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Examining Practitioner Perspectives from an International Airport

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Revealing the Challenges to Automation Adoption in Organizations: Examining Practitioner Perspectives From an International Airport

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ABSTRACT

Sustained adoption of automation is a problem for organizations, despite the promised benefits of automation and the propensity for organizations to expect it to transform their workplaces. To address this problem, previous work in HCI has mostly considered the perspectives and experiences of users interacting with automation technologies and has not considered the broader organizational context consisting of different stakeholders with varying needs and expectations around automation. Taking Amsterdam Airport Schiphol as a case study, we examine the challenges faced by practitioners responsible for integrating automation projects in its airside ecosystem, in an interview study conducted with 8 participants. Our findings reveal three challenges to the adoption of automation within the organization - the lack of consensus among different stakeholders, the need to adapt the technology to the specific context, and the undefined procedures required to maintain automation after implementation, that should be further addressed by the HCI community.

CCS CONCEPTS

• **Human-centered computing → Empirical studies in HCI**.

KEYWORDS

Automation Adoption, Responsible Automation, Autonomous Systems, Organization, Practitioners, Interview Study, Aviation

1 INTRODUCTION

Automation technologies are permeating the workplace at an ever-increasing pace, transforming manual work in organizations [4, 15, 16, 32]. Defined as "the extent to which a system can carry out its own processes and operations without external control," [5, p. 77], automation is described as a balance between the "self-sufficiency" (i.e., ability to self-govern) and "self-directedness" (i.e., the required level of human intervention) of a system [6]. Due to the current developments in artificial intelligence and robotics, new possibilities emerge for automating more and more complex organizational processes [15]. As such, the expected benefits [33] behind the introduction of automation in organizations are significant, including, for instance, the potential to increase the efficiency and precision of operations [26], to compensate human workers' limitations in uncomfortable, repetitive, or physically straining tasks [2, 23], or to reduce labor-related costs [22, 28].

However, automation is hard to adopt and make common in daily operations [18, 33], despite the ambition of organizations to automate their processes and the implementation efforts carried accordingly. Prior HCI research widely criticized the technology-oriented and market-led development of AI solutions [24, 27, 30, 39], and proposed to take human-centered perspectives to study the integration of automated solutions in real, operational contexts and produce compelling user experiences [20]. For instance, in the healthcare sector, Yang et al. [39, 40] investigated clinician work processes to address the implementation of decision-support tools in heart pump implant decisions, Wang et al. [38] inquired data scientists within a multinational technology company about the effect of automated AI in their work practices, or Eißer et al. [15] studied recruiter acceptance of chatbot-based automated communication processes in the context of recruitment in enterprises. All these works exemplify, in different implementation fields, efforts to build a deep understanding of the needs, perspectives, or daily practices of the users that will ultimately interact with automated systems.

Nevertheless, based on the work by Breuer et al. [8], we suspect that there might be a perspective missing to understand the entanglement of organizational adoption of automation, the perspectives of the practitioners who are responsible for its implementation, and whose work affects adoption greatly. Prior work focused on very

narrow application areas, and a broader view into the implementation endeavors within organizations may be lacking [18]. We argue that taking a step back and looking at the wider organizational structures is necessary if we strive for a successful automation implementation. Therefore, in this work, we propose to set the focus on the role of practitioners that work on automation innovation as well as the implementation approaches that they take. The following research question summarizes our goal:

> **RQ.** *What are adoption challenges as experienced by practitioners who are responsible for the implementation of automation in organizations?*

To better understand what are the key contributors to this adoption issue, in this study we propose a case study, where we look at an organization that is immersed in pursuing an ambitious automation plan, as well as aiming for high automation adoption rates. The organization is Amsterdam Airport Schiphol, a large international airport within the Royal Schiphol Group, where the first author is embedded as an action researcher [13] to facilitate a responsible transition to airside automation. The intersection of HCI and automation has previously been analyzed in airport and aviation contexts, related to, for instance, air traffic control [21] or cockpit tasks [9]. This research will instead focus on the automation of ground services at the airport's airside (e.g., baggage handling or passenger boarding bridge movements). Airport ground services constitute an application domain where autonomous processes are gaining interest, as well as high investment rates [34]. Currently, worldwide phenomena related to sustainable transition and globalization, paired with a tight post-Covid labor market in Western contexts, force airports to change their operational models [36]. The traditional approaches might not work anymore, and therefore, many airports are aiming to implement automation to learn if the technology could help alleviate those issues.

While many airport groups envision automation as a possible solution to enhance their airside operations, the technology is still not adopted in their daily operations. The experiences and challenges faced by practitioners can give insights into the subjacent causes. Therefore, in this research we aim to understand 1) the perspectives and experiences of practitioners who took part in automation projects within Amsterdam Airport Schiphol, and 2) the challenges of automation adoption that they faced. We consider that surfacing those challenges will allow the HCI community to propose targeted solutions to address them.

