinction between applying the ISPs or SbD is somewhat blurry, this paper aims to define the differences between these approaches and to shed light on what type of research may be more suitable for one of these. A case study focusing on miniaturization of processes using Hydrogen Cyanide illustrates that although both approaches revolve around the central value of safety, still, we identified some (internal) value conflicts in terms of *safety*, *sustainability*, and *efficiency* where we found that the ISPs would be able to deal with these more appropriately. In addition, certain lock-ins such as (company) culture and already established safety measures imply that we should take multiple values into account when designing for safety - a balance should be found. Therefore, we conclude that SbD would be more suitable for early-stage development, for example, within fundamental research. As applied research may already suffer from lock-ins, this complicates application of the SbD approach, and the ISPs would be more appropriate here.

Need for more transparency in scientific risk assessment: the case of EFSA opinions on bisphenol A

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The European Food Safety Authority (EFSA) is responsible for assuring food safety on the European market. Independence and transparency are key objectives in the functioning of EFSA, to ensure a high level of evidence-based decision making. To this end, an extensive conflict of interest statement is provided by each scientific expert and these documents are made available to the public. However, independence is a complex concept that can be impacted in more subtle ways. One of the factors that can influence independence, is the scientific discipline EFSA panel members are involved in. Topics under discussion by EFSA are complex issues, requiring evaluation of evidence from different disciplines, such as chemistry, toxicology and epidemiology. Each scientific discipline has its own traditions and convictions with regard to performing and evaluating scientific evidence. To provide room for these different interpretations whilst assuring high-quality risk assessment, transparency in the selection and evaluation of scientific literature is crusial. The current study will zoom in on this layer of independence and transparency, by looking at the selection of scientific evidence in EFSA's risk assessment.

Research in various biomedical fields showed that selective citation of scientific findings is a well-known problem in academia. This can lead to biased knowledge development, as the chance of citation was often related to the outcome of the study. To assess if selective use of evidence also occurs in EFSA's risk assessment, we study the example case of bisphenol A (BPA). Since 2006, EFSA has performed five risk assessments on this material. To test for selective use of evidence, we have listed all available epidemiological publications on BPA at the time of each risk assessment and compared those to the publications mentioned in the risk assessments. We found that not all available publications were addressed in the risk assessments, without mentioning reasons explaining this descrepancy. There might have been serious reasons to exclude these publications, but this was not reported in the risk assessments. We therefore conclude that the objective of transparency is not completely met, when looking at the selection of scientific evidence, in the case of BPA.

To better adhere to the objectives of independence and transparency in the risk assessment, reporting a reproducible literature search strategy and clear criteria for including and excluding publications is needed. Implementing this additional form of transparancy will improve the quality and credibility of the risk assessment and accommodates a better interpretation of its conclusions.

Legitimacy, risk and Luhmann

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For several decades, *legitimacy* and *risk* have been studied together (Desai, 2008; Grolin, 1998; Slovic, 2001), with risk frequently being understood as "the chance of injury, damage, or loss" (Slovic, 2001, p. 19), and legitimacy as "a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman, 1995, p. 574).

Risk and legitimacy play a prominent role in the development of potentially socially disruptive technologies, that innovation systems research understands through the technological innovation systems (TIS) framework. A TIS is defined as a "socio-technical systems focused on the development, diffusion and use of a particular technology" (Bergek et al., 2008, p. 408), with legitimacy taking a central role in the framework by linking knowledge development and diffusion with market development (Hekkert et al., 2007).

In the formative stages of a technology, winning legitimacy is imperative and can be thought of as "shaping expectations and defining desirability" (Bergek et al., 2008, p. 581). However, shaping expectations is challenging when a technology comes along with risk. Of interest is when the *innovation process* itself involves risk - a problem which is intensified when a potential consequence of the innovation process is an unwanted and substantial effect on its wider environment.

The matter is further complicated when we consider the difference between the relationship that those developing a technology have with that technology, and the relationship that those affected by the developing technology possess. To consider the challenge of winning legitimacy while developing socially disruptive technology, we turn to the work of Niklas Luhmann (1995, 2018).

Luhmann pointed out that technologies are usually "conceived of as relations between cause and effect, confirmed by scientific knowledge or practical experience. Their use should always achieve the same results" (Luhmann, 1990, p. 224). While this may be true of how those outside the development of a technology relate to that technology, it is not true of the relationship that innovators possess with a technology.

