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Abstract

In organizations, the interest in automation is long-standing. However, adopting automated processes remains challenging, even in environments that appear highly standardized and technically suitable for it. Through a case study in Amsterdam Airport Schiphol, this paper investigates automation as a broader sociotechnical system influenced by a complex network of actors and contextual factors. We study practitioners' collective understandings of automation and subsequent efforts taken to implement it. Using imaginaries as a lens, we report findings from a qualitative interview study with 16 practitioners involved in airside automation projects. Our findings illustrate the organizational dynamics and complexities surrounding automation adoption, as reflected in the captured problem formulations, conceptions of the technology, envisioned human roles in autonomous operations, and perspectives on automation fit in the airside ecosystem. Ultimately, we advocate for contextual automation design, which carefully considers human roles, accounts for existing organizational politics, and avoids techno-solutionist approaches.

CCS Concepts

• **Human-centered computing → HCI theory, concepts and models**; *Empirical studies in HCI*.

Keywords

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

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1 Introduction

In organizations, the use of automation and AI-enabled solutions has seen increasing interest as a means to enhance or substitute their work processes [9, 39, 81]. Automation manifests in different forms (e.g., from digital assistants [42] to autonomous vehicles [19]), as well as domains (e.g., industrial sites [47], healthcare [43], home environments [80], agriculture [11], public administration [3]). The benefits that organizations expect to gain from automation include improved productivity and efficiency in their operations and teams [5, 10, 24, 39, 92], increased process reliability [4, 19], the replacement of repetitive tasks [5, 43, 89], or addressing shortages of highly demanded professionals [3, 39, 92]. Despite those ambitions, adopting automation into their day-to-day operations is often a challenge for organizations [4, 16, 34, 78, 79, 94].

Automation adoption is an entangled process in organizations, where material artifacts and human actions co-constitute each other [49, 50, 68]. Hence, it can be influenced by many socio-technical aspects. For example, prior empirical studies across sectors such as healthcare [34, 94], public administration [56, 60], and aviation [32] highlight several key challenges: a) compatibility of the automation solutions with existing workflows [79, 93]; b) technical difficulties encountered during the testing of the solutions within the context of use [32]; c) the need for appropriate governance structures and strategies on automation adoption within organizations [60], which consider the different interests and priorities of the stakeholders involved [32]; and d) the establishment of procedures that ensure the integration of automation within organizations [32], such as the "last mile" challenge studied by Gyldenkærne et al. [34]. In this article, in line with Humphreys [36] revision of the social construction of technology (SCOT) framework, we argue that these factors are closely linked to the visions of automation held by those who design and promulgate the technology within organizations [6]. Breuer et al. [15] illustrate this further by explaining how *"engineers, when attempting to create human-centered AI and robotics for* *healthcare, do so with certain views on the world, ethics, and (care) relationships in mind"* (p.3); even if the quote refers to the healthcare robotics domain, it also applies to other contexts where automation and AI development and implementation occur. However, while previous research has explored the perspectives on automation of workers, developers, or government bodies, the views of practitioners directly responsible for implementing automation within an organization remain underexplored in HCI literature. Therefore, this study aims to address this gap by investigating the perspectives of practitioners who are in charge of implementing automation in organizations.

In this paper, we specifically study practitioners' perspectives on automation in Amsterdam Airport Schiphol [38], not only to understand their approaches to addressing and shaping automation projects, but also to illustrate the organizational dynamics and complexities surrounding automation adoption. Schiphol Airport is a major international airport in The Netherlands following an ambitious plan to implement automation technologies into their airside processes. These technologies include aircraft-service operations and ground operations (e.g., baggage, passenger, and resource movements) taking place in the external, security-restricted area of the airport terminal where aircraft movements take place [70]. As in any airport, the airside is operated according to specific stakeholder dynamics; while the airport owns the infrastructure, third-party companies are responsible for the operations (e.g., baggage handling) or have authority over the airside environment (e.g., air traffic control or border control), which means that automation projects are situated in multi-stakeholder settings. Even though airside operations are highly standardized and appear suitable for automation, the organization is currently facing challenges in adopting the technology within the airside context; to date, prolonged implementation timelines indicate that automation remains unready for integration into daily operations.

We use *social imaginaries* as a conceptual lens to study the perceptions, understanding, conceptions, and expectations of the practitioners in charge of implementing automation within Amsterdam Airport Schiphol, particularly in the airside context, arguing that automation adoption can be informed by how these practitioners envision its capabilities, limitations, or functionalities and the development pathways that they choose accordingly. This lens has been widely used in prior HCI research [59, 74, 76, 91]. Specifically, we follow the approach of Mlynar et al. [59], where they refer to *social imaginaries*, as oppossed to *sociotechnical imaginaries* [40], as *"the anonymous, collective, unmotivated force that nevertheless has strong agency to mold the world we live in"* (p.3), which they use to study the orientations, symbolic networks, epoch, and world relations of a particular social group (in their case, experts in urbanism) that constitute *"support of the orientations and of the distinctions of what matters and what does not to them"* (p. 3). Social imaginaries are well-suited to our research purpose since we aim to understand the conceptions and motives of a specific social group, practitioners responsible for implementing automation projects, to ultimately illustrate the complexities of automation adoption in organizations through a real-life case.

Imaginaries of automation have been explored previously in various domains, such as autonomous vehicles [65] and agriculture [11]. In prior works, these collective, shared constructions around the technology serve to understand how different stakeholders[1] justify the need for automation, the implications associated with it, or the current frictions in those contexts that automation is expected to solve. Nevertheless, imaginaries are highly situated [91], and our work explores the particularities of the airport context and the perspectives of practitioners who are in charge of automation implementation, which have been under studied in prior literature. We, therefore, address the following research question:

> **RQ.** *What social imaginaries of automation are shared by practitioners who are responsible for its implementation and the challenges of its adoption within organizations?*

This article reports the findings of a qualitative analysis conducted on 16 semi-structured interviews with practitioners who fulfill different roles in Amsterdam Airport Schiphol's automation projects (e.g., system owners, technical experts, innovation consultants, project managers). These practitioners are involved in the implementation of five key airside automation projects currently being developed within the organization, namely: automation of snow fleet, lawn mowers, Passenger Boarding Bridge (PBB), passenger bus, and baggage handling processes. Our interviews discuss practitioners' experiences and development paths via these ongoing projects. It is worth noting that these projects were, at the time of our interviews, at different stages of maturity in terms of their implementation.

Our findings reveal the conceptions that these practitioners have around automation. Overall, they envision it as a direct solution to the current frictions in the airside, and they are optimistic about the opportunities that the technology offers. Still, the imaginaries also manifest the particularities of the airside environment, where automation implementations are expected to face numerous obstacles, such as slow and lengthy procedures for obtaining the necessary permits to test autonomous equipment on-site, and the reluctance of various stakeholders to embrace changes in airport processes. Specifically, the imaginaries describe how practitioners envision the future *"autonomous airside"*, and are illustrated through the airport's *problem formulation* [54], their attitudes towards the *capabilities and the limitations* of the technology, expectations around the *future of work* in the airside, and visions about the integration of *automation in the airport ecosystem.*

Based on these findings, we discuss nuanced aspects and implications of the captured imaginaries, which should be considered in the design, deployment, and evaluation of automation in the future. We contribute by expanding on previous research that warns of the risks that may arise if critical perspectives on the topic are lacking, mainly for the future of work in automated settings [2, 29, 47]. Specifically, we provide recommendations regarding the risk of techno-solutionism in autonomous airside operations, the design of future worker roles in autonomous airside processes, and the need to design automation collaboratively and for the airside context, by accounting for existing organizational politics, internal hierarchies, and the perspectives of all airport stakeholders. All in all, we present research that contributes to the HCI community with 1) an

[1]Note that in this paper, *practitioners* refers to professionals directly involved in and responsible for the implementation of automation projects, while *stakeholders* encompasses a broader network of actors within the context where automation takes place.

empirical study of practitioner-related aspects (i.e., imaginaries), illustrating the experiences, dynamics, and complexities surrounding automation adoption in a real-world organization, and 2) recommendations regarding nuances of those imaginaries, which should be considered in practice and research to promote human-centered automation adoption within organizations.

2 Related Work

Our work lies at the intersection of the automation of human work in organizations and automation adoption (2.1). We draw inspiration from sociomaterial theories, which support that the material and social aspects within organizations are constitutively entangled (2.2) and we utilize *social imaginaries* as a lens to understand the collective visions of practitioners around automation (2.3). In this section, we take a closer look at prior research that was conducted around those themes.