2 PRIOR WORK

Our work lies at the intersection between human-centered automation and automation implementation within organizations. In this section, we will take a closer look into the approaches taken in prior research for studying automation adoption in various organizational applications.

2.1 Automation adoption by end users

As stated previously, prior research can be found that takes user-centered perspectives for the analysis of automation adoption in workplace contexts. The works of Fox et al. [16] and Roto et al. [32] are illustrative examples of this approach. The former claim that worker-centered technology development should be done, and

highlight opportunities to "elicit worker participation at all stages of technology adoption". The latter emphasize the need to design automation for employee wellbeing, and take employee engagement and other emotional aspects into account. In this line, Wang et al. [38] interviewed data scientists within a large, technological organization about the potential transformation of their work practices with the introduction of automated tools for data science.

From a similar perspective, some works reflect on disregarded user aspects as barriers that hinder automation adoption. For instance, in the healthcare field, Yang et al. [39] diagnose poor contextual fit as the cause of the failure of clinical decision-support tools in cardiology practice, Verma et al. [37] mention the "overlooked aspects of clinical and research practices in the development of AI" in oncological contexts, and Galsgaard et al. [17] note that existing communication practices are challenged in radiology practice with AI implementation, ultimately hindering adoption; as such, they claim a need to further "focus on psychological and leadership processes". Baldauf et al. [4] highlight three pressing human-oriented challenges in the field of automation at workplaces, namely, "encountering workplace automation", "collaborating with workplace automation", as well as "building meaningful relationships". Finally, Eißer et al. [15] mention "automation anxiety" as a barrier hindering the adoption of autonomous recruitment processes.

Research within this first category mainly focuses on the end user of the automated systems, to study their perceptions [10, 12, 15], transformed work practices [11, 12, 17, 37–39], or user experiences [4, 11, 16, 32].

2.2 Automation adoption through a broader organizational lens

Little research can be found within prior HCI work that takes a broader view to study the intricacies of automation adoption within organizations and their innovation paths.

The works by Gyldenkærne et al. [18] and Rozzi and Amaldi [33] serve as close inspiration for our own. The first one analyzes the approaches to innovation taken to implement a ML-driven application in a medical context, through an action-research approach. They emphasize the idea that introducing ML solutions requires sociotechnical changes, as well as tactics that address the management and practice levels of the organization. The second one analyzes, in the context of the implementation of an alarm system, the organizational and inter-organizational precursors for "problematic automation", that is, automation that results in "undesirable effects, resulting from the interaction of automation with operational practices". The main precursors that are identified point at 1) failing to consider implementations as innovative safety efforts, 2) lacking assessment of the organizational capabilities to implement a system, 3) a flawed service provider-software vendor integration, and 4) underspecified international standards.

In our case, similar to Rozzi and Amaldi [33] and Gyldenkærne et al. [18], we take a broader organizational view to reveal automation adoption challenges in the complex airport context that we study. Besides, we follow the rationale by Breuer et al. [8]. They emphasize the idea that practitioners' understanding of the technologies and application contexts is crucial, due to their role in shaping the research and development of new technologies. As such, they

analyze the imaginaries of healthcare of the engineers involved in a robotics-related project. Our research takes this premise as a base, as we incorporate the perspectives of multiple professionals working on varying automation projects under a shared organizational automation adoption goal.

3 METHOD

To address the aim of the study, we followed a qualitative approach and conducted interviews with 8 practitioners from Amsterdam Airport Schiphol, which we analyzed through reflexive thematic analysis [7].

3.1 Interview study

In-depth, semi-structured interviews were conducted, which had a duration between 56 and 80 minutes (average of 67 minutes). The interviews took place either online (n=3) or in person (n=5), according to the preference of each participant, and they were conducted in English. We inquired the participants on the following main themes, which we accompanied by follow-up questions: their role in past or present automation projects they were part of, the timeline of the project, the opportunities that motivated the project, successful moments and challenges that occurred in the implementation of the automation solution, and recommendations for automation adoption they would think of, based on their experience.

The conversation was audio recorded, after receiving written consent from the participants. The study was approved by the Human Research Ethics Committee of our university and participants were not financially compensated but received a small gift of equal value to compensate for their time. Once the audio sets were collected, they were transcribed verbatim using an automatic transcription tool (i.e., Trint). The transcriptions were checked once more against the original recording for precision.