Innovators make decisions, calculating risk along the way. Luhmann suggests that when these innovations may affect others, those outside of the innovation process are put in *danger*. He says "[b]ut for people who do not participate in the decision-making process things look different. For them technologies are dangerous, and the acceptance of dangers produced by others is much less likely than the willingness to incur risks in the search for profitable outcomes" (Luhmann, 1990, p. 226).

In our forthcoming study, we seek to link the process of legitimation with Luhmann's conception of risk and danger as they pertain to TIS. We seat this in the context of the development of a technology that requires taking socially disruptive risk. We use Luhmann's theory to delineate the difference between danger and risk, illustrating how legitimacy can facilitate the acceptance of risk taking, and in turn, the imposition of danger.

Bibliography

Bergek, A., Jacobsson, S., & Sandén, B. A. (2008). "Legitimation" and "development of positive externalities": Two key processes in the formation phase of technological innovation systems. *Technology Analysis and Strategic Management*, *20*(5), 575–592. https://doi.org/10.1080/09537320802292768

Desai, V. M. (2008). Constrained growth: How experience, legitimacy, and age influence risk taking in organizations. *Organization Science*, *19*(4), 594–608. https://doi.org/10.1287/orsc.1070.0335

Grolin, J. (1998). Corporate legitimacy in a risk society: The case of Brent Spar. *Business Strategy and the Environment*, *7*(4), 213–222.

Hekkert, M. P., Suurs, R. A. A., Negro, S. O., Kuhlmann, S., & Smits, R. E. H. M. (2007). Functions of innovation systems: A new approach for analysing technological change. *Technological Forecasting and Social Change*, *74*(4), 413–432. https://doi.org/10.1016/j.techfore.2006.03.002

Luhmann, N. (1990). Technology, environment and social risk: A systems perspective. *Industrial Crisis Quarterly*, *4*(3), 223–231.

Luhmann, N. (1995). *Social systems*. Stanford University Press.

Luhmann, N. (2018). *Organization and decision*. Cambridge University Press.

Slovic, P. (2001). The risk game. *Journal of Hazardous Materials*, *86*(1–3), 17–24.

Suchman, M. C. (1995). Managing legitimacy : Strategic and institutional approaches. *The Academy of Management Review*, *20*(3), 571–610.

Polycentric risk governance in new energy technologies.

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The ongoing transition towards renewable energy introduces many new risks to the energy sector. These new risks stem from new energy technologies, as well as the impact of these technologies on the functioning of the energy system. To illustrate, solar panels on domestic roofs pose additional fire hazards, and also complicate the balancing of power supply and demand (Nijhuis et al., 2015). Likewise, biogas production facilities can be the site of inadvertent release of toxic gasses, and their growing presence also increases the need for stringent control to guarantee sufficiently homogeneous gas quality (Riemersma et al., 2020). In both instances, mitigating risk related to new technologies increasingly involves actors with little or no previous experience in upholding safety in public energy networks.

This paper examines risk governance in renewable energy technologies and highlights instances in which risk may remain ungoverned. It bridges two distinct academic debates in doing so. The field of Safety Science advocates the decentralization of responsibilities regarding safety in complex systems (Provan et al., 2020). More broadly (i.e. without a specific focus on safety), the field of (Institutional) Economics calls for the alignment of governance mechanisms with the (increasingly decentral) physical infrastructure of energy systems (Goldthau, 2014). Researchers in both fields highlight the importance of local knowledge, relative independence of local authorities, and flexibility to adjust to unanticipated challenges. In short, both advocate for what has been described as *polycentric governance* (Ostrom, 2010). Studying effective governance of complex systems by framing them as polycentric is gaining traction in Economics (Heikkila et al., 2018; Salter & Tarko, 2018), yielding insights in preferred ways of moving away from centrally organized infrastructures (Schröder, 2018; Villamayor-Tomas, 2018). Calls for polycentric governance also exist in the field of Safety Science, although they have remained largely conceptual (Woods, 2006). This paper further substantiates the concept of polycentric safety governance by positioning the concept of polycentricity more firmly in the field of Safety Science—opening up new avenues for safety governance.