2.1 Automation and AI Adoption in Organizations

Despite their ambition to implement automation and AI in their processes, organizations often struggle with their adoption [31, 34, 78, 95]. In prior research, the concept of *adoption* is studied from a wide breadth of different perspectives [51] (e.g., *technology transfer*, *technology acceptance*, etc.). In this study, we follow the approach of Damanpour and Schneider [21], who describe *innovation adoption* in organizations. In their view, the adoption of innovations is a multiphase and multidimensional process, influenced by factors within several moments and dimensions; the authors list environmental factors, characteristics of the individuals and organizations that adopt the innovation, and characteristics and attributes of the innovation itself. Related to those factors, Gallivan [30] provides a multi-stage process framework that incorporates the unique processes related to organizational adoption and assimilation of innovations, where the effects of factors are mapped according to the bureaucratic innovation cultures within organizations.

In the field of automation and AI, adoption has been examined in empirical studies that were held in various types of organizations, including healthcare contexts [31, 94], public administration [56, 60], aviation [32], or software engineering [79]. These works highlight several key challenges for automation adoption in organizations, that we have grouped in four main categories. First, authors highlight the importance of compatibility between automation solutions and existing workflows [79, 93], arguing that failing to consider the routines, tasks, and collaboration culture of the workers who will interact with the automation often results in failed migrations of the solutions from lab settings to real-world contexts. Second, technical difficulties often arise during the testing of automation in context [32]. In this regard, Gomez-Beldarrain et al. [32] illustrate how the *"plug-and-play"* concept is often mistakenly associated with automation solutions, which actually require significant effort from organizations to adapt the technologies to the specific characteristics of their context. Third, Molin [60] highlights that the absence of appropriate governance structures and strategies impacts the development and adoption of AI. Fourth, after technologies are tested on-site and compatibility with existing workflows is proven, organizational procedures are needed to ensure the integration of automation within their daily operations [32], also known as the "last mile" challenge [34]. Examples of those procedures include rethinking maintenance procedures of new autonomous equipment or integrating new equipment within organizations' digital infrastructure [32]. In this article, we argue that these factors are closely linked to the visions of automation held by those who design and promote the technology within organizations [6, 15].

The role of practitioners that are in charge of implementing automation and AI solutions is quite relevant; not only are they closely linked to the development pathways that are followed, but they are also connected to the adoption issues that were mentioned in prior research. Yet, their perceptions and efforts remain underexplored.

2.2 The Broader Interplay between Organizations and Technology: Sociomaterial Perspectives

The interplay between technology, organizations, and work has long been a focus of investigation in the fields of organizational and management studies. Organizational scholars have extensively theorized the relationship between the material and social dimensions of organizations [7, 48, 49, 66, 68, 69], mostly in the context of emerging technologies, which have the potential to fundamentally shape all aspects of organizations [7]. As such, *Sociomaterial* perspectives are proposed in the works by Orlikowski and Scott [69], with the objective of addressing the limitations of prior prevailing streams of research where technologies and social aspects of organizations had been treated as independent from one another. This distinction resulted in materiality being inadequately reflected in organizational studies, either ignoring it, taking it for granted, or treating it as a special case [49, 50, 68].

Sociomaterial theories support the notion of *"constitutive entanglement"*, which presumes that there are no independently existing entities with inherent characteristics. Instead, humans are constituted through relations of materiality which, in turn, are produced through human practices [66, 68]. Therefore, in organizations, there is an inherent inseparability between the technical and the social, meaning that technology's material and social aspects are entwined or entangled in a complex set of co-constitutive relations and that together perform the modern organization [67, 69]. Thus, in the case of automation adoption within organizations, it would mean that it is not a matter of the material features of the automated solutions having impacts on the social aspects of the organization, but rather that material artifacts and human actions co-constitute each other. Similarly, it also means that technologies are not a mere result of human thought and action.

While in this work we primarily engage with discursive aspects surrounding automation technologies (i.e., practitioners' imaginaries), which focus on how language, narratives, and meaning-making shape social reality, we argue that organizational practices are both discursively constructed (through talk and text) and sociomaterially enacted (through interactions with artifacts). Thus, engaging with discourses is a meaningful starting point to understand sociomaterial aspects in our context. We also take inspiration from those prior organizational and management studies for how they theorize the relation between the social and the material within organizations, where technology adoption is not a separate and salient phenomenon occurring within organizations but rather materiality is an integral aspect of organizational life; additionally, the organizational actions that automation enables or constraints are dependent on multiple relations [7] among, for instance, the components of the technology, the rules governing their usage, or the people who deploy them in their work.

2.3 Imaginaries of Automation

Imaginaries are collective visions of the future, present, or past [52]. The concept is defined as a *"shared network of concepts, images, stories, and myths that make possible common practices and provide a sense of legitimacy"* (p.2) [59]. In the CHI and CSCW research communities, we often find imaginaries (e.g., [1, 15, 23, 35, 44, 52, 59, 73, 74, 91]) as a lens to not only surface the assumptions, expectations, anxieties, or social contexts around new technological constructs, but also to map the future position, impact, and functions of those technologies. The works comprise, for instance, conceptions of the impact of AI in future cities [59] or in clinical and research oncology practices [91], distributed autonomous technology [52], drone implementations in small commercial farms in the Global South [35], or conceptions of competing future visions for agriculture and food systems [23].

In our work, we depart from the concept of *sociotechnical imaginaries* introduced by Jasanof and Kim [40] within science and technology studies (STS), which examines nation-wide understandings of technology and related policies through a macro-social lens. Instead, we follow the approach of Mlynar et al. [59], who, based on the work of the social constructionist Castoriadis [17], refer to *social imaginaries* to study the imaginaries of narower, specific subgroups. As such, we do not aim to depolitize the project, but rather understand the dynamics, ideologies, and expectations that shape automation within organizations (instead of on the country-level) when automation projects are developed. Thus, while we do not specifically look at the macro-level developments and policies that took place in the country where the airport is located, the imaginaries of the practitioners are highly situated and are affected by the broader context. Still, the main difference here is where the focus is set, and social imaginaries allow us to also capture the effects, nuances, or complexities of internal organizational relations.

Research on *imaginaries of automation* has been conducted across various contexts and stakeholder groups. For instance, in the agricultural sector, Baur and Iles [11] studied the imaginaries of automated farm machinery that manufacturers promote, who depict automation as a solution for *all* the frictions that farmers experience (such as, inflexible hours or boring routines), that will as well meet *"the need for greater control over farm operations"* (p. 12). The authors emphasize that the promoted imaginaries coincide with the self-interest of manufacturers, *"who stand to gain further control over farms if automated technologies assume a central role in agriculture"* (p. 14). In the public administration domain, the work by Toll [86] points at three imaginaries surrounding the automated municipality, namely, *"automation is a new era of digitalization"* (held mainly by suppliers and policy makers), *"automation is a powerful tool"* (held mainly by strategists and developers), and *"automation is just another software"* (held by the IT department and civil servants). Finally, the transport and mobility domain was the most studied one, with numerous examples investigating imaginaries related to autonomous vehicles (AVs); the majority of them analyzed discourses surrounding AVs in nation-level policy, industry proposals, or governance strategies [20, 26, 58, 64, 65], presenting imaginaries of automation where, for instance, the desire to pursue automation is characterised by unjustified optimism and strong determinism [26, 58, 64, 65], or where automation is envisioned as a mere technological substitution to current transport [65]. Besides, Graf and Sonnberger [33] provided a complementary perspective; they found that users of autonomous driving are depicted in stakeholders' imaginaries as *responsible*, *rational*, and *accepting* AVs and driving. Finally, Martin [57] compared the imaginaries of AVs of two different stakeholder groups, an automotive manufacturer and an urban planning studio; the findings suggested that stakeholders deploy visual discursive material as a tool of regime stability or change to benefit their own agendas.

From those prior works, we see that across the different domains where *imaginaries of automation* have been studied, collective constructions around the technology often justify the need to implement automation in the frictions of the specific domain, by setting (overly) positive expectations of 'technological salvation' [57] in its capabilities. Those expectations influence the characteristics of automated solutions, as well as the pathways that are chosen to implement the technology. Additionally, the papers acknowledge the stakeholder complexity, noting that different stakeholders have varying motivations regarding automation, which can sometimes lead to tensions.