3.1.1 Participants. Participants consisted of key informants [29], information-rich practitioners who were purposefully selected. The inclusion criteria were as follows: participants have worked in automation-related innovations located in the airside context, specifically regarding the automation of manual work. As such, they should belong to Schiphol Airport's airside ecosystem, meaning that they are employed at the airport, airlines, handling companies, or technology suppliers. Note that the first author is conducting action research [13] within the organization, and has direct access to project meetings and internal documentation. From the internal information that we already had about the stage of the different projects and the departments involved, we targeted potential interviewees whose role in the project we considered relevant. During the interviews, snowball sampling was also conducted by approaching further practitioners whom participants had recommended. 8 practitioners agreed to participate in the study (see Table 1).

3.1.2 Projects. Participants belonged to a variety of airside automation projects. The airside is the external, security-restricted area of an airport terminal dedicated to supporting airplanes and their inherent baggage, passenger, and resource flows. Different automation solutions can be distinguished among the projects, 1) autonomous vehicles (i.e., autonomous bus, snow fleet, and baggage transport vehicles), 2) robotic devices (i.e., autonomous lawnmower

Table 1: Overview of the participants who were part of the interview study. Projects refer to the diverse initiatives that are taken by the organization to develop autonomous processes.

ID	Role	Project
P1	System owner	Lawn mower
P2	Technical expert	Snow fleet
P3	Process manager (handler/airline)	Baggage handling
P4	Procurement and contracting	Snow fleet; Bus
P5	Innovation manager	Baggage handling
P6	IT and Data capability manager	Snow fleet; Bus
P7	Project manager	Boarding bridge
P8	Innovator	Bus

and baggage sorting robots), and 3) autonomous passenger boarding bridge. Those solutions cover different operations within the airport (e.g., the transportation of travelers, maintenance and supporting processes, or baggage handling processes.)

3.2 Data analysis

Data was analyzed through a reflexive thematic analysis approach [7]. After an initial familiarization with the collected transcriptions, the first author coded the data, by focusing on aspects of the experience of the participants that reflected challenges of automation adoption. A further grouping of the codes led to the generation of themes and subthemes, which were discussed, refined, and iterated together with the co-authors of the research. The main challenges encountered by the practitioners in their involvement in automation projects are detailed in the next section.

4 RESULTS

4.1 Lack of consensus in a multi-stakeholder landscape

Practitioners mentioned that every automation project is located in a *"multi-stakeholder environment"* (P8), since different parties (including the airport, operators, air traffic authorities, airlines, or ground handlers) have different ownership, authority, and responsibility levels in the current airport processes. Automation projects are usually initiated by the airport in collaboration with technology supplier companies. As such, a common challenge that was encountered is that some parties within the multi-stakeholder environment were involved *"too late"* (P4) in the implementation timeline. For automation to succeed, participants reported that it is necessary to bring every party to the table early enough, to build a better collaboration where everyone's wishes and opinions are heard.

> *"...You have different companies at Schiphol, like we are a very liberal airport and we work a lot with partners. So it's hard to really define a single process where we're 100% the owner of that process. There are always other people we have to take into account."* (P6)

Most of our participants belonged to the airport organization, and therefore were part of the internal, inter-departmental project working groups that initiate automation projects. Within those

groups, challenges have been experienced by the interviewees in reaching a consensus or sharing a common vision for automation. A possible and often mentioned cause of this lack of consensus is the tension between the operational and strategic mindsets and roles of the different members, who have distinct interests and duties regarding airport operations. While automating certain processes might move the organization further toward its future ambition, it may also destabilize certain crucial daily operations. Therefore, not every member of the working group is keen on taking the risk or additional burden to automate certain tasks. As a consequence, some of the projects would become stagnant in relevant decisions.

> *"That led to a lot of discussion and that took for about maybe half a year. We wouldn't, we were not getting any steps forward. (...) and that just led to nothing. We just keep talking in circles and circles."* (P2)

Participants often mentioned that *"backing from upper management"* (P6) would be key to overcoming these consensus issues. In an organization that is characterized by a *"polder"*-like (P6) decision making culture, *"a lot of talking and making sure that everyone feels heard and gets taken along"* (P6), practitioners experienced a lack of clear governance, which they considered necessary for the prioritization of automation projects.

> *"good governance from the start is key to success. And for [project name], for example, we don't have that. We don't have the governance. So we're discussing with each other."* (P4)

4.2 "Plug and play" idea doesn't work in a highly regulated environment

Projects are often inspired by other contexts where autonomous processes already function. Although getting those already working systems operational at the airport might seem a straightforward step, in reality, the integration of the technology is harder than initially expected. Participants listed many different challenges that might be hindering this initial "plug and play" aspiration.