We show how rules designed for a monocentric gas system can frustrate safety governance in gas provision that is increasingly renewable and polycentric. The article focuses on gas quality governance in distribution systems as a case study. This critical function gets more complex as renewable gas production grows. Continuing in the tradition of Elinor Ostrom and others, we study this collective-action problem by identifying social relationships among a growing group of renewable gas system users: i.e. grid operators, natural gas producers, biogas producers and regulators. (Aligica & Tarko, 2012). Our analysis shows how monocentric governance that has been predominant over the past half-century continues to exert considerable influence on safety governance. It stresses the importance of internalizing safety-specific knowledge that is generated by new actors, and governing new interactions that emerge with every new energy producer or technology provider. We incorporate recommendations from Safety Science literature in outlining how risk governance might better align with the characteristics of these new energy technologies.

Aligica, P. D., & Tarko, V. (2012). Polycentricity: From Polanyi to Ostrom, and Beyond. *Governance*, *25*(2), 237–262. https://doi.org/10.1111/j.1468-0491.2011.01550.x

Goldthau, A. (2014). Rethinking the governance of energy infrastructure: Scale, decentralization and polycentrism. *Energy Research & Social Science*, *1*, 134–140. https://doi.org/10.1016/j.erss.2014.02.009

Heikkila, T., Villamayor-Tomas, S., & Garrick, D. (2018). Bringing polycentric systems into focus for environmental governance. *Environmental Policy and Governance*, *28*(4), 207–211. https://doi.org/10.1002/eet.1809

Nijhuis, M., Gibescu, M., & Cobben, J. F. G. (2015). Assessment of the impacts of the renewable energy and ICT driven energy transition on distribution networks. *Renewable and Sustainable Energy Reviews*, *52*, 1003–1014. https://doi.org/10.1016/j.rser.2015.07.124

Ostrom, E. (2010). Beyond Markets and States: Polycentric Governance of Complex Economic Systems. *American Economic Review*, *100*, 641–672. https://doi.org/10.1257/aer.100.3.641

Provan, D. J., Woods, D. D., Dekker, S. W. A., & Rae, A. J. (2020). Safety II professionals: How resilience engineering can transform safety practice. *Reliability Engineering and System Safety*, *195*(August 2018), 106740. https://doi.org/10.1016/j.ress.2019.106740

Riemersma, B., Correljé, A. F., & Künneke, R. W. (2020). Historical developments in Dutch gas systems: Unravelling safety concerns in gas provision. *Safety Science*, *121*, 147–157. https://doi.org/10.1016/j.ssci.2019.08.040

Salter, A. W., & Tarko, V. (2018). Governing the banking system: an assessment of resilience based on Elinor Ostrom's design principles. *Journal of Institutional Economics*, 1–15. https://doi.org/10.1017/S1744137418000401

Schröder, N. J. S. (2018). The lens of polycentricity: Identifying polycentric governance systems illustrated through examples from the field of water governance. *Environmental Policy and Governance*, *28*(4), 236–251. https://doi.org/10.1002/eet.1812

Villamayor-Tomas, S. (2018). Polycentricity in the water–energy nexus: A comparison of polycentric governance traits and implications for adaptive capacity of water user associations in Spain. *Environmental Policy and Governance*, *28*(4), 252–268. https://doi.org/10.1002/eet.1813

Woods, D. (2006). How To Design A Safety Organization: Test Case For Resilience Engineering. In E. Hollnagel, D. Woods, & N. G. Leveson (Eds.), *Resilience Engineering* (pp. 315–326). Ashgate Publishing.

Using behavioral psychology to increase smoke alarm ownership. A mixed methods approach.