In that regard, building on extensive theorizing in the STS literature on the social and cultural influences in the evolution of technologies and vice versa (e.g., [36, 55, 75]) we draw on the social construction of technology (SCOT) framework to further ground our decision of examining the social imaginaries of practitioners regarding automation within organizations. SCOT, as proposed by Pinch and Bijker [75], emphasizes the multi-directional and nonlinear nature of technological development, highlighting the interplay between *relevant social groups, interpretive flexibility, closure,* and *stabilization.* According to the later revision of the framework by Humphreys [36], the practitioners in our context correspond to *producers*, which along with *advocates, user,* and *bystanders* would form the categorization of the broad relevant social groups, thereby reflecting broader power dynamics. Producers are described as pivotal actors who shape or influence technology through activities such as engineering, design, marketing, or investing, where they embed their beliefs into the technical development. Humphreys [36] categories are broad; as such, we consider the activities of our practitioners, in charge of shaping supplier technologies to the airside needs, best fitting within the *producers'* category, even if they are not engaged in the technical development of automation solutions. While most prior papers examine nation-wide governance efforts behind automation adoption through the lens of sociotechnical imaginaries, mostly studying the imaginaries of *advocates*, we study automation within a single organization through the social imaginaries held by *producers*. We aim to contribute aspects of practitioners' collective understandings of automation not only to understand their approaches to addressing and shaping automation projects, but also to illustrate the organizational dynamics and complexities surrounding automation adoption, arguing that producers are an important component of the power relations which influence the construction of an artifact.

2.4 Research Gap and Motivation

Organizations often struggle with automation adoption, despite the ambition to automate their processes. Failing to consider broader organizational aspects and socio-technical implications that affect automation adoption [31, 78, 79], or understanding adoption as a salient rather than an integral and entangled process in which material artifacts and human actions co-constitute each other [49, 50, 68], could contribute to these persistent adoption issues. This section revealed that, while prior works warn about key organizational aspects challenging automation adoption in organizations, they offer little attention to the influence of the practitioners that are in charge of automation and AI implementation in the overall adoption. Still, practitioners' views and conceptions of a technology affect how it is conceptualized [15], as well as the implementation paths that are chosen [34, 36].

As such, in this work, we aim to scrutinize the imaginaries of automation held by practitioners in charge of implementing autonomous airside operations at Amsterdam Airport Schiphol. We study automation in a single organization through the lens of social imaginaries. We aim to gain insights into aspects of their collective understanding, conceptualization and development efforts to illustrate the dynamics and complexities surrounding the adoption of automation in organizations.

3 Background: Autonomous Airside Operations in an International Airport

Amsterdam Airport Schiphol, the international airport we study as a case, is part of the global Royal Schiphol Group and has formulated a vision to automate its airside processes to respond to emerging needs in relation to throughput and sustainability challenges. The automation vision is executed through a 30-year program, named *"Autonomous Airside Operations 2050"* [38]. The program envisions a fully autonomous airside by the year 2050 and outlines a strategic roadmap for sequencing process automation projects. The airside is the external, security-restricted area of an airport terminal dedicated to aircraft operations and the supporting ground operations (including baggage, passenger, and resource flows) [70]. As an example, we offer an image of Amsterdam Airport Schiphol's airside in Figure 1a. An autonomous airside would involve the automation of all processes related to passenger, baggage, and resource movements in the airside (e.g., aircraft marshalling tasks or the transportation of catering from and to the airplanes), as well as the automation of supporting processes that are essential to ensure a correct operation of the airside (e.g., snow removal or grass cutting tasks). Due to its restricted and highly-regulated nature, with standardized operations following global rules, the airside is considered a propitious environment for automation, offering numerous opportunities to improve the efficiency of airport processes [38].

Currently, five automation projects are being developed within the *"Autonomous Airside Operations"* program. Specifically, the airport is working on the automation of Passenger Boarding Bridge movements, grass mowing operations, snow removal, baggage loading and unloading, and passenger transportation to the aircrafts. We offer images of two of the projects in Figure 1b and Figure 1c, namely illustrating the autonomous bus project and the autonomous baggage handling project. The status of every project varies: some are in the initial conceptualization phase, defining requirements and searching for technology providers (i.e., autonomous snow removal); others are testing autonomous equipment on-site through pilot tests (i.e., autonomous lawnmower, baggage lifting robots, and autonomous bus); and some are more advanced, being deployed in a larger scale (i.e., autonomous PBB). Yet, overall, the airport is finding it challenging to adopt automation within the airside, with testing and implementation timelines often exceeding initial project plans and ambitions. To date, none of the mentioned projects are mature, integrated, or stable enough to be utilizable within the airport's daily operations, meaning that adoption is still not successful within the airside.

In this study, we aim to reveal the imaginaries of automation in the airside by scrutinizing them through the practitioners who are currently involved in those five specific projects which are currently running in the organization. Ultimately, our objective is to understand their approaches to shaping automation projects, to illustrate the organizational dynamics and complexities surrounding automation adoption, as well as to derive implications that the HCI community could address.

Note that airports operate according to specific stakeholder dynamics; while the airport organization is the owner of the infrastructure, third-party companies such as ground handlers, maintenance companies, airlines, baggage handlers, or bus driving companies, are usually hired for the execution of the operations. As such, several stakeholders interact in the development of automation projects, and accordingly, the practitioners we interviewed belong to different projects and stakeholders, and have different roles within their organizations (see Section 4.1).

4 Interview Study

Following the objective to investigate the imaginaries of automation of practitioners in the airside environment, we designed and conducted qualitative semi-structured interviews with 16 participants holding prior experience in automation-related projects within the context that we study. We analyzed the collected data through a grounded theory-informed approach. Note that the set up of the study and the interview procedure were approved by the Human Research Ethics Committee of our university (approval number: 131244).

4.1 Participants

With the goal of collecting significant and nuanced data about the objectives, state, expectations, fears, and development paths surrounding every automation project, we purposefully targeted key informants [72] as potential participants. Prior to the recruitment, through informal meetings, we gathered information on the size and stage of each automation project, as well as the practitioners[2] involved. Afterwards, we invited practitioners who have worked in automating airside processes, specifically in one or more of the five

[2]From now on, we will refer to them as 'participants'.

(a) Aerial view of an airside. The airside is the external, security-restricted area of an airport dedicated to aircraft movements and supporting ground operations, including baggage handling, passenger boarding, and resource flows.

(b) Autonomous bus project, aimed at facilitating boarding and deboarding procedures for passengers and staff in remote aprons (i.e., aircraft parking space within the airside).

(c) Autonomous baggage handling robot, aimed at reducing heavy lifting movements by operators when transporting baggage pieces from the laterals to the containers.

Figure 1: Above, the airside of Amsterdam Airport Schiphol (a). Below, two of the five projects analyzed in this article, the autonomous bus project (b) and the autonomous baggage handling project (c). The images were taken during the pilot tests conducted at Amsterdam Airport Schiphol to test the technology and equipment in the field. [*The images are courtesy of a) Chris Roos, b) Silvia Rey Abeijón, and c) Sanne van der Leest.*]

projects we previously described in Section 3 (i.e., autonomous Passenger Boarding Bridge, bus, lawn mower, snow fleet, or baggage handling projects). Participants belonged both to the airport and to external parties, namely ground handling companies, airlines, or technology suppliers, involved in close collaboration within the automation project teams. For the recruitment, we used a mix of direct contact and snowball sampling, meaning that once the interviewing phase started, we also approached further participants based on the recommendations of the professionals we spoke to. We stopped the recruitment of new participants after 16 practitioners were interviewed, since data saturation was reached at that moment.

Table 1 presents an overview of the 16 participants we interviewed, detailing their roles in the projects and their professional experience. To prevent re-identification, we intentionally avoided linking the identity of each participant with the specific project they were involved in. This is specially relevant in research that is conducted within one single organization [62, 92]. Table 2 provides the distribution of participants per project; since some of them were involved in multiple projects, the total number of participants in the table is not an accurate sum.

Table 1: Overview of the participants of the interview study, including their roles in the projects and their professional experience in years.

Participant	Role	Experience (years)
P1	System owner	11-20
P2	Technical expert	> 30
P3	Technical expert	> 30
P4	System owner (handler/airline)	1-10
P5	Procurement and contracting	1-10
P6	Innovation consultant	11-20
P7	System owner	> 30
P8	Project manager	21-30
P9	Technical expert	1-10
P10	Innovation consultant	1-10
P11	Technical expert	21-30
P12	Project manager	1-10
P13	Innovation consultant	1-10
P14	Innovation consultant	11-20
P15	System owner	21-30
P16	System owner (supplier)	11-20

4.2 Procedure

Prior to all interviews, we prepared an interview guide to structure the conversational-style dialogue and outline the questions. Besides, via email, we requested written consent from participants to audio-record and transcribe the interviews.

The first author conducted the semi-structured interviews, which took place either online via video conferencing (n=8) or in person (n=8), depending on the preference of each participant. The interviews had an average duration of 62 minutes (ranging between 42 and 80 minutes) and they were audio recorded.