> *"...These suppliers often come from material handling, warehouses, in where spaces are usually (...) a lot more clean (...). Airports are dusty, baggage systems are quite rough. (...) So we're working (in) a very dirty space in that sense, and that's something that autonomous vehicles or AGVs cannot really cope with well... And they think, «Okay, my AGV can work in a warehouse, so it can also work in an airport». And what we often see is that that is just not the case."* (P3)

The technological solutions that supplier companies provide need to be adapted to the airport's airside context; practitioners currently address this by training the devices on-site through what they call "pilot tests". Various technical challenges need to be faced and tailored in this pilot stage. For instance, the autonomous bus project entailed the commissioning of its route, the training of the lidar, and the adaptation of the vehicle to the airside traffic and the driving behavior of other vehicles. Apart from these, many technical faults emerge during these piloting phases, which need to be solved and tuned in collaboration with the manufacturers.

> *"So basically, it took time to adapt the vehicle to Schiphol circumstances, because (they) are very specific. People drive like crazy, (traffic) rules are different, weather conditions are different... So the technology needs time to adapt."* (P8)

Besides, practitioners find it hard to give time estimations on how long the project phases will take. This is in part because automation-related projects are unprecedented in ground operations within airside contexts, resulting in a lack of previous references to rely on. This is illustrated by a quote from P7 (see below). Additionally, participants claimed that the tight operational environment of the airport made it hard for them to find available testing spots, since the aprons, routes, or baggage handling carousels that can be *"out of commissioning"* (P7) are limited.

> *"So I don't know if it takes 2 or 3 days to get the whole system up and running or it takes two weeks. And as soon as I get the test and get the first five installed, I can make a little bit of estimation. But before it, it will be very difficult."* (P7)

Finally, regulatory barriers pose additional challenges to the integration and testing of autonomous devices. The airside is a highly regulated and controlled environment, as operational safety and border control are crucial for its correct operation. As such, some participants mentioned difficulties in obtaining access for the devices and engineers of the supplier companies as well as in obtaining clearance for conducting tests near *"high-risk areas"* (P1).

4.3 Post-pilot organizational procedures remain unresolved

Once the pilot tests are successful and the technology is proven to work in the airside context, an additional challenge lies in making autonomous processes become part of the daily operations or *"commodity"* (P6) within the airport. According to the participants, this transformation would require to design new service and business cases (e.g., the service provided by the autonomous bus), as well as to rethink some of the current operations or the standards associated (e.g., *"quality of snow removal"*, P2).

> *"...A lot of things currently happening with automation, (...) it's mainly inspirational in that regard. And it's really difficult to really define the path on how the implementation after that should look. (...) and we're really working along on seeing how they can incorporate that stuff in their day-to-day work."* (P6)

The integration of automation in daily operations also poses a challenge in defining the new human roles that will be required to support it, as participants mentioned the need to change the way how people work at the organization. A function that was often mentioned is the *"safety operator"* (P4) or *"safety driver"* (P8), an operator that oversees an autonomous system and is required to intervene in case the system does not function as desired. Participants stated that the safety driver would still be needed given the readiness level of current technology, for redundancy reasons, as well as to give confidence to passengers and to explain to them how the automated system would work. Finally, participant P4 mentioned that operators could potentially *"rely too much on the*

technology to do their work for them," which was stated as a concern related to overlooking failures in the system.

> *"...This (current) people, they have sixty years. You need to drive the bus with a joystick, and you need to be able to be focused all the time. So it's a completely different profile, you know, the one that you need."* (P8)

Besides, participants stated the need to create a digital infrastructure in which to incorporate all autonomous solutions within the airport system, emphasizing that autonomy requires the integration of both the physical and digital infrastructure. Apart from that, P3 mentioned that different parties (e.g., airlines, handlers,...) will own different sets of data, meaning that how these can be shared among the parties should be thought.

> *"Because it involves also an IT component to be managed, and we always bought vehicles and now we're buying a vehicle with a technology, and this is a new thing and should be thought of carefully."* (P4)

Finally, the need to ensure the continuity and maintenance of the autonomous systems was mentioned as an additional challenge for the adoption of automation, mainly when the market for electronic components moves at such a high pace. P4 stated that, due to the lack of precedents, it is hard to estimate the duration of the projects, as well as to calculate the number of spare parts that should be stored for maintenance.

> *"Something we design and build now is outdated in a year. And one of the main issues with a product like this is that we need to guarantee continuity. (...) Are all these components still available in the coming twenty years (...)?"* (P7)

5 DISCUSSION

Previous HCI research on the adoption of automation in organizations has focused primarily on understanding the perspectives and work practices of the professionals who interact with it. However, there is a gap in our understanding of the broader challenges faced by organizations and their constituent multi-stakeholder processes and collaborations, particularly as they relate to the planning, testing, and sustainment of automated and autonomous systems. Based on the work of Breuer et al. [8] and Gyldenkærne et al. [18], in this research we alternatively put the focus on the practitioners responsible for implementing automation, to surface the challenges they experience. Using Amsterdam Airport Schiphol and its automation efforts as an example, we conducted an interview study with 8 practitioners. Our interviews reveal challenges around three main themes, namely *a)* the lack of consensus among affected stakeholders, *b)* the need to adapt the technology to the context as opposed to the existing approach of retrofitting, and *c)* the undefined procedures needed to sustain automation once it is implemented. Although these findings illustrate the experiences of practitioners in the specific airport setting examined, and the generalizability of the results might be limited in such an action research approach, we argue that many of the lessons can be applied to highly regulated, multi-stakeholder contexts such as healthcare and fintech.