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In the Netherlands, but also worldwide, attempts are made to convince people to invest in prevention measures to reduce the probability of a domestic fire or mitigate its consequences. Although one of the most important fire prevention measures is a functioning smoke alarm (death rate is more than twice as high in homes without a functioning smoke alarm) in the U.S. and also in the Netherlands still about 25% to 30% of the households lacks a smoke alarm (Ahrens, 2019; Kobes & Groenewegen-ter Morsche, 2015). Several fire prevention interventions have been tried over the years, but they are rarely based on a comprehensive problem analysis or on behavior change theories (Eysink Smeets, Heijman, & Postma, 2016; Gielen & Sleet, 2003; Thompson, Waterman, & Sleet, 2004). In our study, we first developed a model for smoke alarm ownership based on the academic literature and several pilot interviews, then conducted a survey (n=621) based on this model to get a better view on the psychological determinants related to smoke alarm ownership, and eventually tested the outcomes of the survey in a field experiment (n=310). In our model for smoke alarm ownership, we included risk perception and risk coping variables from Protection Motivation Theory (Rogers, 1975) and the Health Belief model (Rosenstock, 1966) but also included other possibly relevant variables such as social norms and personal characteristics. We tested the relationships of these determinants with smoke alarm ownership and intention using (logistic) regression analyses on survey data (n=621, of which n=404 non-smoke alarm owners and n=217 smoke-alarm owners). The results showed that determinants that are typically used in fire prevention communication efforts had no or small effects, while other (less commonly used) determinants did have significant effects on smoke alarm ownership and intention. Based on these results we ran a field study in which we developed two e-mails: one focused on the most typically used determinants and one focused on the determinants we found to be strong predictors in the survey. We subsequently tested the e-mails versus a control group in a between-subject experiment (n=310). Behavioral measurements were used to measure smoke alarm intention and ownership (CTR and purchases). Taken together, our study shows that using behavioral psychology and conducting a comprehensive problem analysis for the specific target behavior can help us to better understand people's motivations and barriers, which gives a promising direction for improving interventions to increase smoke alarm ownership.

Risk governance as a continuum of risk perception and legality: The harmonisation of EU electricity sector oversight

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The process of making and applying rules that concern risks related to the transmission of electricity involves a constant consideration of the nature and perception of risks that these rules need to address. This paper discusses the evolving oversight structure that governs three categories of risks linked to the transmission of electricity in the EU. These risks comprise environmental impacts, socio-economic uncertainties, and the possibility of (physical) sabotage or interference in the context of political conflicts.

The analysis is multidisciplinary and assesses the interrelationship between the legality of the EU oversight framework and the perception of the three forms of risk related to electricity transmission. The paper evaluates the legality of EU legislation that pertains to the governance of the electricity sector, using the interactional theory of law by Jutta Brunnée and Stephen J. Toope (2010). The consideration of risk perception relies on Paul Slovic's research approach (1993), in particular related to the notion of trust.

Legal norms can facilitate trust building if they are able to induce compliance. The eight criteria of legality that the interactional theory of law proposes help to determine whether legal norms can foster compliance, both with respect to their procedural and substantive quality. This paper focuses on the substantive legality of the EU oversight framework of the electricity sector that has been evolving since the adoption of both the 2019 Clean energy for all Europeans legislative package and the EU investment screening mechanism.

In order to study how socio-economic, environmental, and geopolitical risks are perceived and formulated and, subsequently, inform EU legislation, this paper examines the involvement of State Grid, a large Chinese state-owned transmission company, in the EU electricity sector. This company's recent activities relate to all three risk categories. State Grid intends to establish a worldwide grid to trade renewable electricity globally. The scheme also seeks to promote ultra-high voltage transmission technology that State Grid has developed and deployed in China. The company wants to export this technology and aspires to become a leader in international standard setting. Its approach to the lowcarbon energy transition and the technological standards and solutions it promotes are in conflict with the values and parameters that shape EU electricity sector legislation. Thus, the trust in the regulatory framework that guides the EU energy transition also concerns the way in which risks are averted that potentially could result from the involvement of third-state actors. Hence, the example of State Grid helps to illustrate the interrelationship of legality, compliance, and trust for all three risk categories that this paper assesses.

The paper shows, based on the legality analysis, that the evolving oversight framework of the EU electricity sector is capable of enhancing its substantive legality and thus compels institutional and business actors to comply with the rules. Still, only a meaningful harmonisation of member states' legislation and continuous reassessments of perceived risks and adaptation of the regulatory framework to new challenges can ensure the trust of the public in the governance of the energy transition.

Public opinion of industrial CCS in the UK and the Netherlands: Effects of outcome perceptions, proximity and industry attitudes

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Carbon Capture and Storage at industrial processes (industrial CCS) is expected to play an important role in reducing CO_2 emissions in industry in the short term. As plans to implement industrial CCS in countries such as the Netherlands and the UK are progressing, questions remain on how to deal with the lack of public support that has hampered CCS projects in the past. To support public engagement and site selection strategies, insight is needed into the factors that may contribute to citizens' opinions towards industrial CCS. Yet, no study to date has systematically explored citizens' opinions about industrial CCS.