The interviews started with an introduction by the main researcher. We reminded the participants that they were free to withdraw the study at any time, highlighting the fact that their insights would be anonymized at all times, which we consider specially relevant in such an organizational-level study. Following that, as an ice breaker, participants were asked to present themselves, their role within the airport, as well as to explain any past or present experience in automation-related projects. In line with the common practice in qualitative semi-structured interviews, the questions were introduced according to the conversational flow. The remaining of the interview was organized into the following themes:

(1) Definition of automation.
(2) Rational supporting the project(s) they were part of.
(3) Successful milestones and challenges in those projects.
(4) The role of human workers in future autonomous operations.
(5) Future vision and recommendations to bridge the challenges encountered.

4.3 Interview Coding and Identified Themes

The analysis was informed by the foundations of Grounded Theory [18]. After transcribing and validating all interviews, we carefully went through them once more with the goal of acquainting ourselves with the collected data. The coding procedure started with an open coding phase, which was aimed at developing codes that explain the data by staying close to it. Three researchers openly coded 25% of the transcripts, individually. Afterwards, we organized a session where to gather and integrate the codes into significant categories, which was followed by a second session where we iterated on the descriptions of the categories we agreed upon. These meetings unfolded smoothly and included fruitful discussions and comparisons, where every researcher would add nuances to the conversations.

Table 2: Overview of the analyzed projects and the distribution of participants across each project.

Project	# Participants per Project
Lawn mower	5
Snow fleet	5
Baggage handling	5
Bus	6
Passenger Boarding Bridge	3

We describe the resulting codebook in Table 3, which consists of 8 codes and their descriptions. Afterwards, the first author analyzed all 16 transcripts, to determine which quotations corresponded to each code. This analysis sequence helped us discern, understand, and unpack the different elements that shape the imaginaries of the participants involved in the automation projects, which we detail in the next section (Section 5).

4.4 Statement of Positionality

The authors of this paper are HCI and design researchers with diverse backgrounds in Human-AI Collaboration and Social Cognition, Human-Centered AI, Complex Environments, and Design Engineering, which makes our approach particularly inclined to studying human-centered technology implementation in complex settings, as well as to propose interventions or guidelines that unite the requirements of the stakeholders involved.

In the context of this study, the first author spends one day a week as an external researcher in Amsterdam Airport Schiphol, within the department mandated to implement automation in the airside environment. This role allows the first author to observe daily routines and projects undertaken by the department's teams. In that regard, we benefit from a privileged position to experience the developments that are taking place in the autonomous airside domain, as well as access to the professionals, organizational culture, and context around the presented projects. Overall, we are in favor of a responsible adoption of automation, that consolidates the needs and experiences of diverse stakeholders and manifests through iterative participatory process.

5 Results

From the analysis of the 16 interviews, we derive *problem formulations* of the airside (5.1), participants' attitudes towards the *capabilities and the limitations* of the technology (5.2), visions about

Table 3: The codebook. The table provides the codes and a description for every code.

Code	Description
Attitudes and motivations towards automation	Positive benefits, improvements, opportunities, or contributions that can be derived from automation, according to the personal views of the participants, which trigger and justify the need for automation and reflect their standpoint towards the technology and its capabilities.
Failures and fears of automation	Negative assessments and evaluations of automation and its potential consequences, according to the personal views of the participants, which reflect their standpoint towards the technology and its capabilities.
Defining automation	Passages of the interviews in which participants explain their understanding of what automation is, including ideas and assessments about its essential characteristics, what automation can and cannot do, and the level of quality, maturity, or evolution of current automated solutions.
Automation acceptance	Ideas related to the favorable or unfavorable reception or agreement of airport stakeholders towards new automated solutions.
Future of work in an automated setting	Reflections related to the role of human workers in automated processes and contexts, including topics such as new training requirements, transformation of the current setting, job satisfaction, or the level of human involvement needed.
The airport world	Reflections on the particularities of the airport field, including assessments of the context, stakeholders involved, working culture, collaborations with other airports, competition with other airports, etc.
Pathways in automation adoption	Experiences and reflections on the conceptualization, development and implementation pathways followed in automation projects, including discussions around the infrastructure fit, solution search on suppliers' portfolios, needed tests, or the efforts of making automation a commodity in everyday use contexts.
Governance and stakeholders	Discussions around the structures of power within organizations and stakeholder networks as well as participants' standpoint on how automation visions and projects are promoted, communicated, and led.

the future of work in autonomous airside operations (5.3), and expectations on the integration of *automation in the airport ecosystem* (5.4).

5.1 Problem Formulation: Pressing Issues Surrounding the Airside

Participants described the airside context as navigating *"uncertain"* times, characterized by multiple entangled issues that require immediate solutions. We grouped the problems in the following two categories: 1) capacity-related issues, and 2) issues related to the working conditions on the airside. These issues emerged in all the interviews; participants often justified their automation projects by citing current airside issues as arguments supporting the need for automation.

5.1.1 Limited capacity of the airside operations. 'Capacity' refers to the amount of flights that the airport is able to serve, given its infrastructure and resources. Our participants explained that the airport's limited capacity is currently a *"major problem"* and is expected to become critical in the future as demand increases. This capacity limit is linked to the finite infrastructural growth (e.g., due to long building timelines but also unavailable land), as well as the requirement *"to maintain the highest safety standards and the highest passenger experience"* (P10). As such, the need for *"optimizing capacity"* was mentioned by some participants, who explained that the airport could aim to increase the operational availability of the airside assets (and personnel) by employing them more efficiently and reducing waiting times. Related to the autonomous Passenger Boarding Bridge project, for example, P11 and P12 mentioned the need of having quicker connecting times to *"get more planes in a stand"* (P12) and *"get more operational availability"* (P11) at the airport.

Many participants mentioned On Time Performance (OTP) as a factor directly linked to operational capacity, *"This is something everybody's looking at. Everybody who's traveling wants to go on time"*, (P7). The OTP measures the punctuality of the various processes that service the airlines that need to land or depart from the airport. It is usually used as a KPI; for instance, P11 explained that for Passenger Boarding Bridge connections handlers *"have a KPI which states that they have to be within a couple of minutes before the door open signal can be given. So they've got a time frame to connect the PBB"*. Related to that, P7 mentioned that the bus operation tries to keep their OTP around 70%, but that there are moments in the year (e.g., the summer vacation period) in which it can undesirably *"even go under 50%"*. All in all, the ambition to improve OTP was mainly linked to delays costing *"a lot of money"* (P7); in the operations that fall under the airport's responsibility, the airlines can claim financial compensation when the established schedules and KPIs are not met by cause of the airport.

> *"If we don't make a boarding time, it's money straight out of Schiphol's pocket, because we're responsible for that bridge, so the airlines can claim,* "Hey, I leave 15 minutes late because of you." (P12)

Related to that, a common cause of delay is human error. As participants explained, when an operator leaves a task incomplete, technical failures occur which result in system blockages that require the intervention of maintenance personnel, and thus, also extra time to carry out a process:

> *"For the passenger bridges (...) about 50% of all the malfunctions that occur during the docking process comes from driver induced mistakes. So, the operator of the bridge physically makes a mistake, and the bridge is designed in such a way that as soon as it goes out of certain parameters, it will block. And it's a simple reset, but it can only be done by the maintenance company, (...). So, it's not a big problem, but the operator can't continue, which leads to a delay; and the main contractor has to be within 15 minutes on the location, but sometimes they don't make it. But if you're in a plane and you wait 15 minutes, it's a long time because you want to get out."* (P12)

Participants pointed that worker expertise and experience are strongly linked to the errors mentioned; for instance, P10 stated, *"it really depends on the experience, how fast or how slow you can dock [a] passenger bridge, or even ruin the aircraft."* Besides, it was mentioned that some workers *"take their own planning"* (P7), which can sometimes result in delays. Apart from the delays, the airport is addressing human errors to reduce damage to airside equipment. For instance, in the autonomous snow fleet project, volunteer drivers would often cause damage, as illustrated by P5: *"because of the inexperience of the driver, when the driver needs to make a turn, he does it too sharp or not at all, and therefore he hits the lamps on the side. (...) you destroy maybe 20 to 30 lamps at one go. And (...) you also damage the vehicle, the arms that are spraying the liquid."*

5.1.2 Issues related to working conditions on the airside. While the airport's strategic focus is to provide "healthy working environments", our interviews reveal that the polluted airside environment is a major health problem. Workers are currently exposed to ultrafine particles emitted by aircraft engines, which are present in the airside air and pose significant health risks when inhaled.