First, our participants reported that the lack of consensus, as well as the lack of consensus-building mechanisms, among the various stakeholders involved in automation efforts, has been a major impediment to the progress of specific projects analyzed. Consequently, our participants saw early stakeholder involvement, even while developing a common vision, as an effective way to build consensus and commitment to automation projects. Previous research has identified these issues when introducing automation into multi-stakeholder environments (e.g., [19, 31, 35]). For instance, in healthcare, ethnographic approaches have been used within multi-stakeholder groups to understand the needs of different parties towards AI algorithms [17, 39, 40]. Furthermore, in the context of autonomous vehicles, Kim et al. [25] proposed the creation of a stakeholder-centric taxonomy to enable collaborative discussions on the design elements that should be considered. Therefore, we suggest that organizational mechanisms should be established to identify and consolidate the expectations and needs of different stakeholder groups in the early stages of projects, along with guidelines to encourage and sustain discussion and decision-making throughout the automation lifecycle. In addition, these mechanisms and procedures should be iteratively evaluated and periodically reinforced.

Second, our interviewees revealed that their organization is conducting "pilot testing" with the incoming autonomous systems to adapt them, not amalgamate them, within the very specific nature of the airside ecosystem. This required testing the systems *in situ*, as well as resolving any technical issues that arose, and was not as straightforward as some of the technology vendors had initially anticipated. In addition, the process was slowed by the operational intensity of the airport and its regulatory barriers; therefore, our participants found it difficult to estimate the duration and complexity of the pilots. These challenges are comparable to the ones found in the work by Rozzi and Amaldi [33], mainly with regard to the relationship between technology vendors and application contexts. Future research might also look into the perspective of technology suppliers, as well as their needs to better serve the in situ pilot phases.

Third, our interviewees explained that many of the procedures that would be needed to incorporate "pilot-tested" automated systems into daily airport operations remain unavailable or incomplete. A similar challenge has been reported by Gyldenkærne et al. [18] and Coiera [14] with regard to the transition of AI systems from the testing to the operational phase, in what is referred to as the "*last mile*" in the implementation of AI systems, which in turn is touted as requiring as much effort as the development of the system in the first place. The adoption of airside automation would involve, for instance, the modification of some of the current processes to allow for a broader adoption of automation, or the establishment of new services (i.e., business cases) that can potentially lead to such processes. Our participants also emphasized the need for digital infrastructures and maintenance protocols that can effectively integrate new automation systems. In addition, our interviewees expressed a desire to transform existing work protocols and rethink new roles for human operators to enable a harmonious transition to automation. In this regard, Bainbridge [3] argues for avoiding leaving human operators with responsibility for abnormal conditions, which they argue could cause an increase in the required cognitive

workload and potentially lead to an increase in human errors. We argue that future work in HCI should focus on rethinking the role of the human user, who is increasingly interacting with highly autonomous systems. In summary, our findings are in line with a comprehensive need for a responsible "*automation policy*" [1] that consolidates the reflection on the impact and implications on various actors, societal, economic and legal procedures, and ethical concerns within organizations.

Based on our findings, and as our future work, we aim to consolidate these challenges in designing interventions that can enable the different stakeholders, including those who will eventually be the users for automation systems (i.e., operators), in establishing consensus, prescribing custom requirements about various aspects of automation systems, and facilitating the establishment of proper procedures for automation systems to function in a responsible manner.

6 CONCLUSION

In organizations, there is a high ambition to implement autonomous systems as significant benefits are expected from their operational use. Nevertheless, automation is hard to adopt and make common in daily operations. The experiences of practitioners involved in the implementation of automation can provide insights about the underlying reasons, as well as help broaden the narrow focus of prior research. Following this rationale, we conducted the present study in the context of an international airport (i.e., Amsterdam Airport Schiphol) that is currently focused on automation endeavors. The results reveal challenges around three main themes, namely, the lack of consensus among affected stakeholders, the need to adapt the technology to the context as opposed to the existing approach of retrofitting, and the undefined procedures needed to sustain automation once it is implemented. These findings reveal the need for HCI research to create organizational mechanisms and guidelines to support stakeholders, technology integration, and automation procedures.