This paper presents the findings of an online informed opinion survey (N = 1961) conducted in the Netherlands and the UK. In this survey, respondents received information about industrial CCS (with offshore CO_2 storage) and its anticipated outcomes before giving their opinion about the implementation of industrial CCS. We included items to measure outcome perceptions, industry attitudes, actual and perceived proximity of citizens' households to industry, knowledge about CCS, climate change belief, trust in CCS stakeholders, proximity to the coast and socio-demographic factors. We also asked respondents to the survey to explain their opinion about industrial CCS in a few sentences. We then conducted a content analysis of these explanations to investigate the arguments respondents used to substantiate their opinion.

The findings show that respondents felt neutral to slightly positive about the implementation of industrial CCS in their country. Awareness and perceived knowledge levels were higher in the Netherlands, while overall opinion was more positive in the UK. Perceptions about the outcomes of implementing industrial CCS were strongly associated with overall opinion, when compared to other factors such as socio-demographics, proximity to industry (actual and perceived), and psychological variables.

Our findings imply that supportive opinions toward industrial CCS are more likely to develop if citizens not only think positively about the contribution of industrial CCS to climate change mitigation – but also about the (economic) effects of implementing industrial CCS on companies, consumers and government spending, as well potential risks of CCS and measures taken to address these risks. The former implies that Government needs to plan industrial policy carefully, given its importance for the public's support for technologies benefiting from these policies. The latter implies that, given the negative perception of the safety outcomes of industrial CCS, alleviating these concerns likely requires more intensive engagement between citizens and experts (e.g. co-creating monitoring systems and procedures together with citizens). Such intensive engagement may also build trust in the stakeholders deciding and communicating about CCS, as well as institutions in general. Our findings show that fostering trust in industry is likely to lead to more positive opinions about the implementation of industrial CCS. These suggestions may offer a path forward for government, project developers and other stakeholders to foster much needed public support for CCS and for other technologies that aim to decarbonize industry in the future.

Stakeholder Engagement in Radiological Protection – Comparing and contrasting three exposure contexts

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Stakeholder engagement has become a key topic in the governance of radiological risks. Alongside legal requirements, generic guidelines and recommendations have been elaborated for stakeholder engagement in the context of specific exposure situations, recognizing the opportunities, pitfalls and potential solutions. The European project ENGAGE ("ENhancinG stAkeholder participation in the GovernancE of radiological risks for improved radiation protection and informed decision-making"), investigated how these demands and expectations are translated into participation practices at national and local levels. It compared and contrasted three contexts of exposure to ionising radiation: medical exposures, radiological emergency preparedness and response, and exposure to indoor radon.

The empirical focus in each of these contexts was threefold:

i) to analyse the formal discourses prescribing or recommending engagement, as formulated in international and national legislation and guidelines and mobilised by different actors, highlighting how stakeholders and stakeholder engagement are defined; what the underlying rationales are; and what is included or excluded from these frames;

ii) to highlight, through case studies and more systematic mapping exercises, the forms of real or potential stakeholder engagement that can be observed in practice, with attention to what the issues at stake are; how the outcomes and processes of participation are crafted; what are the main challenges and opportunities; and how these practices relate to the frames set by the legislative documents and guidelines analysed. The project took into account that invited participation by institutional actors is only one part of a more complex "ecology of participation", alongside citizen-led initiatives.

iii) to investigate through case studies the role and potential benefit of radiological protection culture in facilitating stakeholder engagement and informed decision-making, with identification of processes to build and transmit radiation protection culture, adapted to the specificities of different exposure situations.

This contribution presents a number of selected findings from the research conducted along the aforementioned lines.

Unsettling the Science-Technology-Society Nexus: Grassroots Citizen Science as a Risky Technology of Governance.

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Grassroots citizen science is a rapidly-expanding form of public engagement with science, which creates new opportunities and challenges for science, technology, and innovation governance. But what are these opportunities and challenges? How do they play out? And what do we learn from them? This paper seeks to provide empirically-grounded responses to these questions based on a comparative analysis of environmental grassroots citizen science initiatives in radiation pollution (Japan) and air pollution (Flanders, Belgium). Drawing on concepts from Science and Technology Studies, it casts grassroots citizen science as a *technology of governance* that is imbued with risks (e.g., risky data and devices, risky concepts and discourses) and risk taking (e.g., risky exchanges and relationships between citizens, scientists, policymakers, and other stakeholders). How we appreciate these risks is of key importance to the effective and democratic governance of environmental issues; yet, this question is rarely explicitly considered and addressed in citizen science processes and in citizen science literatures. The paper recommends foregrounding the assumptions and expectations that inform various risk conceptions, as well as how risks are handled and negotiated between concerned parties. Opening a space for these considerations can help parties to familiarize themselves with new (and old) risks and risk approaches, in ways that usefully unsettle (rather than disrupt) the science-technology-society nexus.