Apart from that, our participants highlighted that airside operations are often intense and physically demanding, as described by P3: *"Carrying loads, lifting loads and moving their body in unnatural ways, (...), at high repetition, that is really hurting people. And that is with handling the bags, so loading and offloading, (...) but also the maneuvering by hand of carts and dollies."* The exposure to such physically straining activities can create injuries or even physical damage in a longer term, as pointed by some participants. Besides, participants also referred to the monotonous nature of the airside tasks. For instance, P7 expressed the following about the bus driving tasks: *"Younger people are not willing to go on a bus on airside, because if you're here for [an] eight-hour shift, they drive a maximum of 50km, so it is worthless. You're not a bus driver."* Finally, some participants also pointed at the working space itself, noting that the airside can be noisy and either very cold or warm, depending on the season. Moreover, baggage halls are usually *"noisy", "damp", "dark"*, and illuminated solely by *"artificial lighting"*. *"It is not a very pleasant working environment"*, as P3 noted.

P4 suggested that people no longer want to do the kind of work that the airside requires. Related to that, many of the participants referred to the difficulties that they are having for recruiting personnel: *"as you know, employees are very hard to get"* (P2); *"there are not enough people anymore,"* (P3); *"there are too less drivers"* (P7). Additionally, P7 pointed that the post-Covid environment has intensified this phenomenon, since the personnel terminated during the Covid pandemic found alternative jobs that involve less physical strain.

Apart from that, some participants mentioned that the strict airside conditions lead to a lengthy onboarding process, which adds to the difficulty of incorporating new staff. This is the case not only because of the long training procedures workers must undergo (see quote below this paragraph), but also because of the numerous security clearances that are required from personnel for airside access, which further extend the overall recruitment process.

> *"So it's quite hard to get staff, especially for certain functions. And even if you get them, it takes quite a while until you onboard them. So if you have gate planners, it takes quite a while to be gateman; I think [you need] to take 6 to 9 months of training before you can run your own shift."* (P10)

To address those issues, the snow fleet service sources voluntary drivers from various airport departments (e.g., office workers). Participants explained that this volunteer-based work arrangement is possible because, in their particular context, snow days only occur two or three times a year; plus, it helps ensure that there will be available personnel to handle snow operations whenever the meteorologic conditions require it. Yet, P5 pointed that this set up still requires many training hours to be conducted, which are not proportional to the service hours that the volunteers finally perform; to this point, P2 added that *"Training with the current vehicles means emissions. So, the less you have to train, the better it is for the environment."*

> *"With the snow fleet it's more of a thing that we today have voluntarily people, doing this service. And there is a lot of 'animo' (...) to carry out the snow fleet organization because it's fun, you sit on a truck in the winter, you feel really part of the operations. But these people, they sit maybe on this truck, maybe for ten hours a year. So each year we have to do a training."* (P5)

Overall, participants often repeated that *"we are too dependent on people"* (P5). Similarly, terms like *"human dependence"* were often mentioned as a characteristic of the airports' airside operations, to highlight the need and heavy reliance on workers for these activities.

5.2 Conceiving Automation, Attitudes towards its Capabilities and its Limitations

Autonomous airside operations are not only motivated by the pressing issues that the airport is currently facing (Section 5.1), but also by the additional benefits that are associated with automation.

During the interviews, participants explained what automation is in their understanding, its capabilities, the rationale behind the different solutions they are currently working on, or the fears and challenges that the technology might pose due to its limitations, which reflect their conceptions of automation.

We asked participants to provide a definition of automation, based on their own understanding and experience. Most of them agreed on the fact that machines, with some degree of self-sufficiency or self-regulation, would take over tasks that previously relied on human operators. However, there were also some nuances in the answers given, mainly regarding two elements: 1) the intelligence of the autonomous assets, and 2) the degree of human involvement that the systems would require.

First, while some participants described automation quite closely to mechanization, others included intelligence traits to define the concept. For instance, P5 mentioned that there would be *"a machine doing the thinking for us,"* or P3 explained, *"In my opinion, it's more automated as the machine makes his own decision"* which, they elaborated, was enabled by *"artificial intelligence and cameras"*.

Second, participants' responses reflected varying levels of human involvement in automation. Some considered a solution to be 'automation' if it simply *"makes our work more efficient"* (P1), while others emphasized that automation should reduce human involvement. A few noted that automation could eliminate the need for humans to be physically present on-site, and finally, some participants only recognized automation as such if it completely removed the need for human intervention, or as P14 noted, if the process *"can be just be done by itself."*

> *"The system should be able to keep itself up during operation. So, whenever something happens, (...) that the system itself will find a way to do with that."* (P4)

Finally, note that participants occasionally mentioned other characteristics of automation, such as the quality, evolution, or maturity of current solutions. They observed that these solutions are highly dependent on, and limited by, market evolution: *"the self-driving baggage truck, we had high expectations, whereas I think we're currently also in the market, still improving technology,"* (P10). Besides, some of them clarified that their understanding of automation elements extends beyond hardware, highlighting the importance of intelligence-related elements such as *"sensors"* and *"camera tooling"*.

5.3 Imagining the Role of Humans in Autonomous Operations

Participants reflected on the future of airside work, anticipating the effect of the automated operations they are developing. Specifically, they described necessary human operator roles at different project stages: 1) temporary human roles required during automation development, and 2) human roles needed once automation is implemented, envisioned as the end goal.

5.3.1 Human roles during the development phase. The development phase refers to the project stages where previously selected supplier solutions are brought into the airside for on-site testing. The suitability and feasibility of the products are tested under different experimental conditions. As such, this stage is characterized by high safety considerations and an iterative mindset, where emerging technical problems are fixed.

Participants described the role of *"safety operators"*; their function is twofold, 1) to safely initiate autonomous operations by checking their environment or approving the information detected by the systems, and 2) to press the deadman switch in case a takeover or stop would be needed. These functions aim to ensure safe operations during automation development phases and address potential liability issues.

Our participants noted that the required human skills for such a role already differ from those needed in manual operations. Ralated to that, in the autonomous bus project, they initially tried to have current bus drivers as safety operators, with no success:

> *"They're older people from about 60-65 years old, that drive in those vehicles. The only thing you have to do is press the start button if there's something dangerous going on. And they want to drive it like a normal bus. They didn't get used to it. So we have to stop that project with them ."* (P7)

As mentioned earlier, the *"safety operator"* roles are seen as *"temporary operator positions"* (P4). Participants expect not to need them anymore once the maturity and integration of an autonomous process are complete: *"If the system proofs itself so reliable that those people don't need to be there anymore physically, then we will ask the people to do other jobs"* (P14).

5.3.2 Envisioned human roles after the implementation of automation. Participants envisioned tasks that human workers would need to carry out in future autonomous operations; based on those tasks, we could distinguish three main roles for humans: 1) monitoring roles, 2) supporting roles, and 3) hosting roles.

First, monitoring roles would be required to control the performance of autonomous assets real-time. Their main function is to ensure safe operations and to cover possible liability issues, described by P12 as *"an extra set of eyes"*. Some participants mentioned that they would be in charge of deciding if a process is *"good to go"*, whereas others described cases where the operator would be *"on the button"*, meaning that they would be able to stop a process if required by any extraordinary circumstances. Finally, P12 raised a concern regarding these monitoring tasks, stating that a moment could arrive when operators *"get too comfortable"* or *"rely too much on the technology to do their work for them"*, increasing the risk of ignoring potential malfunctions.

Second, concerning supporting roles, operators would *"step in"* or *"troubleshoot"* a system when, *"by exception"*, it cannot self-govern anymore, or it failed in the execution of its task. For instance, P4 envisioned operators *"topping up containers because they're not full enough"*. Or P11 mentioned *"if it's not correct, the operator of the VDGS should put in the correct airplane type"*. They emphasized that operators would have a managing role rather than one that is fully engaged in the operation, and that their tasks would mostly be devoted to operations that are hard to solve technically. For example, in the snow fleet project, operators are expected to transport the fleet to the airfield, where it could then automatically conduct snow removal. Finally, some participants mentioned that maintenance tasks would also be carried by dedicated operators once the assets are autonomous: *"you're probably gonna need one person who is dedicated to look after the robot mowers... Five times a week, maybe. You don't have that with the conventional methods right now"* (P1).

When envisioning these two roles (i.e., monitoring and supporting roles), our participants often talked about a *"remote control room"*. They referred to a central, office-like room that would be located in the terminal, where operators would sit and be able to monitor and operate automated airside processes. As such, the room would have screens displaying airside video feeds, joysticks to control the assets, and alarms to alert operators about malfunctions. As a benefit of having this room, P12 explained that it *"could limit the amount of people you need for the same job",* since it would allow operators to go from one asset to the other faster.