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REFERENCES

[1] Paola Amaldi and Anthony Smoker. 2012. The problem with automation is not over-automation but lack of automation policy. In *Proceedings of the 2nd International Conference on Application and Theory of Automation in Command and Control Systems* (London, United Kingdom) *(ATACCS '12)*. IRIT Press, Toulouse, FRA, 176–181.

[2] Aleksandre Asatiani, Olli Copeland, and Esko Penttinen. 2023. Deciding on the robotic process automation operating model: A checklist for RPA managers. *Business Horizons* 66 (2023), 109-121 pages. https://doi.org/10.1016/j.bushor.2022.03.004.

[3] L Bainbridge. 1983. Ironies of Automation. *Automatica* 19 (1983), 775–779. Issue 6.

[4] Matthias Baldauf, Peter Fröhlich, Shadan Sadeghian, Philippe Palanque, Virpi Roto, Wendy Ju, Lynne Baillie, and Manfred Tscheligi. 2021. Automation Experience at the Workplace. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems* (Yokohama, Japan) *(CHI EA '21)*. Association for Computing Machinery, New York, NY, USA, Article 89, 6 pages. https://doi.org/10.1145/3411763.3441332

[5] Jenay M. Beer, Arthur D. Fisk, and Wendy A. Rogers. 2014. Toward a framework for levels of robot autonomy in human-robot interaction. *J. Hum.-Robot Interact.* 3, 2 (jul 2014), 74–99. https://doi.org/10.5898/JHRI.3.2.Beer

[6] Jeffrey M. Bradshaw, Robert R. Hoffman, David D. Woods, and Matthew Johnson. 2013. The seven deadly myths of 'autonomous systems'. *IEEE Intelligent Systems* 28 (2013), 54–61. Issue 3. https://doi.org/10.1109/MIS.2013.70

[7] Virginia Braun and Victoria Clarke. 2021. *Thematic analysis, a practical guide.* Sage publications, London, UK.

[8] Svenja Breuer, Maximilian Braun, Daniel Tigard, Alena Buyx, and Ruth Müller. 2023. How Engineers' Imaginaries of Healthcare Shape Design and User Engagement: A Case Study of a Robotics Initiative for Geriatric Healthcare AI Applications. *ACM Trans. Comput.-Hum. Interact.* 30, 2, Article 30 (mar 2023), 33 pages. https://doi.org/10.1145/3577010

[9] Joan Cahill and Gabriel Losa. 2007. Flight crew task performance and the design of cockpit task support tools. In *Proceedings of the 14th European Conference on Cognitive Ergonomics: Invent! Explore!* (London, United Kingdom) *(ECCE '07)*. Association for Computing Machinery, New York, NY, USA, 83–87. https://doi.org/10.1145/1362550.1362568

[10] Francisco Maria Calisto, Nuno Nunes, and Jacinto C. Nascimento. 2022. Modeling adoption of intelligent agents in medical imaging. *International Journal of Human-Computer Studies* 168 (2022), 15 pages. https://doi.org/10.1016/j.ijhcs.2022.102922.

[11] Francisco Maria Calisto, Carlos Santiago, Nuno Nunes, and Jacinto C. Nascimento. 2021. Introduction of human-centric AI assistant to aid radiologists for multimodal breast image classification. *International Journal of Human-Computer Studies* 150 (2021), 24 pages. https://doi.org/10.1016/j.ijhcs.2021.102607.

[12] Francisco Maria Calisto, Carlos Santiago, Nuno Nunes, and Jacinto C. Nascimento. 2022. BreastScreening-AI: Evaluating medical intelligent agents for human-AI interactions. *Artificial Intelligence in Medicine* 127 (2022), 16 pages. https://doi.org/10.1016/j.artmed.2022.102285.

[13] David Coghlan and Teresa Brannick David Coghlan. 2019. *Doing action research in your own organization.* Sage publications, London, UK.

[14] E Coiera. 2019. The Last Mile: Where Artificial Intelligence Meets Reality. *Journal of Medical Internet Research* 21, 11 (2019), 4 pages. https://doi.org/10.1145/3432932

[15] Judith Eißer, Mario Torrini, and Stephan Böhm. 2020. Automation Anxiety as a Barrier to Workplace Automation: An Empirical Analysis of the Example of Recruiting Chatbots in Germany. In *Proceedings of the 2020 on Computers and People Research Conference* (Nuremberg, Germany) *(SIGMIS-CPR'20)*. Association for Computing Machinery, New York, NY, USA, 47–51. https://doi.org/10.1145/3378539.3393866

[16] Sarah E. Fox, Samantha Shorey, Esther Y. Kang, Dominique Montiel Valle, and Estefania Rodriguez. 2023. Patchwork: The Hidden, Human Labor of AI Integration within Essential Work. *Proc. ACM Hum.-Comput. Interact.* 7, CSCW1, Article 81 (apr 2023), 20 pages. https://doi.org/10.1145/3579514