Examining the factors that influence public participation intention concerning decommissioning of nuclear power plants in Belgium

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After their operational time is going to expire, the nuclear installations must be decommissioned. This makes decommissioning of nuclear installations a pertinent energy-related matter. While to most people, this would be a technical, not a social task, it actually involves many associated risks and public concerns which make decommissioning of nuclear installations a vivid example of social links to a technical task.

In order to analyse who is willing to participate in decommissioning-related decision-making procedures (e.g. public hearings; consultations; or discussions) this study draws on a theoretical framework rooted in the Value-Belief-Norm theory and on the levels of participation as defined by Arnstein's ladder. In addition, it includes the processing of empirical results using data from a large public opinion survey (N=1028) in Belgium in 2015 which were analysed on the basis of Structural Equations Modelling (SEM).

Results show that the people that are more interested in the topic of decommissioning and have a higher radiological risk perception (direct effects) are more willing to participate in decision-making related to decommissioning. Furthermore, we found that the people that are more willing to participate in decision-making related to decommissioning are people that have lower trust in nuclear industry, are ideologically oriented towards the left, have more negative attitudes towards nuclear energy and live in the vicinity of a nuclear installation. The impact of these variables is mediated by interest on the topic of decommissioning and radiological risk perception.

This shows that while public participation in decision-making seems a promising way for inclusive, transparent and mutual decision-making, there are still some challenges that need to be addressed in practice. For instance, based on our results people that are already interested on the topic and hold certain negative opinions related to nuclear energy are more willing to participate than those who are more in favor of nuclear energy. Although these people may raise legitimate points and bring good arguments in the discussion, we need to make sure that all diverse opinions are represented in order for the discussion to be fair and comprehensive.

Based on these findings we point out to some challenges that can appear in decision-making processes and some recommendations on how to prevent or solve them. In addition to theoretically and methodologically contributing to studies on public participation, this study also offers valuable insights for authorities responsible for decommissioning of nuclear installations and public engagement practitioners in order to successfully plan required public engagement in decommissioning processes. The findings of this study contribute to address different challenges such as NIMBY-effects, participatory biases and polarizing effects in public hearings.

Risking patient safety: the sad career of a technological innovation

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Failure rates for the implementation of innovations in healthcare organisations are estimated at between 30-90%. This paper takes a perception of risk perspective to examine the failure to implement a technological innovation designed to improve patient safety in an NHS hospital, tracing the process over a number of years. In particular, the paper examines the impact of multiple and qualitatively different perceptions of risk on the decision-making of different actors in relation to implementation.

Much of patient care comprises routine tasks designed to monitor patients' physical condition and provide early warning of problems. Failure of routine procedures may account for up to 30% of the adverse events recorded annually in the NHS. One such routine task, notorious for being inadequately and inaccurately carried out, is the recording and monitoring of patients' fluid input and output.

In the hospital studied, observational and interview study data, collected as part of research into how hospital staff perceive and respond to risk, indicated that despite awareness of the serious consequences of failure to recognise early signs of deterioration, which had recently resulted in the death of a patient, both fluid balance charts and their contents (lists of figures) were frequently ignored by both medical and nursing staff.

Consideration of ways of triggering awareness of fluid balance data, particularly cumulative totals which show trends over time, prompted design of a fluid balance bar chart. This was visible even across the ward, providing 'at a glance' information about a patient's fluid balance status which, it was hoped, would alert staff to problems which might otherwise be overlooked. Senior management staff saw the bar chart as an effective way to reduce risk to patients, and a steering group was set up to oversee its implementation on all wards throughout the hospital.

Seven years later, the project was finally abandoned. Key reasons for failure included: a perception at ward level that current systems adequately protected patient safety; a lack of perception of urgency in relation to prioritisation of this particular threat; delays in provision of the required equipment occasioned by perceptions of risk unrelated to the bar chart itself; a reluctance on the part of some individuals to take action, even when alerted by the chart to possible danger; attenuation of risk perception regarding fluid balance measurement at senior management level; and, ultimately, the advent of different digital technologies perceived as superior to and overriding the need for paper based methods of ensuring patient safety.