> *"We're going to have some kind of control room with a couple of men and women who's operating the bridge, so they will have to say,* "okay, everything's clear, you can connect now." *And if there is a failure, they have to connect the PBB [Passenger Boarding Bridge] by hand, from the remote controlled area."* (P11)

Third and lastly, hosting roles would be dedicated to welcoming passengers and catering to them. Unlike the prior two roles, which were dedicated to supporting and ensuring safe autonomous operations, this one is enabled by automation itself; participants envision an autonomous airside where operators' time is freed up and can be devoted to improving passenger experience.

Regarding the job requirements, our participants indicated that, ideally, these jobs require little prior knowledge and could be done by anyone; P12 mentioned that, as a consequence, *"you don't need job specific operators. Which is, of course, beneficial for airlines and the handlers."* Still, they mentioned that operators would need to be *"tech savvy"*, *"they need to understand the dynamics of what an autonomous system does"* (P5), and thus, they envision a change in their hiring profile. All in all, in participants' views, automation will bring more time to focus on other tasks, resulting in staff being required to do less, especially by eliminating recurring tasks and by helping them execute tasks more efficiently.

Finally, participants also mentioned some processes which in their opinion will still be manual in the future. They argued that processes that would have a high impact on safety if they were automated, or which are technically challenging to automate, would still require human operators. For instance, this is the case of the fueling task:

> *"I think some processes they're a bit more challenged because they can have quite a lot of impact. So for instance, "fueling", especially with safety. I think it's quite difficult for people to change how it works currently, because now if you put [an] operator who fuels the aircraft, then you have someone who's responsible. But if you don't have an operator, who will be responsible."* (P10)

5.4 Imagining Automation in the Airside Ecosystem

Descriptions of the specific airport context where automation is expected to operate were frequently mentioned in the interviews. Participants highlighted that the complexity of 1) the highly regulated environment, and 2) the multi-stakeholder setting around the airside could obstruct the implementation of automation.

5.4.1 The airside as a highly regulated, complex environment. The airside was depicted both as a *sensitive* environment, a specific *safety critical* area within the airport that has *"zero tolerance for mistakes"* (P5), and a *highly regulated*, operational environment. First, the sensitive nature of the environment is characterized by the *sensitive areas,* where *sensitive equipment* is placed (for instance, equipment required to support the landing and take-off of airplanes), and some *no-go zones*, where staff and external equipment are banned to ensure safety. Thus, the airside has restricted access, with authorization needed to let equipment or humans in. Second, interviews presented the airside as an operational environment that has its own operation rules:

> *"It will meet a lot of other traffic like luggage trolleys, or service cars (...) also has to recognize* "is it an airplane?" *Because an airplane has always priority,* "or is it a bus? Or is it just any other vehicle?" *And you have to have priority rules, and that constantly has to be managed."* (P2)

The highly regulated nature of the airside environment is seen as favorable for automation, since processes are easier to automatize in standardized environments, in participants' view (*"especially in aviation, it's quite strict, then it should be relatively easy to automate"*, P12). Therefore, many of them mentioned that automation would be easiest to achieve in predictable and isolated processes that do not interact with other manual traffic, like, for instance, snow management. Participants advocate for starting the autonomous airside initiative in those kind of *"easier"* processes.

> *"The bus is harder to automatize... (...) There's much more traffic, from everywhere, people walking around, cars driving around. And when we got an autonomous snow fleet then it's a restricted area, that nobody's in there. So I think it's easier. It's just a straight ride straight way, turn around and go back."* (P15)

However, connected to these perceptions, participants also experienced or foresee challenges for integrating automation in the airside context. Airside safety is the most important priority for automation projects, and thus, participants explained that they usually include *extra safety measures* in the systems that they build. For instance, in response to the question asking for the rationale for double GPS, P1 responded:

> *"It's nothing more than extra safety measurements you probably want to have on an highly risk area, like an airfield. [...] So that you really make sure that the system is hundred percent or 99.9999 safe, that a robot lawnmower won't go end up in the middle of the runway."* (P1)

Besides, it *"takes a lot of time just to get it started and get approval to do a proof of concept in airside"* (P14), due to the required *"permits"*, *"procedures"*, and *"steps"* that are needed to bring equipment in; those were perceived as many, unknown, and changing over time. Participants also mentioned that external operators usually need to be guided in the airside since they do not posses the documentation or clearance to *"solitary drive on airside"* (P1). Regarding testing phases, ideas related to placing their prototypes near or far from the sensitive areas emerged; while some participants preferred to have their equipment tested near sensitive environments, others suggested that alternative test fields could be used to avoid the struggles that the highly regulated and operational nature of the airside entails.

Finally, timely planning is also challenging; the operational environment of the airport requires our participants to inform airport authorities in advance about their upcoming development and testing plans, since the areas, stands or roads that can be taken out of commissioning are very limited, which requires careful and long-term arrangements:

> *"This product is built on passenger boarding bridges, which are crucial for the operations, so either we have to join projects that are already taking a stand out of commissioning, or we have to get that same stand and make it unservicable for the time being. So that means Operations has one less stands to work with and at Schiphol Airport we already don't have an abundance of stands available during the day."* (P12)

Participants mentioned other airports and contexts as inspiration sources for automation. They often try to translate solutions from these environments to their own. However, they argued that this is not as simple; other airports have different site *lengths*, *fields*, *climate*, number of flights, airside rules, worker and organizational cultures, etc. Furthermore, they admitted that the unique characteristics of the airport context make it even more challenging to implement external automation solutions:

> *"Material handling warehouses in where spaces are usually (...) a lot more clean than what we see here in airports. Airports are dusty... baggage systems are quite rough. You often see bag parts in the baggage hall, you see baggage labels. We're working [in] a very dirty space, 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."* (P4)

Participants reflected on the infrastructure fit of automation implementations. On the one hand, while greenfield innovations (i.e., systems built from scratch) seem promising, they are usually quite hard to initiate in such an operational context. Thus, this approach is limited to the construction of new infrastructure or to big renovations that allow for a *"huge innovation leap"* (P4). On the other hand, concerns about brownfield implementations (i.e., built upon existing projects or spaces) include fitting new equipment into the dimensions of existing airport infrastructure, connecting the new assets to the airport's IT systems, and the interaction of autonomous assets with existing airside traffic.

Finally, some participants shared that equipment renewal should be done *"gradually"*, *"step by step"*, and by *"phasing out"* some of the current assets (*"we should not do for sure an all in implementation, (...) but you should build in phases, like for example, each year we try to take from the 80 buses that we have today, we disengage maybe five of them."*, P5). This is the case not only because of the commercial and operational commitment of the airport or the need to gradually *"experience the bottlenecks that come along with this change"* (P5), but also because assets are bought with a certain service life in mind. As such, the availability to buy autonomous equipment for a given process will be highly dependant on when the current machinery for that process was bought. For instance, about the bus operation, P7 specified: *"This [electric, not-autonomous] buses, they are here by now. We buy them for 15 years. That means, that the next 15 years, we do not have autonomic busses on airside, unless we sell these and we buy other ones back."* Related to equipment service life, the temporality of automated systems needs consideration as technologies in airport contexts are not updated often.

5.4.2 Developing automation in a multi-stakeholder ecosystem. Following the depiction of the airside as a complex yet highly standardized environment, participants reflected on the surrounding stakeholder ecosystem, which they unanimously described as *"multi-stakeholder"*. The airport is the owner of the infrastructure, yet, the provision of the services mainly lies with the airlines and handlers, and additional third parties and authorities are responsible for the supporting processes (i.e., maintenance contractors, air traffic authority, border police,...) or for the provision of new technological solutions (i.e., technology suppliers). The following two quotations aim to illustrate this:

> *"As a main contractor, we are hired to maintain the assets on airside for Amsterdam Airport Schiphol. So, Schiphol is still the asset owner. Think of the asphalt the planes land on, but also the cables in the ground that feed the lights to make sure that the plane can land safely."* (P16)

> *"Yeah, it's activity of the handler. So many different handlers can operate one Passenger Boarding Bridge. We've got about 1500 people who are licensed to operate."* (P11)

According to participants' experience, this intertwined stakeholder relations closely define how automation projects are conceptualized and developed. Projects are usually initiated by the airport in its more strategic departments, yet, professionals from many different departments (e.g., the operations department, asset management, etc.) and third parties need to collaborate as part of a same working group. For instance, the airport usually collaborates closely with external suppliers: *"So it is basically a partnership. We developed a system together with two other companies"*, to *"develop the product to a standard that we like"*, (P12).

Our participants perceive that the different roles, responsibilities, priorities, *"different opinions, (...) different goals, or KPI's"* (P1) among the involved stakeholders challenge the consensus around the conception and development of automation. Usually, stakeholder management, *"to get them on board or to get them enthusiastic and willing to participate takes a lot of energy"* (P1) from them. For instance, this was relevant during some experiments that required approval from air traffic authorities and delays occurred. In some cases, differences in culture, *"way of working,"* and *"efforts to steer them in a direction that you want"* (P12) made it hard to work with third parties.