[17] Astrid Galsgaard, Tom Doorschodtc, Ann-Louise Holtena, F. C. Müllerd, Mikael Ploug Boesen, and Mario Maas. 2022. Artificial intelligence and multidisciplinary team meetings; a communication challenge for radiologists' sense of agency and position as spider in a web? *European Journal of Radiology* 155 (2022), 10 pages. https://doi.org/10.1016/j.ejrad.2022.110231

[18] Christopher Gyldenkærne, Jens Ulrik Hansen, Morten Hertzum, and Troels Mønsted. 2024. Innovation tactics for implementing an ML application in healthcare: A long and winding road. *International Journal of Human-Computer Studies* 181 (2024), 103162. https://doi.org/10.1016/j.ijhcs.2023.103162

[19] Benjamin V. Hanrahan, Carleen Maitland, Timothy Brown, Anita Chen, Fraterne Kagame, and Beatrice Birir. 2021. Agency and Extraction in Emerging Industrial Drone Applications: Imaginaries of Rwandan Farm Workers and Community Members. *Proc. ACM Hum.-Comput. Interact.* 4, CSCW3, Article 233 (jan 2021), 21 pages. https://doi.org/10.1145/3432932

[20] Karen Holtzblatt and Hugh Beyer. 2017. *Contextual Design: Design for Life (Second Edition).* Morgan Kaufmann, Burlington, Massachusetts, United States.

[21] Stephan Huber, Johanna Gramlich, and Tobias Grundgeiger. 2020. From Paper Flight Strips to Digital Strip Systems: Changes and Similarities in Air Traffic Control Work Practices. *Proc. ACM Hum.-Comput. Interact.* 4, CSCW1, Article 28 (may 2020), 21 pages. https://doi.org/10.1145/3392833

[22] Stefan Jovanović, Jelena S Đurić, and Tatjana V Šibalija. 2019. ROBOTIC PROCESS AUTOMATION: OVERVIEW AND OPPORTUNITIES. *International Journal "Advanced Quality* 46 (2019), 6 pages. https://www.researchgate.net/publication/332970286

[23] Bzhwen A. Kadir, Ole Broberg, and Carolina Souza da Conceição. 2019. Current research and future perspectives on human factors and ergonomics in Industry 4.0. *Computers and Industrial Engineering* 137 (11 2019), 12 pages. https://doi.org/10.1016/j.cie.2019.106004

[24] Euiyoung Kim, Lianne W. L. Simonse, Sara L. Beckman, Melissa M. Appleyard, Herb Velazquez, Antonio Suarez Madrigal, and Alice M. Agogino. 2022. User-Centered Design Roadmapping: Anchoring Roadmapping in Customer Value Before Technology Selection. *IEEE Transactions on Engineering Management* 69, 1 (2022), 109–126. https://doi.org/10.1109/TEM.2020.3030172

[25] Soyeon Kim, Elisabeth Shi, FjollË Novakazi, and Oscar Oviedo-Trespalacios. 2023. Stakeholder-Centred Taxonomy Design for Automated Vehicles. In *Adjunct Proceedings of the 15th International Conference on Automotive User Interfaces and Interactive Vehicular Applications* (Ingolstadt, Germany) *(AutomotiveUI '23 Adjunct)*. Association for Computing Machinery, New York, NY, USA, 249–251. https://doi.org/10.1145/3581961.3609820

[26] Steven C. Mallam, Salman Nazir, and Amit Sharma. 2020. The human element in future Maritime Operations–perceived impact of autonomous shipping. *Ergonomics* 63 (3 2020), 334–345. Issue 3. https://doi.org/10.1080/00140139.2019.1659995

[27] Jakub Mlynar, Farzaneh Bahrami, André Ourednik, Nico Mutzner, Himanshu Verma, and Hamed Alavi. 2022. AI beyond Deus ex Machina – Reimagining Intelligence in Future Cities with Urban Experts. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems* (<conf-loc>, <city>New Orleans</city>, <state>LA</state>, <country>USA</country>, </conf-loc>) *(CHI '22)*. Association for Computing Machinery, New York, NY, USA, Article 370, 13 pages. https://doi.org/10.1145/3491102.3517502

[28] Steve Omohundro. 2014. Autonomous technology and the greater human good. *Journal of Experimental and Theoretical Artificial Intelligence* 26 (7 2014), 303–315. Issue 3. https://doi.org/10.1080/0952813X.2014.895111

[29] Michael Quinn Patton. 2015. *Qualitative research & evaluation methods*. Sage publications, London, UK.