Finally, the paper speculates on how, with hindsight, initial enthusiasm for an effective way of improving patient safety might have been maintained through creating and sustaining a heightened perception of risk amongst key stakeholders.

Self-tracking technologies and risk in healthcare

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The purpose of my presentation is to discuss how self-tracking technologies affect risk assessment and risk perception in health-related uses. The increasing popularity of self-tracking devices such as smart devices and wearable sensors and smart devices led to them being used more prominently in healthcare, a development that has seen much attention from scholars (cf. Ajana 2017; Lupton 2016; Ruckenstein and Schüll 2017; Sharon 2017). Fitness bands, smart watches and other similar devices are today more and more relied upon by both patients and health professionals as they enable them to collect data that could be crucial for diagnosing or battling many diseases. These tools makes it possible to track metrics that would have been too expensive, impractical or even impossible to track in standard healthcare environments and the tracking can be undertaken over longer periods of time as the patients do not require assistance of trained medical staff. Although the constant measurement of physical activity or heart rate does not take away the need for regular check-ups and specialised tests, self-tracking has already proven useful in limiting risk-factors, pinpointing situations that make symptoms more severe and even saving lives (as evidenced by accounts of diabetes patients alerted by tracking devices when their glucose levels became too high).

However, despite these clear advantages arising from the use of self-tracking technologies in healthcare, the discussed development is not without its drawbacks. The increasing ability to track numerous variables relating to one's body and to quantify every aspect of everyday activity can be seen as requiring individuals to stay aware of all the numbers describing their physical state – any failure to do so could be seen as negligence and jeopardising one's own wellbeing. In fact, the development of self-tracking technologies (as well as the general turn towards preventive healthcare) makes it possible to no longer think of being healthy as the absence of adverse symptoms, but as a certain way of living. In order to be healthy, one needs to constantly monitor their activity, engage in 'health-boosting' practices, avoid harmful behaviour and limit risk factors. This could overly burden patients with managing their exposure to risk factors and optimizing their bodily processes to the point where being recognized as healthy could require the individual to engage in excessive care over their body. Moreover, I will argue that the reliance on self-tracking technologies in healthcare overly shifts responsibility for the health of the patients from healthcare providers to patients themselves.

References

Ajana, Btihaj. 2017. 'Digital Health and the Biopolitics of the Quantified Self'. Digital Health 3: 1–18.
Lupton, Deborah. 2016. Quantified Self. Cambridge: Polity Press.
Ruckenstein, Minna, and Natasha Dow Schüll. 2017. 'The Datafication of Health'. Annual Review of Anthropology 46 (1): 261–78.
Sharon, Tamar. 2017. 'Self-Tracking for Health and the Quantified Self: Re-Articulating Autonomy, Solidarity, and Authenticity in an Age of Personalized Healthcare'. Philosophy & Technology 30 (1): 93–121.

Social media posts as indicator of acceptance of vaccines against Covid-19

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New technologies may provide benefits, but may also introduce new risks. In that respect, vaccines against Covid-19 are a very interesting case. Alleged benefits are high (mortality reduction, alleviation of social distancing measures etcetera). Yet, the vaccines are new and have been developed in a relatively short period, which has been identified as an argument for concern among the public regarding its safety.

Social media platforms are nowadays important information channels. Characteristic to social media is that the content is generated by the users of the platform. It is tempting to view the content on social media expressions as a reflection of the attitudes among the public. The question is whether that is a valid assumption.

This study analyses the number and content of publicly available social media expressions on the risks and benefits of vaccination against Covid-19, and the vaccines that will be offered to the public during the first months of 2021. Guiding questions are 1) whether there are differences in the number and content of social media expressions over time and 2) to what extent the content of social media expressions corresponds with data on vaccine acceptance that is otherwise available.

Social media data are gathered by means of Coosto, social media management software to monitor the number of expressions on social media and their sentiment. As the study focuses on the Netherlands, only expressions in Dutch are included. Time frame: October/November 2020 through January 2021. Additionally, an inventory will be made of survey results on the perceptions regarding vaccine risks, vaccine benefits and vaccine acceptance in the same period. First social media analysis showed that there are many expressions on social media related to vaccines against covid-19 (corona) in the period mid-December 2020 through mid-January 2021. Most were of neutral sentiment. There were further more negative than positive posts. Results will be presented and implications will be discussed.