> *"Probably the biggest stakeholder, that's air traffic control. (...) They don't see the problems we face, because* "Oh, the grass is mowed every couple of weeks. We need to take a runway out of service, but yeah, it works and it works for years now." *And, they don't have the same goals as at Schiphol Airport, for example, sustainability goals."* (P1)

As such, they mentioned that a robust strategy is needed where *the point of view*, *vision*, *desires*, and *wants* of all the parties are considered, by giving *"a seat in the table"* (P5) to every stakeholder. In relation to that, P5 explained, by using the autonomous bus project as an example, that the late involvement air traffic authorities caused blockage:

> *"They [the air traffic authority] have been involved too late. When we already made the decision, they felt pressured, because we were already wanting to do the implementation, while they wanted to see the business case. Like how can it help [them] to coordinate two extra vehicles on the airside without interference with planes passing by, because it's them that is responsible for the movement on the ground and we are not. So, because we approached them too late, they were like.* "Yeah, it's nice that you want to implement this, but you should have started way before because it concerns us as well." (P5)

Overall, our participants noted reluctance to change among internal and external stakeholders, which they had to address to advance their automation projects. First, participants argued that many stakeholders within the organization see automation as a *"risk"*, and thus *"are scared"*, *"afraid"* or hesitate. Participants argued that automation must be reliable for people to trust it, so they conduct tests that will prove the solutions' safety. Additionally, showcasing automated solutions through videos or on-site displays helped build confidence in the technology: *"I have to convince everybody every time that it's a good product, that it's reliable, that it's safe. They have to see with their own eyes."* P7. Second, participants often described the airport ecosystem as *"conservative"*, an organization that is not *"keen on implementing a lot of change"* in processes that already work, nor an early adopter of new technology when there is risk involved. Airport contexts are known to be conservative, as shown in prior scholarly work [46, 88]. As such, participants have difficulties in having their automation proposals accepted in the wider organization, as well as in getting the approval from other stakeholders, which, when happened, is described as a successful achievement after a *"convincing"* act.

> *"Nothing really happened yet so far, like a mower that escaped or something. But, I get the feeling that people kind of are scared. And as it comes down to the safety of people, like airplane safety, people get really alert, and it doesn't really help if you close the door right away, instead of meeting at the table and create that atmosphere where you can experience kind of those situations."* (P16)

6 Discussion

The primary goal of this article was to scrutinize the imaginaries of automation shared by practitioners responsible for implementing autonomous airside operations at Amsterdam Airport Schiphol, who face various challenges related to its adoption. Our empirical results provide insights into their collective understanding and development efforts in automation projects, while also illustrate the organizational dynamics and complexities surrounding automation adoption.

In this section, we discuss the nuanced aspects and implications of the captured imaginaries, that should be considered in the design, deployment, and evaluation of automation to support a human-centered approach to its adoption within organizations. We specifically provide recommendations under three main themes: techno-solutionism in airside operations (6.1); poor definition of human roles in automated processes (6.2); and the lack of consideration of the airside context in the design of automation (6.3).

6.1 The Risk of Techno-solutionism in Autonomous Airside Operations

Participants ground the need for automation in the major issues that the airside is currently facing; they envision potential benefits of the technology (i.e., efficiency, precision, quality of automated operations, opportunity to replace human workers with machines) as a solution to the problems they formulate in the airside context (i.e., limited capacity, employee availability, working conditions). This could be associated with the *"Deus ex machina"* perception of AI that Mlynar et al. [59] present in their paper; the concept refers to a machine or character (in their case, AI) that is expected to resolve a tragic plot with enormous effects. Gamkrelidze et al. [31] similarly talk about *"technological-solutionism"* [61] in the context of AI systems for radiology practice, *"in the quest for solutions to complex socio-organizational problems, AI is often presented as a quick fix that can save time, increase efficiency, and help workers cope with deteriorating conditions"* (p. 12), where the technology is expected to solve *"everything"*. Besides, Baur and Iles [11] noted that often times these narratives are amplified by technology suppliers, who use techno-optimistic rhetoric to push their commercial offers into their clients' workplaces.

Beyond the overly positive perspectives that regard automation as an ideal solution, the way problems are formulated could also be a crucial aspect to consider. Prior literature calls for scrutinizing the process by which problems are defined [27, 53, 71, 83], arguing, for instance, that problems are not static or given, but rather, are created and continually recomposed [53], entailing difficult translations from business objectives to technical questions [71], and reflecting specific values and assumptions [71]. Specifically, Lyles and Mitroff [54] conducted an exploratory study of the process of problem formulation and influencing factors in organizations, where, among other results, they concluded that most problems managers discussed were ill-defined, complex, and strategic rather than well-defined, and that managers typically became aware of problems through informal signals (e.g., intuition, casual conversations) rather than formal indicators (like financial reports).

Therefore, we argue that the current approaches to problem framing and solution finding might be problematic for Amsterdam

Airport Schiphol; they might promote ill-conceived technology-centric automation pathways which divert the attention from the root causes of the issues the organization is facing [11, 31]. As such, the airport may fall into costly, supplier-dependent automation processes that fail to solve the capacity and employee-related issues the airside is suffering from entirely (since those are issues that technology alone cannot solve). Additionally, it might also create unknown and unconsidered new problems as a consequence of their implementation (e.g., how to coordinate a fleet of baggage robots in high-demand moments?).

As an alternative, we recommend considering other approaches to automation that might be more suitable for the airside context we study. For instance, Gamkrelidze et al. [31] highlight the need to design systems and work organizations jointly, rather than having organizational aspects follow technological solutions. This goes in line with the sociomaterial perspectives and their claim that, in organizations, there is an inherent inseparability and co-constitutive relation between the material and the social spheres [67, 69]. Such an approach would, for instance, help address issues related to airside working conditions by not only considering how technologies should be designed but also by proposing new work arrangements. As such, we consider suitable the instrumental approach to AI that Verma et al. [90] propose, since the technology is seen as a "means to an end"; such an approach would help Amsterdam Airport Schiphol clarify the expectations that are set in the technology. Apart from that, Yang et al. [93] propose the notion of *unremarkable AI*, based on Tolmie et al. [87]'s *Unremarkable Computing* notion, and argue that by augmenting their routines, AI can have significant importance for the users and still remain unobtrusive. We argue that airside automation can remain unobtrusive if implemented within current systems and designed to augment human workers, rather than striving for full automation with a primary focus on technology.

6.2 Poor Consideration and Definition of Human Roles in Autonomous Airside Processes

The interviews revealed that the motivation for automation is driven by the vision of reducing the *"human dependency"* of airside operations; participants described a problem space where hiring new personnel is very challenging, the working conditions in the airside are not desirable, and capacity issues are linked to human error and expertise. A human-less future is craved for the airside. Participants conceive automation as an enabler of this future, expecting machines to perform current operations independently, replace human operators, and outperform them. These are common misconceptions of automation, as described in prior work [2, 8, 13, 14, 37]. First, human labor and involvement in automation continues beyond its design and development in supervision, maintenance, commanding, or repair activities [13, 22, 63]. As such, human involvement is often opaque and distributed [13]. Second, it is too simplistic to assume that automated solutions can replace human workers on a one-to-one basis. As Akridge et al. [2] illustrate in their study of bus operators, human labor exceeds the capacity of automation technologies: *"Even on fixed bus routes, bus operators regularly described confronting unexpected circumstances, both in navigating the road and managing the social environment of the bus"* (p. 2). As such, the authors emphasize the need to make human labor visible, to understand what aspects may be lost if an overly reductionist approach to automation is applied. These two points coincide with two of the "7 deadly myths of autonomous systems" that Bradshaw et al. [14] point at, namely with Myth 5 (i.e., *"Once achieved, full autonomy obviates the need for human-machine collaboration"*) and Myth 6 (i.e., *"As machines acquire more autonomy, they will work as simple substitutes (or multipliers) of human capability."*)

The concept of "safety operator" emerged quite often in the interviews. Participants described this role as the one ensuring clearance for the initiation of an autonomous process, or being liable for taking over in case of malfunctions or anomalies. They also pointed to monitoring roles, which represented similar functions. In prior literature, a common worry related to keeping operators in the loop of autonomous systems is that overseeing an automated system that could function more accurately and more reliably than the operator could, can affect system performance in the event that operator intervention is needed. This was first framed by Bainbridge [8] and remains unresolved 30 years later [12, 84], related to issues such as the difficulty of monitoring automated technology real-time or automation-related skill degradation. Further, Chu et al. [19] studied the lived experiences of safety operators engaged in developing autonomous vehicles. They describe safety drivers as operators that need to work with *"non-perfect AV in high-risk real-world traffic environments"* such that they are forced to take risks accumulated from the AV industry upstream and are also confronting restricted self-development in working for AV development. Based on that, the authors highlighted the need to improve workers' experiences and suggested guidelines such as mental model calibration or involving safety drivers into human-centered AI research as potential contributors to this goal.