[30] Iyad Rahwan, Manuel Cebrian, Nick Obradovich, Josh Bongard, Jean-François Bonnefon, Cynthia Breazeal, Jacob W. Crandall, Nicholas A. Christakis, Iain D. Couzin, Matthew O. Jackson, Nicholas R. Jennings, Ece Kamar, Isabel M. Kloumann, Hugo Larochelle, David Lazer, Richard McElreath, Alan Mislove, David C. Parkes, Alex 'Sandy' Pentland, Margaret E. Roberts, Azim Shariff, Joshua B. Tenenbaum, and Michael Wellman. 2019. Machine behaviour. *Nature* 568 (2019), 477–486. https://doi.org/10.1038/s41586-019-1138-y

[31] Jelena Rosic, Florian Hammer, Michael Gafert, and Peter Fröhlich. 2021. Acceptance is in the Eye of the Stakeholder: Gathering the Needs for Automated Road Transport Logistics. In *13th International Conference on Automotive User Interfaces and Interactive Vehicular Applications* (Leeds, United Kingdom) *(AutomotiveUI '21 Adjunct)*. Association for Computing Machinery, New York, NY, USA, 207–209. https://doi.org/10.1145/3473682.3481871

[32] Virpi Roto, Philippe Palanque, and Hannu Karvonen. 2019. Engaging Automation at Work – A Literature Review. In *Human Work Interaction Design. Designing Engaging Automation*, Barbara Rita Barricelli, Virpi Roto, Torkil Clemmensen, Pedro Campos, Arminda Lopes, Frederica Gonçalves, and José Abdelnour-Nocera (Eds.). Springer International Publishing, Cham, 158–172.

[33] Simone Rozzi and Paola Amaldi. 2012. Organizational and inter-organizational precursors to problematic automation in safety critical domains. In *ATACCS '12: Proceedings of the 2nd International Conference on Application and Theory of Automation in Command and Control Systems*. Association for Computing Machinery, London, UK, 98–106.

[34] Airport Technology. 2021. *The sky's the limit: how automation is transforming airside operations*. Airport Technology. https://www.airport-technology.com/features/sky-limit-automation-transformig-airside-operations/?cf-view

[35] Daniel Toll, Maria Booth, and Ida Lindgren. 2023. Digitalization and automation for the sake of IT? Insight from automation initiatives in Swedish municipalities.. In *1In 16th International Conference on Theory and Practice of Electronic Governance (ICEGOV 2023)*. Association for Computing Machinery, New York, NY, USA, 8 pages. https://doi.org/10.1145/3614321.3614333

[36] S. Tuchen, M. Nazemi, S. M. Ghelfi-Waechter, E. Kim, F. Hofer, C. F. Chen, M. Arora, S. Santema, and L. Blessing. 2023. Experiences from the international frontlines: An exploration of the perceptions of airport employees during the COVID-19 pandemic. *Journal of Air Transport Management* 109 (2023), 13 pages. https://doi.org/10.1016/j.jairtraman.2023.102404

[37] Himanshu Verma, Jakub Mlynar, Roger Schaer, Julien Reichenbach, Mario Jreige, John Prior, Florian Evéquoz, and Adrien Depeursinge. 2023. Rethinking the Role of AI with Physicians in Oncology: Revealing Perspectives from Clinical and Research Workflows. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems* (<conf-loc>, <city>Hamburg</city>, <country>Germany</country>, </conf-loc>) *(CHI '23)*. Association for Computing Machinery, New York, NY, USA, Article 17, 19 pages. https://doi.org/10.1145/3544548.3581506

[38] Dakuo Wang, Justin D. Weisz, Michael Muller, Parikshit Ram, Werner Geyer, Casey Dugan, Yla Tausczik, Horst Samulowitz, and Alexander Gray. 2019. Human-AI Collaboration in Data Science: Exploring Data Scientists' Perceptions of Automated AI. *Proc. ACM Hum.-Comput. Interact.* 3, CSCW, Article 211 (nov 2019), 24 pages. https://doi.org/10.1145/3359313

[39] Qian Yang, Aaron Steinfeld, and John Zimmerman. 2019. Unremarkable AI: Fitting Intelligent Decision Support into Critical, Clinical Decision-Making Processes. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (Glasgow, Scotland Uk) *(CHI '19)*. Association for Computing Machinery, New York, NY, USA, 1–11. https://doi.org/10.1145/3290605.3300468

[40] Qian Yang, John Zimmerman, Aaron Steinfeld, Lisa Carey, and James F. Antaki. 2016. Investigating the Heart Pump Implant Decision Process: Opportunities for Decision Support Tools to Help. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems* (San Jose, California, USA) *(CHI '16)*. Association for Computing Machinery, New York, NY, USA, 4477–4488. https://doi.org/10.1145/2858036.2858373