The participants of our study also described *supporting roles* among the human roles that will be necessary for future automated processes. Operators were expected to step in when autonomous assets failed during a process, or to support parts of the processes that are still technically difficult to solve. Fox et al. [29] named this type of work as "patchwork", *"human labor that occurs in the space between what AI purports to do and what it actually accomplishes"* (p. 1). As they explain, human operators are often tasked with smoothing the relationship between autonomous assets and their organizational, social, and material environments; as such, they perform complex acts of integration, troubleshooting, compensation, and improvisation, that lead to new forms of labor that require increased attention and responsibility. They claim these jobs fall short of the "upskilling" often promised by automation. Similarly, other authors argue against this approach to automation and human work. Boeva et al. [13] alert us to precarious conditions in which workers *"fill gaps that computer technologies lack skills and sensibility for, are too expensive, and still unreliable"*, highlighting their mental health risks. Similarly, Baur and Iles [11] shows that the promised liberation of workers through automation is inconsistent, since manufacturers acknowledge the persistent need for human operators to be on stand-by to handle unexpected hiccups or machinery breakdowns. Finally, Akridge et al. [2] highlight that automation tends to produce new burdens for workers, often in the form of *"invisible work"*, a term that was brought by Star and Strauss

[82] and Suchman [85]. As such, they claim that when worker voice is not included in the design and development of the solutions, they suffer *"articulating the distance between the full range of circumstances they face and technologies built with a more limited range of circumstances in mind"* (p.4).

Overall, we recommend that recognizing the continued existence of human roles in automated systems is the first step toward more successful automation adoption. While not being a novel conclusion, it has been surprising to observe how widespread misconceptions about automation are, even in an environment that is considered at the forefront of automation innovation. Besides, it is necessary to define human roles in detail, through worker-centered perspectives [28] that, beyond the technical feasibility of the systems, consider other essential aspects such as worker well-being or building up engaging user experiences [9, 77] and *repair* the imbalances that the introduction of the technology might cause [25]. In that regard, Akridge et al. [2] calls for participatory research that involves operators early in the design process of new technologies. We consider that HCI could add great value to these challenges, as it is able to understand such complex worker contexts and needs and to mobilize them to shape automated systems.

6.3 Lack of Stakeholder Collaboration and Consideration of the Airside Environment in Automation Design

Participants reflected on the airside as a context for automation; they initially viewed it as a very suitable environment for automation, but later experiences revealed that its unique challenges made it difficult to apply solutions from other automated contexts. This goes in line with the *"poor contextual fit"* issue diagnosed by Yang et al. [93]; the lack of consideration of the procedures, workflows, and particularities for a context causes failure in the migration of solutions. It is also aligned with the *contextual* dimension (along with *collaborative*, *conscious*, and *controlled*) of the social imaginaries Mlynar et al. [59] identified following their interviews with urban experts. This dimension emphasizes the contextual grounding of the technological developments, i.e., designed with local knowledge and to support local practices. Their work focuses on urban AI, but they suggest the outcomes may apply to other contexts as well. As they explain, AI requires "human beings and their knowledge of the local context, setting, culture, terminology, and workplace practices". Other works make similar premises in what they call *"situatedness"* of digital innovation [34] or *"locally specific"* work practices [91]. From the interviews, we draw several implications for the design of future automated airside systems. For instance, the on-site testing of automated solutions is highly affected by the operational airport environment and the procedures that must be followed. Future projects should consider these restrictions from the start. Besides, alternative test fields could be used for some of the experiments, to avoid having to access the airside unnecessarily. Finally, the airport's particularities should be taken into account as requirements for suppliers; as noted by Fox et al. [29], in highly complex organizations technologies have to be *adapted* to particular sites and routines.

Participants also provided insights into the multi-stakeholder airside ecosystem. They often highlighted that the different roles, responsibilities, authority, priorities, or goals of the involved stakeholders challenged consensus on the conception of automation and that these disparities slowed development paths [32]. Recent work has addressed the complexity of designing and deploying automated solutions and AI in multi-stakeholder contexts. For instance, Mlynar et al. [59] describe the collaborative nature of AI, emphasizing the necessity of democratic processes for human collective participation in producing AI outcomes. In healthcare, Verma et al. [91] also see this as a requirement for research on human-AI collaboration. Nevertheless, we argue that our particular context is not, per se, a democratic one, and that further alignment might be needed with the current hierarchies, organizational structures and dynamics. Related to those organizational hierarchies, Elish and Watkins [25] explains that the introduction of new technologies such as AI not only creates new pathways to achieve a goal but also upsets existing power hierarchies. In that regard, the automation of airside processes may threaten current power dynamics among stakeholders, leading to resistance if affected stakeholders' opinions are excluded from system design or if *"organizational politics"* [34] are ignored. How can HCI support a shared automation ownership and help bridge the challenges in this regard? In prior work, Kim et al. [45] highlights the need for a stakeholder-centered taxonomy for automated vehicles that incorporates their perspectives and requirements; similarly, Kawakami et al. [41] created a guidebook to support effective multi-stakeholder decision-making in early-stage public AI projects. Thus, all affected stakeholders should be included early enough and efforts to automate a process should not be one-sided but rather collaborative. Shared ownership is required for automation projects to succeed in such a multi-stakeholder ecosystem. We consider HCI relevant here since it should be able to foster such synergies, question and disentangle the power shifts created by automation, and create collaboration paths accordingly through collaborative and critical approaches.

In conclusion, our findings suggest that if the dynamics, rules, relations, and intricacies of the context are not considered, automation initiatives are prone to fail in the airside context.

6.4 Limitations and Future Work

There are some limitations to acknowledge in our work, which should be taken into account when conducting future studies, mainly regarding the representativeness of the results found.

First, while the objective of the study was intentionally set on a single case, Amsterdam Airport Schiphol, an international airport in Western Europe, this choice might limit the generalizability of the insights found. As such, we propose that further studies may replicate the method used in alternative contexts, to compare the results with the ones we got here. Still, an in-depth, elaborate picture of a single airport is beneficial in that it allows for the understanding of the intricacies of the context, which are especially relevant when studying imaginaries and automation adoption. We argue that, although context-specific cultural, organizational, and regulatory frameworks may shape social imaginaries (and automation implementation), the implications of our findings could still be relevant to other airports. Overall, the paper provides airports with a means to critically reflect on their own automation endeavors and pathways.

Second, in that same line, regarding the choice of *social imaginaries* as a methodological lens, the studied collective visions belong to a single social group within the airport (i.e., practitioners in charge of automation). This was a conscious decision, since we wanted to understand the specific point of view, approaches, and experiences of practitioners. However, we urge further automation research to inquire and include airside workers too. We not only consider their perspectives crucial for a responsible automation transition, but also view them as an essential category within the relevant social groups that influence the social construction of technology [36, 75].

For future work, our study highlights several important questions that merit attention. On the one hand, alternative conceptions of automation should be explored further, to insert them in pathways that will avoid techno-solutionist conceptions of the technology by practitioners and other relevant stakeholders. On the other hand, collaborative ways to integrate different views and motivations towards automation should be investigated, to allow the integration and ownership of the different stakeholders involved in airports in particular and in organizations in general. Finally, our research highlights the urge to define human roles in automated systems in detail, as well as to do that by including workers in the design and development processes.

7 Conclusion

In a time when organizations are aiming to implement automation into their work processes, the aspiration of this paper has been to explore practitioners' perspectives and approaches to automation in a particular context: the airside of Amsterdam Airport Schiphol (The Netherlands). Specifically, we focused our inquiry on illustrating the organizational dynamics and complexities surrounding automation adoption, based on the collective understandings of the practitioners who are in charge of implementing the technology. In that aim, we used *social imaginaries* as a lens to guide our inquiry. Our findings reveal practitioners' problem formulation on the airside, their attitudes toward the capabilities and the limitations of the technology, their visions for the future of work in autonomous airside operations, and expectations for the integration of automation into the airport ecosystem. Based on those empirical results, we provide recommendations that should be considered in the design, deployment, and evaluation of automation in the future, which we discuss under three main themes: techno-solutionism in airside operations; poor definition of human roles in automated processes; and the lack of consideration of the airside context in the design of automation. Ultimately, those recommendations should support efforts towards a human-centered automation adoption in organizations.

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